PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY

OF LONDON.

NOVEMBER 1833 TO JUNE 1838.

VOL. II.

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CORRIGENDA.

Page 13,	Table, last column, (No. 34.) *f.*	*for*	Marrington Dingle, *read* Mary Knoll Dingle
	g.	—	Prescold *read* Prescoed
	k.	—	Corton *read* Corston
			Dele the comma after Castell Craig
—— 24,	line 25	*for*	Bailey *read* Bayly
—— 53,	— 14 and note *	—	Ovelipore *read* Oudeypore
—— 146,	— 7 from bottom	—	1784 *read* 1824
—— 147,	— 9	—	Hardy *read* Hardie
—— 149,	— 6 from bottom	—	outline *read* outlier
—— 161,	— 19	—	medal *read* Proceeds
—— 162,	— 30	—	Wallickii *read* Wallichii
—— 171,	— 18 from bottom	—	shisti *read* schisti
—— 196,	bottom line	—	white *read* while
—— 210,	line 16	—	F. Darwin *read* C. Darwin
—— 221,	note	—	No. 41, vol. ii. p. 191. *read* No. 36, vol. ii. p. 83.
—— 416,	line 21 }	—	Hunter *read* Hunton
—— 417,	— 10 & 22 }		
—— 450,	— 10 from bottom	—	Plaistic *read* Plastic
—— 530,	— 21	—	Walton Naze *read* Harwich Barracks Cliff
—— 535,	— 3	—	breaches *read* beaches
—— 537,	— 8 from bottom	—	rocks and *read* rocky

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. • 1833—1834. No. 33.

Nov. 6.—THE Society assembled this evening for the Session.

John Ward, Esq. of Holwood, Bromley; John F. South, Esq., St. Thomas's-street, Southwark; and Francis Walker, Esq. of Southgate, Middlesex, were elected Fellows of this Society.

A paper was first read "On a Band of Transition Limestone, and on Granite Veins, appearing in the Greywacké Slate of Westmoreland, near Shap Wells and Wastdale Head," by the Rev. Adam Sedgwick, V.P.G.S., and Woodwardian Professor in the University of Cambridge.

The author began by stating, that his communication was a short supplement to a former paper, in which he described the range of a band of transition limestone from the south-western extremity of Cumberland through a portion of Lancashire and Westmoreland. He there had stated that this limestone was cut off by the Shap granite, and did not reappear on the north side of it. During the past summer, however, he ascertained, by the help of some new artificial sections laid bare near Shap Wells, that the band of limestone does reappear, nearly in its original line of direction; and that it passes, along with the slate rocks, unconformably under the terrace of old red sandstone and mountain limestone. The phænomena are noticed in detail: and a mineral spring is described as rising among these beds, in near connexion with a protruded mass of porphyry.

The paper then describes some granite veins in the same neighbourhood, which rise from the central granite near the farm called Wastdale Head, and penetrate the grauwacké slate. Near the junction of the granite and slate, the latter puts on the character of the killas of Cornwall. The change extends to some distance, but gradually disappears, and the slate then returns to its common type, and contains organic remains. The author considers these facts as proving (in this instance) the posterior origin of the granite, and the protrusion of the granite veins into the preexisting slate rocks.

A paper was then read entitled "A Notice respecting some Points in the Section of the Coast near St. Leonard's and Hastings," by William Henry Fitton, M.D., V.P.G.S. &c.

The improvements in the neighbourhood of St. Leonard's which have rendered it necessary to cut down the face of the cliffs from Hastings to that place, have brought to light several portions of the strata, previously concealed. The object of the present paper is to describe some of these details; and a great part of it, consequently, is not susceptible of abridgement.

Several rocky ledges run out obliquely from the shore, both on the east and west of Hastings; these are analogous to the ledges which occur in the equivalent of the Hastings Sands, on the south coast of the Isle of Wight; and for the greater part consist of concretional grit, including especially fresh-water shells, of the genera Cyclas, Paludina, and Unio; others again are composed of a pisolitic sand-rock, inclosing numerous grains of reddish brown oxide of iron, which is found all along the shore from the Lover's Seat to the west of Bopeep. With the rocks above mentioned beds are found to alternate,—of sand-rock varying in colour and degrees of hardness, clay, and fuller's-earth. In proceeding westward from Hastings, the strata are observed to decline gradually towards the west as far as the gate of St. Leonard's; but at a very short distance beyond that point, they rise towards the west, and the same strata are found to recur, but in a reversed order. This appearance, which might at first be ascribed to some derangement, is produced, in fact, by a slight projection of the shore at the eastern point of the Marina at St. Leonard's, where the range of the beds coincides with the direction of the coast; the strata which come up from the sea at a small angle towards the interior, and are continued in the cliffs on the east and west, thus rising in different directions.

Among the strata which have recently been disclosed in the cliffs, a continuation of the remarkable group of the White-rock is one of the most conspicuous, and can be traced from its emergence in the sea under the White-rock to the cliff within the New Brewery. Beneath, at an interval of about 30 feet, the well-known bed of white sand-rock which forms the cliff of the Castle Hill at Hastings, rises on the shore, and being continued to the north-east, may be traced in the upper part of the East-cliff, and thence nearly to the summit of Fairlight Down.

The group of the White-rock contains a subordinate stratum, in which numerous specimens of *Endogenites erosa* have been found; and the large number of specimens exposed during the progress of the works, has brought to light some additional circumstances respecting this singular vegetable. The specimens, which were found lying horizontally, in a stratum composed of sand with alternate layers of clay, consist of two portions, perfectly distinct from each other: 1st, An external coating of lignite; within which is, 2ndly, A stony kernel or nucleus, the internal structure of which has been already described*. The general form of the whole appears to have been originally nearly cylindrical, and this has been modified by pressure, so that the transverse section both of the

* Geol. Trans., 2nd Series, vol. i. p. 423: and Mantell's Tilgate Fossils.

masses, and of the tubular cavities within, generally approaches to an oval figure. The specimens differ very much in size; being from less than one foot to nine feet in length; the stony matter within occupying, in the largest, about 5 feet, with a thickness of 6 to 9 inches, and a general width of about 1 foot. This stony nucleus was invested with a coating of coal, from $\frac{1}{10}$th to $\frac{1}{2}$ an inch in thickness, which was found to extend, at both extremities, 2 or 3 feet beyond the nucleus. The external surface of the coaly covering is uniform and smooth, of a light brown colour, and glistening: but neither in this surface, nor in the coal beneath, could any traces of organization be discovered. Thin polished slices of the nucleus were exhibited.

A ledge which is observable on the shore below St. Leonard's, may be traced thence in the cliffs, through the site of the church, and westward to the summit of the hill above the Sussex Hotel. In this group also, a specimen of Endogenites was found by Woodbine Parish, Esq.; by which and other circumstances it is identified with that of the White-rock ledge: and from its including also a thin band of siliceous conglomerate, abounding in the remains of animals like those of the well-known grit of Tilgate Forest,—the teeth and bones, especially, of the Iguanodon of Mantell,—there can be no doubt of its geological identity with some of the strata of that place.

The coast sections, described in this paper, will be useful in assisting to determine the order of succession in the Hastings Sands; a point of difficulty, from the great similarity, both in the rocks, and the included fossils, of the several members composing that formation: and the author thinks it deserving of inquiry, whether the Ashburnham group, which has hitherto been referred to the lower portion of the Hastings Sands, may not be identical with some of these groups upon the shore,—and, consequently, may not belong in reality to the upper part of the formation.

A letter was afterwards read from Woodbine Parish, Esq., addressed to George Bellas Greenough, Esq., P.G.S., accompanying a collection of fossils made by Mr. Parish during the last summer at St. Leonard's.

These fossils Mr. Parish states were principally found in a layer of very compact conglomerate varying from 1 inch to 3 inches in thickness, and forming a crust upon a stratum of sandstone which extends from the new church to the western extremity of St. Leonard's. They consist of remains of the Iguanodon, and other Saurians, and of the *Lepisosteus Fittonii.*

Mr. Parish also describes, in his letter, a submarine forest, which he traced at low water, from the western extremity of St. Leonard's to the headland at Bulverhithe, and he is of opinion that it is a continuation of the submarine forest which occurs off Hastings. The trees, he says, are chiefly oak, and appear to have fallen towards the sea.

In the peat forming part of the deposit he found hazel nuts, a variety of seeds, and the remains of beetles and other insects. No tradition has been preserved of the irruption of the sea by which the forest was submerged.

Nov. 20.—Joseph Burkart, Esq., Engineer of Zacatecas, Mexico, and John Kenyon, Esq., of Devonshire Place, were elected Fellows of this Society.

A paper was read entitled, "Notes on the Geology of the North Coast of the River and Gulf of St. Lawrence, from the Mouth of the Saguenay (Long. 69° 16′) to Cape Whittle (Long. 60°)," by Captain Bayfield, R.N., and communicated by George Bellas Greenough, Esq., P.G S.

The line of coast surveyed by the author, and described by him in this memoir, includes above 500 miles. It is traversed by ranges of round-backed hills, rarely exceeding 1000 feet in height, and towards the eastern termination of the district sinking nearly to a level with the sea. In some parts of the coast the hills approach close to the shore; but in others they recede to a distance from it, and the country presents a succession of flats or extensive peat bogs.

The formations of which the main land and adjacent islands consist, are granitic and syenitic compounds, limestone, a deposit of clay, sand and gravel, and modern alluvial accumulations.

The granitic and syenitic rocks compose the whole of the hilly districts, with the exception of a tract opposite the Mingan Islands. True granite was noticed only in one place, the prevailing rocks being formed of felspar, quartz, hypersthene and hornblende. Porphyry, passing into syenite, was observed at the falls of the Maniton river; and veins of trap were occasionally noticed traversing the syenite. Magnetic iron was found in great abundance along the whole line of the coast, either as a constituent of the rocks or as beds of sand accumulated on the beach.

The limestone forms the Mingan and Esquimaux Islands, and it occurs on the adjacent main land, reposing in horizontal beds on the syenite. It composes also the whole of the island of Anticosta, which lies to the southward of the Mingan Islands, as well as Cape Gaspé on the south shore of the St. Lawrence. It varies considerably in its characters, being sometimes compact, at others earthy, arenaceous, shaly, or crystalline; and it generally abounds in fossils, which agree with those found in the limestone of Lake Huron and near Quebec. The strata, except at Cape Gaspé, dip at a very low angle towards the S.W.

The deposit of clay, sand and gravel forms a series of horizontal strata, sometimes 300 feet thick, in the valleys and basins between the syenitic hills. The clay invariably occupies the lowest portion, and the gravel generally the highest. No shells were noticed, though the water-courses of the rivers cut through the deposit.

The modern alluvial accumulations are of great extent, and in some parts of the coast are rapidly increasing. In Outard Bay (100 fathoms deep) the surface of the water was highly charged with earthy matter, which the surveying vessel cut through in her course, and displayed beneath the pure sea water.

The peat bogs occur towards Cape Whittle, the eastern part of the district examined, and rest upon the syenite.

During his investigations, the author noticed many evidences of change having taken place in the relative level of land and water. He mentions, that in the Mingan Islands he traced a succession of shingle beaches, the most distant from the shore and covered with trees, being 60 feet above the level of the highest tides. In the Bay of the Seven Islands, and in almost every other bay, and at the entrance of the valleys near the sea, he observed parallel ridges of sand, sometimes attaining a height of 100 feet, and occasionally containing shells analogous to those now inhabiting the St. Lawrence. This change the author conceives has been produced, not by successive depressions of water, but by successive elevations of land; and he supports his opinion by showing, 1st, that no permanent depressions could have taken place in the water of the River and Gulf of St. Lawrence, without corresponding ones in the Atlantic; and 2ndly, that the beach now forming on the Mingan Islands presents the same characters as the beaches which he traced at a distance from the shore; that the water-worn pillars of limestone which accompany each beach, bear evidence of having been worn or scooped out at different periods, the successive action of the water agreeing in level with the successive ridges of limestone shingle; and he states that the distance between these marks of action of water on the limestone pillars, exactly agrees with the rise of the present tidal wave of the St. Lawrence. He also proves, by a minute description of the alluvial accumulations now forming on the shore of the main land, and a careful comparison of them with the parallel ridges of sand already mentioned, that an identity of character exists.

In conclusion, the author briefly refers to the geological structure of the south shore of the St. Lawrence, between the meridian of the Saguenay and Cape Gaspé, and states that it consists of alternating strata of slate and grauwacké, overlaid conformably, at the latter point, by limestone, containing fossils analogous to those of the Mingan Islands and Lake Huron.

Dec. 4.—Viscount Oxmantown, M.P.; Sir George Magrath, M.D., of Plymouth; Jones Quain, M.D., Professor of Anatomy and Physiology in the University of London; George Rushout, Esq., of the 1st Life Guards; Rev. Thomas Smith Turnbull, M.A., F.R.S., Caius College, Cambridge; C. H. Weston, Esq., B.A., of Trinity College, Cambridge, and Russell-square; John Waterhouse, Jun., Esq., of Halifax, Yorkshire; and Richard Hollier, Esq., of Marc Hill, Greenwich, were elected Fellows of the Society.

A letter from Hugh E. Strickland, Esq., addressed to George Bellas Greenough, Esq., was first read.

This letter was accompanied by a manuscript map, on which are laid down, with greater accuracy than had before been attempted, the boundaries of the red marl and lias in the districts adjacent to Pershore, Evesham, Bitford, Alcester, Droitwich and Worcester. Mr. Strickland points out, also for the first time, a line of fault ranging from a little north of Bredon Hill in Gloucestershire, to Inkberrow, north of the road from Alcester to Worcester. By this fault the relative position of the red marl and the lias has been affected, the former constituting a valley of elevation, bounded on each side by the latter. Mention is also made of bones and teeth of the Hippopotamus and of a Deer having been found in the gravel near Cropthorne, between Evesham and Pershore. Mr. Strickland likewise alludes to the occurrence, on Shotover Hill near Oxford, of fossils which he believes to belong to the fresh-water genus Paludina; but the specimens which he procured are imperfect casts. These shells, he adds, were first discovered by the Rev. H. Jelly of Bath, in a sand-pit on the brow of the hill, much higher than the pit at which the Portland strata occur.

A paper on the Strata of Quainton and Brill in Buckinghamshire, by James Mitchell, LL.D., F.G.S., was then read.

In this communication the author confines his observations almost solely to an enumeration of the beds belonging to the Portland stone, presented at the two localities of Quainton and Brill.

The principal quarries at the former place are composed of the following strata:

		Feet.
Top	Vegetable mould	3
	Clay	—?
	Iron sand (lower green sand) containing a layer of Fuller's earth	6 to 8
	Hard sandstone	1 to 2
	Clay	2
	Soft, calcareous sandstone (Pendle stone) abounding in fossils	2
	Building stone,—numerous fossils	2
	Soft, white limestone	2½
	Sand	6
	Rubble stone,—abundance of fossils	3
	Sand	6
	Coarse, soft, blue stone	1½

Besides the fossils common to the Portland stone, the author procured caudal vertebræ of a Plesiosaurus and a Crocodile.

The strata at Brill are then enumerated in the following order:

	Feet.
Vegetable mould	4
White, soft limestone, with fossils	7
Sand	3
Rubble, with fossils	4
Sand and clay, with nodules of blue stone in the lower part	8
Coarse, white sand	2
Blue clay	2

In the lower part of this quarry is an abundance of green sand.

The upper beds of stone in the Quainton quarries, the author adds, are wanting in those at Brill; and the lower beds at each locality are stated to be nearly the same, though not agreeing precisely in all their details.

A paper was next read, entitled "Observations on the Cliff at Reculver in Kent," by James Mitchell, LL.D., F.G.S.

The object of this paper is twofold: 1st, It describes the geological structure of the cliff; and 2nd, It gives a chronological account of the changes which have taken place on this part of the coast of Kent since the period of the Roman dominion.

The cliff, described in the memoir, is situated between Reculver and Herne Bay, and is about two miles in extent. The upper part, where the beds are fully displayed, consists of about 35 feet of mottled, brown and red clay; and the lower part of about 50 feet of sand, containing a layer of masses of sandstone. Fossils are stated to be found only in the sand, and to belong chiefly to a species of Venus. Sections are given of different parts of the cliff, and it is shown that the strata dip gradually towards the west, the sandy portion of the series sinking beneath the level of the shore, and being replaced entirely by the clay.

In tracing the history of the change on the line of the coast, the author first draws attention to the present hydrography of the bed of the Thames, and gives his reasons for concluding that many of the sand banks now dry at low water, were formerly islands; and in additional support of this opinion, mentions the large island which is laid down in Ptolemy's map in the position of the present Margate sands.

The author then states that historical documents, and inscriptions on altars, prove that Reculver, or Regulbium, was at the period of the Roman dominion a military station and a sea-port, and that the Isle of Thanet was at that æra separated from the rest of Kent by a navigable channel; that at the period of the Norman Conquest the district of Reculver was one of the hundreds of Kent, though it now forms only an obscure portion of the hundred of Bleangate; that in the reign of Henry VII. the channel between the Isle of Thanet and Reculver was so far filled up as to permit a bridge to be built,—but according to Leland, in the beginning of the reign of Henry VIII., Reculver was then half a mile from the sea, or, in proportion to other distances mentioned by him, about one mile; that in the year 1780, the wall of the Roman castrum, distant 80 yards from the church, had been only lately taken down; and lastly, that about the beginning of the present century, the church itself was abandoned as a place of worship, and would in all probability have long since disappeared, but for the precaution taken by the Trinity House to defend the cliff from further destruction.

Dec. 18.—Lieut.-Colonel Clive of the Grenadier Guards; Charles Denham Orlando Jephson, Esq., M.P., Mallow; Dr. MacDougle, of Duke-street, St. James's; and Charles Spicer, Esq., Royal Hospital, Chelsea, were elected Fellows of this Society.

A paper, entitled "Notes on the Geology of the Brown Clee Hill in Shropshire," by Rumley Wright, Esq., employed in the Ordnance Survey, was first read.

The base of the Brown Clee Hill is stated to consist of old red sandstone, and the upper part of coal measures surmounted by basalt. The top stratum of the sandstone is a conglomerate, and the same formation contains two beds of nodular limestone or cornstone, the lower of which is about 12 feet thick. The strata are said to dip regularly towards the centre of the hill at an angle of about 7°.

The coal-field is represented to have the form of the figure 8. The strata are said to be about 150 feet thick, and to dip towards a common centre at an angle of from 3 to 5 degrees. Three beds of coal have been discovered, varying from 1 foot 7 inches to 2 feet 6 inches in thickness, but the coal is of inferior quality to that of the Titterstone Clee Hill.

Three faults are described, and stated to range nearly parallel to each other, and to traverse the coal measures in a north easterly direction. One of them, the author observes, is marked by a dyke of basalt connected with an overlying mass of the same rock. It is 13 yards in horizontal thickness, and though the wall of the dyke is so hard as to require to be blasted, yet the coal is not in the least charred.

The overlying basalt is shown to form the two highest points of the hill, one of them being 1800 feet above the level of the sea, and the other 1600.

A memoir "On the Geology of the Banks of the Indus, the Indian Caucasus, and the Plains of Tartary to the Shores of the Caspian," by Lieut. Alexander Burnes, was then read.

The author has endeavoured in this paper to embody the geological observations which he made on a journey during the years 1831 and 1832, up the river Indus and across the lofty range of Hindoo Koosh to the Caspian Sea.

He first describes the province of Cutch, situated near the eastern mouth of the Indus. He states that it is mountainous; that the soil is either rocky or sandy, with masses of lava scattered over its surface; and that sulphur, coal, iron and alum are found in the district.

Nummulites occur in a ridge near the right banks of the Indus. The delta of the river is composed of a succession of beds of earth, clay and sand of different colours, sometimes parallel, and sometimes having one stratum dovetailed into another. The sea is described as being discoloured to a distance of three miles by the detritus carried down by the river, with regard to which it may be stated that the base of the triangle of the delta is above 125 miles.

After mentioning a range of hills called the Hala Mountains, which extends in a northerly direction from the sea-shore westward of the mouths of the Indus, and terminates to the N.W. of Cabool in the Hindoo Caucasus, and which consists, in part of compact nummulitic limestone, the author proceeds to describe the principal geological features which he observed on the banks of this great river. The town of Hydrabad, he states, is built on a finely grained, shelly limestone. At Schwan in lat. 26° 22′ and at Curachee, are hot wells; and the island of Bukhur, in lat. 27° 42′, consists entirely of flint. On the eastern bank of the river, opposite this island, is a precipice of flint, 40 feet high, on which the village of Roree is built. In lat. 28° 55′ the rivers of the Punjab fall into the Indus. Still higher up, in lat. 33°, at Kara Bagh, the river cuts through a range of hills, described by Mr. Elphinstone as the salt range. The salt is found in layers of about a foot in thickness, separated from each other by thin strata of clay. With the exception of this range of hills, which is estimated to be about 1800 feet above the level of the sea, the district of the Punjab is uniformly flat; but the hilly district is intersected by numerous defiles, presenting vertical strata, which terminate in peaked points Between the river Sutlege and Lahore the country consists of indurated clay, sometimes gravelly.

At Attoch, much higher up, the rocks by which the Indus is confined consist of a dark coloured micaceous slate, which is said to extend to the southward until it meets the salt range above mentioned. Near this place gold is washed out of the sand of the river.

At Lahore, in February 1832, the author experienced a very violent shock of an earthquake. Several valleys were choked up by the masses of rock thrown down from the overhanging precipices, and a great part of the population of Badakhshan was destroyed In crossing the Punjab the author observed that several buildings of the Mogul Emperors were decaying from the foundations, and were encrusted with an efflorescence of nitre. Proceeding to the westward from the Indus, he found bituminous coal at Cohat, and that the salt range above mentioned extended across the country into this district. The river of Cabool flows through a very narrow defile, the rocks of which rise to a height of 2000 feet, and consist of sandstone, quartz rock and mica schist, the strata of the latter being vertical. Cabool is situated 6000 feet above the sea. The neighbouring hills are covered with rounded pebbles of all sizes, sometimes loose, at others forming a conglomerate. A beautiful white marble is found near Cabool, and the rocks are occasionally covered with asbestus.

From Cabool the author crossed the Hindoo Caucasus to Balkh and the plains of Tartary. This range of mountains is the prolongation of the Himalaya to the westward of the Indus.

Hindoo Koosh is, properly speaking, the name given to the highest peak in the range, the only part of which that is covered with perpetual snow is the Koh-i-Baba, between Cabool and Bameean, from which latter place the waters flow northward into the Oxus. In some of the defiles through which the author passed, the sides rose to a height of 2000 or 3000 feet. The loftiest peak which he observed between Cabool and Hajeeguk consisted of gneiss or granite, sometimes deeply impregnated with iron. These formations were succeeded by blue slates and quartz rock, and precipices of micaceous schist. From the summits of the precipices masses of green granite and other rocks had been hurled into the valley below. Further down is a calcareous conglomerate, succeeded by cliffs of reddish and purple coloured clay, and by ridges of indurated clay mixed with bands of a harder nature. In this ridge great idols are carved and caves excavated, for it is easily worked. The neighbourhood of Bameean is described as producing gold, lead, copper, tin, antimony, sulphur and iron.

The lower passes of Hindoo Koosh consist principally of a light brown splintery limestone, of great hardness, and susceptible of a high polish. This formation is followed by sandstone rocks, in one of which round flint stones are imbedded at regular intervals. The real peak of Hindoo Koosh lies about a degree to the eastward of this route, and the difficulty of crossing it is very great.

From Khooloom, whence the author descended into the plains of Toorkistan, the country slopes gradually towards the Caspian. It is generally flat and is watered by the Oxus.

The author then describes the course of the Oxus, from its source in the high plain of Pameer until it is lost in the sea of Aral, after passing through a low and swampy district. He does not believe that the Oxus ever terminated in the Caspian Sea, and concludes that what are called the dry river beds between Astrabad and Khina are the remains of ancient canals. The natives pretend that the waters of the Aral pass by a subterranean communication into the Caspian Sea, and that at a place called Kara-goombuz, between the two seas, the water may be heard gushing beneath. It is, however, remarkable, that in the sandy ridge near this place, water is found near the surface, although further south it cannot be had within a hundred fathoms. The author then fully describes the navigation, course, rise and fall, and inundations of the Oxus; and he mentions that it is frequently frozen over.

The author then notices the effects of the great earthquake of 1832 in the valley of Badakhshan. The roads in this valley were blocked up for several days by the falling of stones and cliffs, and this place seems to have been the centre of the convulsion. Badakhshan is famous for its rubies, which are found imbedded in limestone.

The country which extends from the north of the Oxus towards Bokhara is next described. It consists of a succession of low ridges of soft yellowish limestone, sometimes oolitic, with a superficial coating of loose gravel, alternating with plains of hard clay. Sand hills of greater or less extent, raised by the winds, also occur in several places on this plain, and in some of the valleys are saline rivulets and deposits of salt.

The author afterwards offers some remarks upon the inhabitants, and on the meteorological phenomena which he observed in the neighbourhood of Bokhara; and concludes his memoir with a description of the sandy desert of the Turcomans, between the Oxus and the Caspian Sea.

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THE GEOLOGICAL SOCIETY OF LONDON.

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Jan. 8, 1834.—George C. Lewis, Esq., of Henrietta Street, London; Thomas Jameson Torrie, Esq., of Edinburgh; Peter B. Brodie, jun., Esq., of Lincoln's Inn Fields; Wm. Copland, Esq., of Edinburgh; and Benjamin H. Bright, Esq., of Stone Buildings, Lincoln's Inn, were elected Fellows of this Society.

A paper was read by Roderick Impey Murchison, Esq., F.R.S., F.G.S., "On the Old Red Sandstone in the Counties of Hereford, Brecknock and Caermarthen, with collateral Observations on the Dislocations which affect the north-west margin of the South Welsh Coal-basin."

This memoir is the first of a series of communications resulting from researches made during the last summer.

A short sketch is given of the structure of that portion of the carboniferous limestone of the South Welsh coal-field, which, in Brecknock and Caermarthenshires, is contiguous to those older formations, which were the particular subject of the author's examination.

After noticing some features which are common to the mountain limestone in other districts, such as an oolitic structure, and the existence of caverns and funnel-shaped cavities, attention is specially called to a portion of the limestone near Gwinfe in Caermarthenshire, the exterior of which exhibits a high polish. As these polished beds protrude from the edge of a turf bog, it is suggested that such effects may have been produced by the long-continued action of a weak vegetable acid issuing from the morass, and altering the surface of the rock.

I. Old Red Sandstone.—The old red sandstone is divided into three groups.

a. Conglomerate and sandstone. *b*. Cornstones and marl. *c*. Tilestones.

a. The uppermost of these groups, occupying the loftiest summits of the country described, as the Brecon and Caermarthen Fans, is uniformly capped by a band of conglomerate, underlaid by a vast thickness of sandstone. Neither calcareous beds nor organic remains have been discovered in this group.

b. The central group is spread in undulating masses over the greater part of Herefordshire. The red argillaceous marls of which it consists, contain many beds of concretionary limestone or cornstone, with some strata of sandstone.

Remains of Crustacea have been found in this group, together with defences of fishes, &c.

c. The tile-stones are best exhibited in a remarkably rectilinear escarpment, extending from the north-western extremity of the Mynidd Eppint to near the mouth of the Towey, a distance of about thirty-five miles.

These beds contain fossils in Caermarthenshire, and also in their north-eastern prolongation into Shropshire: among them are Lingula, Avicula, three or four species of univalves, a small species of Orthoceras, &c. These fossiliferous tile-stones constitute the beds of passage into the "*Ludlow Rock,*" or highest member of the grauwacke series.

The limits of certain detached basins of the old red sandstone, partially described during the last session, and which are spread over the area of the inferior Ludlow rocks, have this year been extended westward to the source of the Teme, twenty-five miles to the north-west of the ancient line of demarcation. The absence of all vegetable remains, with the exception of a few small fragments, notwithstanding the full exhibition afforded by many natural, deep sections of the mineral structure of all the groups of the formation, is insisted upon as demonstrating the hopelessness of ever finding any workable quantity of coal in the old red sandstone of this part of the kingdom.

The maximum thickness of the whole formation is estimated to be about 10,000 feet.

II. Outliers of Carboniferous Limestone, &c.; Dislocations of the Old Red Sandstone.

A very remarkable outlier of carboniferous limestone and millstone grit, is first described, occupying the summit of a mountain of old red sandstone to the south of the town of Crickhowell. This mass, called Pen Cerrig Calch, is distant from the main escarpment of carboniferous limestone from four to five miles, and is separated from it by the deep valley of the Usk. It is shown, by the position and slight inclination of the beds, that the limestone of Pen Cerrig Calch must have been connected with that of the main escarpment anterior to the excavation of the intermediate valley, and the case is cited as one of the deepest and most extensive denudations which has come within the author's observation.

Numerous and complicated dislocations of great extent, occur in that segment of the margin of the South Welsh coal-basin, which extends from the Caermarthen Fan to the latitude of Llandeilo. The largest of these breaks is the great upcast of Fan Sirgaer, by which the old red conglomerate is thrown up about 700 feet from its regular horizon at Cerrig Ogof. The greatest downcast has taken place at the spot marked by the polished limestone; but the most extraordinary of all these disruptions is that which has given rise to the position of the singular outlier of carboniferous limestone called Castel Cerrig Cennen. This outlier, by a violent elevation of the old red sandstone, has been dismembered from its parent rock, and left insulated with the dip of its beds reversed, in the centre of a valley of the old red sandstone.

By these great elevations and subsidences large masses of car-

Table of the stratified Deposits beneath the Coal-measures in the Counties of Hereford, Salop, Montgomery, Radnor, Brecknock, Caermarthen, Monmouth, Worcester, Stafford and Gloucester.

DESCENDING ORDER.

To face page 13.]

	Formations.	*Maximum approximate thickness.*	*Subdivisions.*	*Lithological Characters.*	*Characteristic Organic Remains.*	*Some Localities.*
	Carboniferous limestone.	Feet. 500?	Limestone. Shale.		Corals differing in species from those of the formations below the old red sandstone. Producta hemispherica. P. Martini. Spirifer triangularis, &c. (Defence and teeth of fishes. Clee Hill, Salop.)	Lilleshall, Steeraways, Orleton, south end of Clee Hills, and Llanymynech, Shropshire. The edge of the South Wales Coal-basin.
	Old red sandstone.	10,000.	a. Red conglomerate and sandstone.	a. Quartzose conglomerate overlying thick-bedded sandstones	a. No organic remains observed	a. Caermarthen and Brecon Fans, S.E. part of Black Forest, Brecknockshire: flanks of the Brown Clee Hill, Shropshire.
			b. Cornstone and argillaceous marls.	b. Red and green, concretionary limestones, with spotted argillaceous marls and beds of sandstone.	b. Crustacea of undescribed genera	b. Central and northern parts of Herefordshire: eastern part of Brecknockshire: Whitbach near Ludlow, and base of the Clee Hills, Shropshire: Tenbury and Shaterford, near Kidderminster, Worcestershire.
			c. Tile stone.	c. Flaggy, highly micaceous, hard, red and green sandstone	c. Avicula, n. s. Pileopsis, n. s. Small Orthoccra. Small Ichthyodorulites?	c. Pontarlleche, Cwmdwr, Caermarthenshire: Clyro Hills, Brecknockshire: Tinmill Copse, near Downton Castle, Herefordshire: Clun Forest, Shropshire.
UPPER GRAUWACKE SERIES.	I. Ludlow rocks.	2000.	d. Upper Ludlow rock.	d. Slightly micaceous, grey-coloured, thin-bedded sandstone........	d. Avicula, n. s. A. retroflexa, Hisinger. Atrypa (Dalman), n. s. Cypricardia, n. s. Homonolotus Knightii, new genus, König. Leptæna lata, V. Buch. Orthis, several new species. Orbicula, 2 new species. Orthocera, several new species. Pleurotomaria? 2 new species. Turbo, n. s. Gigantic serpuline bodies, &c. &c.	d. Ludlow Castle, Whitcliffe, Munslow, Diddlebury, Larden, Shropshire: Croft Castle, Mortimer's Cross, Titley, Kington, Fownhope, Stoke Edith, Herefordshire: West flanks of Malvern and Abberley Hills, Worcestershire: west flank of May Hill, Tortworth, Gloucestershire: Presteigne, Pain's Castle, Radnorshire: Trewerne Hills, Corn-y-fan, Brecon, Llanbadock near Usk.
			e. Aymestry and Sedgeley limestone.	e. Subcrystalline or gray and blue argillaceous limestone	e. Pentamerus Knightii, M. C. Pileopsis vetusta, M. C. Bellerophon, n. s. Lingula, n. s. Atrypa, n. s. Terebratula Wilsoni, M. C. Calamopora fibrosa, Goldf., and a few other corals.	e. Aymestry, Croft Ambry, Gatley, Bringdwood Chase, Downton on the Rock, Herefordshire: Yeo Edge, Shelderton, Norton Camp, Dinchope, Caynham Camp, Shropshire: Sedgeley, Staffordshire.
			f. Lower Ludlow rock.	f. Sandy, liver and dark-coloured shale and flag, with concretions of earthy limestone.	f. Phragmoceras, new genus, Broderip, 3 species. Asaphus caudatus. Ichthydorulites? small. "Cardiola." Brod., a new genus, 2 sp. Nautilus, n. s. Spirulites, 2 n. s. Pentamerus. Atrypa galeata, Dalm., n. s. Pleurotomaria, n. s. Orthocera pyriformis, n. s. and several others.	f. Escarpments of Mocktree and Bringdwood Chase, Gatley, and valley of Woolhope, Herefordshire: Marrington Dingle, Westhope, Hopedale, and Long Mountain, Shropshire: west side of Abberley and Malvern Hills; escarpments in Montgomery, Radnor, Brecknock and Caermarthenshires.
	II. Wenlock and Dudley rocks.	1800.	g. Wenlock and Dudley limestone.	g. Highly concretionary gray and blue subcrystalline limestone ...	g. Corals and Crinoidea in vast abundance. Bellerophon tenuifascia, M. C. Euomphalus rugosus. Eu. discors. Conularia quadrisulcata, M. C. Pentamerus, n. s. Natica, n. s. N. spirata, M. C. Leptæna euglypha, Dalman. Spirifer lineatus, M. C. S. n. s. Terebratula cuneata, Dalm. Producta depressa, M. C. Orthocera, several species. Asaphus caudatus. Calymene Blumenbachii. The Bar Trilobite and others.	g. Lincoln Hill, Benthall and Wenlock Edge, Shropshire: Burrington, Nether Lye, near Amestry, Nash, near Presteigne, Old Radnor: Pwll-Calch, Caermarthenshire: valley of Woolhope, Ledbury, and west side of Malvern Hills: east side of Abberley Hills, Dudley, Worcestershire: Long Hope, near May Hill, Gloucestershire: Prescold and Cil-na-Caya, near Usk.
			h. Wenlock and Dudley shale.	h. Argillaceous shale, liver and dark gray-coloured, rarely micaceous, with nodules of earthy limestone.	h. As. caudatus variety, C. Blumenbachii. Lingula, n. s. Orthis, n. s., and others. Cyrtia trapezoidalis, Dalm. Delthyris, n. s. Orthocera, n. s. O. annulata, M. C. Crinoidea, &c.	h. Buildwas, Hughley, Wistanstow and Clungunford, Salop: escarpments in Montgomery, Radnor, Brecknock and Caermarthenshires: west flank of Malvern Hills, Alfrick, Worcestershire: centre of Wren's Nest, Dudley, &c. &c.
	III. Horderley and May Hill rocks.	2500.	i. Flags.	i. Thin-bedded, impure, shelly limestone, and finely laminated, slightly micaceous, greenish sandstone.	i. Pentamerus lævis, M. C. P. oblongus, n. s. Leptæna, n. s. Pileopsis, n. s. Orthis Callactis, Dalm., and several new species. Terebratula, n. s. Tentaculites and Crinoidea, abundant, } Corals rare.	i. Banks of the Onny, near Horderley, Acton Burnell, Chatwall: the Hollies near Hope Bowdler, Cheney Longville, Acton Scott: east flank of Wrekin and Caer Caradoc, Salop: Eastnor Park, Obelisk, and centre of Woolhope Valley, Herefordshire: May Hill, Gloucestershire.
			k. Sandstones, grits, and limestones.	k*. Thick-bedded, red, purple, green, and white freestones. Conglomeritic quartzose grits. Sandy and gritty limestones.	k. Nucula, n. s. Pentamerus, n. s. Trilobites of undescribed species, and 14 species of the genus Orthis have been found, including O. aperturatus, Dalm., all differing from those of the overlying formations.	k. Horderley, Hoar Edge, Long Lane, and Corton, Shropshire: Ankerdine Hill, Old Storridge, Howler Heath, S.W. of Malvern Hills, Worcestershire: May Hill, Gloucestershire: and the same localities as i in Shropshire: Guilsfield and Alt-y-maen, Montgomeryshire: Castell Craig, Gwyddon, Caermarthenshire.
	IV. Builth and Llandeilo flags.	1200.		l. Dark-coloured flags, mostly calcareous, with some sandstone and schist.	k. Asaphus Buchii. Agnostus, Brongn., undescribed Trilobites of three species; differing from those of the overlying formations.	l. Rorington, near Shelve, Shropshire: Llandrindod and Wellfield, near Builth, Radnorshire: Tan-yr-Alt to Llandeilo, Caermarthenshire.
	V. Longmynd and Gwastaden rocks.	Many thousand feet.		m. Hard, close-grained, grey, greenish and purple sandstone. Red and grey quartzose conglomerate. Slate-coloured and purple schists. Coarse slates: little or no calcareous matter.	l. No organic remains have yet been observed in this great system.	m. The Longmynd, Linley, Haughmond, Lyth, Pulverbatch Hills, Salop: Gwastaden, east of Rhayader, Brecon, &c. &c.: hills west of Llandovery, Caermarthenshire.

N.B. No vegetable remains, except the *Fucus serra* (Brongn.), and some very imperfect fragments of Fucoids? have been found in any portion of the deposits below the carboniferous limestone, nor has any coaly matter, beyond small nests of Anthracite. In the list of organic remains, only such individuals have been mentioned as are characteristic of each subdivision. Others, as for example the *Terebratula affinis*, M. C. (*Atrypa reticularis*, Wahl.), which occurs in several formations, have been omitted in this short Table, but will be given hereafter in a full and descriptive account of all the organic remains. None of the species of corals or shells are identical with those found in the true carboniferous limestone.

* The sandstones (i and k) pass into quartz rock in the vicinity of certain trap rocks (Wrekin, Caer Caradoc, Blaen Dyffrin garn, &c.), as will be explained in a subsequent Memoir.

ERRATA IN THE TABLE, *last column* (No. 34.)

f. *For* Marrington Dingle, *read* Mary Knoll Dingle,
g. — Prescold *read* Prescoed
k. — Corton *read* Corston
Dele the comma after Castell Craig

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boniferous limestone are, as it were, thrown out *en echellon* from the circumference of the coal-field into the area of the old red sandstone.

This portion of the memoir concluded with a comparison between these violent yet local disturbances which have dislocated the carboniferous limestone and old red sandstone, and that great movement from north-east to south-west, which in Brecknockshire and Caermarthenshire threw up the mural ridge formed of the lowest beds of the old red sandstone and the Ludlow rocks or upper member of the grauwacke series. It is also shown that although this ridge of transition rocks passes in one part of its course within three miles of those disturbances, which subsequently convulsed the coal-measures, yet still preserves the true south-westerly strike in an unbroken line, as if unaffected by them.

Jan. 22.—Alexander Trotter, Esq., of Orchard Street, and Robert Walters, Esq., of Lincoln's Inn Fields, were elected Fellows of this Society.

A paper was read "On the Structure and Classification of the Transition Rocks of Shropshire, Herefordshire and part of Wales, and on the Lines of Disturbance which have affected that Series of Deposits, including the Valley of Elevation of Woolhope," by Roderick Impey Murchison, Esq., F.R.S., F.G.S., &c.

I. Another summer's work, during which the author revisited Shropshire and the Welsh counties, formerly described, and also examined the eastern side of Herefordshire, with portions of Monmouth, Gloucester, Worcester and Staffordshires, has enabled him to lay before the Geological Society much more copious information respecting the "Transition rocks," or "Fossiliferous Grauwacke" of this quarter of Great Britain; and to subdivide the same into formations.

The following classification is, therefore, substituted for that proposed last year, being founded upon more extensive observation and an increased knowledge of the organic remains and the order of superposition.

1. *Ludlow Rocks.*—Commencing beneath the old red sandstone, described in the memoir read before the Society, January 8th, he names the superior formation of the grauwacke series, the "Ludlow rocks." This sandy, argillaceous deposit, has in its centre, the zone of limestone well known at Aymestry, Downton on the Rock and other places, by its containing in abundance the *Pentamerus Knightii*. It is stated that the black limestone of Sedgeley, near Dudley in Staffordshire, is identical in character and in organic remains with that of Aymestry in Herefordshire, and the Yeo edge in Shropshire, and that this calcareous zone is everywhere separated from the Wenlock and Dudley limestone by a thick deposit of shale and flag, to which the author has assigned the name of "Lower Ludlow rock". For the chief characters and order of superposition of the groups of this formation and all those of the descending series, the reader is referred to the annexed tabular view, in anticipation of details and illustrations which will, at some future time, be

laid before the public. The number of unpublished organic remains in the formation is considerable, including a new genus of Crustaceans, another of Cephalopods, and a third of Conchifers.

2. *Wenlock and Dudley Rocks.*—The coralline limestones of Wenlock and Dudley having been shown to be equivalent, the term of "Wenlock and Dudley rocks" has been adopted, that the name of the last-mentioned place, so well known for its organic remains, may serve to mark a zone in the Geological Series.

The lower part of this formation is termed the "Wenlock shale," the local term of "Die earth," used last year, having been abandoned by the author, because he finds that it has been applied by the miners to any stratum of the transition series upon which their coal bearing measures have been deposited; so that in one case their "Die earth" is the lower shale of the Ludlow formation, in another the shale beneath the Wenlock limestone.

3. *Horderley and May Hill Rocks.*—This formation, consisting of shelly sandstones, impure limestones, grits, &c., having been more thoroughly examined, is found to contain many more organic remains, and to be of much greater thickness than was formerly supposed.

The strata on the banks of the river Onny at Horderley, Salop, are described in detail, as they present a full type of the formation. The name of May Hill in Gloucestershire, is added to that of Horderley, because in that well known hill, several members of the formation (particularly the red and shelly sandstone) are well exhibited.

4. *Builth and Llandeilo Flags.*—These flags, so peculiarly marked by the presence of the large *Asaphus Buchii*, and so fully developed in Caermarthen and Brecknockshires, have this year been discovered at Rorington in the west of Shropshire.

5. *Longmynd and Gwastaden Rocks.*—These constitute a great mineral axis in Shropshire, occupying the hilly region of the Longmynd, Linley, the Stiper Stones, &c.; extending to the north-east in Lyth and Haughmond Hills, and throwing off upon their vertical flanks, the overlying formations.

These rocks are again found in the same geological horizon at Gwastaden in Brecknockshire, and also west of Llandovery in Caermarthenshire, where the siliceous and gritty members are frequently in the form of concretions. The whole of this vast system (No. 5) is void of organic remains.

Each of the four fossiliferous formations above enumerated, is distinguishable by an individuality of character of the organic remains, by lithological structure, and by geographical boundaries; whilst the underlying slaty and conglomeritic system is perfectly dissimilar in aspect and composition from any of the overlying groups. These distinctions are explained in the annexed Table. The author however states, that in Brecknock and Caermarthenshires it is very difficult to draw those neat lines of separation between these formations, which nature has established in Salop, Herefordshire, &c., and the calcareous members being almost entirely absent in South Wales, it is only in certain places that these subdivisions can be defined. In addition to this, the several formations thin out so rapidly in their course to the south-west, that beyond Llandeilo, the Ludlow and Wenlock formations appear in the same escarpment, and in like manner on the left bank of the Towey, between Llandeilo and Llangadock, it is difficult to separate the shelly sandstones of the third formation from the black flags of Llandeilo, with which they are associated; the great fossiliferous system which in Shropshire, Hereford, Radnor, &c. is expanded over so wide an area, being there compressed into a narrow zone between the old red sandstone on the one side and the rocks of roofing slate on the other.

II. The next chapter describes such of the above-mentioned formations as occur in the Abberley Hills, upon the flanks of the Malvern Hills, Herefordshire, in the vicinity of Usk, Monmouthshire, or in May and Huntley Hills, Gloucestershire, &c. It is stated that Nos. 1 and 2, or the Ludlow and Wenlock formations, are much the most persistent, usually occupying two distinct ridges, as in Shropshire, though on a smaller scale. The impure limestone at the base of the Wenlock shale and constituting the top of the shelly sandstones is also strongly marked by its peculiar characters and organic remains. The arenaceous or great mass of this third formation is brought out from beneath the others at certain points only, as at Ankerdine and Old Storridge Hills, and at Howlers Heath, Worcestershire. May Hill, in Gloucestershire, is cited as a good type of the formation, where it is also overlaid by the superior deposits.

III. *Woolhope Valley of Elevation.*—A valley of elevation which the author conceives to be the most symmetrical in Great Britain, is then pointed out as occurring south-east of Hereford, where the two superior formations of the grauwacke series are incurvated round a central dome-shaped mass, composed of the shelly sandstones of the third formation, from which the strata dip away on all sides at angles varying from 15° to 70°. The harder strata of each formation having resisted destruction, whilst the shales have been worn away, the former constitute the higher encircling ridges, the latter deep trenches of intervallation. The outer zone contains all the fossils characteristic of the Ludlow rocks, and passes beneath the old red sandstone; the inner zone, those of the coralline formation of Wenlock and Dudley, and both these are wrapped round a nucleus of the third formation. The outer zone is unbroken by any transverse gorge, throughout two thirds of its circumference; but at Mordiford it is violently dislocated, and the result has been a chasm, by which and by two minor fissures, the valley is entirely drained. The whole of the valley is stated to be one of clean denudation, being entirely free from any fragments, even of the old red sandstone, though the inferior and denuded strata must have been raised up through that formation. The author calls attention to the south-eastern apex of this valley, where the encircling formations successively become confluent, and the line of the axis of elevation in its prolongation to the south-east being alone marked by a thin ridge of the Ludlow formation, bears the same geographical relations to the ovoidal mass, as the tail of a school-boy's kite does to its body. This phenomenon he will hereafter point out as occurring in other valleys of elevation of similar epoch.

This line of elevation trending from north-west to south-east, is stated to be prolonged through May and Huntley Hills to Flaxley in Gloucestershire, where the three superior grauwacke formations being reproduced, a separate description of them is annexed.

Mr. Maclauchlan had previously laid down upon the map of Ordnance Survey a correct outline of this mass of transition rocks, in its general relations to the old red sandstone.

IV. *Lines of Direction and Dislocations.*—The author here referred to the sheets of the Ordnance Survey on which he had laid down numerous details illustrative of the outlines of each formation, and of the direction and dislocation of the strata.

The prevailing strike of all the deposits described, is from north-east to south-west, as indicated by the line of junction of the Ludlow rocks with the old red sandstone in the counties of Salop, Hereford, Brecknock and Caermarthen. The western limits of these counties, together with those of Montgomery and Radnorshire, exhibit the same direction of the strata. This tract is about 100 miles in length from Lilleshall Hill and Wellington on the north-east to the mouth of the Towey on the south-west, and has a breadth of from 30 to 40 miles. Within this space there are numerous minor axes of elevation, which are only traceable for short distances on the strike, but they are all parallel to each other, and subordinate to the same great line of elevatory movement. These are for the most part marked by eruptive ridges of trap rock, which tilt the strata upon their flanks both to the north-west and to the south-east; and wherever such parallel outbursts are numerous, as between the Wenlock edge and the river Vierniew in Montgomeryshire, they occasion the folding over and repetition of strata of the same age, far to the north-west of their regular line of bearing, upon the confines of Shropshire and Herefordshire. Wherever on the contrary, the longitudinal influence of these short outbursts has ceased, the younger formations, or those of Ludlow and Wenlock, overlie in slightly disturbed positions, the vertical and dislocated beds of the older groups. Hence it is, that the old red sandstone and the Ludlow rocks occupy so large and detached an area on the west, as in Clun, Knighton and Radnor forests.

The line of elevation of which the trap rocks of Old Radnor mark the center, terminates on the north-east in the valley of elevation of Wigmore, having the promontory of Ludlow as its apex; and on the south-west in the narrow anticlinal ridge of Corn-y-fan near Brecknock. The trap rocks extending from Llandrindod to Builth, and other ridges of porphyritic rocks discovered by the author in Brecknock and Caermarthenshires (hereafter to be described), occasion similar, short anticlinal lines all trending from north-east to south-west. This general line of direction is broken through transversely by many cracks and fissures, some of which have been the scene of great dislocation, and it is shown, that through such rents in the strata, the principal rivers escape from the mountains of Wales into the lower counties of England, viz., the Severn, the Onny, the Teme, the Lug, the Wye, &c.

On the eastern side of the trough of old red sandstone of Herefordshire, the mean direction of the strata, as determined by the outline of the trap and sienitic ridges of Abberley and Malvern, is from north to south. But there are many aberrations from that direction, and innumerable local disturbances, curvatures and faults. Thus, for example, the superior grauwacke formations strike south-south-east from Knightwick bridge upon the Teme for a distance of six miles, until they are met by the sienitic ridge of the Malvern running due north and south. The result of this contact is, that the sedimentary deposits are cut out, deflected from their course, and their direction accommodated to the western sides and promontories of the intrusive rock. In the neighbourhood of Eastnor Park three of the grauwacke formations have the north-east and south-westerly strike so persistent in Salop and Wales; but this direction is merely local, being only maintained in a length of about 2½ miles, for the Ledbury ridge, which terminates this group, is seen to strike due south at its apex near Clencher's Mill. The discrepancy is still greater between the strike of the major axis of the Woolhope Valley extending to Flaxley in Gloucestershire (a distance of about 18 miles), and that of Shucknell Hill, which although only two miles distant from the northern end of the Woolhope Valley, and composed of the same rocks, has a direction from south-west to north-east, and at right angles to the former, which runs from north-west to south-east. The strike of the strata of Shucknell Hill is parallel to the line of bearing of the adjoining trap rocks of Bartestree.

Notwithstanding the numerous data explanatory of these divergencies in the direction of the strata of the same age on the east side of Herefordshire, and in other parts an occasional coincidence of parallelism between the strike of formations of very different age, the author declines for the present to enter upon the general theoretical question put forth by M. Elie de Beaumont, conceiving that the scale upon which he has observed may by some geologists not be considered sufficiently expansive to enable him fairly to discuss the merits of that theory. It might also be contended that the phenomena apparent on the eastern side of Herefordshire have been simply the offsets of those stupendous forces to which the mountain chains of Wales owe their origin, and that such small exceptions could not vitiate a train of reasoning deduced from the phenomena observed throughout a whole mountainous region.

Intending to pursue this inquiry, he restricts himself, on this occasion, to the statement of the fact, that the carboniferous limestone and coal-measures near Wellington, and in the Titterstone Clee Hills where these deposits are penetrated by basalt, have been thrown up into the same north-east and south-west direction as the grauwacke series of Salop and Wales; whilst in the Abberley Hills, and at Dudley in Staffordshire, a southerly movement has affected both the transition rocks and the coal-measures.

This part of the memoir was concluded by the notice of a very remarkable case of dislocation, amounting to an *entire reversal of the two younger formations of the grauwacke series* along a distance of several miles upon the flanks of the Abberley Hills. In this tract the Lower Ludlow overlies the Upper Ludlow rock, at angles varying from 70° to 45°; and the adjacent parallel ridge of the Wenlock limestone is conformably tilted over, giving the appearance of the Ludlow rocks passing beneath the older formation. This phenomenon is supposed to have been brought about by the outburst of the contiguous trappean hills of Abberley and Woodbury, the elevating forces accompanying which, it is conceived, have bent them back upon their axes, and produced their present inverted position. This mode of explanation, it is stated, is rendered conclusive on tracing the same sedimentary groups to those points where, from their south-south-easterly direction they impinge upon the sienite of the Malvern chain, and where the same phenomenon of reversal, on a small scale, is again apparent. Here the strata near the sienite are bent backwards; but those which are removed from it not having been disturbed in so great a degree, incline towards the west, the Wenlock and Dudley limestone dipping beneath the exterior and upper zone of Ludlow rocks.

In further illustration of the country of which he has undertaken the review, the author announced as future communications—

1st, A special notice of the Ludlow and Wenlock formations as they appear at Sedgeley and Dudley in Staffordshire, and of their relations to the coal-measures of that district.

2ndly, A sketch of the gravel and alluvial deposits of Herefordshire and the surrounding counties.

3rdly, On certain new lines of demarcation which he has established between the old and new red sandstones in Shropshire, Worcestershire, Hereford and Gloucestershire; with some observations on the coal-fields of Pensax, Billingsley, Deuxhill and Sherlot in Salop.

4thly, An account of the trap rocks in the country described, including basalts, green-stones, porphyries and sienites, and of the effects produced at their points of eruption through the sedimentary deposits.

Feb. 5.—John Donkin, Esq., of Great Surrey Road, Blackfriars Bridge; Edward Ord Warren, Esq., Horkesley Hall, Colchester; Edward Clarke, Esq., of Mincing Lane; and James F. W. Johnston, Esq., Professor of Chemistry in the Durham University, were elected Fellows of this Society.

A paper was first read "On some of the Faults which affect the Coal-field of Coalbrookdale," by Joseph Prestwich, jun., Esq., F.G.S.

In this communication the author confines his observations almost entirely to the direction of the principal faults, and to the changes which they have produced in the relative position of the beds of coal; and he refers to the memoirs of Mr. Murchison for an account of the formations on which the coal-measures repose.

The coal-field is traversed a little north of the Severn by a ridge called "the limestone fault," which has a nearly east and west direction, and by which the field is divided into two unequal parts. That portion which lies to the north of the line of disturbance is intersected by four faults trending from nearly north-east to south-west, but without preserving a strictly parallel direction. They are called the Boundary, Ketley, Main or Leightmore, and Ranley faults.

The Boundary fault, which ranges from Lilleshall Hill to Arcol Hill, the author does not consider to be a true fault, but only to mark the line beyond which, to the north-west, no workings are conducted. Along the line, the dip of the beds suddenly increases from 2° north-west to 13°, and afterwards to 30°. These changes have been ascertained by sinking shafts; and by means of workings conducted from them it has been proved that the beds of coal, after preserving the last dip for a short distance, suddenly rise towards the surface, in an opposite direction, at an angle of 30°. The out-crop of the measures is concealed by the overlying red marl, but the author is of opinion that the strata may terminate against an under-ground ridge of limestone or against one of the rocks composing the Wrekin. Between New Hadley and the Glass House, in the direction of the synclinal line, the "clod coal" is 180 yards deep.

The Ketley fault is situated to the south-east of the Boundary fault. It is perpendicular, and was traced by the author from the Glass House to the Red Lake, but he states from the information which he received, that it extends to the base of Steeraways Hill. At the Glass House, and in other parts of its range, the walls of the disjointed measures are in contact, but they are occasionally 30 yards asunder, and the space is filled with the detritus of the adjoining strata. The greatest difference of level is about 140 yards.

The Main or Leightmore fault was traced from Sneeds Hill Engine to Coalbrookdale. It inclines towards the south-east, and its breadth is about 60 yards, the intervening space being filled with fragments of the coal-measures. The greatest difference of level on the opposite sides of the fault is stated to be 260 yards.

The Ranley fault ranges parallel to the Main. The author did not discover its north-eastern extremity, but he traced it from Dark Lane towards Sturchley; he states, however, from the information of the colliers, that it extends to the limestone fault. The breadth is 10 yards, and the inclination towards the south-east. The greatest difference of level is 50 yards.

Besides these four principal faults of the northern portion of the coal-field, the author notices several minor ones which have a direction generally at right angles to the principal faults, and which appear to have had considerable influence in producing the difference in the level of the strata.

The ridge called the limestone fault, which divides the coal-field into two parts, the author traced from Lincoln's Hill to Windwill Farm, but he noticed the limestone only at the extremities of the ridge, it being elsewhere covered by the coal-measures. The ridge varies in breadth from a quarter to half a mile. On the north side the coal-measures abut against it, but on the south side they incline with the ridge at an angle of 40° or 50°.

To the south of the ridge are several faults which the author describes in detail, but from their complicated character it is impossible to convey a clear notion of their nature without the assistance of ground plans.

The author concludes his memoir with some observations on the fossils he procured principally from the ironstone. Of 18 genera of shells which he enumerates, 12 are marine. The lower layers of the ironstone nodules contain, in general, the greatest number of shells, and the upper the greatest number of plants; but the bed called the "Chance-penny ironstone," the highest wrought, contains the greatest abundance of a species of Productus. The most remarkable fossils obtained by the author, are the remains of Trilobites hitherto undescribed. He procured them from a bed of ironstone in the centre of the coal-measures. He notices also a Coleopterous insect, and another apparently belonging to the genus Aranea, in the possession of Mr. Antice of Madeley, and which were obtained from ironstone nodules.

A paper was then read, entitled, " Notes on the Forest of Wyre Coal-field," by the Rev. Thomas England, F.G.S.

The district, described in this memoir, is bounded on the east by the Severn, on the north by the coal-field of Coalbrookdale, on the west by the Rea and the Hopton to their junction with the Teme, and on the south by the latter river and the Abberley Hills. The superficial transported matter, the author states, is confined chiefly to elevated spots and hill-tops. The gravel consists of pebbles of quartz, trap, slate, hornstone, granite, porphyry, limestone and hard grits; and near Chelmarsh church is a boulder of grey granite weighing about two tons.

The next deposit described is the new red sandstone, which the author states consists of only the lower beds of the formation immediately covering the coal. He says that it forms majestic rocks on each side of the Severn, south of Bewdley, and that between Blackston Hermitage and Kidderminster it appears to rise from beneath the forest coal strata. At Winterdine the sandstone is stated to contain beds of conglomerate. From the Borle brook, near Higley, the formation is said to constitute a long north-west range of high land through Chelmarsh and east of Chetton, bending north-east to Tasley. It consists of beds of white and grey sandstone sometimes spotted black and brown, of brown clay and loamstone, and red sandstone. The true nature of this ridge, it is stated, may be plainly seen in rising from the Borle brook to Higley church, and its internal structure partly examined along the Bridgenorth road. To the south of Cardington, both banks of the Severn are said to be capped with the new red sandstone, and the coal series to appear half way down the declivity. The author is of opinion that the coal-measure ranges uninterruptedly from Coalbrookdale to the Abberley Hills. The greater part of the workings are only shallow pits, touching merely the sulphureous beds, locally called "stinkers."

The upper portion of the measures is chiefly composed of sandy, micaceous, thinly bedded loamstone with vegetable remains, sandstone and quartzose conglomerate; the middle and lower part, in which the coal is chiefly wrought, of slate clay, micaceous loamstone, sandstone grit and calcareous conglomerate. Abundance of vegetable remains are found in the shale, but no other fossils.

The author states that this coal-field is peculiar in the constant occurrence of a calcareous conglomerate called cornstone. He says it is seen in different parts of the series, sometimes at the top, as at Glazeley, and sometimes in the middle, forming a concretionary limestone. The lowest of the coal strata are described as being more indurated than the upper, and as consisting of brown and grey sandy loamstone, and coarsely laminated flagstone grits, with thin layers of conglomerate of a deep chocolate colour. The author then briefly alludes to the base of the coal-measures or the old red sandstone, and to the intrusive rocks, which he says abound on every side of the great south Shropshire coal-field.

A paper was lastly read "On a Freshwater Formation containing Lignite in Cerdagne in the Pyrenees," by Charles Lyell, Esq., Foreign Sec. G.S.

The upper part of the basin of the river Segre in Cerdagne presents an example, rare in the Pyrenees, of a great longitudinal valley running east and west, or nearly parallel to the axis of the chain. This basin is formed by a depression in the central region of granitic rocks, which, in the eastern division of the Pyrenees is of considerable breadth. The lacustrine strata occupy the lower parts of the depression, reposing horizontally on the granite, hornblende schist and argillaceous schist. The breadth of the freshwater formation is about five miles, and its elevation above the sea probably between three and four thousand feet. Its eastern limits are seen to the eastward of Livia, where the boundary is formed by the ridge of granite from which the head waters of the Segre descend. At this outcrop the freshwater clays are seen to be covered with beds of such gravel as might now be supplied from the waste of the surrounding mountains of granite and schist. On crossing the ridge of granite from the basin of Segre to that of the Têt, the author found no recurrence of the freshwater strata in the valley of the last-mentioned river. The northern outcrop of the lacustrine deposit is well seen at Ur, between Porté and Puycerda, where the strata consist chiefly of coarse gravel resting on highly inclined hornblende schist. The deposit is for the most part composed of variously coloured clays, often laminated, in which shells of the genera Limneus and Planorbis abound, as at Estavan, near Livia, in French Cerdagne, where lignite has been worked, and where there are bituminous clays containing impressions of plants. Lignite is still procured from pits at Prats, near Senabastre, in Spanish Cerdagne.

The author offers no opinion as to the tertiary epoch to which the formation may belong, for the shells obtained at Estavan, although entire, were too much flattened to allow M. Deshayes to determine the species. As some portions of the freshwater beds, especially those to the eastward, are highly elevated above others, it appears that the country has undergone great geographical changes since this part of Cerdagne was a lake.

The position of the tertiary basin of Cerdagne was illustrated by two transverse sections across the Pyrenees. The memoir concluded with some remarks on the signs of obliterated lakes which abound in the valleys of the Pyrenees at a great variety of levels.

The first of the sections alluded to, extended from Pamiers south of Toulouse through the highest part of the Pyrenees to Puycerda in Spain. Beds of a conglomerate (*a*), are seen on the river Arriege near Verhilles, inclined to the south; and next in a succession are limestone strata much contorted, containing nummulites and other fossils (*b*); then a formation of grit, sandstone and coal, (*c*). In passing from Verhilles to Foix the groups *b* and *c* appear to be more than once repeated in consequence of the derangement of the strata. In the remaining part of the section between Ussat and Puycerda, the rocks consist chiefly of granitic and argillaceous schists, covered here and there by limestone in which no fossils were observed.

The second section extended from La Estéla in the low country of Catalonia to Céret in France. Immediately north of La Estéla, which stands upon horizontal tertiary strata, the geologist, on ascending the Pyrenees, finds strata of conglomerate having a southerly dip and probably identical with the group *a* of the first section. This conglomerate resembles the pudding stone which caps the lofty hill of Montserrat in Catalonia. Next to this comes a nummulitic limestone (*b*), which is seen at Tarrades, and is also inclined to the south; then a series of shales and sandstones (*c*); and next to this, proceeding towards the north, a formation of red sandstone and red marl (*d*). This last is well exhibited in the valley of the river Muga not far from San Lorenzo. It recurs on the north of that valley with a southerly dip, and rests on strata of mica schist and gneiss, which dip to the north. A little to the north of this point the secondary and primary rocks come in contact with opposite dips; the Pyrenees here consist of gneiss, mica schist and clay slate, which continue to near Céret, where tertiary formations are seen at the base of the Pyrenees.

The above section passes through Masanet, to which place Maclure supposed that the volcanic rocks of the Olot district extended. The author searched in vain for any of these modern igneous rocks near that place, and convinced himself that the extent of the modern volcanic region of Catalonia has been greatly exaggerated, and that it does not stretch in a direction from Olot towards Masanet much farther than Castel Follit, or some point between the last-mentioned town and Besalu.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1833—1834. No. 35.

AT THE

ANNUAL GENERAL MEETING,

21*st February* 1834,

The following Report from the Council was read:—

The Council have great satisfaction in being able this year to report that the affairs of the Society continue in a state of progressive improvement. Not only has the number of Members increased very considerably, notwithstanding the great mortality which the Society has this year to lament, but the finances may be said to be flourishing in a manner totally unprecedented in former years.

Fifty-one new Members have been elected during the last year, but there were twenty-two deaths and five resignations, leaving, at the end of the year 1833, a total number of 716 Members.

With regard to the finances, the balances in hand amount at present to the sum of 763*l.*; and in compliance with the suggestion of the Auditors, the sum of 440*l.* has, in the course of the year, been invested in the purchase of 500*l.* Consols. The whole balance, therefore, in the hands of the Society may be calculated at 1203*l.*, an increase of about 300*l.* upon the balance with which the Society commenced the year; to which may be added the sum of 179*l.* 7*s.* 9*d.*, the difference between the amount of the outstanding debts at the end of 1832 and at the end of 1833, which at the former period amounted to 297*l.* 11*s.* 6*d.*, and at the latter only to 118*l.* 3*s.* 9*d.*

It may also be observed, that the balance of the property of the Society, without including the value of the collections, the library, or the furniture, is nearly equal to the amount of all the sums which have been received for compositions since the formation of the Society, viz. about 2200*l.*

From the Report of the Committee appointed to examine the state of the Museum, it will be seen that additional space is now become absolutely necessary, for the arrangement of the specimens in a manner consistent both with the objects and interests of the Society, and with the attention which is due to the individuals who have presented them. A safe and convenient depository is also requisite for the casts of the Megatherium which have been sent to the Society.

The Council beg to direct the attention of the Society to the state of the Library, which they consider to be deficient in works relative to the progress of Geology on the Continent, and to observe that foreign works and maps connected with this subject will be the most acceptable donations which can be made to the Society.

The Council have to announce that the Supplement to the third volume of the Transactions will soon be published, and that the first part of the fourth volume is also now in the press*.

The Council have also directed that the proceedings up to the close of the last Session, together with a full index and title-page, which have been ordered to be prepared, should complete the first volume of the Proceedings. The index and the title-page will soon be ready for delivery.

In pursuance of a resolution of Council of the 22nd of January, 1834, one year's dividend of the Wollaston Fund has been directed to be paid to M. Agassiz in testimony of the high opinion entertained by the Geological Society of London, of the scientific value of his work on Fossil Fishes, and to encourage him in the prosecution of his important undertaking.

The great additional labour which has devolved upon the Curator of the Museum has induced the Council to direct Mr. Lonsdale to engage another clerk to assist him in the discharge of his duties. They have now to announce that Mr. Bailey has been provisionally appointed on trial for three months.

REPORT of the Committee appointed to examine and report on the state of the Museums.

5th February, 1834.

The Committee have the satisfaction of announcing to the Council that the Curator has made very considerable progress since the last Anniversary in the arrangement of the different collections, and in the removal of unnecessary and duplicate specimens.

The principal features of the arrangements which have been carried into effect by Mr. Lonsdale are:

1st. That in the Foreign Collection nearly all the specimens presented up to the close of the Session of 1833, have been introduced into the series, the only exceptions being those presented by Capt. King from the Straits of Magalhaens, and by Capt. Belcher from the

* The following is the statement of the stock of Transactions now remaining on hand:

Vol. I. Part 1,	4 Copies.		Vol. II. Part 3,	190 Copies.	
—— — 2,	30	——	Suppl.	247	——
Vol. II. Part 1,	127	——	Vol. III. Part 1,	206	——
—— — 2,	173	——	—— — 2,	264	——

Both parts of vol. i. being thus out of print, and the number of these parts having originally been equal to that of the others, the donation of that volume or of either of the parts, will be acceptable to the Society.

West Coast of America, and that the greater part of these specimens have been labelled with the localities and names of the donors.

2nd. That in the English Collection the specimens presented up to the close of the Session 1833 have been also introduced, with the exception of those presented by Mr. Murchison from the counties of Salop, Herefordshire, and the neighbouring parts of Wales, the arrangement of which has stood over until his observations on that part of the country are completed.

And 3rdly, That in the Scotch and Irish collections all the specimens presented up to the close of the Session 1833, have also been arranged.

The Curator has been most anxious to introduce a regular and systematic method of labelling all the specimens, but his whole time having been occupied in the performance of the above-mentioned duties, he has this year been unable to make any progress in the labelling of the British Collections. The appointment of an additional clerk, as already authorized by the Council, will enable Mr. Lonsdale to proceed immediately in the prosecution of this desirable object.

The Museum has been considerably improved as a place of study by the addition of a collection, arranged and presented by the President, illustrative of some important phænomena in geology, such as the alteration of rocks in contact with granitic and other mineral veins, the varieties of concretionary structure, cleavage, weathering, &c. &c.

The same department of the Museum has also been enriched by a collection of mineral veinstones from Cornwall, presented by Mr. Henwood, which it is hoped will form the nucleus of a series to be collected from different parts of the world to elucidate this still obscure subject.

The Society has been indebted to Captain Basil Hall for the donation of a cabinet containing the results of the experiments of the late Sir James Hall on the fusion of rocks. The Committee hope that the possession of this series will facilitate further investigations on a subject, which would probably yield an ample harvest of discovery to future inquirers.

Amongst the other donations, those which the Committee feel themselves particularly called upon to notice are:

A collection of specimens from the neighbourhood of Bonn, presented by Mr. Horner.

Specimens of rocks from Würtemburg, presented by Count Frederick Mandelsloh.

An extensive series of specimens from the formations of the border counties of England and Wales, collected during the last summer, and presented by Mr. Murchison.

A collection of certain products of Vesuvius, preserved in sealed, glass bottles, presented by Mr. Auldjo.

The Committee have also the pleasure of stating that the Library has been increased during the last year by 142 books and pamphlets.

A valuable series of more than 800 Admiralty Charts has been presented by the Admiralty; and the Committee have the satisfaction of observing, that that department continues to send to the Society, from time to time, their newly published charts.

The Honourable Board of Directors of the East India Company have also presented Charts of the East India Seas, to which Captain Horsburgh has added his own Surveys.

The collection of maps has also been considerably increased by the donation of a portion of the Irish Ordnance Townland Survey, comprising the county of Londonderry in 49 sheets, which has been presented by the Lord Lieutenant of Ireland through Col. Colby.

The Committee cannot speak in too high terms of the plan which, under the direction of the President, has been adopted for arranging and facilitating a reference to the Admiralty charts. The other charts will be arranged in the same manner. The Committee recommend that two similar cabinets be procured for the maps and drawings.

The Committee cannot conclude their Report without again alluding to the great inconvenience which is experienced from the want of proper room to arrange the daily increasing number of the specimens, an inconvenience which is now the greater, from there not being sufficient space left for the large casts which have lately been received.

The casts alluded to consist of—1st, The bones of the Megatherium, brought to England from Buenos Ayres by Mr. Woodbine Parish, and for which the Society are indebted to the Royal College of Surgeons; and 2ndly, The inferior maxillary bones of the Mastodon and Tetracaulodon, presented by the American Philosophical Society of Philadelphia.

R. I. MURCHISON.
C. LYELL.
W. I. HAMILTON.

February 21st, 1834.

Fellows.	31st Dec. 1832.	31st Dec. 1833.
Having compounded	70	76
Contributing	210	225
Non-residents	306	311
	586	612
Honorary	48	44
Foreign Members	57	57
Personages of Royal Blood	3	3
	694	716

The following Persons were elected Fellows of this Society during the Year 1833.

January 9th.—Mr. Justice Bosanquet, of Montague-place, Russell-square.

January 23rd.—Herman Merivale, Esq. of Woburn-place, Russell-square; Rev. Robert Hankinson, of Bilney Lodge, Lynn; and Charles Atticus Monck, Esq. M.A. Trinity College, Cambridge, and Coldstream Guards.

February 6th.—John Taylor, jun. Esq. of Coed-ddû, Flintshire; Richard Taylor, Esq. of Perran Arworthal, near Truro, Cornwall; Richard Davey, Esq. of Redruth, Cornwall; Henry Enfield, Esq. of Raymond-buildings, Gray's Inn; and P. I. Martin, Esq. of Pulborough.

February 27th.—William Henry Booth, Esq. of Old-square, Lincoln's Inn; and Chaning Pearce, Esq. of Bradford, Wiltshire.

March 13th.—Rev. William Otter, M.A. Principal of King's College London; and James Harfield, Esq. of Queen-square-place, Westminster.

March 27th.—Robert Williams, jun. Esq. of Grosvenor-square.

April 17th.—Thomas Colbeck, Esq. of Maddox-street, Regent-street.

May 1st.—Robert Scarlett, Esq. of Park-street, Westminster; Rev. R. W. Browne, B.A. Fellow of St. John's College, Oxford; George Silvertop, Esq. of Minster Acres, Northumberland; Andrew Martin, Esq. of Suffolk-place, Pall Mall East; Henry Darwin Rogers, Esq. of Philadelphia; and John Lewis Prevost, Esq. Consul-General for Switzerland, of Suffolk-street, Pall Mall East.

May 15th.—George Wareing Ormerod, Esq. B.A. of Brazenose College, Oxford, and of Ardwick, Lancashire; Viscount Borringdon, M.P. Kent House, Kensington; James Garth Marshall, Esq. of Headingley, near Leeds, and of Upper Grosvenor-street; Capt. Chartres, Royal Artillery, Bath; Damiano Floresi, Esq. Commissioner of the Bolaños and Vetu Grande Mines in Mexico; and Joseph Prestwich, Esq. of Lawn, South Lambeth.

May 29th.—Richard Grantham, Esq. of Limerick, Civil Engineer; and James Hardie, Esq. on the Bengal Medical Establishment.

June 12th.—Stephen Woolryche, Esq. Inspector General of Hospitals, of Heath Farm, Cashiobury, Hertfordshire; Rev. Edward Denison, Fellow of Merton College, Oxford; Philip Pusey, Esq. of Pusey near Farringdon, Berkshire; Richard Westmacott, jun. Esq. of Wilton-place; and Abel Lewis Gower, Esq. of Finsbury-square.

November 6th.—John Ward, Esq. of Holwood, Bromley, Kent; John F. South, Esq. of St. Thomas's-street, Southwark; and Francis Walker, Esq. of Southgate, Middlesex.

November 20th.—Joseph Burkart, Esq. Mining Engineer of Zacatecas, Mexico; and John Kenyon, Esq. of Devonshire-place.

December 4th.—Viscount Oxmantown, M.P. of Berkeley-square; Sir George Magrath, M.D. of Plymouth; Jones Quain, M.D, Professor of Anatomy and Physiology in the University of London; George Rushout, Esq. 1st Life Guards; Rev. Thomas Smith Turnbull, M.A. of Caius College, Cambridge; Charles Henry Weston, Esq. B.A. of Trinity College, Cambridge, of Lincoln's Inn, and of Russell-square; John Waterhouse, jun. Esq. of Halifax, Yorkshire; and Richard Hollier, Esq. of Maze-hill, Greenwich.

December 18th.—Lieut.-Col. Edward Clive, of the Grenadier Guards; Charles Denham Orlando Jephson, Esq. M.P. of Mallow, in the county of Cork; Charles Spicer, Esq. Royal Hospital, Chelsea; and Dr. MacDougle, of Duke-street, St. James's.

The names of the Fellows and Honorary Members deceased are as follows:—

Compounders, (None.)

Residents (7), William Babington, M.D; John Badams, Esq.; W. P. Brigstock, Esq.; Lord King; Roger Pettiward, Esq.; William Sotheby, Esq.; Duke of Sutherland.

Non-residents (11), Sir James Affleck; Adam Clerke, LL.D.; Turnbull Christie, M.D.; John Crosse, Esq.; Marquis de Funchal; J. Francis Berger, M.D.; Sir C. Giesecke; Rev. Lansdowne Guilding; Sir John Malcolm; Rev. Daniel Pettiward; Thomas Walford, Esq.; David Scott, Esq.

Honorary (4), David Crawford, Esq.; C. S. Harford, Esq.; Rev. Benjamin Newton; Alexander Nimmo, Esq.

The MUSEUM has received many Donations since the last Anniversary, among which are included the following:—

British and Irish Specimens.

A collection of recent Shells from the English Coast, and Fossils from Weymouth; presented by Miss Warne.

Specimens from the border counties of England and Wales; presented by Roderick Impey Murchison, Esq. F.G.S.

Geological Specimens from the Isle of Man; Specimens of Ripple Marks in the New Red Sandstone of Cheshire; Geodes from the Magnesian Limestone, Yorkshire; and Specimens from the Mountain Limestone and Coal Shale of Kulkeagh, county of Fermanagh; presented by Viscount Cole, M.P. F.G.S. and Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

Part of a Basaltic Column from the Giant's Causeway; presented by Sir William Blizard, F.R.S.

Fossils from the neighbourhood of Weymouth; Agate Nodules from the Magnesian Limestone, Mendip Hills; and Casts of perforations by *Teredina personata*, from the Plastic Clay, Hengisbury, Hants; presented by the Rev. Prof. Buckland, D.D. F.G.S.

Fossils from the neighbourhood of Weymouth; presented by Henry Thomas De la Beche, Esq. V.P.G.S.

Specimens of Bechite and fossil Corals from Devonshire; presented by the Marquis of Northampton, F.G.S.

Head of a Fish from the London Clay; presented by George Stewart Nicholson, Esq. F.G.S.

Cast of the Paddle of the Plesiosaurus found near Bedford; presented by Dr. Lee.

Specimens from the Chalk of Wiltshire; and of Silicified Wood from the Isle of Portland, Dorsetshire; presented by Miss Benett.

Specimen of Manganese; presented by Mr. James De Carle Sowerby.

Chalcedonic Flints from Hemel Hempstead; presented by Henry Campbell White, Esq. F.G.S.

Specimens from the Mountain Limestone in the neighbourhood of Tenby; presented by the Rev. T. Salway.

Bones of the Elephant, Rhinoceros and Ox, from the gravel, Brookhall, near Lawford; presented by the Rev. William Thornton.

Fossils from the Cliffs at Hastings and St. Leonard's, and part of a Tree from the Submarine Forest near Hastings; presented by Woodbine Parish, jun. Esq. F.G.S.

Specimens of *Endogenites erosa* from St. Leonard's; presented by William Henry Fitton, M.D. V.P.G.S.

Specimens from the Submarine Forest near Hastings; presented by Robert Wrench, Esq.

A Specimen of the Hastings Sandstone with Ripple Marks; presented by Charles Babbage, Esq.

Specimens from the Coal-field of the Forest of Wyre; presented by the Rev. Thomas England, F.G.S.

Foreign Specimens.

Fossil Shells of existing species from the shores of the Red Sea; presented by James Burton, Esq. F.G.S.

Specimens from the South of Spain; presented by George Bellas Greenough, Esq. P.G.S.

Coal Plants from Cape Breton, Gulf of St. Lawrence; presented by Thomas Bigge, Esq. F.G.S.

Cast of the Lower Jaw of a young Tetracaulodon; presented by Dr. Harlan.

Fossils from France; presented by Miss Warne.

Specimens from the neighbourhood of Bonn; presented by Leonard Horner, Esq. F.G.S.

Series of Specimens illustrative of the Geology of Würtemburg; presented by Count Frederick Mandelsloh.

Specimens of Glarus Slate, and of Kupfer-shiefer, with impressions of Fishes, from Mansfield; presented by Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

Fossils from the Montagne de Fis; presented by Viscount Cole, M.P. F.G.S., and Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

Silicified Wood from Ava; presented by Mr. Jas. De Carle Sowerby.

Specimens from the Brazils; presented by James Sturz, Esq.

Specimens from the Cave of Santo Ciro, near Palermo; presented by Samuel P. Pratt, Esq. F.G.S.

Specimens from the Mouth of the Tigris; presented by William P. Richards, Esq. F.G.S.

Specimen of Thorit; presented by Professor Esmark, For. Mem. G.S.

Specimens of Lead Ore from Gador, South of Spain; presented by John Willimott, Esq. F.G.S.

Specimens from the North Shore of the River St. Lawrence; presented by Captain Bayfield, R.N.

Specimens from Vesuvius, Calabria, Sicily and Mount St. Gothard; presented by Count de Bylandt.

A Specimen of Marble perforated by Lithodomi, obtained from a ship sunk in the Leghorn Roads in the year 1750; presented by William Richardson, Esq. F.G.S.

Specimen of Rock Salt from Huamanga, between Huancavelica and Cusco; presented by I. M. Maclean, Esq.

Specimens from Vesuvius; collected and presented by John Auldjo, Esq. F.G.S.

Chromate of Lead from Siberia; presented by Mons. Donati.

Fossils from Malta; presented by J. W. Collings, Esq.

Asbestus from Corsica; presented by Richard Knight, Esq. F.G.S.

Specimens from the Azores; presented by the Rev. J. H. Simpson.

Specimens from the banks of Indus, Hindu Koosh, &c.; presented by Lieutenant Alexander Burnes.

Specimens from Jersey; presented by Ashhurst Majendie, Esq. F.G.S.

Specimens from Australia; presented by Capt. Henry Smyth, R.N.

Casts of the Bones of the Megatherium from Buenos Ayres, brought to England by Woodbine Parish, jun. Esq. F.G.S.; presented by the Royal College of Surgeons.

Casts of the Inferior Maxillary Bones of the Mastodon and of the Tetracaulodon; presented by the American Philosophical Society.

Specimens of the Tertiary Formations in the South of Spain; presented by Col. Silvertop, F.G.S.

The Library has been increased by the Donation of 142 Books and Pamphlets.

Charts and Maps.

A complete series of the Charts published under the direction of the Admiralty; presented by Captain Beaufort, by the command of the Lords Commissioners of the Admiralty.

The Townland Survey of the Counties of Londonderry and Antrim; presented by Lieut.-Col. Colby, by command of His Excellency the Lord Lieutenant of Ireland.

Sheets 45, 56, and 73 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.

The Sheets of the Trigonometrical Survey of India, published during the last year; presented by the Honourable the Court of Directors of the East India Company.

Miscellaneous.

Cast of the Colossal Bust of Baron Cuvier, by M. David; presented by M. David.

A Silver and Bronze Medal of Count Sternberg; presented by Count Sternberg.

A Medal of Lem. Jacob Berzelius, M.D. For. Memb. G.S. in Selenium; presented by M. Batka.

Portions of Iron Boiler Tubes from the Steam Engines, Cornwall; presented by John Taylor, Esq. Treas. G.S.

The following LIST contains the NAMES of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received since the Anniversary of 1833.

Admiralty, Lords Commissioners of the.
Anti-Slavery Reporter.
Arts, Society of.
Asiatic Society of Calcutta.
Auldjo, John, Esq. F.G.S.
Aylmer, His Excellency Lord.
American Philosophical Society.

Babbage, Charles, Esq.
Babbington, B. G. M.D.
Batka, M.
Bayfield, Captain, R.N.
Beaufort, Capt. R.N. Hon. Mem. G.S.
Beaumont, M. Elie de, For. Mem. G.S.
Beke, Mr. C. T.
Belcher, Captain, R.N. F.G.S.
Benett, Miss.
Besser, M.
Bigge, Thomas, Esq. F.G.S.
Black, Young and Young.
Blizard, Sir William.
Bohn, Mr. John.
Boubée, Mr.
Brewster, Sir David, F.G.S.
Bristol Institution.
Broderip, W. J. Esq. V.P.G.S.
Brookes, Henry, Esq. F.G.S.
Buckland, Rev. W., D.D. F.G.S
Burnes, Lieut. Alexander.
Burton, James, Esq. F.G.S.
Bylandt, Count de.
Cambridge Philosophical Society.
Chaubard, M.
Christie, Prof. Alexander.
Clerget, M.
Colby, Lieut.-Col. R.E., F.G.S.
Cole, Viscount, M.P. F.G.S.
Collings, J. W. Esq.
Committee of the Athenæum.
Cooper, ——, M.D.
Cotta, C. Bernard.
Crocker, E. Esq.
Cumby, Wm. Esq.

Dechen, Heinrich von, For. Mem. G.S.
De la Beche, Henry Thomas, Esq. V.P.G.S.
Donati, M.
Dufrénoy, M. ——, For. Mem. G.S.
Dumont, M. A.

East India Company, Directors of.
Editor of the Literary Gazette.
Egerton, Sir Philip, Bart. F.G.S.
Esmark, Prof. For. Mem. G.S.
England, Rev. Thomas, F.G.S.

Faraday, Michael, Esq. F.G.S.
Finch, J. Esq.
Fitton, Miss.
Fitton, William Henry, M.D. V.P.G.S.

Geological Society of Dublin.
Geological Society of France.
Gilbert, Davies, Esq. F.G.S.
Gordon, Alexander, Esq.
Gould, Nathaniel, Esq.
Gower, Lewis, Esq. F.G.S.
Greenough, G. B. Esq. P.G.S.

Hall, Capt. Basil, R.N. F.G.S.
Harlan, Dr.
Hausmann, J. F. L.
Hays, Isaac, M.D.
Herschel, Sir John F. W., F.G.S.
Hoeninghaus, M. F. W.
Hookham, Mr.
Horner, Leonard, Esq. F.G.S.
Horsburgh, Captain.
Hutton, William, Esq. F.G.S.

Jackson, Col. J. R.

Jones, Mr.

Killaly, Richard G. Esq. F.G.S.
Knight, C. Esq.
Knight, Richard, Esq. F.G.S.

Laurillard, M. C. L.
Lea, Isaac, Esq.
Lee, ——, LL.D.
Lewis, Rev. T. T.
Lindley, John, Esq. F.G.S.
Linnean Society of London.
Literary and Historical Society of Quebec.
London and Birmingham Railway Company, Directors of.
Lord Lieutenant of Ireland, His Excellency the.
Loudon, J. C. Esq. F.G.S.
Lyell, Chas. Esq. For. Sec. G.S.

Macneill, John, Esq.
Maclean, I. M. Esq.
Majendie, Ashhurst, Esq. F.G.S.
Man, W. Esq.
Mandelsloh, Count Frederick.
Mantell, Gideon, Esq. F.G.S.
Master General and Board of Ordnance.
Meyer, von Hermann.
Monnet, M.
Morris, Mr.
Murchison, Roderick Impey, Esq. F.G.S.
Murray, Hugh, Esq.

Nattali, Mr.
Natural History Society of Ile Maurice.
Nicholson, George S. Esq. F.G.S.
Northampton, Marquis of, F.G.S.

Page, Frederick, Esq. F.G.S.
Parish, Woodbine, jun. Esq. F.G.S.
Parker, Joseph, Esq.
Paxton, Mr. Joseph.
Perthis, M.
Phillips, Richard, Esq. F.G.S.
Phillips, Thomas, Esq.
Plymouth Institution.
Pratt, Samuel P. Esq. F.G.S.
Procter, J. Esq.

Reinwardt, M. G. C.
Richards, W. P. Esq. F.G.S.
Richardson, William, Esq. F.G.S.
Roberts, Mr.
Royal Academy of Science of France.
Royal Academy of Berlin.
Royal Asiatic Society of Great Britain.
Royal Astronomical Society of London.
Royal College of Physicians.
Royal Society of Edinburgh.
Royal Society of Literature.
Royal Society of London.
Royal College of Surgeons.

Salway, Rev. T.
Schmerling, Dr. P. C.
Scrope, George P. Esq. F.G.S.
Silliman, B., M.D. Hon. Mem. G.S.
Silvertop, Col. C. F.G.S.
Silvertop, George, Esq. F.G.S.
Silvestre, Giovanni.
Simpson, Rev. J. H.
Smyth, Capt. Henry, R.N.
Society of Arts.
Sowerby, Mr. James de Carle.
Sternberg, Count G., For. Mem. G.S.
Stratford, W. S. Esq.
Sturz, James, Esq.
Sykes, Lieut.-Col. F.G.S.

Taddy, Mr. Sergeant, F.G.S.
Taylor, John, Esq. F.G.S.
Taylor, Richard, Esq. F.G.S.
Thornton, Rev. William.
Thorpe, Mr. Thomas.

Upton, Mr.

Vandermaelen, Mr.
Vaughan, Petty, Esq.

Walker, F. Esq. F.G.S.

Warne, Miss.
Wetherell, Nathaniel, Esq. F.G.S.
Whewell, Rev. William, F.G.S.
White, Henry C. Esq. F.G.S.
Wild, Isaac, Esq.
Willimott, John, Esq. F.G.S.
Woodward, Samuel, Esq.
Wrench, Robert, Esq.
Wright, Mrs.

Yorkshire Philosophical Society.

Zoological Society of London.

List of Papers *read since the last Annual Meeting*, Feb. 15th, 1833.

February 27th.—Description of parts of the Kingdoms of Valencia, Murcia and Granada, in the South of Spain; by Captain Cook, R.N. F.G.S.

———— Observations relative to the Structure and Origin of the Diamond; by Sir David Brewster, K.C.H. LL.D. F.G.S. F.R.S.

———— Notice on the occurrence of Bones of Animals in a Coal-mine in Styria; by Professor Anker, of the Joanneum in Gratz.

March 13.—On the Environs of Bonn; by Leonard Horner, Esq. F.G.S.

March 27 and April 17.—On the Sedimentary Deposits which occupy the western parts of Shropshire and Herefordshire, and are prolonged from N.E. to S.W. through Radnor, Brecknock and Caermarthenshires, with descriptions of the accompanying rocks of intrusive or igneous characters; by Roderick Impey Murchison, Esq. F.G.S.

May 1.—Notice of a Machine for Regulating High Temperatures, invented by the late Sir James Hall, Bart. F.G.S., drawn up by Captain Basil Hall, R.N. F.G.S.

——— A Letter from Mr. Telfair to Sir Alexander Johnstone, V.P.R.A.S., accompanying a specimen of recent Conglomerate Rock from the Island of Madagascar, containing fragments of a Tusk, and part of a Molar Tooth of a Hippopotamus; communicated by Roderick Impey Murchison, Esq. F.G.S.

May 15.—Observations on the Cliffs in the neighbourhood of Harwich, made in December 1832; by James Mitchell, Esq. LL.D. F.G.S.

——— A Memoir on the Valley of the River Medway and the adjacent Country; by R. Dadd, Esq. and communicated by James Mitchell, Esq. F.G.S.

——— On a Fossil in the Bristol Museum, and discovered in the Lias at Lyme Regis; by Dr. Riley, and communicated by Charles Stokes, Esq. F.G.S.

May 29.—On the Oolitic Formation and its Contents, as occurring in a Quarry at Bearfield, near Bradford, Wilts; by J. Chaning Pearce, Esq. F.G.S.

May 29.—A Paper upon some Tertiary Deposits in the Province of Granada and part of that of Sevilla, and along the line of coast from Malaga to Cartagena, in the South of Spain; by Col. Charles Silvertop, F.G.S.

June 12.—A Notice on some Specimens from the Coal Shale of Kulkeagh, and the subjacent Limestone, in the County of Fermanagh; by Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

——— On the Osseous Cave of Santo Ciro, about two miles to the S.E. of Palermo; by Samuel Peace Pratt, Esq. F.G.S.

——— A Communication from Captain Colquhoun, and addressed to Roderick Impey Murchison, Esq. F.G.S., "Descriptive of Masses of Meteoric Iron found in Mexico and Potosi."

——— A Letter from Mr. Gardner, Geographer, to Roderick Impey Murchison, Esq. F.G.S, "On the Relative position of Land and Water with Respect to the Antipodes."

November 6.—On a Band of Transition Limestone, and on Granite Veins appearing in the Grauwacké Slate of Westmoreland, near Shap Wells and Wastdale Head; by the Rev. Adam Sedgwick, F.G.S. Woodwardian Professor in the University of Cambridge.

————— Notice respecting some Points in the Section of the Coast near St. Leonard's and Hastings; by William Henry Fitton, M.D. V.P.G.S.

————— A Letter from Woodbine Parish, Esq. F.G.S. addressed to George Bellas Greenough, Esq. P.G.S., accompanying a collection of Fossils made by Mr. Parish during the last summer at St. Leonard's.

November 20.—Notes on the Geology of the North Coast of the River and Gulf of St. Lawrence, from the Mouth of the Saguenay (long. 69° 16′) to Cape Whittle (long. 60°); by Captain Bayfield R.N., and communicated by George Bellas Greenough, Esq. P.G.S.

December 4.—A Letter from Hugh E. Strickland, Esq. addressed to George Bellas Greenough, Esq. P.G.S., On the Red Marl and Lias of parts of Gloucestershire, Worcestershire and Warwickshire, and on a Line of Disturbance which affects those Formations between Bredon Hill in Gloucestershire, and Inkberrow in Worcestershire.

————— On the Strata of Quainton and Brill in Buckinghamshire; by James Mitchell, LL.D. F.G.S.

————— Observations on the Cliff at Reculver in Kent; by James Mitchell, LL.D. F.G.S.

December 18.—Notes on the Geology of the Brown Clee Hill in Shropshire; by Rumley Wright, Esq. employed in the Ordnance Survey.

————— On the Geology of the Banks of the Indus, the Indian Caucasus, and the Plains of Tartary to the Shores of the Caspian; by Lieutenant Alexander Burnes.

January 8.—On the Old Red Sandstone in the Counties of Hereford, Brecknock and Caermarthen, with Collateral Observations on the Dislocations which affect the N.W. margin of the South Welsh Coal-basin; by Roderick Impey Murchison, Esq. F.G.S.

January 22.—On the Structure and Classification of the Transition Rocks of Shropshire, Herefordshire and part of Wales, and on the Lines of Disturbance which have affected that Series of Deposits, including the Valley of Elevation of Woolhope; by Roderick Impey Murchison, Esq. F.G.S.

February 5.—On some of the Faults which affect the Coal-field of Coalbrookdale, and on the occurrence of Trilobites and Marine Testacea, associated with Freshwater Shells in the Ironstone of that District; by Joseph Prestwich, Esq. F.G.S.

———— On the Coal-field of the Forest of Wyre, near Stourport, in Shropshire; by the Rev. Thomas England, F.G.S.

———— On the Freshwater Formation of Cerdagne in the Pyrenees, and on the evidences which that Chain affords of obliterated Lakes at different altitudes; by Charles Lyell, Esq. For. Sec. G.S.

Sums actually Received and Expended,

Receipts.

	£	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
Balances in hand January 1, 1833:												
Banker (including 104*l.* 8*s.* 0*d.* Wollaston Fund)							878	17	4			
Accountant							40	1	0			
										918	18	4
Arrears:												
Admission Fees							67	4	0			
Annual Contributions							98	19	6			
										166	3	6
Ordinary Income:												
Annual Contributions							546	0	0			
Admission Fees:												
Residents				138	12	0						
Non-Residents				189	0	0						
							327	12	0			
										873	12	0
Compositions, six										189	0	0
Transactions				99	17	6						
Received from Messrs. Treuttel and Würtz for copies sold during 1832	97	2	8									
Ditto sold at the Apartments in 1832	0	16	0									
				97	18	8						
							197	16	2			
Proceedings							4	3	0			
										201	19	2
Wollaston Fund										32	10	4
Dividends on 500*l.* 3 per cent. Consols, six months										7	10	0
										£2389	13	4

during the Year ending December 31, 1833.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes	9	5	0			
Salaries and Wages	75	0	0			
Collector's Poundage, (1831 and 1832)	33	0	0			
Petty Expenses for December 1832	30	15	3			
Ironmonger's Bill	3	18	3			
Treuttel for Books	3	0	0			
R. Taylor, Printing	12	11	0			
Wyon, for Wollaston Dies and Medal	63	0	0			
Lonsdale, award of Wollaston Donation Fund, 1832	32	10	4			
Vandercomb, Bond and other Law Expenses	34	11	8			
				297	11	6

	£.	s.	d.	£.	s.	d.	£.	s.	d.
General Expenditure:									
Household Furniture	1	4	0						
Repairs of House	18	7	4						
House Expenses	156	18	3						
Taxes, Parochial	22	5	0						
——, King's	53	9	4						
Insurance	6	0	0						
				258	3	11			
Salaries and Wages:									
Curator and Clerk	150	0	0						
Porter	75	0	0						
Collector's Poundage	25	19	0						
				250	19	0			
Scientific Expenditure				100	15	3			
Stationery and Miscellaneous Printing				34	9	6			
Tea for Meetings				43	7	0			
							687	14	8

	£.	s.	d.	£.	s.	d.
Cost of Publications:						
Transactions	151	1	0			
Proceedings	47	5	6			
				198	6	6
Purchase of 500*l.* 3 per cent. Consols	441	17	6			
Power of Attorney to receive Dividends	1	1	6			
				442	19	0
Balance in hand Jan. 1, 1834:						
Banker (including 41*l.* 8*s.* Wollaston Fund)	723	1	8			
Accountant	40	0	0			
				763	1	8
				£2389	13	4

VALUATION *of the Society's Property;* 31*st December* 1833.

PROPERTY.

	£.	s.	d.	£.	s.	d.
Balances in hand (including 41*l.* 8*s.* 0*d.* Wollaston Fund)				763	1	8
Arrears due to the Society:						
Admission Fees	121	16	0			
Annual Contributions	310	11	0			
				432	7	0
Estimated value of unsold Transactions				582	16	6
500*l.* Stock, 3 per cent. Consols				440	0	0
Due from Treuttel and Würtz, on account of Transactions sold				40	16	0
Due for copies of Transactions sold at the Society				11	10	0
				£2270	11	2

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.*]

JOHN TAYLOR, TREASURER.

DEBTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes	8	5	0			
Salaries and Wages	75	0	0			
Collector's Poundage	5	0	0			
Petty Expenses, Dec. 1833	23	11	3			
Limbird, Stationery	1	17	6			
Treuttel and Co.	2	2	0			
Serle, stitching Transactions and Proceedings	2	8	0			
				118	3	9
Cash belonging to the "Wollaston Fund"				41	8	0
Arrears not likely to be received				100	0	0
Balance in favour of the Society				2010	19	5
				£2270	11	2

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed,
Jan. 31, 1834.

G. W. AYLMER,
LEONARD HORNER, } AUDITORS.

ESTIMATES *for the ensuing Year*, 1834.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31, 1833				432	7	0
Ditto from Treuttel and Co. on account of Transactions sold				40	16	0
Due for Transactions sold at the Society				11	10	0
Ordinary Income for 1834 (estimated):						
Contributions of 155 Fellows				490	0	0
Admission Fees:						
Residents (20)	126	0	0			
Non-Residents (15)	157	10	0			
				283	10	0
Compositions (three)				94	10	0
Sale of Transactions				250	0	0
—— Proceedings				20	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends on 500*l*. 3 per cent. Consols				15	0	0
				£1670	3	4

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31, 1833				118	3	9
General Expenditure:						
Repairs of House	50	0	0			
Taxes	95	0	0			
Insurance	12	0	0			
House Expenses	180	0	0			
Household Furniture	25	0	0			
				362	0	0
Salaries and Wages:						
Curator and Assistant	200	0	0			
Clerk	75	0	0			
Porter and Servant	100	0	0			
Collector's Poundage	25	0	0			
				400	0	0
Scientific Expenditure, Cabinets and Bookshelves				150	0	0
Stationery and Miscellaneous Printing				50	0	0
Tea for Meetings				50	0	0
Cost of Publications:						
Transactions	300	0	0			
Proceedings	80	0	0			
				380	0	0
Arrears not likely to be received				100	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
Balance in favour of the Society				27	9	3
				£1670	3	4

The Reports having been read, it was Resolved:—

That these Reports be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows of the Society.

The President then stated that the Council had awarded to M. Agassiz the proceeds of the Wollaston Fund for the past year, in order to promote his important work on Fossil Fishes.

It was next Resolved:—

1. That the thanks of the Society be given to William Henry Fitton, M.D. and the Rev. Professor Sedgwick, retiring from the office of Vice-President.

2. That the thanks of the Society be given to Francis Chantrey, Esq.; Viscount Cole, M.P.; Earl Fitzwilliam; Captain Pringle; and William Somerville, M.D., retiring from the Council.

The Meeting then proceeded to ballot for the Officers and Council for the ensuing year; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected:—

OFFICERS.

PRESIDENT.

George Bellas Greenough, Esq. F.R.S. & L.S.

VICE-PRESIDENTS.

William John Broderip, Esq. B.A. F.R.S. & L.S.
Henry Thomas De la Beche, Esq. F.R.S. & L.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.
Henry Warburton, Esq. M.P. F.R.S.

SECRETARIES.

Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.
William John Hamilton, Esq.

FOREIGN SECRETARY.

Charles Lyell, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S.

COUNCIL.

George William Aylmer, Esq.
Rev. Prof. Buckland, D.D. F.R.S. L.S. Professor of Geology and Mineralogy in the University of Oxford.
Major S. Clerke, K.H.
Rev. W. D. Conybeare, M.A. F.R.S.
C. G. B. Daubeny, M.D. F.R.S. Professor of Botany and Chemistry in the University of Oxford.
Sir Philip de Malpas Grey Egerton, Bart. F.R.S.
William Henry Fitton, M.D. F.R.S. & L.S.
D. Gilbert, Esq. D.C.L. F.R.S. S.A. L.S. & H.S. Hon. Mem. R.S. Ed. M.R.I.A.
Woodbine Parish, jun. Esq. F.R.S.
Captain A. Robe, R.E.
Rev. Adam Sedgwick, M.A. F.R.S. Woodwardian Professor in the University of Cambridge.
Lieut.-Col. Sykes.
J. H. Vivian, Esq. M.P. F.R.S.
Rev. J. Yates, M.A. F.L.S.

Address delivered at the Anniversary Meeting of the Geological Society, on the 21st of February 1834, by George Bellas Greenough, *Esq. President.*

Gentlemen,

You have learned from the Report of the Council that the Society has considerably gained in number since the last Annual Meeting. So large an accession of members shows the growing popularity of our science, and is at once a gratifying reward of your past exertions and a sure presage of your further success.

You have also been informed that during the same period the losses of the Society have been unusually numerous. Several of the deceased, whose main objects in life, if not alien, were connected but remotely with those of our institution, conferred upon it, notwithstanding, by their enlightened encouragement, important advantage: but the merits of the poet, the historian, the statesman, the warrior, though recorded in the annals of a grateful country, must not here be dwelt upon. To the memory of those only who have been closely allied to us, as fellow-labourers, will you desire that I should pay, individually, the well-earned tribute of our common regret.

The late Dr. Babington, whom we have been accustomed to look to with a respect almost filial, attached himself in early life to the study of chemistry and mineralogy. In the year 1795, he published a Systematic Arrangement of his collection of minerals purchased of the Earl of Bute, the finest, perhaps, which at that period existed in England; and in 1799, his New System of Mineralogy, which may be considered a continuation of the former work. These works, now superseded by others, which the introduction of improved modes of inquiry and the application of new instruments have rendered more perfect, evince much patient research and an exact knowledge of the state of mineralogy at that time. Active in the cultivation of science himself, Dr. Babington was quick to discern and eager to encourage merit in others. With a view to enable Count Bournon, of whom he had been a pupil, to publish his elaborate monograph on carbonate of lime, Dr. Babington, in 1807, invited to his house a number of gentlemen the most distinguished for their zeal in the prosecution of mineralogical knowledge. A subscription was opened and the necessary sum readily collected. This object having been accomplished, other meetings of the same gentlemen took place for the joint purpose of friendly intercourse and mutual instruction, From such small beginnings sprang the Geological Society; and among the names of those by whose care and watchfulness it was supported during the early and most perilous crisis of its history, that of Dr. Babington must always stand conspicuous.

But while Dr. Babington employed his leisure in the study of chemistry and mineralogy, he gradually rose into eminence as a physician, and at last became occupied with the care of a numerous family, and subjected to all the labour and responsibility of extensive medical practice. During many years, he was disabled from pursuing his favourite sciences with that unremitted attention which alone leads to original discovery; and accordingly our Transactions do not contain any communication from his pen: no man, however, more steadily cheered us in our progress or more heartily rejoiced in our success. In the year 1822, he was elected to the presidency of this Society, an office which he accepted in deference to the earnest wish of the Members, and held for two years at great personal sacrifice. His conduct in this chair afforded to us ample opportunity of observing the native goodness and kindliness of his heart, the urbanity of his manners, the evenness and cheerfulness of his temper, and the aptitude with which he exercised every liberal feeling.

During the presidency of Dr. Babington, and at his suggestion, was established the practice of submitting to immediate discussion the papers read at the table of the Society. Apprehensions were entertained by some persons at that time, that the collision of argument and the desire of personal distinction might interfere with the love of science or break the bonds of social intercourse,—that we might learn to contend less for truth than for victory. I appeal to you, Gentlemen, whether the brighter anticipations of Dr. Babington have not been amply justified by experience; whether our discussions, continued now during twelve years, have not been strongly characterized by a love of truth; whether the bonds of friendship have not been more closely cemented by them. Our conversations have been animated, but never intemperate; they have encouraged the timid, assisted the investigator in discovering the object of his research, and given additional value to every paper in our Transactions.

Dr. Babington was a Vice-President during the years 1810, 1811, 1812, 1813 and 1814, and a Trustee from 1811 to 1821. His donations to our library and museum were extensive, and from subscriptions set on foot to promote the objects of the Society his name was never withheld.

Dr. Babington retained to the latest period of his life a keen relish for the attainment of knowledge, and made considerable sacrifices to enable himself to keep up with its rapid progress. After descending from this chair he took private lessons in geology of Mr. Webster. So late as the winter of 1832–3 he enrolled his name at the University of London as a student of chemistry, and there attended with the utmost punctuality a course on that science of seven months' duration; he afterwards in the same spirit, and in his 77th year, once more applied himself seriously to geology, and went over the collection of fossils in our museum. I can scarcely imagine a more gratifying spectacle than that of a veteran in the labours of professional duty, thus returning to the pursuits which he had loved when young, and seeking relaxation, not in ease and repose, the allowable luxuries of old age, but in the indulgence of an enlightened passion for knowledge.

I need not apologize for these extended comments; they are more than justified by the occasion. The duties which your benefactor owed to the Society he cheerfully and fully performed. May his memory kindle in us a feeling not merely of gratitude but of emulation!

Dr. Berger, who died in the early part of last year, was a native of Switzerland, and had been employed in geological study for some years previous to 1813, when he sought in England an asylum from the foreign oppression which in those days of revolution had visited his country. In 1816, at the request of some of his friends in this Society, he agreed to devote himself for three years to geological investigations in the British Islands; and an annual sum was insured to him during that period by a subscription of some of our members. The north-west coast of Ireland was suggested for his first examination, and there, as might perhaps have been foreseen, the movements of a foreigner, who spoke our language imperfectly, and whose occupation must have appeared to the inhabitants mysterious, if not dangerous, at first excited doubt and obstruction, which, though not unamusing, were attended with some embarrassment, and called for the interference of his friends. He laboured with great zeal and assiduity, in that interesting field of inquiry, till his health unfortunately gave way. His papers and collections were therefore incomplete; and his attention appears to have been given perhaps too much to the investigation of details not immediately connected with the proper and immediate business of the geologist. His merit, however, must be judged of, not by reference to the present state of knowledge and the methods of inquiry now pursued, but to the condition of the science at that time. The facts he accumulated were valuable. "A Memoir on the Dykes of the north-east coast of Ireland," by himself, appears in the third volume of our Transactions; his remaining papers were put into the hands of the Rev. William Conybeare, who subsequently went over the same country with Dr. Buckland; and we are indebted to the labours of Dr. Berger, extended and illustrated by these geologists, for one of the most valuable memoirs in the earlier volumes of our Transactions. The late years of Dr. Berger's life were passed in his native country, in bad health: he died at Geneva in 1833.

In perusing at the distance of so many years the record of the arrangement by which Dr. Berger's services were obtained for this Society, and the names subjoined*, I have been much struck by the delicacy with which his personal feelings were consulted, and have looked back with pride and exultation to the early history of our institution. I cannot be surprised at the success which has attended your exertions, when I call to mind the noble and disinterested spirit by which the first steps in your progress were directed. On no occasion since I have known the Geological Society, (and I have known it from its birth until the present hour,) have the Members hesitated to contribute, with the most liberal devotion, both personal labour and pecuniary support, whenever the *probable* advancement

* The paper bears, with the names of other Members who still remain, the signatures of the late Dr. Babington, Dr. Marcet, Mr. Francis Horner, Mr. Morgan, Dr. Wollaston, Sir Joseph Banks and Mr. Ricardo.

of science appeared to call for them. I mention this with double satisfaction, because I am convinced that this good spirit still subsists amongst us with undiminished vigour.

Dr. Alexander Turnbull Christie imbibed in the class room of Professor Jameson a taste for geology, which he afterwards improved in India, as far as opportunity allowed, under many discouraging circumstances. On his return to Europe he applied himself to the science with great earnestness; he studied the best works, courted the society of their authors, familiarized himself with the contents of collections, and practised in the open air the most approved methods of investigation. He became the pupil of M. Brongniart at Paris, and the companion of M. de Beaumont and M. von Buch in the Alps. His studies were by no means confined to geology; they embraced every department of natural history. The climatological and geographical distribution of plants was a subject to which he paid much attention. Having provided at his own expense the best instruments for the purpose, he returned to India with the design of instituting there a continued series of barometric, hygrometric, and other experiments, as well as of exploring the physical structure of that vast region, and of determining the relations of its rocks to those of Europe. On his way he visited Sicily, and transmitted to the Society an account of some of the younger deposits of that island, and the phænomena that accompanied their elevation. He wrote also a description of some bone caves near Palermo, and of tidal and other zones observed on limestone along the shores of Greece. These notices will be found in Jameson's Journal. Dr. Christie died prematurely of a Jungle Fever, while crossing the Nilgherry hill in November 1832.

Mr. Lansdown Guilding, though not himself engaged in the pursuit of geology, added several valuable specimens to our collection, and materially assisted the progress of some other branches of natural history, especially in connexion with the West Indies.

Sir Charles Gieseckè was born at Augsburg in 1761. He was originally intended for the church; after various changes of occupation and a life of some adventure, he devoted himself in about his fortieth year to mineralogy, and studied under Werner at Freyberg in 1801. He subsequently travelled with mineralogical views in several parts of the North of Europe; in 1806 he entered into the service of Denmark and repaired to Greenland, leaving at Copenhagen a valuable collection of books and minerals, which were destroyed during the bombardment of that city. In Greenland he formed acquisitions of great interest in various departments of natural history, but foreseeing the probability of their capture on the passage to Europe, he with great resolution and perseverance went a second time over the ground he had examined, and remained in that desolate region till his object was accomplished. In the mean time the vessel which contained his first treasures was taken, and the cargo sold by auction at Leith. The minerals attracted but little general notice, in part, I have been informed, from their being packed in moss and sea-weed, and perhaps also from the very circumstance of many of the species being unknown. Mr. Allan purchased nearly the whole collection, which upon examination proved to contain a great number of new and rare substances of the highest mineralogical interest, cryolite, sodalite, allanite, with mixed groups of striking variety and novelty; and all in such abundance that most of the cabinets of England (when collectors, if not more numerous, were at least more active than I fear they are at present,) were supplied from this source. Mr. Giesecké himself accidentally arrived at Leith in 1813, not long after Mr. Allan had published an account of his purchases, and with great generosity contributed to the improved catalogues and descriptions of specimens which subsequently appeared. He was soon after appointed Professor of Mineralogy to the Royal Dublin Society, and went to reside in Ireland, where he spent the remainder of his life. About this period also he was honoured with an Order of Knighthood by the King of Denmark; but having now passed his fiftieth year, his health was broken, and much of the energy lost which distinguished his early life. He lived to the age of 72, and died at Dublin in March 1833. Sir Charles Giesecké meditated, after his return from Greenland, an extensive work upon that country; he published a brief account of it in Dr. Brewster's Encyclopædia, but the larger work was deferred till the voyages of Ross and Parry had deprived the subject of the interest of novelty. His meteorological observations appeared in the Edinburgh Philosophical Journal for 1818; and he gave to Mr. Scoresby, for his work on the Greenland Coast, the use of his maps and other materials. The Edinburgh Philosophical Journal for 1822, contains an account of his discovery of the geological situation of Cryolite. His only publications on the mineralogy of Ireland are, I believe, a brief notice of the geological situation of Beryl in the county of Down *, and an account of an excursion to the counties of Galway and Mayo †.

Mr. Alexander Nimmo was a civil engineer of high reputation. He was born in Fifeshire in 1783, and at a very early age showed a strong propensity to physical and mathematical inquiry. One of his first public employments was a survey of some of the bogs in Ireland, on which he delivered a report to the Commissioners in 1811, containing some general observations on the geological character of part of Roscommon, Kerry, Cork and Galway. He was afterwards engaged in various works of great importance, principally in Ireland. He was the author of several articles in Brew-

* Annals of Philosophy, 1825. New Series, vol. x. pp. 74 & 75; republished from the Dublin Philosophical Journal.

† Annals of Philosophy, 1826; republished from the Dublin Philosophical Journal.

ster's Edinburgh Encyclopædia, on subjects connected with his profession. One of his latest and most valuable literary productions, on the publication of part of which he was engaged at the period of his death in January 1832, was a Chart of the Irish Channel, with sailing directions for the coast of Ireland, a performance probably connected with a paper which he laid before the Royal Irish Academy "On Geology as applicable to the Purposes of Navigation."

Mr. David Scott was one of the numerous class of officers in the service of the East India Company who have found means to combine with the most exemplary discharge of their official duties, a constant attention to the interests of literature and science. He was the second son of Archibald Scott, Esq., of Montrose, and died prematurely in India in 1831, at the age of 45, having passed through many offices of high trust with distinguished credit, and holding at the time of his death the situations of Civil Commissioner in Bungpoor and other districts, and agent to the Governor General in the North-east of Bengal. His exertions and success in discharging his official functions, and in promoting the welfare of the country in which he was placed, by diffusing education, were highly appreciated, and a monument has been erected to his memory by the Supreme Government of India. Mr. Scott possessed great knowledge in several branches of science not immediately connected with this institution, and lost no opportunity of attending to geological research. Our Transactions are indebted to him for the substance of a valuable paper communicated by Mr. Colebrooke*, "On the Geology of the North-eastern Border of Bengal," in which is described a remarkable deposit on the left bank of the Burrampooter river, containing an assemblage of fossils that bear an extraordinary likeness to those of the London clay. "Among the remains of fishes," Mr. Colebrooke states, "bony palates and the fins of the Balistes are common to the Indian clay and to that of Sheppey; and the shells of Cooch-behar bear a strong generic, if not specific, resemblance to the marine formations above the chalk in France and England." This communication contains also some valuable facts respecting a succession of strata, like those of our coal-fields, in the Tista and Subuk rivers; and in the same volume, is an extract from a letter written by Mr. Scott, describing the situation of a limestone and clay containing Nummulites at Robagiri, a village in the North-east of Bengal. Such resemblances, though they are far from establishing the contemporaneous formation—much less the continuity—of the groups in which they occur, are interesting, from the proof they furnish, of the operation of similar causes in very distant parts of the former surface of the globe.

On the accounts of the past year put into your hands today, I will make but one observation. From the report of the Auditors it ap-

* Series II. vol. i. pp. 132—140.

pears that the balance of disposable property in favour of the Society, taken at a very moderate estimate, is £2010, while the total amount of the compositions of all the compounders in the List of Fellows since the foundation of the Society does not exceed £2394. The difference is less than £400. If, then, the value of the collections, library, and furniture belonging to the Society be taken into account, our actual property considerably exceeds the claims of all our compounders, our current income being wholly disposable and free.

Wollaston Medal.—The product of the Wollaston Fund during the past year has been awarded to Mr. Agassiz of Neufchatel, in promotion of his work on the "General History of Fossil Fishes."

The first part of Mr. Agassiz's publication has but recently reached England, and the Council have availed themselves of the earliest opportunity of giving support to an undertaking of great geological importance. The author's qualifications for this work were so highly appreciated by the late Baron Cuvier, who had himself been engaged in a similar project, that on seeing Mr. Agassiz's collection of drawings, and hearing a statement of his views, and the results at which he had arrived, that profound naturalist at once transferred to Mr. Agassiz the whole of his materials. The approval of Cuvier is fully sanctioned by the portion of the work which is now before the Society. In deciding on the present award, the Council have acted strictly in compliance with the bequest of Dr. Wollaston. The work of Mr. Agassiz is intimately connected with the objects of this Society; it demands for its completion great labour and expense. It is still in progress, and its publication has been ably commenced with a full assurance of the author's competency to the fulfilment of the task he has begun.

In his prospectus, Mr. Agassiz solicits the contribution of specimens from all quarters; and I cannot better close the announcement of a testimony of approbation which I trust will be gratifying to his feelings, than by requesting the Fellows of the Geological Society to aid the progress of this important work, by giving or lending to its author any drawings and specimens of fossil fishes which they may either possess or obtain. The transmission and return of these loans can be easily effected through the medium of the officers of this house.

The History of Geology has been recently treated by several authors, especially by Mr. Conybeare and Mr. De la Beche, in a manner which would render any observation from me on that subject at once superfluous and imprudent. The communications read at our general meetings have been fixed in your memory by the discussions to which they have given rise, and the published abstract of their contents. Still, however, it may be well to enumerate these communications, that you may measure the exertions made here since the last Anniversary, and the effect they have had on the state of geological knowledge.

Miscellaneous.

The experiments of Sir James Hall mark an important epoch in science. It was with great delight, therefore, that we received from Captain Basil Hall, R.N., a collection of the products of these experiments, and some of the instruments with which they were conducted. Among the latter is a machine for regulating high temperatures, accompanied by an account of its properties and mode of acting.

Mr. Gardner, the well known geographer, has drawn our attention to the curious fact, that of the land on the surface of the globe only $\frac{1}{27}$th part has land at its antipodes.

Sir David Brewster has communicated to us his interesting observations on the properties of the diamond, from which it would appear to be of vegetable origin,—the cavities whence these properties are derived being found in amber, but not in any product either of igneous fusion or of aqueous solution.

Home Geology.

Dr. Mitchell has laid before the Society a detailed account of the geology of Harwich in Essex, of the Reculvers in Kent, of Quainton and Brill in Buckinghamshire. Mr. Dadd has described the Vale of Medway and its neighbourhood. Dr. Fitton, who published in the early part of the year, a geological sketch of the vicinity of Hastings, has supplied us with an account of some instructive sections recently exposed to view at St. Leonard's. Mr. Woodbine Parish has sent to us portions of the Iguanodon and Lepidosteus from the well known "White Rock," situate in the same district, and now almost destroyed. Our knowledge of the inland Extent of the Wealden Formation has been enlarged by a paper of Mr. Strickland, accompanied by specimens of Paludina from the ferruginous sand of Shotover hill.

Mr. Strickland has also rectified the boundaries of some of the strata near Bewdley, and traced a line of fault from the north of Bredon Hill to Little Inkbarrow.

Sir Philip Egerton has supplied us with further information in respect to the lower portion of the Connaught Coal district. Beneath the coal at Kulkeagh in the county of Fermanagh is a shale 600 feet thick, with subordinate layers of black marlstone and clay-iron ore towards the top, and a thin stratum of micaceous grit near the bottom. All the beds are replete with ammonites, orthocera, producta, encrini, corals and calamites. This deposit lies on sandstone separated by the mountain limestone from another bed of shale marked by characteristic fossils, and the entire system therefore appears to bear a strong resemblance to the lower portion of the carboniferous beds in the South-west of England.

In the carboniferous strata of Coalbrookdale, Mr. Prestwich has described a heterogeneous assemblage of plants and shells both of fresh- and salt-water species. A band of ironstone, nearly in the centre of this series, contains four genera of Trilobites: in the same coal-field Mr. Anstice has recognised two genera of insects. On the opposite side of the Severn, Mr. Murchison has found at Pontesbury, Uffington, Le Botwood and other places, a band of compact limestone, between two beds of coal, resembling the lacustrine limestone of central France, and containing freshwater shells. These discoveries may throw light on those which have been since made at Burdie-house and elsewhere in the neighbourhood of Edinburgh.

The structure of other coal-fields has been illustrated by Mr. Murchison, Mr. R. J. Wright, and Mr. England.

After careful examination of the Old red Sandstone, Mr. Murchison has proposed to divide it into three parts: the uppermost, characterized by quartzose Conglomerate; the middle, by Cornstone; the lowermost, by Flagstone. The cornstone and marlstone of the middle group contain undescribed genera of crustacea; and in the tilestone beneath are found some defences of fish, together with a few remains of testacea.

Mr. Murchison has employed three summers in examining a range of country situate between Shrewsbury and Caermarthen; and the geological positions as well as the mineral and zoological characters of the several rocks which border England and Wales are now determined with as much exactness as those of any portion of the secondary system. Taking the old red sandstone as a line of departure, the rocks beneath are disposed in descending order as follows:

1. The Ludlow series, divisible into three parts, the upper, middle and lower. To the middle belong the well-known limestones of Amestry and Sedgley: the upper and lower consist of sand, marl, or flagstone, having some fossils peculiar to each, and others in common. The thickness of the whole is estimated at 1000 feet.

2. The Dudley or Wenlock series, consisting of limestone: its thickness may be taken at 2000 feet.

3. The Hordesley or May Hill series, composed of party-coloured sandstone, conglomerate and impure calcareous flagstone: it is said to attain a thickness of 2500 feet.

4. The Built or Llandilo series, a black flagstone, characterized by the *Asaphus Buchii*.

5. The Longmynd or Linley series, consisting of coarse roof slate, sandstone and conglomerate; no fossils have been discovered in it.

It is well known that Professor Sedgwick has studied with equal assiduity the rocks which lie beneath those I have mentioned. When his observations are published, the Society will have a type of the whole of the transition rocks of Wales. The rocks described by Mr. Murchison are, for the most part, exceedingly well characterized by their fossil contents. Some of the shells which he has discovered, appear to have escaped the notice of antecedent observers; but the genera, if not the species, of others, may occasionally be found in the works of Hisinger and other continental writers. If, then, the transition as well as the secondary and tertiary beds can be identified over great tracts of country by their fossil remains, let us hope that a clue is now at hand, by which we may find our way through that vast assemblage of beds, which, not in England only, but in Scotland, Ireland, Germany, Russia, Sweden, and North America, has hitherto presented to the observer a mere scene of confusion.

In Mr. Murchison's paper we find also, traced with exactness, several hitherto unexplored lines of disturbance, producing sometimes, as in the Abberley Hills, a complete inversion of dip. The rocks which border the old red sandstone, acquire in some places an anticlinal dip, and reappear in parallel ridges far westward of their natural site, insomuch that the Ludlow series is met with even in Montgomeryshire. Mr. Murchison has examined in detail the trappean and porphyritic rocks to which these disturbances are for the most part assignable, but the description of them has been reserved for communications not yet before us.

Professor Sedgwick has transmitted to us a notice on the granite of Shap in Westmoreland. From recent excavations it appears that veins of this granite penetrate the adjoining strata, from which he infers that it is of posterior date.

Mr. De la Beche, one of our Vice-Presidents, acting under the direction of the Board of Ordnance, has produced a geological map of the county of Devon, which, for extent and minuteness of information and beauty of execution, has a very high claim to regard. Let us rejoice in the complete success which has attended this first attempt of that honourable Board to exalt the character of English topography by rendering it at once more scientific and very much more useful to the country at large.

Organic Remains.—Every succeeding year brings to light new fossil animals which cannot be assigned to existing genera. Dr. Riley, deeply skilled in physiology and comparative anatomy, has given us an account of an animal so extraordinary, that naturalists differ even respecting its class. After careful examination, he considers it a cartilaginous fish, partaking of the character both of the Rays and the Squales. Here then is another instance of a link, now wanting to connect existing genera, having formerly existed.

Towards the close of the last session Mr. Channing Pearce exhibited to the Society a matchless collection of Apiocrinites found at Bradford in Wiltshire. To the description of this fossil as given by the late Mr. Miller, Mr. Pearce adds that the column was occasionally ten inches long. He has found in the great oolite, three species of Apiocrinites, differing in the form of their body, and the thickness of its component plates.

Foreign Geology.

Europe.—The structure of the South of Spain has been illustrated by Colonel Silvertop and Captain Cook. From the joint labours of these gentlemen we learn, that the country between the Sierra Morena and the Mediterranean consists of lofty ranges of granite, slate, serpentine and limestone, succeeded either by red sandstone or by vast beds of secondary, compact, dolomitic limestone. We also learn from them that the valleys and plains which border the shore of the Mediterranean, are composed of tertiary strata; but we are indebted solely to Col. Silvertop for pointing out to us, on the authority of M. Deshayes, that the tertiary deposit of Malaga and the districts adjacent belongs to the Pliocene, while that of the basins of Baza and Alhama belongs to the Miocene epoch.

Mr. Lyell has laid before us an account of the lignite formation of Cerdagne in the Eastern Pyrenees. This lacustrine deposit reposes in horizontal beds on granite and hornblende and argillaceous schist at the height of 3000 and 4000 feet above the level of the sea. The shells procured are too imperfect to determine its age.

A memoir on the neighbourhood of Bonn was presented last year by Mr. Horner. After describing the characters of the grauwacke, trachyte, basalt, brown coal, gravel and löss, the author compares the age of these with that of analogous formations in other parts of Europe, and of one another. The beds of grauwacke as they contain Terebratulæ and other shells he refers to the upper part of that system; he considers the brown coal more recent than the plastic clay, some of its plants and shells having been identified with specimens found at Aix en Provence. The löss, which reposes on a thick bed of gravel, and contains existing land shells, together with bones of extinct quadrupeds, is considered the latest deposit, and attributed to the bursting of a lake in the upper part of the Rhine. From the beds of trachytic tuff being interstratified with brown coal, and from the occurrence of a bed of basalt above it, Mr. Horner infers that volcanic operations took place during, and even subsequently to, the deposition of the lignite. Having thus established the comparative age of the brown coal, he also determines that of the volcanic rocks.

The tertiary coal or lignite near Gratz, in Styria, is interesting on account of its organic remains. In the memoir of Professor Sedgwick and Mr. Murchison on the Eastern Alps, the strata of this deposit, which are nearly horizontal, are shown to rest on "an inclined system of secondary green-sand." Imbedded in the coal are various vegetable remains, shells of a Cypris, scales of fishes, and fragments of bones of Mammalia and Tortoises. Professor Anker of the Joanneum, has sent to the Society an account of these, together with the drawing of a jaw, which Mr. Clift conceives to have belonged to a Hyæna.

Mr. Pratt, ignorant of the prior researches of Dr. Christie, carefully examined, in the year 1832, the caves of Monte Grifoni near Palermo; and having ascertained the height to which the perforations of lithodomi extend in each, infers that the change of level was not effected by one movement, but by several.

Asia.—Much information has been received from the East during the past year. Mr. Burnes, distinguished for his travels in India, Persia and Toorkistan, has presented to the Society his geological memoranda of the countries lying between the mouth of the Indus and the Caspian Sea. Mr. Burnes, though he did not travel for the express purpose of studying geology, carefully and faithfully noted whatever attracted his attention. In reading his account of these hitherto almost unknown regions, we cannot but be struck with the resemblance of their geological structure to that of Europe. The central axis of the Hindoo Koosh is composed of granitic rocks, succeeded by various schists, conglomerates, variegated marls, limestones and sandstones. Besides this mighty system, some portion of which cannot be identified with European strata for want of fossils, there is a vast range of salt (previously noticed by Mr. Elphinstone), of coal, and, near the mouth of the Indus, nummulitic limestone.

In a late number of Jameson's Journal is part of a memoir on the structure of the Valley of Ovelipore* by Mr. Hardie, one of our recently elected Fellows.

This valley had previously been noticed by Captain Dangerfield†; but Mr. Hardie has been the first to describe a singular Indian formation which occurs there, called Kunkur. It is rarely, if ever, stratified; it forms a bed, seldom exceeding a few feet thick, which mantles over the irregularities of the country. It is sometimes imperfectly oolitic; at others globular, botryoidal or nodular; in some places a compact limestone; in others it resembles chalk: not unfrequently it contains round and angular fragments of rocks. No animal or vegetable remains have been noticed in it. The author carefully distinguishes Kunkur from modern tufaceous deposits, but assigns to it a similar origin.

America.—Captain Colquhoun and Mr. Burkart have presented to us a specimen of native iron from Zacatecas, and memoranda on this and similar masses found in Mexico.

Captain Bayfield has communicated to us a paper on the shores of the River and Gulf of St. Lawrence from the Saguenay to Cape Whittle. The information contained in this memoir completes our knowledge of the north coast of the St. Lawrence‡; and from the previous labours of Mr. Green in the district of Montmorency§; of Lieutenant Ingall in the country bordering the rivers St. Maurice and aux Lievres‖; of Captain Bonnycastle in Upper Canada¶; of Dr. Bigsby**, Captain Bayfield†† and Dr. Richardson‡‡, on the shores of Lakes Ontario, Erie, Huron and Superior; and of Dr. Richardson in the overland expeditions to the Arctic Seas, we have a

* The city of Ovelipore is in lat. 24° 25′ N. long. 73° 44′ E.

† See Sir John Malcolm's Central India.

‡ See on the country between the St. Maurice and the Saguenay, Trans. Quebec Society, vol. ii. p. 216. On the Saguenay country and St. Paul's Bay, *ibid.* vol. i. p. 79; vol. ii. p. 76. On Quebec, Proceedings Geol. Soc. No. 5, p. 37.

§ Quebec Trans. vol. i. p. 181.

‖ *Ibid.* vol. ii. p. 7.

¶ *Ibid.* vol. i. p. 62.

** Proceedings Geol. Soc. No. 3, p. 23. Trans. Geol. Soc. Series II. vol. i. p. 175. Journal Royal Institution, vol. xviii. pp. 1, 228.

†† Quebec Trans. vol. i. p. 1.

‡‡ Appendix, Expedition to Polar Seas.

general account of the geological structure of the whole country between the mouths of the Mackenzie and Copper Mine rivers and the Gulf of St. Lawrence. The researches made during the expeditions of Captain Ross, Sir Edward Parry and Sir John Franklin, have also given us a general insight into the nature of the formations which constitute a large portion of the shores of the Western Polar Seas. Why should I repress the feeling of patriotic pride which rises within me on contemplating how vast a range of the western continent has thus, in the brief period of a few years, been brought within the pale of our science almost entirely by the exertions of English officers? Great is the gratitude we owe them; yet have their services not been wholly without reward. The taste for scientific research which sprung up in the minds of these gallant men, spontaneously, as it were, and without the aid of regular systematic culture, has been to many of them a welcome relief from the toil and monotony of professional duty; while to others it afforded pleasurable occupation in the solitude of trackless deserts, under exposure to all the rigour of an arctic climate, in the absence of European indulgences, and even under the terrible apprehension of impending starvation.

The district surveyed by Captain Bayfield is bounded by hills, composed of granite, sienite and trap rocks, which enter so largely into the structure of the two Canadas. Clay, sand and gravel, apparently recent, occupy the coast. The Mingan, the Esquimaux and Anticosti Islands are of limestone, containing fossils like those of Lake Huron. But the most interesting feature in this communication is the evidence it affords of a change in the relative position of land and water. In the Mingan Islands is a series of shingle terraces, agreeing in character with the recent beach, the most distant being 60 feet above the level of the highest tide. The author describes, with great care, the different vegetation of each terrace, the one furthest from the shore being covered with trees, the nearest almost barren; parallel to the shore, in this island, natural columns of limestone have been scooped out by the action of water at different periods; the levels of the water-worn portions agree with those of the terraces, and the depth of the scooped parts, with the rise of the present tidal wave of the St. Lawrence. Captain Bayfield has noticed similar terraces on the adjacent mainland and in the neighbourhood of Quebec, and thinks the phænomena indicate successive elevations of the land rather than successive depressions of the water.

Among the subjects which have for some years past engaged the thoughts of geologists, none perhaps has excited so general and intense an interest as the Theory of Elevation. I shall avail myself, therefore, of the present occasion to lay before you a connected statement of the scattered facts and opinions upon which it rests.

On entering upon this subject, it is necessary to understand distinctly what is meant by Elevation. Definitions have recently been decried, I think unwisely. The formation of definitions, it has been said, and the establishment of unerring distinctions are among the last, and not the first steps of systematic knowledge. Equally true, and far more salutary is the lesson that science cannot be advanced by equivocation. As in trading concerns fixed weights and measures are necessary guards against fraud, so in philosophical investigation words of definite meaning are indispensable securities against sophistry and self-delusion. Euclid did not end, he began with defining. Mathematical certainty has no other basis than mathematical precision, and the greater part of those absurdities which from time to time attach themselves to all other branches of knowledge derive their subsistence from ambiguity of language and a dearth of definition.

A torrent brings down a quantity of alluvial matter, and the plain on which it rests is said to be *elevated.*

An opening occurs in the earth; ejected ashes, scoriæ and lava accumulate around it; a Monte Nuovo is formed; and the area it occupies is said to be *elevated.*

By the persevering labour of polypi, a coral reef gradually attains the surface of the ocean; and the fabric so constructed is said to be *elevated.*

A porous rock covers a rock that is not porous; the rain filters through the superincumbent bed; springs break out in the subjacent; and at last, for want of support, the porous rock, originally horizontal, acquires an inclined posture, one end being directed upwards, the other downwards; and the whole is said to be *elevated.*

An earthquake takes place at the mouth of a river; the sea is violently affected; a bar is formed at the entrance of a harbour from the washing in of new alluvion, or from some obstruction to the escape of the old; where a ship floated, a barge is aground; and the land is said to be *elevated.*

Such instances of Elevation are common and incontestible; but elevation of this kind is quite different from that which forms the subject of my present inquiry.

By the term *Elevation,* I mean only the removal of any given object from a lower level to a higher level; consequently it is necessary, before I speak of an object as *elevated,* that I should be prepared to show two things: first, the level at which it has stood; secondly, the level at which it stands.

That I might form a right opinion of the theory, the merits of which I am about to investigate, I have endeavoured to determine the site, the number and the magnitude of those multifarious objects to which the attribute of elevation is continually applied. The attempt has proved unsuccessful: they are indefinite in place, in form, and in dimension. That Mountains should be elevated is not surprising, but we are familiarized also with Valleys of elevation*. In ancient times an Island (Delos, for example,) would alternately

* Valleys of this nature are properly called by Mr. Scrope "valleys of "elevation and subsidence," or more concisely, "anticlinal valleys." See Scrope on Volcanoes, p. 213.

emerge from, and plunge beneath, the sea. Extensive Provinces, nay, entire Kingdoms, now perform the same feat. The existence of Craters of Elevation is by some still considered doubtful; but it is an accredited fact that Mountains and Mountain Chains have risen, either *per saltum* or *per gradus*. All the Strata have been raised; and all Unstratified Rocks would doubtless have been raised also, but that some have risen of themselves. The Bed of the Sea has been elevated again and again. Continents too have been raised, though "by an operation distinct from that which raised the Primary Strata."

The arguments advanced in favour of these doctrines are derived either from observation, or from induction.

It is stated by Von Hoff, that in the year 1771 several tracts of land were upraised in Java, and that a new bank made its appearance opposite the mouth of the river Batavia. The authorities cited for the effect of this and several other earthquakes mentioned in the same place by this author, are Sir Stamford Raffles, John Prior's Voyage in the Indian Seas, and Hist. Gen. des Voy. tom. ii. p.401. Mr. Lyell has cited the first of these only, but no such fact is noted in either edition of the work of Sir Stamford Raffles. The other authorities adduced by Von Hoff I have been unable to consult; but from the Appendix to the Batavian Transactions (which contains an apparently authentic account of all the recorded earthquakes that have taken place in Java during a century and a half,) it would seem, that in the year 1771, in which the uprising is said to have happened in that island, there was no earthquake at all.

The Earthquake of Chili in 1822 has been so much* insisted on, that it requires detailed consideration. Of this event an account by Mrs. Graham is inserted in our Transactions. I am deeply sensible of the honour that lady conferred on the Society by her obliging compliance with the request which elicited her narrative, and it is only the importance of its contents which could induce me to subject them to the test of rigid examination.

According to this account "it appeared on the morning after the "earthquake, that the whole line of coast from north to south, to the "distance of above 100 miles, had been *raised* above its former level." But by what standard was the former level ascertained? who on the morrow of so fearful a catastrophe could command sufficient leisure and calmness to determine and compute a series of changes, which extended 100 miles in length, and embraced (according to a statement in the Journal of Science,) an estimated area of 100,000 square miles? How could a range of country so extensive be surveyed while the ground was still rocking, which it continued to do on that day, and for several successive months? What was the average number of observations per square mile? Who made, checked and registered them? By what means did the surveyors acquaint themselves with what had been the levels and contour before the

* Bakewell's Geology, edition 4, pp. 98. 504. Lyell, vol. i. pp. 401. 455. De la Beche's Manual, edition 2. Scrope on Volcanoes, p. 209.

catastrophe took place, by which, as we are told, all the landmarks were removed, and the soundings at sea completely changed?

Mrs. Graham states that by the dislodgement of snow from the mountains, and the consequent swelling of rivers and lakes, much detritus was brought to the coast; and further, that sand and mud were brought up through cracks to the surface. Amid so many agents it should not be easy to assign to each, its share in the general result.

That fishes lay dead on the shore may prove only that there had been a storm. In her published travels, Mrs. Graham represents them as lying on the beach, which may very well have been thrown up, as the Chesil bank has been, by a violent sea. Some muscles, oysters, &c., still adhered, she says, to the rocks on which they grew; but we know not the nature or dimensions of these rocks, whether fixed or drifted. The occurrence of a shelly beach above the actual sea-level is an observation which must not be lost sight of. I propose to speak of it hereafter: in the mean time be it recollected, that these beaches are said to occur along the shore at *various* heights, along the summit of the highest hills, and even among the Andes.

Neither in the paper of Mrs. Graham, nor in the anonymous account published about the same time in the Journal of Science, can I find any paragraph to justify the position (which, from the seductive character of the work* in which it appears, may, if not now assailed, soon be deemed unassailable,) that a district in Chili, one hundred thousand miles in area, "was *uplifted* to the average height "of a foot or more; and the cubic contents of the *Granitic Mass* "added in a few hours to the land." By what means we get the average I do not know. Mrs. Graham says the alteration of level at Valparaiso, was about three feet; at Quintero, about four feet: but *the granitic Mass!* has the geological structure of Chili been sufficiently examined to assure us that Granite extends over one hundred thousand square miles?

In the well-known work of Molina, a Jesuit who passed the greater part of his life in Chili, and wrote a natural history of that country, I find no ground for supposing that in any earthquakes which took place there from the time the Spaniards first landed on its shores to the date of his publication, any similar phenomena had been noticed. Moreover, the statement of Mrs. Graham, and of the writer before alluded to, respecting the *Elevation of land* which occurred during the earthquake of 1822, has not been confirmed by Captain King, nor by any naval officer or naturalist who has since visited that region, though many have visited it who had heard the circumstance, and who would willingly have corroborated it if they could. But they saw no traces of such an event; and the natives with whom they conversed, neither recollected nor could be induced to believe it.

The 16th number of the "*Mercurio Chileno*," a scientific Journal, contains an account of this earthquake, by Don Camilo Enriquez, which I have not been able to procure. A later number refers to this account, and to another published in the *Abeija Argentina*, a work

* Lyell, vol. i. p. 473.

of considerable reputation, which, by the kindness of Mr. Woodbine Parish, I have been enabled to consult. The account there given of the earthquake of 1822, is strongly recommended to the reader, "as a sensible straight-forward description of what actually took "place, without the high colouring in which ignorance and terror "and exaggeration are apt to indulge."

No notice is here taken of the permanent *Elevation of the Land*, and the account concludes thus:

"The earth certainly cracked in places that were sandy or "marshy; I saw cracks too in some of the hills, but mostly in "the low nook where much earth had run together; the sea was "not much altered,—it retired a little, but came back to its old "place. Don Onofri Bunster, who, on the night of the earthquake, "was walking on the shore at Valparaiso, in front of his house, had "a mind to go up on the hill, but could not, so great was the quan-"tity of falling dust and stones: he repaired to his boat therefore, "and with some difficulty got aboard; this done, he made obser-"vations on the motion of the sea; on sounding, the depth was "thirteen fathoms; he heaved the lead a second time, and the "depth was no more than eight fathoms: this alternate ebbing and "flowing lasted the whole night, *but did not the slightest harm on* "*shore.*"

These are the only cases I remember to have met with, in which the testimony of eye-witnesses has been adduced to prove the Rise of land by Earthquakes. That such Rise may have taken place, at different times, without being recorded, perhaps even without being observed, is not very improbable; but if I am to pronounce a verdict according to the evidence, I believe there is not as yet one well authenticated instance in any part of the world, of a non-volcanic Rock having been seen to rise above its natural level in consequence of an Earthquake.

Before I quit this subject, it may not be amiss to mention, that on comparing the times at which the successive shocks took place in Chili, as given by Mrs. Graham, and the other authorities to which I have had occasion to refer, the discrepancy is extraordinary.

I have already intimated in a few words, my opinion, as to the sense in which land can be said *to be elevated by means of Volcanoes.* Of these, Vesuvius is perhaps the most constantly observed; and among the innumerable authors who have described its effects, from the time of Pliny down to the present day, not one pretends that the Apennine limestone, close at hand, has been in the least raised by that volcano. We shall do well to bear this in mind, when we have occasion to consider the height at which tertiary shells are found on Etna. That those shells belong to beds thrown up by Etna, is a doctrine founded upon induction, not upon experience. As far as experience goes, we have no reason to think that Etna, in its most violent paroxysms, will ever raise those tertiary strata above their present level.

Leaving these scenes of paroxysmal violence, let us next inquire, whether there may not be going on, in the calmest seasons and in the stillest countries, a *chronic and almost imperceptible impulsion of land upwards.*

As early as the time of Swedenborg, who wrote in 1715, it was observed that the level of the Baltic and German Ocean was on the decline. About the middle of the last century an animated and long-continued discussion took place in Sweden, first as to the cause of this phenomenon, and then as to its reality. Hellant, of Tornea, who had been assured of the fact by his father, an old boatman, and who afterwards witnessed it himself, bequeathed all he had to the Academy of Sciences, on condition that they should proceed with the investigation: the sum was small, but the bequest answered the purpose. Some of the members of the Academy made marks on exposed cliffs and in sheltered bays, recording the day on which the marks were made, and their then height above the water. The Baltic affords great facility to those who conduct such experiments, as there is no tide, nor any other circumstance to affect its level, except unequal pressure of the atmosphere on its surface and on that of the ocean: this produces a variation which is curiously exemplified at Lake Malar near Stockholm. As the barometer rises or falls, the Baltic will flow into the lake, or the lake into the Baltic. The variation resulting from the inequality of atmospheric pressure, however, is trifling. In sheltered spots, mosses and lichens grow down to the water's edge, and thus form a natural register of its level. Upon this line of vegetation marks were fixed, which now stand in many places two feet above the surface of the water.

In the year 1820-1, Bruncrona visited the old marks, measured the height of each above the line of vegetation, fixed new marks, and made a Report to the Academy. With this Report has been published an Appendix by Halestrom, containing an Account of Measurements made by himself and others along the coast of Bothnia. From these documents it would appear, 1. That along the whole Coast of the Baltic the water is lower in respect to the land than it used to be. 2. That the amount of variation is not uniform. Hence it follows, that either the Sea and Land have both undergone a *change of level*, or the Land only; a change of level in the Sea only will not explain the phenomena.

A quarter of a century has now elapsed since Mr. von Buch declared his conviction that the surface of Sweden was slowly rising all the way from Frederickshall to Abo, and added that the Rise might probably extend into Russia. Of the truth of that doctrine the presumption is so strong, as to demand, that similar experiments and observations should be instituted and continued for a series of years in other countries, with a view to determine whether any change of level is slowly taking place in those also. The British Association for the Advancement of Science have already obeyed the call. A committee has been appointed to procure satisfactory data to determine this question as far as relates to the coasts of Great Britain and Ireland, and I cannot but hope that similar investigations will also be set on foot along the coasts of France and Italy, and eventually be extended to many of our colonial possessions.

The inductive arguments in favour of the *Elevation of land*, whatever the size, and whatever the amount of Rise, are founded chiefly on the following circumstances: 1. The height of sedimentary beds and marine bodies, whether corresponding or not to those of adjacent seas, or of the actual globe. 2. The height of terraces resembling sea beaches. 3. The height of ripple marks. 4. The change of posture which horizontal strata undergo in the neighbourhood of "unstratified rocks." 5. The various heights at which the same rocks occur in different parts of their course. 6. The anticlinical posture of strata frequent in, though not confined to, mountain chains. 7. The arched or domed configuration of some strata. 8. The occurrence of coral, apparently recent, high above the present surface of the sea. 9. The position of ancient buildings, viz. the temple of Serapis at Puzzoli, &c. I have not time to consider these arguments in detail; each deserves to form the subject of a separate treatise. Some of them prove not Elevation, but only change of level, which Subsidence would explain equally well. Some prove local disturbance, whereby one portion may have been thrown up, the other down. Some again afford a fair presumption of real *local* Elevation or Ascent. Most of them are good to a certain point: all are continually overstrained; and I am frequently astonished to observe how prodigious the weight, how slender the string that supports it.

The assigned *Causes of Elevation* are exceedingly various. One author raises the bottom of the sea by earthquakes; another, by subterranean fire; another, by aqueous vapour; another, by the contact of water with the metallic bases of the earth and alkalis. Heim ascribes it to gas; Playfair, to expansive force acting from beneath; Necker de Saussure connects it with magnetism; Wrede, with a slow continuous change in the position of the axis of the earth; Leslie figured to himself a stratum of concentrated atmospheric air under the ocean, to be applied, I suppose, to the same purpose.

It is impossible within the narrow limits of this discourse, that I can enter into the merits of these and other hypotheses seriatim. I must therefore throw them into two classes, the first of explosive forces, the second of sustaining forces; they are one and the same in Plutonic language, but still it will be convenient to separate them.

That explosive forces exist, or may exist, under the surface, no one can deny; but I cannot adopt the opinion (however high the authority from which it comes,) that "in volcanic eruptions we find a power "competent to raise *Continents* out of the ocean." The force we find in volcanic eruptions is limited in time, place and action; it fuses bodies of easy fusibility; it tosses up those that are refractory, and thus forms either a current of lava or a shower of stones, scoriæ and ashes. What resemblance is there between this operation and the rise of a continent? With more propriety might it have been said that in a mole-hill we behold the action of a cause competent to raise mountains.

If by *Continent* is meant a whole Continent, and nothing but a Continent, its rise, provided this happened only once, would seem difficult to understand; but to me still more incomprehensible is the confident assurance we continually receive from writers of high and deserved reputation, that this event has happened again and again. Before we admit the Submersion of a continent, we must admit either that at a period immediately preceding that catastrophe, there existed under the land a cavity large enough to contain the continent about to be submerged, or that during the process the subjacent beds shrunk in consequence of a reduction of the temperature, and to such an extent that the contraction in a vertical line equalled the distance from the level of the highest tops of the continent to that of the surrounding ocean. In like manner, before we can admit the Elevation of a continent, we must admit either that, at a period immediately preceding that catastrophe, there happened an inroad of sustaining matter equal in thickness and in extent to the Continent about to be uplifted, or that during the process the subjacent beds expanded in consequence of an increase of temperature, and to such an extent that the expansion in a vertical line equalled the distance from the level of the highest tops of the continent to that of the surrounding ocean. These therefore are the events which we are taught to credit, as having taken place again and again, notwithstanding the tendency which caloric has to diffuse itself, and the apparently unaltered dimensions of the fissures and local caverns by which the strata are so often separated or intersected.

I will not expend more of your time in arguing against such doctrines. All men are more or less lovers of the marvellous, but few, I think, will upon reflection approve such marvels as these.

Solids, fluids and aeriform substances exist, we know, in the interior of the earth, and expand by heat, which exists there likewise. All of these, therefore, are fit *Agents of Elevation*, subject to certain conditions.

Dr. Daubeny attributes the liquefaction of lava, the throwing up of ashes, and all other phenomena of disturbance attendant on volcanic eruptions, to the Action of Water upon the Metallic Bases. This cause is not opposed to experience, and appears well proportioned to the effect, which is sudden, violent, occasional, temporary, accompanied by heat and by flame. To me, at least, it seems far more satisfactory than the explanation of those who ascribe the effect to the Elastic Power of Subterranean Fires, repressed in one place and relieved in another, or to the Undulations of a Heated Nucleus.

A heated *Central Nucleus* is a mere invention of fancy, traceable, I believe, to no other source than the hope of obtaining a good argument from the multiplication of bad ones. To the Huttonian and every other geological sectary who relies on this postulate, I say, be cautious; "*incedis per ignes dolosos.*"

The only observation I recollect to have met with in favour of central heat is, that the deepest mines are the warmest—be it so! Might not a geologist by parity of reasoning argue thus?—In travelling from Rome to Chamonix, the country becomes continually more and more mountainous; some of the peaks of Chamonix are from ten to fifteen thousand feet above the level of the sea. Imagine, therefore, what they must be at Hamburgh!!

If mines derive their temperature from heat lodged in the centre of the earth, the temperature ought to vary with their distance from the centre, and therefore, since the earth is an oblate spheroid, the mines of Scandinavia ought at the same depth from the surface to be proportionally warmer than those of tropical countries; a result which has never been, I believe, even suspected.

The existence of *Central Heat* in the sense and to the extent assumed in the Huttonian theory, is contrary to all our experience. If Heat there be in the Centre of the globe, it must have the properties of heat and none other. I ask not how the Heat originally was lodged in that situation, for the origin of all things is obscure; but I ask why, in the countless succession of ages which the Huttonian requires, the Heat has not passed away by conduction, and if it has passed away, by what other heat it has been replaced?

Dr. Chalmers in speaking of Sir Isaac Newton, observes, that it was a "distinguishing and characteristic feature of his great mind, that it "kept a tenacious hold of every position which had proof to substan- "tiate it; but a more leading peculiarity was, that it put a most de- "termined exclusion on every position destitute of such proof. The "strength and soundness of Newton's philosophy was evinced as much "by his decision on those doctrines of science which he rejected, as "by his demonstration of those doctrines of science which he was "the first to propose. He expatiated in a lofty region, where he met "with much to solicit his fancy, and tempt him to devious speculation. "He might easily have found amusement in intellectual pictures, he "might easily have palmed loose and confident plausibilities of his "own on the world. But no, he kept by his demonstrations, his mea- "surements, and his proofs."

Gentlemen, let us, as far as is consistent with the nature of geological investigation, show the strength and soundness of our philosophy in the same manner.

That Heat of considerable intensity prevails occasionally, in certain places, at some depth, is all that we have as yet clearly established. Whether that Heat is permanent, whether it is generally diffused, whether it is central, are questions of mere speculation.

Intimately connected with the hypothesis of *Central Heat* is that of *Refrigeration.*

It has been observed by one of our members, that "the Remains both "of the animal and vegetable kingdom preserved in strata of different "ages, indicate that there has been a great Diminution of Tempera- "ture throughout the northern hemisphere, in the latitudes now oc- "cupied by Europe, Asia and America; the change has extended to "the arctic circle as well as to the temperate zone; the heat and "humidity of the air, and the uniformity of climate, appear to have "been most remarkable when the oldest strata hitherto discovered "were formed. The approximation of a climate similar to that now "enjoyed in these latitudes, does not commence till the æra of the "formations termed tertiary; and while the different tertiary rocks "were deposited in succession, the Temperature seems to have been "still further lowered, and to have continued to diminish gradually "even after the appearance of a great portion of existing species upon "the earth." The little knowledge we have of the fossil productions of countries south of the temperate zone, induces me to believe tha these observations are as applicable to the southern hemisphere as to the northern.

This *Refrigeration,* one of the most undoubted facts in geology, is supposed by the Huttonians, and if I mistake not, by M. Elie de Beaumont and others, to arise from a decrease of the *Central Heat*; an opinion, however, which cannot, I think, be supported.

We know of one method only by which Central Heat, if it exists, can pass from the earth, viz. by Radiation. It cannot pass by Conduction. Conduction implies conductors, which in empty space are not to be procured*, but the Radiation of heat, at low temperatures, is so slight that it is scarcely sensible at 100° of Fahrenheit's thermometer, a temperature twice as great as the medium temperature of the surface of the globe at this time. The Temperature of the earth's surface has been shown by Fourier to be as constant as are the dimensions of its orbit, and the period of its annual revolution. Laplace observes, that our planet has undergone no Contraction of Size during the last 2000 years; consequently there has been no sensible *Refrigeration* during that period, and the last Seculum of M. de Beaumont has already extended to more than twice the length of a Millennium.

Another argument, or rather postulate, has been adduced in favour of *Central Heat,*—the Fusion of Unstratified Rocks, and their forcible Injection into the Stratified.

Gentlemen, I have confessed to you again and again, that I am not aware, nor has any one as yet informed me, by what test Stratified and Unstratified rocks can be distinguished; the only test I know is the good will and pleasure of those who make the distinction. The followers of Pluto seize and appropriate to his use as many rocks as they think proper. By virtue of such seizure, these Rocks become necessarily Unstratified: why so? because if Stratified they would be no longer Plutonic. Stratification I know is a question to be determined not by the senses but by the fancy; otherwise, I would say, that the magnificent range of basaltic cliff, which extends from the county of Derry along the coast of Antrim as far as Fairhead, is as distinctly stratified as any mountain-limestone, oolite or chalk in Great Britain.

However, I waive this objection as it leads me away from my subject, and return to the consideration of *Central Heat.* Have those who believe in this agent ever taken into their account the nature of the substances said to have been fused? Many of the trap rocks, not all of them, (for the family is large, and many of its members have been introduced into it, not by nature but by adoption,) I attribute to the agency of the causes which have produced lava, causes which, comparatively speaking, I do not believe to be very deep-seated. These rocks I put out of consideration for the present; the remarks about to be offered apply to granite and its congeners, under which head I would give to every one full liberty to include or reject quartz rock, gneiss, mica slate, eurite, cipollino, hornblende rock, serpentine, &c. Some or all of these, it is the bounden duty of *Central Heat* to fuse and to eject.

* See Comparative View of the Huttonian and Neptunian Systems of Geology.

Such and so limited are the means of Chemistry, that of many substances thus brought within the sphere of our inquiries, the point of fusion is at this day unascertained. The author of the masterly publication before adverted to, brought together many useful observations upon this subject. He observes that "Lavoisier could not melt a "particle of Carbonate of Lime by the intense heat of a burning mir-"ror, and that Quartz, according to Saussure, requires for its fusion "a temperature = 4043° of Wedgwood's pyrometer, Glass requiring "at a medium only 30° of the same scale."

That the Difficulty, which here suggests itself, of providing, in the absence even of imaginary fuel, a Supply of imprisoned Heat sufficient to fuse the substances I have mentioned and others scarcely less refractory, may be mitigated by extending the time employed in the process, or by the aid of compression and other circumstances, I am ready to admit; but, in the most favourable view of the case, the Heat wanted, (when we consider the thickness and extent of these rocks, comprising entire mountains and mountain chains,) must be prodigious; and I cannot but admire the singular taste of those geological speculators, who, enjoying the free range of the globe, have deposited their Caloric exactly in that spot in which it can be of least use to them. The inconvenience of this distribution becomes still more apparent when it is recollected that fusion is not all that is necessary; but that, when fused, these substances must be propelled in a determinate direction and with sufficient force, in many instances, to raise the bed of the sea to the height of an Alpine chain. I will not attempt to point out to you the way in which this is accomplished, but confess at once that I do not understand it.

And yet it appears certain that the surface of our planet has become cooler and cooler, from the period when organic life commenced to the tertiary epoch. If this cannot be explained by the Escape of Heat, there remains only one other mode of explaining it,—a continually diminishing Supply. The latter is the explanation offered by Mr. Lubbock. Sir John Herschel, also, has brought into view causes within the range of physical astronomy which, independently of a Loss of Internal Heat, produce a slow but certain Diminution of Temperature on the surface of our globe*. These auxiliaries, however, are insufficient.

Mr. Lyell has offered another solution of the problem, depending not on celestial but terrestrial causes. The chapter that contains it abounds in valuable information and ingenious reasoning; but when the author tells us that † in every country "*the land has been in some* "*parts raised, in others depressed, by which and other ceaseless changes,* "*the configuration of the earth's surface has been remodelled again and*

* The Baobab-tree of Senegal is supposed by Adanson to have attained the age of 5150 years, and De Candolle attributes to the *Cupressa disticha* of Mexico a still greater longevity. (Lyell, vol. iii. p. 99.)

If these opinions be correct, it seems improbable that any great change either of level or climate can have taken place at these spots within the last 5000 years.

† Principles of Geology, vol. i. p. 113.

" again since it was the habitation of organic beings, and the bed of the " ocean lifted up to the height of the highest mountains," I cannot but wish that he had stated this as an opinion, not as a fact.

All these theories have one defect in common; they do not meet the whole of the case. We have to explain not only the *Cooling gradual* during the long interval that occurred between the formation of the carboniferous beds and the chalk, but also the *Sudden Chill* which followed, and seems to have continued from that time to this. There is yet another element to be taken into account. The coal-beds of Melville Island contain various plants, natives of the country where they are found, and which, if we may trust analogy, require for their healthy growth or for their growth at all, not only tropical heat*, but a tropical apportionment of the periods of exertion and repose. It is a botanical impossibility that such plants could have flourished in a region in which they must have been stimulated by months of continuous Light, and paralysed by months of uninterrupted Darkness. The distribution of Light, therefore, as well as of Heat, must formerly have been different from what it is at present.

To meet this further difficulty, recourse is had to physical astronomy, which gives us the *Precession of the Equinoxes, and a Shifting Axis of Rotation*: but the periodical changes of astronomers are insufficient to explain the phenomena to which I have just drawn your attention. It has therefore been suggested that a greater change may, in the course of ages, have been produced on the axis of the earth's rotation by some foreign cause, say the *Collision of a Comet.*

Such change is undoubtedly possible, but of possibilities there is no end, and we must circumscribe our researches to render them useful. Sir John Herschel gives us no encouragement, therefore, to proceed with this speculation. Mr. Conybeare also dissuades us from it, but by an argument which to me at least appears inconclusive.

His argument, founded upon the lunar theory, is this,—that the internal strata of the earth are ellipses parallel to its external outline, their centres being coincident, and their axes identical with that of the surface. The present axis of the earth must therefore have been its axis from the beginning. It may have been so, yet I should like to be told by what process the form of the internal strata of the earth had been so nicely determined. Possibly, however, I may not understand the expression " internal *Strata.*" All I believe to be ascertained is, that of corresponding sections of the interior the density is nearly the same, and if so, my inference is, not that the earth has never changed its axis of rotation, but that if it has done so, the interior was then sufficiently pliant to accommodate itself to the change.

A much more formidable objection to the employment of such a cause is, that if once called in, we must take it with all its consequences. The effects produced by it will not be what we wish performed, but what its nature obliges it to perform. In explaining the

* Since this passage was written, doubts have been expressed whether the specimens of these plants preserved at the British Museum are sufficiently distinct to warrant the inference.

phenomena of Melville Island, it might render inexplicable those of the rest of the world. If we choose to change the axis upon which the earth revolves, let us at least fix upon the best time for doing it; now what is that time? immediately after the formation of the carboniferous series? The reduction of temperature at that epoch was inconsiderable; tropical plants and animals are found in the lias, in the oolite series, in the chalk. A much more convenient time would be on the first appearance of the tertiary rocks; but however satisfactory it might be to trace to such a cause the violent changes and disturbances which appear to have taken place about that period in all other parts of the world, I am afraid our satisfaction would be greatly diminished on finding that Gosau and Maestricht * escaped unhurt.

Be the cause what it may, the effect is certain. The Temperature of the Crust of the Earth must have been higher when the Coal-measures were deposited than now, and we have reason to think it was still higher at antecedent periods. That a considerable degree of Heat still exists, either partially or generally, at no great distance from the surface, appears from thermal springs and volcanoes.

I am aware that the doctrine of *Internal Cavities* has been regarded as visionary; and in the extent to which it was carried by some of the old Cosmogenists it was so; but that comparatively near to the surface, there are, I do not say Vacuities, but large Spaces unoccupied by solid matter, is not only probable, but almost proved. It seems, indeed, to be a necessary consequence of the structure of the crust of the earth. No miner has ever got to the bottom of a vein, and a vein itself is often a half empty pipe or fissure. The correspondence of the phases of distant volcanoes, the continuous ranges of their eruptive openings, the vast extent of territory shaken simultaneously by their convulsions, are so many proofs of communication below the surface. The bulk of the ejected matter cannot be less than that of the concreted ejections which we see; for at the temperature of fusion it is greater than at a lower temperature, and for every foot of matter ejected, it is necessary to provide a substitute in the place which it occupied.

The continuous streams of lava which issued in Iceland, on one occasion, attained the length of forty or fifty miles. But the bulk of volcanic matter presented to view, does not enable us to form a correct estimate of the quantity of matter ejected; we must take further into account the combustible substances which have vanished, the gases which have escaped, the dust and ashes which, projected into the air, have fallen many miles distant from the place of explosion †. Then only can we entertain a just idea of the Cavities that must have been created in the interior of the earth by the escape of a mass of matter competent to produce an Etna or a Chimboraço. Such Cavities are ill suited to support such Mountains; La Metherie therefore supposes Cavities to be at a distance, and volcanic matter to flow

* See the descriptions of these places in Geol. Trans.

† In 1783, a submarine Volcano off the coast of Iceland ejected so much pumice that the ocean was covered to a distance of 150 miles, and Ships were considerably impeded in their course.

from these through long galleries and fissures of communication. Nor have we in volcanic countries alone decisive evidence of the existence of subterranean Cavities. No rock is exempt from Fissures : in thick beds of limestone Fissures and Caverns are exceedingly abundant; and the extent of these last is sometimes prodigious. Who has not heard of the Grotto of Antiparos? of the Caverns of Carinthia and Carniola, the content of which amounts to some hundred thousand cubic feet? of the Kingston Cave recently explored near Michelstown in Ireland?

To the frequency of Caverns and Openings, by whatever name designated, I ascribe many of the inequalities which vary the surface of the earth; such openings, I conceive, produce phenomena sometimes of Subsidence, sometimes of Elevation. I cannot entertain a doubt, that many of the tilts and contortions of strata usually ascribed to *Soulèvement,* have been occasioned solely by want of adequate support.

The Duchy of Finland exhibits an endless series of lakes filling up the hollows of a granitic surface. Let me be allowed a similar series of subterranean lakes occupying similar basins beneath the level of the Baltic, and receiving, by means of Fissures extending up to the summits of the Scandinavian chain, a continual supply of water which has no outlet; in other words, let me be allowed the use of hydrostatic pressure; and without having recourse to central heat or secular refrigeration, I think I shall be able to account, without difficulty, not by a general and uniform Rising, but by a number of unequal and partial Risings, for the phenomena observed along the shores of the Baltic.

Steam is often referred to as capable of producing the same result, nor will I deny that it might do so under favourable circumstances; but I apprehend Steam rarely does act in nature under such circumstances; for its existence depends on the access of heat, and its force on close confinement, contingencies not very likely to occur in the porous and fissured strata of the earth. Any of the various Gases, if compressed, might also become agents of elevation, but only under the same conditions as steam.

I have reserved for the last the popular theory which accounts for Elevation by the forcible *Inroad of igneous rocks into sedimentary.*

To put this theory to the test, it is natural to inquire, what igneous rocks are. My answer is, whatever geological speculators think proper to call so. The late Professor Dugald Stewart cautioned us strongly, though, alas! in vain, to avoid the language of theory. Appearances, he observes, "should always be described in terms which involve no "opinion as to their causes. These are the objects of separate examination, and will be best understood if the facts are given fairly, "without any dependence on what should yet be considered as unknown; this rule is very essential where the facts are in a certain "degree complicated."

In dealing out to rocks the appellation of *igneous,* some geologists are more liberal than others. I have not time to enumerate the various rocks which enjoy this title, still less to investigate their respective claims to retain it. I will therefore content myself with observing, that in the scantiest catalogue they are many in number, and consequently, if ejected in a state of fusion, must have been ejected from different reservoirs and cauldrons, not from a *central* cauldron.

That any rock whatever was originally igneous, is a gratuitous assumption. Lavas themselves may be, and probably are, in very many cases, Rocks not originally igneous, but Rocks which have been exposed at one time or other to the action of fire.

Granite is one of the rocks most usually considered as an *Agent in Elevation,* for what reason I am at a loss to discover. Solid Granite has no inherent principle of motion; if it move, it can only be by virtue of the impulsion it has received from some other body, not in consequence of its igneous origin or its want of stratification. The disturbances of strata that adjoin granite are not more constant, nor more striking nor more extensive than those of strata far remote from it, as for instance, the limestone shales of Derbyshire or the coal-beds of Liege. Granite veins are too small to raise mountains, and the changes or anomalies that take place at the junction of granite with other rocks, whatever else they may prove, appear to me to have no bearing on the question of *Elevation.* On the other hand, the arguments adduced against the doctrine that Granite while fluid has been forcibly injected from beneath into its present position, are to my mind conclusive; especially that which is founded on the frequent transition which takes place from Granite to the rocks that adjoin it. We find a continuous series from Granite through Gneiss and Mica slate to Clay-slates and the Fossiliferous Slates; and it is not possible to stop at any point of this progress, and to say in which direction the tendency is strongest. If the gradation were single, the difficulty would be great, but what shall we say to a repetition of such gradations? In Mr. Weaver's paper on the East of Ireland, two detailed sections are given, in one of which, more than six layers of Granite alternate with as many of Mica slate, and in the other five alternations of the same kind occur, the rocks in each instance forming bands from three to seventy fathoms in thickness.

The reliance which some authors place on Granite and other unstratified rocks, as *Agents of Elevation,* is to me very extraordinary; let one instance suffice. At Castrogiovanni in Sicily, the Pleiocene Beds attain an altitude of three thousand feet; hence it has been inferred, that *since these beds were deposited, there has been formed and introduced into the beds subjacent, a body of Granite, Sienite, Porphyry or other crystalline and unstratified Rocks three thousand feet in thickness.* This supposition is said to be necessary, but since I do not see the necessity, I will venture another supposition, viz. that Etna has not risen to the height of ten thousand feet without occasioning large cavities in its neighbourhood, some of them submarine; that Castrogiovanni is situate over one of these; that the Pleiocene strata have closed the cavity and rendered it water-tight, except on the side of Etna; from whose lofty flanks and cloud-capped crater the caverns beneath are regularly supplied by fissures with rain-water and melted snow. Let the author grant me so much,—I ask no more. The hydrostatic paradox has tripped up the hills of the geological one, and I behold my Pleiocene beds mounted at once on a pedestal three thousand feet high, and capable of still further promotion.

If the explanation here offered meets the case of Castrogiovanni, it will equally account for the height of the tertiary beds in different parts of the Val di Noto, and for similar phenomena in every country which is or has been formerly the site of volcanic eruptions.

To the appearances on the Gulf of St. Lawrence, described by Captain Bayfield, I have already adverted.

My Predecessor directed your attention last year to the existence in the Morea of four or five distinct Ranges of ancient Sea-cliffs, marked at different levels in the limestone escarpments by lithodomous perforations, lines of littoral and sea-worn caverns, and other striking proofs of former tidal action. Similar Terraces have been observed in Sicily, in Chili, in the Gulf of St. Lawrence and various other places. At Uddevalla in Sweden, are ancient Beaches with shells of living species, two hundred feet above the level of the Baltic, a height strikingly disproportionate to the very moderate Rise ascertained to have taken place in other parts of the Scandinavian coast: many examples of similar phenomena have been found in Great Britain. It would be rash to offer a solution of these phenomena in the gross. Every individual case deserves separate examination. All I undertake at present is to put a new key into the hands of the decipherer.

It was my intention on commencing this address to have discussed at some length the theory of M. Elie de Beaumont, but there is not time now to do it justice. He belongs to that class of authors whose opinions, right or wrong, always instruct me. There is no part of his theory which does not evince thought and diligence, a habit of correct observation and an enlarged mind. In some respects I differ from him, and it will not be difficult to infer from what I have already said, wherein the difference consists. Should these observations engage his notice, I would beg him to consider whether the disturbances in the Alps and elsewhere have not been generalized rather more than they will bear, whether the tilts and upliftings may not have taken place bit by bit at various epochs, and whether, if the *secular Refrigeration of the Globe* cannot be established, and *Central Heat* be an *Ignis fatuus*, his attention may not be usefully directed to more partial but better authenticated sources of disturbance and elevation.

Allow me, in conclusion, to say a few words upon a subject in connexion with which my name has of late been brought forward much more prominently than I could have desired;—I mean *Diluvial Action*.

Some fourteen years ago I advanced an opinion, founded altogether upon physical and geological considerations, that the entire earth had, at an unknown period, (as far as that word implies any determinate portion of time,) been covered by one general but temporary Deluge. The opinion was not hastily formed. My reasoning rested on the facts which had then come before me. My acquaintance with physical and geological nature is now extended; and that more extended acquaintance would be entirely wasted upon me, if the opinions which it will no longer allow me to retain, it did not also induce me to rectify. New data have flowed in, and with the frankness of one of my predecessors, I also now read my recantation.

The varied and accurate researches which have been instituted of late years throughout and far beyond the limits of Europe, all tend to this conclusion, that the geological schools of Paris, Freyberg and London have been accustomed to rate too low the various forces which are still modifying, and always have modified, the external form of the earth. What the value of those forces may be in each case, or what their relative value, will continue for many years a subject of discussion; but that their aggregate effect greatly surpasses all our early estimates, is I believe incontestably established. To Mr. Lyell is eminently due the merit of having awakened us to a sense of our error in this respect. The vast mass of evidence which he has brought together, in illustration of what may be called *Diurnal Geology,* convinces me that if, five thousand years ago, a Deluge did sweep over the entire globe, its traces can no longer be distinguished from more modern and local disturbances. The first sight of those comparatively recent assemblages of strata, which he designates the *Eocene, Meiocene* and *Pleiocene* Formations, (unknown but a few years ago, though diffused as extensively as many which were then honoured with the title of universal,) shows the extreme difficulty of distinguishing their detritus from what we have been accustomed to esteem Diluvium. The Fossil Contents of these formations strongly confirm this argument. M. Deshayes has shown that they belong to a series unbroken by any great intervals, and that, if they be divided from the secondary strata, the chasm can have no relation to any such event as is called The Flood.

Further, the elephants and other animals once supposed to be exclusively *Diluvial,* are now admitted to be referrible to two or three distinct epochs; and it is highly probable that the blocks of the Jura Mountains, of the North of Germany, of the North of Italy, of Cumberland, Westmorland, &c., are not the waifs and strays of one, but of several successive Inundations.

It is, Gentlemen, a well-known rule of such institutions as ours, that the "Authors alone are responsible for the facts and opinions contained in their respective productions." Under that feeling have I spoken on the present occasion, and having freely set before you what has occurred to me on some points of general interest to our science at this time, I think it my duty, in concluding this address, to disclaim and deprecate any attempt to connect what I have here expressed with the general sentiments of the Geological Society. The opinions I have uttered are my own, and I should be sorry that more importance should be attached to them than they intrinsically deserve, from the accident of their having been delivered from this Chair. Had not the whole responsibility fallen on myself, I should have hesitated, or perhaps altogether forborne to bring before you Opinions, several of which I know are little in accordance with those of some of the most distinguished members of our association.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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February 26.—Charles Allsop, Esq., of Broombriggs, near Loughborough; James R. Hope, Esq., B.A., Fellow of Merton College, Oxford, Royal Hospital, Chelsea; and Williamson Peile, Esq., of Whitehaven, were elected Fellows of this Society.

A paper "On the Quantity of Solid Matter suspended in the Water of the Rhine," by Leonard Horner, Esq., F.G.S., F.R.S., was first read.

The experiments referred to in this paper, were made by the author at Bonn, in the months of August and November. The apparatus which he used was a stone bottle capable of containing about a gallon, and furnished with a cork covered with greased leather, having a long string attached to it. A weight was suspended from the bottle by a rope of such a length, that when the weight touched the ground, the mouth of the bottle was at the desired distance from the bottom of the river. The cork was then removed by the string, and the instant the bottle was full it was drawn up.

The first set of experiments was made in August, at 165 feet from the left bank of the river, and at 7 feet from the surface, or 6 feet from the bottom. The Rhine was unusually low, and the water was turbid and of a yellowish colour. The quantity of solid matter obtained from a cubic foot of water, and slowly dried, was 21·10 grains, or about $\frac{1}{20,734}$th part. The residuum effervesced briskly with diluted muriatic acid, was of a pale yellowish-brown colour, smooth to the touch, and in appearance and properties undistinguishable from the loess of the Rhine Valley.

The second set of experiments was made in November on water taken from the middle of the river, and about one foot below the surface. A great deal of rain had fallen some time before, and also fell during the experiment. The water was of a deeper yellow than on the former occasion, but when taken up in a glass was not very different in appearance. The residuum of a cubic foot weighed 35 grains, or the $\frac{1}{12,500}$th part. The author then enters into an approximate calculation of the medium quantity of earthy matter borne down by the Rhine during 24 hours. He assumes that the annual mean breadth of the river opposite Bonn, is 1,200 feet, the mean depth 15 feet, the mean velocity $2\frac{1}{2}$ miles in an hour, and the average amount of solid matter held in suspension to be 28 grains in the cubic foot of water. From these data he deduces the result that 145,981 cubic feet of solid matter are borne past Bonn every 24 hours.

A paper was next read, entitled, "Observations on the Geological Structure of the Neighbourhood of Reading," by J. Rofe, Esq., and communicated by Robert Hunter, Esq., F.G.S.

This communication was accompanied by a collection of fossils from the neighbourhood of Reading, and was prepared by the author chiefly to point out the localities and geological connexions of the specimens; but he also describes some beds belonging to the plastic clay, which are not mentioned in the published accounts of the district.

In detailing the section presented by the Katsgrove pits, he states, that the upper part of the chalk is perforated to about the depth of a foot by tubular cavities resembling those made by the Teredo in wood. The oyster-bed, which rests upon the chalk, he says, is divisible into two parts, each about a foot thick, the lower consisting principally of brown clay, and the upper of the sand containing green particles. Above this bed the author observed about a foot and a half of clay, and in the quartzose sand resting upon it a layer of ochreous nodules. The account given by Dr. Buckland of the strata above the one last mentioned*, the author says is correct, with the exception of a thin bed of shells which occurs about 6 feet from the top of the section, and which is not mentioned in Dr. Buckland's paper. This bed was also noticed by Mr. Rofe in many other places in the immediate neighbourhood of Reading, and at Woodley Lodge, about three miles to the east of the town. At the latter locality the order of the beds is as follows:

Blue clay, about	40 feet.
The shelly stratum.	
Mottled clay..............	55 —
Ditto, occasionally sandy....	35 —

In conclusion, the author states that all the wells in Reading, excepting those supplied by land-springs, both on the north and south of the Kennet, and even within 30 yards of its banks, are regulated by the Thames, rising and falling with that river. This phenomenon, he conceives, may be accounted for, by the Kennet flowing over a bed of tenacious clay, whereas the Thames flows over gravel resting immediately upon chalk, into which the wells are sunk.

March 12.—Col. Pasley, C.B., Royal Engineers, Woolwich; the Knight of Kerry; and Edward Hill, Esq., B.A., of Christ Church, Oxford, were elected Fellows of this Society.

A paper was read, entitled, "Observations on the Temple of Serapis at Pozzuoli, near Naples; with Remarks on certain Causes which may produce Geological Cycles of great Extent. In a Letter to W. H. Fitton, M.D., from Charles Babbage, Esq."

* Geol. Trans., 1st Ser., vol. iv. p. 278.

The author commences this paper with a general description of the present state of the Temple of Serapis, and gives the measurement of the three marble columns which remain standing, and which, from the height of 11 feet to that of 19, are perforated on all sides by the *Modiola lithophaga* (of Lamarck); the shells of that animal remaining in the holes formed by them in the columns. A description is then given of the present state of twenty-seven portions of columns, and other fragments of marble, and also of the several incrustations formed on the walls and columns of the temple.

The conclusions at which the author arrives are—

1. That the temple was originally built, at or nearly at the level of the sea, for the convenience of sea-baths, as well as for the use of the hot spring which still exists on the land side of the temple.

2. That at some subsequent period the ground on which the temple stood subsided slowly and gradually; the salt water, entering through a channel which connected the temple with the sea, or by infiltration through the sand, mixed itself with the water of the hot spring containing carbonate of lime, and formed a lake of brackish water in the area of the temple, which, as the land subsided, became deeper, and formed a dark incrustation.

The proofs are, that sea-water alone does not produce a similar incrustation; and that the water of the hot spring *alone* produces an incrustation of a different kind; also, that Serpulæ are found adhering to this dark incrustation; and that there are lines of *water-level* at various heights, from 2·9 feet to 4·6 feet.

3. The area of the temple was now filled up to the height of about seven feet with ashes, tufa, or sand, which stopped up the channel by which sea-water had been admitted. The waters of the hot spring thus confined converted the area of the temple into a lake, from which an incrustation of carbonate of lime was deposited on the columns and walls.

The proofs are, that the lower boundary of this incrustation is irregular; whilst the upper is a line of water-level, and that there are many such lines at different heights;—that salt water has not been found to produce a similar incrustation;—that the water of the Piscina Mirabile, which is distant from the sea, but in this immediate neighbourhood, produces, according to an examination by Mr. Faraday, a deposit almost precisely similar;—that no remains of Serpulæ, or other marine animals, are found adhering to it.

4. The temple continuing to subside, its area was again partially filled with solid materials; and at this period it appears to have been subjected to a *violent* incursion of the sea. The hot-water lake was filled up, and a new bottom produced, entirely covering the former bottom, and concealing also the incrustation of carbonate of lime.

The proofs are, that the remaining walls of the temple are highest on the inland side, and decrease in height towards the sea-side, where they are lowest;—that the lower boundary of the space perforated by the marine Lithophagi is, on different columns, at different distances beneath the uppermost or water-level line;—that several fragments of columns are perforated at the ends.

5. The land continuing to subside, the accumulations at the bottom of the temple were submerged, and Modiolæ attaching themselves to the columns and fragments of marble, pierced them in all directions. The subsidence continued until the pavement of the temple was at least nineteen feet below the level of the sea.

The proofs are derived from the condition of the columns and fragments.

6. The ground on which the temple stood appears now to have been stationary for some time, but it then began to rise. A fresh deposition, of tufa or of sand, was lodged, for the third time, within its area,—leaving only the upper part of three large columns visible above it.

Whether this took place before or subsequently to the rise of the temple to its present level, does not appear; but the pavement of the area is at present *level* with the waters of the Mediterranean.

The author then states several facts, which prove that considerable alterations in the relative level of the land and sea have taken place in the immediate vicinity. An ancient sea-beach exists near Monte Nuovo, two feet above the present beach of the Mediterranean;—the broken columns of the Temples of the Nymphs and of Neptune, remain at present standing *in the sea*;—a line of perforations of Modiolæ, and other indications of a water-level 4 feet above the present sea, is observable on the sixth pier of the bridge of Caligula; and again on the twelfth pier, at the height of 10 feet;—a line of perforations by Modiolæ is visible in a cliff opposite the island of Nisida, 32 feet above the present level of the Mediterranean.

The author considers the preceding inferences as a legitimate induction from the observed and recorded facts; and proceeds to suggest an explanation of the gradual sinking and subsequent elevation of the ground on which the temple stands. From some experiments of Col. Totten, recorded in Silliman's Journal, he has calculated a table of the expansion, in feet and decimal parts, of granite, marble, and sandstone, of various thicknesses, from 1 to 500 miles, and produced by variations of temperature of 1°, 20°, 50°, 100°, 500° of Fahrenheit: and he finds from this table, that if the strata below the temple expand equally with sandstone, and a thickness of five miles were to receive an accession of heat equal only to 100°, the temple would be raised 25 feet;—a greater alteration of level than is required to account for the phenomena in question. An additional temperature of 50° would produce the same effect upon a thickness of ten miles; and an addition of 500° would produce it on a bed only a single mile in thickness.

Mr. Babbage then adverts to the various sources of volcanic heat in the immediate neighbourhood: and he conceives that the change of level may be accounted for by supposing the temple to have been built upon the surface of matter at a high temperature, which subsequently contracted by slowly cooling down;—that when this contraction had reached a certain point, a fresh accession of heat from some neighbouring volcano, by raising the temperature of the beds again, produced a renewed expansion, and which restored the temple to its present level. The periods at which these events happened are then compared with various historic records.

The second part of this letter contains some views, respecting the possible action of existing causes, in elevating continents and mountain-ranges, which occurred to the author in reflecting on the preceding explanation. He assumes as the basis of this reasoning the following established facts:

1. That as we descend below the surface of the earth at any point, the temperature increases.

2. That solid rocks expand by being heated; but that clay and some other substances contract under the same circumstance.

3. That different rocks and strata conduct heat differently.

4. That the earth radiates heat differently, or at different parts of its surface, according as it is covered with forests, with mountains, with deserts, or with water.

5. That existing atmospheric agents and other causes, are constantly changing the condition of the surface of the globe.

Mr. Babbage then proceeds to remark, that whenever a sea or lake is filled up, by the continual wearing down of the adjacent lands, new beds of matter, conducting heat much less quickly than water carries it, are formed; and that the radiation, also, from the surface of the new land, will be different from that from the water. Hence, any source of heat, whether partial or central, which previously existed below that sea, must heat the strata underneath its bottom, because they are now protected by a bad conductor. The consequence must be, that they will raise, by their expansion, the newly formed beds above their former level;—and thus the bottom of an ocean may become a continent. The whole expansion, however, resulting from the altered circumstances, may not take place until *long* after the filling up of the sea; in which case its conversion into dry land will result partly from the filling up by detritus, and partly from the rise of the bottom. As the heat now penetrates the newly formed strata, a different action may take place; the beds of clay or sand may become consolidated, and may contract instead of expanding. In this case, either large depressions will occur within the limits of the new continent, or, after another interval, the new land may again subside, and form a shallow sea. This sea may be again filled up by a repetition of the same processes as before:—and thus alternations of marine and freshwater deposits may occur, having interposed between them the productions of dry land.

Mr. Babbage's theory, therefore, may be thus briefly stated.—In consequence of the changes actually going on at the earth's surface, the *surfaces* of equal temperature within its crust, must be continually changing their form, and exposing thick beds, near the exterior, to alterations of temperature; the expansion and contraction of these strata will probably form rents, raise mountain-chains, and elevate even continents.—The author admits that this is an hypothesis; but he throws it out, that it may be submitted to an examination which may refute it if fallacious,—or, if it be correct, establish its truth,—because he thinks that it is deduced directly from received principles, and that it promises an explanation of the vast cycles presented by the phænomena of geology.

March 26.—William Palmer, Esq., of Essex Court, Temple, and Alexander Melville, Esq., F.R.S., of Upper Harley Street, were elected Fellows of this Society.

A letter was first read from Charles Denham Orlando Jephson, Esq., M.P., F.G.S., to George Bellas Greenough, Esq., P.G.S., "On Variations of Temperature in a Thermal Spring at Mallow."

The observations recorded in this letter were made principally during the autumn and winter months of 1833. The extreme variations were 67° and $71^\circ\frac{3}{10}$, the difference depending, in Mr. Jephson's opinion, on the quantity of water acted upon. From 80 to 100 yards north of the spring at which the observations were made, are other thermal springs, the temperature of which is 1° higher, and from 60 to 80 yards to the south is a cold spring, having a temperature of 54°. The formation from which the waters issue is limestone.

A letter was then read from William Henry Egerton, Esq., F.G.S., addressed to Charles Lyell, Esq., For. Sec. G.S., "On the Delta of Kander."

The Kander in its ancient course flowed parallel to the Lake of Thun, and emptied itself into the Aar, beyond the village of Heimberg; but in consequence of the injury done to the land by its frequent inundations, the Government of Bern determined to direct its waters into the lake of Thun. This object was finally accomplished about the year 1713, by making two parallel tunnels, about a mile in length, between the original course of the river and the lake; and no sooner was the Kander admitted into them than it burst up the arches, tore away the masses of rock which obstructed its passage, and bore a vast heap of gravel and detritus into the lake. The delta thus commenced, and increased by the sedimentary matter brought down during nearly 120 years, now presents a tract covered with trees, extending about a mile along the original shore, and a quarter of a mile from it into the lake. The depth of the ravine by which the Kander now enters the lake is 50 feet. The depth of water at the part occupied by the delta Mr. Egerton could not ascertain, but, from the declivity of the ancient banks, he conceives that it must have been considerable, and Saussure found some parts of the lake to be 350 French feet in depth. The author determined by actual measurement the angle at which the new deposit dips beneath the waters of the lake, at the extremity of the delta. At 30 yards from the shore, he found 14 fathoms of water; at 60 yards, 23 fathoms, and at 120 yards no bottom at a depth of 32 fathoms.

A communication by Colonel Sykes was then read, entitled, "A Notice respecting some Fossils collected in Cutch by Captain Smee, of the Bombay Army."

The district from which the specimens were procured is situated between the 23rd and 24th parallels of N. lat. and 70th and 71st degrees of E. long., and is bounded on the E. and S. by the Run. The fossils consist of four species of Ammonites, one of Trigonia, two of Astarte, one of Corbula, one of Gryphæa, and a coral having a nummulitic form. One of the Ammonites has a general resemblance to *A. Wallichi,* and another agrees in some respects with *A. Nepauliensis,* both of which occur in the fossils procured in the Himalaya range; one specimen of the Gryphæa is stated to resemble closely the Gryphæa of the Oxford clay of England; and the coral belongs to the genus which occurs in the Kressenberg iron ore. Specimens of silicified wood, lignite and alabaster from Cutch were also exhibited, and of durable oolite from near Poorbunda, on the W. coast of the peninsula of Goojrat; and it is stated that the same rock is found abundantly at Raujcote in the centre of the peninsula. In conclusion, Colonel Sykes observes, that if English analogies may be taken for a guide, the district from which the above fossils were obtained would seem to be composed of secondary rocks, as Ammonites, Trigonia, and Gryphæa have not been found in England higher than the upper chalk.

A paper was afterwards read "On the Gravel and Alluvial Deposits of those Parts of the Counties of Hereford, Salop, and Worcester which consist of Old Red Sandstone; with an Account of the Puffstone, or Travertin of Spouthouse, and of the Southstone Roch near Tenbury," by Roderick Impey Murchison, Esq., V.P.G.S.

The district of which the transported materials are described is bounded on the west by the transition rocks, extending from the environs of Ludlow to the S.W. of Kington, and on the E. by the Abberley Hills, thus including a large portion of the trough of old red sandstone. It is shown that all the detritus within these limits has been derived from the adjacent rocks. In the neighbourhood of Kington bowlders of the contiguous trap rocks are found upon the talus of the Ludlow rocks, extending to the edge of the old red sandstone, and in the plain W. of Ludlow the surface of the old red is frequently covered with coarse gravel, in which are numerous fragments of the trap rocks of the W. of Shropshire. In general, however, the gravel is chiefly made up of the debris of transition rocks, the coarser varieties being found only near the boundary of those formations. Detailed sections are given in the neighbourhood of Ledbury; and the valley of the Teeme is particularly described to prove that, on receding from the transition chains, the gravel becomes more finely comminuted, and exhibits near Tenbury the characters of lacustrine or fluviatile sediments, the materials of which consist exclusively of fragments of the surrounding rocks of old red sandstone.

Two remarkable cases of a modern travertin, 5 and 8 miles E. of Tenbury, are then cited, the one near the Spouthouse farm, the other the Southstone Roch, both of which have been accumulated in narrow dells, which intersect transversely promontories of the old red sandstone. At the former the travertin is associated with much sandy marl. The latter is a cavernous rock of about 50 feet in height, and has a superficies of more than a quarter of an acre, having on its surface a small house and garden. In both cases the travertin incloses Helices of existing species, and has been occasionally quarried for purposes of building and burning to lime.

These modern rocks are shown to have been formed by small springs which issue from the calcareous or cornstone strata of old red sandstone, and still encrust the leaves and grasses over which they flow, a process which the author (judging from the size of the rocks produced) supposes to have been in undisturbed action during the whole period of history.

Although no bowlders of foreign rocks are to be found in the districts above described, it is stated that on the northern confines of the old red sandstone near Bridgenorth and Wenlock, there are many large fragments of granite of various sorts. These are also seen in abundance on the flanks of the Wrekin, but they are not to be traced into the area of the old red sandstone, and as they are entirely different from any of the Welsh rocks, the author refers them to a northern region. In conclusion, it is suggested that the superficial accumulation of the old red sandstone of Salop, Herefordshire, and Worcestershire may be referred to causes in operation during three epochs, which may hereafter be divided into other distinct periods.

1. To the currents caused by the elevation of the adjacent transition rocks of Wales, when the associated volcanic action was in full activity.

2. To the subsequent degradation of the old red sandstone, both when submarine and during its elevation.

3. To various alluvial causes, of date posterior to the desiccation of the old red sandstone, including the erosion of rivers, the deposits of partial lakes, and the accumulation of travertin.

April 9.—James Bryce, Jun., Esq., M.A., of Belfast; the Rev. Edward Tagart, of Addison-road, Kensington; William Hopkins, Esq., M.A., of St. Peter's College, Cambridge; the Rev. Christopher Sykes, of Roop, near Hedon, Yorkshire; and Sir Charles Mansfield Clarke, Bart., M.D., of Saville-street, were elected Fellows of this Society.

A paper was first read, entitled "A short notice of the Coast Section from Whitstable in Kent to the North Foreland in the same County," by William Richardson, Esq., F.G.S.

The author commences his memoir by describing the changes which the line of coast has undergone; and he states that many parts of it, as Hearne Bay and the Old Haven, near Bishopstone, have completely lost the features to which they owe their appellation. He then enters into a minute detail of the London and plastic clays, of which the district is principally composed. He shows that the former constitutes the whole of the cliffs from Whitstable marshes to Hearne Bay, and the upper part of that to the eastward of it. The clay he divides into two portions; the higher contains much sand and green earth, and is occasionally marked with patches and streaks of light blue or green clay; and the lower preserves the usual characters of the formation. The only organic remains which he noticed were fragments of wood, teeth of fishes, and portions of an Encrinite and of *Pentacrinites sub-basaltiformis*. Iron pyrites and selenite are stated to abound in every part of the clay, and amber and jet to be occasionally found in it. A minute description is given of the Septaria, which are said to be very numerous and to have the surface often covered with small ramifications resembling branches flattened by pressure.

Of the plastic clay formation only the sandy portion is said to occur on the coast. It first appears to the east of Hearne Bay rising from beneath the London clay at an angle of about 5°, and extends to Birchington, where it is succeeded by chalk. It contains beds of pebbles and friable sandstone inclosing shells. Sectional lists are given of the cliff near Bishopstone, and of that on which the Reculver Towers are situated; and the author rectifies the error in the "Outlines of England and Wales," where it is stated that the Reculver cliff is composed of London clay. The fossils mentioned in the paper are confined to the genera Venus, Cerithium and Trochus, and the remains of fishes. The chalk which forms the coast from Birchington to the North Foreland is mentioned only for the purpose of showing that it declines to the westward at the same angle as the superior formations. A bed of brown loam containing a few flints is described as covering the surface of the London and plastic clays, and to be thickest in those parts where the cliffs rise to the greatest height. The vast accumulation of bones in the oyster-bed opposite Swale Cliff is also described, and among those obtained by the author are the remains of the elephant, horse, bear, ox and deer.

A paper was afterwards read, "On the several Ravines, Passes, and Fractures in the Mendip Hills and other adjacent Boundaries of the Bristol Coal-field, and on the geological Period when they were effected," by the Rev. David Williams, F.G.S.

The district included in this memoir comprehends the western portion of the Mendip Hills, and the western and north-western boundaries of the Bristol coal-field. It presents a series of lofty ridges composed of mountain limestone and traversed by deep transverse ravines which connect the valleys on the opposite sides of the ridges. The author describes, in great detail, the characters, both physical and geological, of each ravine; and shows that in consequence of their being filled, in part, with horizontal beds of dolomitic conglomerate, red marl, and lias, they were formed previously to the deposition of those formations; but he also shows that the ravines have been subsequently acted upon by a body of water, forming what he terms valleys of denudation in valleys of elevation.

In describing the defile of St. Vincent's Rocks, near Bristol, the author states, that he has discovered two lines of fracture independent of the one noticed in the memoir of Dr. Buckland and Mr. Conybeare on the south-western coal-field*. He says that the principal evidence which he has of the existence of these two faults, rests on the beds of clay, belonging to the lower limestone shale, occurring twice on both sides of the ravine between the first fault and the commencement of the shale beds in their true position beneath the mountain limestone.

In alluding to the bone-caves and fissures of the Mendip Hills, the author conceives that they were formed contemporaneously with the ravines; and that he had found among their organic contents the remains of the Mastodon.

April 23.—Sir Oswald Mosley, Bart., M.P., of Rolleston Hall, Staffordshire; and Edward J'Anson, Esq., of Burntwood Grange, Wandsworth Common, were elected Fellows of this Society.

A paper was first read, "On the Tertiary Formations of the Kingdom of Murcia, in Spain," by Charles Silvertop, Esq., retired Brigadier in the Spanish Service, K. R. O. C. III., F.G.S.

This memoir is a continuation of papers on the tertiary formations of the South of Spain, read before the Society during the last and preceding Sessions†. The district described is situated in the south-eastern portion of the kingdom of Murcia, and consists of extensive plains and valleys of tertiary formations, bounded by discontinuous ridges of mica slate, transition rocks, and nummulitic limestone. The tertiary deposits the author divides into four districts, which he names from the principal towns situated in their immediate neighbourhood, viz. Lorca, Totana, Alhama and Mula, and Cartagena.

The tertiary strata of Lorca he separates into two systems, one characterized by the beds being horizontal, the other by their being highly inclined. The horizontal beds consist of reddish friable sandstone and greyish marl. In the sandstone the author noticed no organic remains; but near the eastern boundary of the district he observed, in a mass of clay mixed with sand, innumerable small oysters; and in a yellowish, calcareous freestone, corals, clypeasters, pectens, and oysters. The best points for examining the argillaceous beds are stated to be in the ravines between Lorca and Velez Rubio, where they consist of about fifty feet of marl, containing a few thin strata of reddish pulverulent sandstone, and inclose shells belonging to the genera Pecten, Ostrea, Venus, Tellina, Murex, Emarginula, &c. Upon the argillaceous strata rests a bed of conglomerate in which the author found the long-hinged oyster, so abundant in the newer formations of the South of

* Geol. Trans., 2nd Ser., vol. i. p. 241.

† Proceedings of the Geol. Soc., vol. i. pp. 216, 234, 485.

Spain. The inclined system occurs in the immediate vicinity of Lorca, and consists in the lowest part of sandy loam and sandstone, calcareous and quartzose freestone, and fine conglomerate; and in the upper part of foliaceous, indurated marl, gypseous marl, and gypsum. No organic remains were noticed by the author. The strata dip towards the north at an angle of 15 or 20 degrees, and rest upon the highly-inclined beds of transition rocks.

Totana. This village is about twenty miles E.N.E. of Lorca, and is situated in a prolongation of the highly-inclined gypseous system of the latter place.

Alhama and Mula. In the immediate neighbourhood of Alhama no tertiary strata occur, but to the north of the plain extending from it to Murcia, is a hilly tract in which is situated Mula. The southern part of this tract is composed of an immense deposit of earthy, whitish-grey, argillaceous marl, containing numerous beds of gypsum and brine springs, and the northern of a thick series of sandstone and argillaceous beds which are slightly inclined towards the south and dip under the former. In the alternating sandstone and argillaceous beds, portions of the long-hinged oyster were found. Beneath this series, in the neighbourhood of Mula, occur beds of reddish sandy loam and sandstone, resting on highly inclined strata of nummulitic limestone; and to the north of this ridge of limestone is an horizontal deposit of the tertiary, shelly freestone before described. Along the south-eastern border of the hilly district, the gypseous formation is disturbed in the same manner as at Lorca and Totana.

Cartagena. In the neighbourhood of this town the tertiary strata are extensively developed, and constitute, apparently, the whole of the great plain which ranges from Cartagena northwards to the Fuensanta ridge. On the southern extremity of the plain the strata dip towards the north, and at the northern extremity towards the south. The surface of the district consists of clay, marl and sand, which the author conceives have been derived from the decomposition of the tertiary strata. The beds from the eastern termination of the Fuensanta ridge to the Segura, consist of the calcareous sandstones and comminuted shelly limestone; and in the neighbourhood of Cartagena the same beds are well displayed in numerous and extensive quarries.

The author in conclusion states that M. Deshayes considers the tertiary deposits of this portion of Murcia to belong to the second and third epochs.

A memoir was afterwards read, "On the Geology of the Bermudas," by Lieut. Nelson, of the Royal Engineers; and communicated by the President.

The author commences the memoir with a general description of the form, structure, and meteorological phenomena of the Bermudas, and draws a minute comparison between the characters which they present, and those assigned by Kotzebue to the Coral Islands in the Pacific.

He says that the Bermudas consist of about one hundred and fifty islets, lying within a space of fifteen miles by five, and situated on the S.E. side of a zone of coral reefs, approximating in form to an ellipsis, the *major* axis of which is twenty-five miles and the *minor* thirteen. The highest point is stated to be Sears Hill, 260 feet above the level of the sea; and the undulating portions of the islands are described as resembling sand-hills in shape, and chalk downs in colour.

The whole group is composed of calcareous sand and limestone, derived from comminuted shells and corals, and the different varieties are associated without any definite order of position, the harder limestones occasionally resting upon loose sand. The arrangement of the beds is often domed-shaped, but in many instances the strata are singularly waved.

The bottom of the basin within the zone of coral reefs is stated to consist of corals, calcareous sand, and soft calcareous mud resembling chalk, and considered by the author to have been derived from the decomposition of Zoophytes.

Under the head of encroachments, he describes the banks of detritus thrown up by the sea, and the progress which, under certain circumstances, the loose sand makes in overwhelming tracts previously fertile. He states that wherever the shrubs and creepers have been destroyed, the sand has spread rapidly, but that it is invariably stopped as soon as it arrives at a plantation or row of trees.

The shells found by the author in the sand as well as the limestone, belong entirely to recent species, the most abundant being the *Venus Pensylvanica*, which in some of the islands constitutes entire beds. The only vegetable remains which he observed were casts of the root of a plant considered by the natives to belong to the palmetto which now grows upon the island.

Caverns are stated to be very numerous, and their origin is assigned to the undermining action of the sea.

The memoir concludes with an account of the method by which the author conceives coral islands and reefs are formed.

May 7.—Richard Prime, Esq., of Walburton near Arundel; William Henry Breton, Esq., Lieut. R.N.; Edmund Buxton, Esq., of Devonshire Place; and Capel Cure, Esq., also of Devonshire Place, were elected Fellows of this Society.

A paper was first read, "On the Distribution of Organic Remains in the Lias Series of Yorkshire, with a View to facilitate its Identification by giving the Situation of its Fossils," by W. Williamson, jun., Esq. of Scarborough.

The part of the Yorkshire coast to which this paper immediately refers, extends from the Peak Hill near Robin Hood's Bay to the village of Saltburn near Redcar. The lias presents the threefold arrangement of alum-shale, marlstone, and lias marl or lower lias rock.

The first of these deposits, the author says, consists of three distinct divisions, viz. (*a*) soft, rubbly shale 130 feet thick, (*b*) hard shale breaking into large lamellar blocks, 30 feet thick, and (*c*) soft sandy shale from 15 to 20 feet thick. The upper part of the superior bed of soft shale (*a*) is characterized by *Ammonites striatulus*, *A. communis*, *A. crassus*, and *Trigonia literata*; the middle portion, from which alum is manufactured, by *Ammonites Walcottii*, *A. heterophyllus*, and *Nautilus astacoides*; and the lowest by *Ammonites exaratus*, *A. elegans*, *Nucula ovum*, and the remains of saurians. The hard shale (*b*) is distinguished by the presence of jet, *Ammonites elegans*, *Belemnites compressus*, *B. tubularis*, and *Inoceramus dubius*; and the lower bed of soft shale (*c*) by the great abundance of *Ammonites annulatus*.

The marlstone, or second division of the lias series, is characterized by *Ammonites Hawkerensis*, *A. Clevelandicus*, *A. Stokesii*, *Belemnites conicus*, *B. elongatus*, *Turbo undulatus*, *Dentalium giganteum*, *Isocardia lineata*, *Cardium multicostatum*, *C. truncatum*, *Corbula cardioides*, *Amphidesma recurvum*, *Mya V-scripta*, *M. literata*, *Plagiostoma læviusculum*, *Pecten equivalvis*, *P. sublævis*, *Avicula inæquivalvis*, *A. cygnipes*, *Plicatula spinosa*, *Modiola scalprum*, *M. Hillana*, and *Terebratula bidens*, *T. subrotunda*, *T. tetrahedra*, and *T. triplicata*.

The lower lias rock is distinguished by *Ammonites planicostâ*, *Plicatula spinosa*, *Hippopodium ponderosum*, *Lutraria ambigua*, *Pinna folium*, *Gryphæa depressa*, *G. Maccullochii*, *G. incurva*, *Pentacrinites Briareus*, and *P. vulgaris*.

In preparing these lists, the author says that he has omitted to mention those fossils which he has not seen, or those which, from their rarity, can be of little use in distinguishing the different subdivisions of the lias series; and in conclusion, he states, that he has found the fossils enumerated above, almost invariably in the beds to which he has assigned them; and he is of opinion that similar sections may be drawn up on the same minute scale of the contents of all the other strata, but that it remains for further investigation to determine to what extent.

A paper was afterwards read, entitled, "Observations on the Loamy Deposit called Loess in the Valley of the Rhine," by C. Lyell, Esq., For. Sec. G.S.

In this paper Mr. Lyell details some observations made by him in the summer of 1833, on the loess between Cologne and Heidelberg, and in several parts of Baden, Darmstadt, Würtemberg and Nassau. Near Bonn large deposits of loess containing recent shells rest on the gravel of the plain of the Rhine. The author collected two hundred and seventeen entire shells, of which one hundred and eighty-five individuals were of terrestrial species belonging to the genera Helix, Pupa, and Clausilia, and thirty-two of aquatic species of the genera Limnea, Paludina and Planorbis. This large proportion of land shells is very general in the formation. The author then made a collection of such shells as are now drifted down by the Rhine and occasionally cast ashore by the waves, in which case the shells for the most part retain their colour and are perfectly distinguishable from fossils washed out of the loess. Out of two hundred and seventy-three individuals thus procured, one hundred and forty-seven were land shells and one hundred and twenty-six aquatic. The author infers that if the waters of the Rhine were now received into a lake, the sediment of such a lake might contain more terrestrial than aquatic shells.

After some observations on the hollows and furrows in the gravel of the Rhine which have been filled with loess, the author states that the interior of the crater of the volcanic mountain called the Roderberg is in great part filled up with pure loess, which was pierced to the depth of 65 feet in digging a well in 1833. But although this and other sections prove the posteriority of the loess in general to the volcanic formations of the Eifel, Mr. Lyell admits that at Andernach there have been considerable falls of pumice, scoriæ and volcanic sand during the period of the formation of the loess. In proof of this, the sections in the Kirchweg near Andernach, are described.

The loess is then stated to be spread almost everywhere over the tertiary and secondary strata around Mayence, Oppenheim, Alzey, Flonheim, Eppelsheim and Worms. There is a section of loess with shells, alternating several times with gravel, at the Manheim gate of Heidelberg.

The loess between Heidelberg and Heilbronn appears to attain the height of seven or eight hundred feet above the sea. In this district, shells of the *Succinea elongata* alone are so abundant as to exceed in number all the accompanying land shells. The author then mentions the loess near Stuttgard and between Göppingen and Boll in Würtemberg. He found no traces of it in the course of a tour by Heidenheim, Solenhofen, Nuremberg, Bayreuth, and the cave district of Müggendorf, but he found it again between Bamberg and Wurtzberg in the valley of the Mayne. It was wanting in the Spessart and the country around Aschaffenberg, but is abundant near Frankfort and in several parts of Nassau. In the valley of the Lahn near Limburg, it contains its usual shells and alternates frequently with gravel.

From these facts and others mentioned in the paper, the author deduces the following conclusions:—

First, That the loess is of the same mineral nature as the yellow calcareous sediment with which the waters of the Rhine are now commonly charged.

Secondly, The fossil shells contained in the loess are all of recent species, consisting partly of land and partly of freshwater shells.

Thirdly, The number of individuals belonging to land species usually predominates greatly over the aquatic, and this seems now to be the case with the modern shells drifted down by the Rhine.

Fourthly, Although the loess when pure appears unstratified, it must have been formed gradually, as the shells contained in it are numerous and almost all entire, and beds of shelly loess sometimes alternate with strata of gravel or volcanic matter.

Fifthly, Some volcanic eruptions must have taken place during and after the deposition of loess.

In conclusion, the author states that great changes must have occurred in the physical geography of the basin of the Rhine since some of the loess was deposited, and consequently at a comparatively modern geological era, when the recent testacea existed.

As the waters must have been at rest when the loamy sediment was thrown down, we must suppose one or many temporary lakes and ancient barriers which have since been removed. It is shown that to assign the probable places of these would be very difficult, and more data are required respecting the greatest height which the loess attains.

May 21.—Thomas Clements Parr, Esq., was elected a Fellow of this Society.

A paper was read, "On certain Trap Rocks in the Counties of Salop, Montgomery, Radnor, Brecon, Caermarthen, Hereford, and Worcester; and the Effects produced by them upon the stratified Deposits," by Roderick Impey Murchison, Esq., V.P.G.S. F.R.S. &c.

Having established an order of succession in the various sedimentary formations between the carboniferous series and the older grauwacke slates, the author proceeds in this memoir to explain the nature of the trap rocks which rise to the surface in the region under review. These rocks are described in the following order.

1st. Those which protrude in separate ridges through various members of the grauwacke series between Lilleshall Hill, Salop, on the north-east, and Llangadock, Caermarthenshire, on the south-west.

2nd. The Malvern and Abberly Hills, including dykes which traverse the old red sandstone.

3rd. Rocks penetrating the coal measures.

I. *Shropshire and Montgomeryshire.*—Lilleshall Hill consists chiefly of compact felspar rock, having in parts a sienitic structure. The Wrekin, which has been described by Mr. A. Aikin in the Geological Transactions*, is of nearly similar composition. Lea and other rocks near Wrockardine have the same base, but pass into porphyry and clinkstone.

In Charlton Hill, porphyries and greenstones occur where they had not been previously noticed.

These rocks mark parallel axes of different lengths on the north bank of the Severn, ranging from north-east to south-west, and piercing through beds of grauwacke, chiefly those of the third, or Horderley and May Hill † formation, the sandstones of which, on the sides of the Wrekin and Arcal, and at Charlton Hill, are converted into quartz rocks at their points of contact with the trap.

The line of disturbance occasioned by the protrusion of the zone of Charlton Hill, is traced in certain trap rocks which appear in the bed of the Severn, near Cound, extending thence to the south-west.

Caer Caradoc.—This remarkable ridge, formerly described by Mr. A. Aikin ‡, is on a line of eruption parallel to that of the Wrekin.

* Geol. Trans., 1st Series, vol. i. p. 191.

† *Ante*, Table, p. 13.

‡ Geol. Trans., 1st Series, vol. i. p. 207.

It includes the hills of Lawley, Great and Little Caradoc, Helmeth, Ragleath, &c., together with a large *contrefort* on its south-eastern face. At Cardington and Hope Bowdler it consists of many varieties of felspar rock, sienite and greenstone. The beautiful amygdaloid with actynolite first pointed out by Dr. Townson, and supposed to be peculiar to one spot, is shown to be of frequent occurrence in several of these hills. The axis of elevation of this ridge has been traced by the author to nearly six miles south-west of the limit formerly assigned to it, the trap reappearing at Wartle Knoll, Hopesay, Sibdon, Aston and Corston.

Numerous examples are adduced of the conversion of sandstone into quartz rock where in contact with the eruptive rocks of these hills, particularly on the south-eastern flank of the Lawley, Little Caradoc, and Cardington Hills, the strata of sandstone being thrown off the flanks of the trap rock in vertical and dislocated forms, in some of which the traces of bedding are with difficulty observed. These conversions of sandstone on the sides of the Wrekin and Caradoc Hills are supposed to have been caused by the action of heat, accompanying the forcible intrusion of some of these trap rocks. A large mass of impure limestone, somewhat indurated, and containing many fossils of the Ludlow formation, has been heaved into a vertical and detached position at Botville, on the north-western face of Caer Caradoc.

Besides these dislocated masses, the author describes a portion of the third formation (May Hill and Horderley), which rises from beneath the Wenlock shale, contains organic remains, and reposes on the flanks of these trappean hills, as being in structure so analogous to the unstratified rocks themselves, that he terms it "*Volcanic Sandstone*," and conceives that it must have been formed during a period of volcanic action, and that the materials of which it is composed are the residue of ashes given off during submarine ejections. A similar rock is found near the Wrekin.

Longmynd, Linley, Pontesford, and Haughmond Hills.—The ancient grauwacke system of the Longmynd and Linley Hills, or mineral axis of Shropshire*, is penetrated by a vast number of points of eruptive trap, chiefly greenstones. Pontesford Hill, amid varieties of greenstone, contains also a porphyry and a remarkable amygdaloid. This zone is reproduced at intervals in Sharpstone Hill, and has been observed by the author in Haughmond Hill, four miles north-east of Shrewsbury, where it passes into a coarse sienite. Vertical, veined, and indurated strata appear at different points along these lines of eruption. Copper ores have been partially worked on the western sides of the Longmynd, and at Norbury. Quartz crystals and small portions of anthracite are found here and there, and at Lyds Hole are jaspidified red sandstones, with abundant veins of carbonate of lime, &c., the whole being in a state of extreme contortion and irregularity.

Shelve, Corndon, &c.—The mining district of Shelve is an iso-

* *Ante*, p. 14.

lated tract, separated from the Linley and Longmynd Hills by the remarkable ridge of quartz rock, called the Stiper Stones. It is made up of parallel ridges of trap, and alternating depressions in grauwacke. The trap rocks of this district are greenstones, porphyries, claystones, &c. These are separated by the author into two classes; the one, alternating conformably with the strata of the third and fourth grauwacke formations, is supposed to be contemporaneous with them; the other is shown to be posterior to the consolidation of the stratified deposits. In the contemporaneously formed traps are several varieties, some of which, although aggregates of compact felspar with a concretionary structure, contain organic remains: others graduate into the class of volcanic sandstone. The first are best seen near Leigh Hall, the latter in the Corndon flagstones, Mary Knoll dingle, &c., where they are largely quarried.

The other class, or the intrusive trap, rises to the greatest heights and to the largest masses in the Corndon, Stapely, Taudley, and Roundton Hills, which form the chief axis of the district; but there are other linear eruptions, many of which are of extreme tenuity, occasioning numerous alternations of trap and grauwacke. The trap rocks consist of greenstones, porphyritic greenstone, compact felspar, concretionary felspar simple and porphyritic, amygdaloids, &c.

Some remarkable parallel dykes are described running from north-east to south-west between beds of grauwacke, shale, and calcareous flag, which latter in some instances is converted near the prismatic ends of these dykes, into cream-coloured porcellanite. In the grauwacke adjacent to the trap are also many productive veins of lead, which are respectively described at the Snailbach, Penally, Bog, Gravel, Grit, and Roman Mines.

Besides these ores of lead, sulphate of barytes, sulphuret of iron, and carbonate of lime are very abundant.

Stiper Stones.—This dentated and lofty ledge of quartz rock belongs to sandstones of the fifth formation of the previous table*, which have been altered by igneous action, and thrown up into their present highly inclined and broken forms by the eruption of volcanic rock, lines of which are pointed out both on the western and eastern faces of the ridge, and some of which it is presumed lie concealed beneath it.

To the west and south of the above district small portions of trap are noticed at Nantcribba, Montgomery, and at Heblands near Bishop's Castle.

Breiddin Hills.—These hills are divisible into ridges running from east-north-east to west-south-west, which, although parallel to each other, are not parallel to those previously mentioned. The eastern or chief of these is marked at one extremity by the Middleton and Moel y Golfa Hills, and at the other by those of Builthey and Bauseley. In this ridge are compact felspar rocks, slaty

* *Ante*, Table, p. 13.

porphyries, greenstone, and much concretionary rock, frequently of very large size. These trap rocks burst through strata of grauwacke, in some of which fossils of the Ludlow and Wenlock formations have been found. The strata in contact are much hardened and fractured, and contain many veins of carbonate of lime, and sulphate and carbonate of barytes, &c. &c.

The other chief ridge, or that on which Rodney's Pillar stands, is composed in great part of coarse-grained columnar greenstone, passing at its extremities into fine concretionary trap and clinkstone. The Criggan, a third or minor ridge, included between these, exhibits bosses of greenstone, with altered and silicified schists on their sides.

A new locality of singularly spotted trap rock piercing through an impure limestone full of shells, is noticed at the Cefn, between the Moel y Golfa and Welch Pool.

The celebrated quarries of building-stone at Welch Pool expose a broad dyke of columnar greenstone, passing in one part into concretionary trap traversing strata of the same age, and producing great changes in them in contact. The direction of this great dyke is in the prolongation of the volcanic axis of the Breiddin Hills. The last traces of these concretionary traps are observable in Powis Castle Park.

Radnorshire.—The trap rocks in Radnorshire run in distinct ridges from north-east to south-west: the most eastern are those near Old Radnor; the central or chief masses range from Llandegley and Llandrindod to Builth; a third and unimportant ridge occurs at Baxter's Bank, five miles north-west of Llandrindod.

Old Radnor Group.—These trap rocks occupy two parallel ridges comprising Stanner Rocks, Worsel Wood, and Hanter Hill on the south-east, and Old Radnor Hill and its dependencies on the north-west. These rocks are distinguishable from all others mentioned in this memoir by the abundance of hypersthene, and exhibit many passages from a coarse crystalline hypersthene rock to a fine-grained greenstone. Unlike the hypersthene rocks in the Isle of Skye, their base is for the most part of compact felspar, which passes into granular felspar, porphyry, &c.

In Old Radnor Hill, besides hypersthene rock and greenstone, there are concretionary traps, bastard serpentine, &c. Towards Harpton Court these latter rocks throw off a peculiar conglomerate, having a base of felspar inclosing pebbles of quartz, which the author supposes to have been formed by a mixture of volcanic matter with submarine detritus.

The eruptive masses of trap tilt the strata of the Ludlow formation on the one side, and those of the Wenlock rocks on the other, the most interesting phænomena being observable near Old Radnor church and the quarries to the south of it, where the limestone has been cleared away from the abrupt faces and points of the intrusive rock. Bands of imperfect serpentine are frequent between the trap and the limestone. The latter, near the contact, is wholly unstratified, crystalline, and hard, and only resumes its ordinary appearance at a certain distance from the trap. The shale is altered into a hard slaty substance. Coatings and nests of anthracite, together with minute veins of copper ore and iron pyrites, appear near the junction, sometimes running from the trap into the altered deposits.

The author states that the phenomena are very analogous to those of the Val di Fassa in the Tyrol.

On the north-eastern prolongation of this line of eruption is the limestone of Nash Scar, which, although at its extremities (Woodside and Corten,) is demonstrably the equivalent of the Wenlock and Dudley rocks, yet in this central part is a craggy mass of altered and crystalline limestone, the changes in which are doubtless due to the igneous influence which has shown itself on the same line at Old Radnor.

Llandegley, Llandrindod, and Builth Group.—This large trappean district having a length of nearly ten miles and a breadth of five, is very similar in structure and physical features to that of Shelve and Corndon in Shropshire, consisting of sharp ridges of trap and deep trenched valleys in grauwacke, all running from north-east to south-west. It is further analogous in presenting some evidence of volcanic eruptions of date contemporaneous with the sedimentary deposits containing the *Asaphus Buchii.* Transverse sections near Gelli and Buries, illustrate these phenomena of repeated conformable alternation of concretionary felspar and other rocks of igneous origin with stratified shelly deposits.

The most prominent elevations of trap consist of greenstones of many varieties, felspar rock with quartz crystals, porphyries, both amorphous and slaty, passing into porphyritic greenstone, amygdaloids of various characters, concretionary rocks, claystone, &c.

The author points out, in some detail, the reckless folly which has led people in this district to seek for coal by driving horizontal galleries through the black schist on the sides of these eruptive ridges, endeavours which they have been led to persevere in from the occasional presence of small pieces of anthracite near the junctions.

The altered strata of grauwacke within and around the exterior of these hills are of too frequent occurrence even to be named in an abstract. Among a great number of cases, the author calls particular attention to the south-western termination of the great mountain of Carneddau near Builth, where certain lower ridges of greenstone, &c., cut through the shale and calcareous flag containing the *Asaphus Buchii*, the beds of which are distorted, broken, indurated and silicified, and in some instances changed to a milk white colour, and to a brittle condition resembling some sorts of porcelain. Numerous and large crystals of iron pyrites occur in these altered beds, and as the mineral waters of the Park wells issue from them, their origin is supposed to be due to the decomposition of the crystallized pyrites. Hence the author infers that the mineral sources of Builth, Blaen Eddw, Llandegley and Llandrindod, which severally issue from pyritized beds of grauwacke at points of contact with intrusive rocks, are as much the result of volcanic action as the mineral veins of Shelve in Shropshire.

Baxter's Bank contains a coarse-grained greenstone throwing off black shale, which, in contact, is a silicified schist. Galleries in search of coal have also been driven through these inclined strata. A little spur of trap reappears at Caerfagie, one mile south-west of Baxter's Bank.

Brecknockshire.—A ridge of trap rock of about three miles in length and half a mile in width, extends from the stream of Nant-einon on the north-east to the right bank of the Yrfon near Llanwrtyd on the south-west. The gorge, in which the little river Cerdin flows, separates this ridge into two mountains, Gaer *Cwm* and Carn Dwad.

The predominant character of the trap is porphyritic, including greenstones, compact felspar rocks, &c. Some of the porphyry is columnar. This nucleus is irregularly coated over with a thin and broken covering of highly altered grauwacke schist, which is frequently in the state of Lydian stone, from beneath the dislocated beds of which bosses of trap protrude. Other varieties of altered rock in contorted positions are seen on the flanks of the ridge, in some of which are crystals of iron pyrites and small portions of carburet of iron.

Absurd trials for coal, similar to those previously described, have been made on the sides of these hills. The mineral source of Llanwrtyd issues from the pyritized schist on the banks of the Yrfon, and it was from a conviction that the phenomena in this case might be due to volcanic action similar to that noticed in the cases near Llandrindod and Builth, that the author was induced to examine this remote district. The result justified his anticipations, and led him to the discovery of this intrusive ridge.

Caermarthenshire.—The only example of trap rock in the large portion of Caermarthenshire which has been examined, was detected last summer in the small rocky knoll of Blaen-Dyffrin-garn, about three miles south-east of Llangadock. This trap is more or less porphyritic, from which state it passes into a rock having a base of compact felspar in parts containing concretions and disseminated green earth. It throws off strata of sandstone of about the same age as those found on the sides of the Wrekin and Caer Caradoc, and the phenomena resulting from the contact are identical with those of Shropshire, the sandstone being converted into a hard and granular quartz rock, having a conchoidal fracture.

This line of altered rocks runs precisely parallel to the strike of the strata of the grauwacke series, and is traceable for miles to the south-west, the most prominent elevation of the quartz rocks being Cairn-goch, formerly a Roman camp.

Small metalliferous veins, chiefly of lead, have been found along this line of eruptive elevation, particularly on the right bank of the river Sowdde.

The only lead mines now in work in Caermarthenshire are at Nant y Moen, seven miles north of Llandovery, and it is highly worthy of remark, that although these are situated so far to the westward of the range of fossilliferous grauwacke, their relations are analogous to those of the Shelve district, in presenting on one flank a mountainous wall of highly altered conglomerate and quartz rock running from north-east to south-west, which forms the chief rider to those veins, as in the case of the Stiper Stones in Shropshire.

II. *Malvern and Abberley Hills.*—The author highly commends the description of the Malvern Hills published by Mr. Horner in the Geological Transactions*, and refers to it for a faithful account of their mineralogical structure. The present memoir dwells more at length on the effects produced by these sienitic rocks upon the grauwacke strata among which they have been protruded, and which have been altered into chloritic and micaceous schists, highly indurated grits, &c.; whilst others, although unaltered, have been thrown into an inverted position, as pointed out upon a former occasion†.

The author points out the existence of certain bosses of sienite and greenstone in Cowley park to the north of the main chain. He then proceeds to indicate the various points at which masses of eruptive rock hitherto unnoticed appear at the surface in the northern prolongation of the direction of these hills, and connect the Malvern with the Abberley Hills. These are the hills of Berrow, Woodbury and Abberley. They are all of rounded forms, and so covered with vegetation that their structure can only be ascertained from the knobs of rock which occasionally protrude. They chiefly consist of concretionary, compact felspar, sometimes containing crystals of common felspar. That they have, however, a mineral nucleus similar to that of the Malverns, is to be inferred from two observations: 1st. The discovery at the north end of Berrow Hill of a small boss of rock having quite a granitoid character, being made up of compact felspar, quartz and silvery mica, and therefore undistinguishable from a sienite of the Malverns. 2ndly. The discovery of a remarkable dyke at Brockhill, on the right bank of the river Teme, Worcestershire. This dyke is evidently a spur from the trappean hills of Woodbury and Abberley, from the first of which it is distant only 1½ mile, being thrown out in a direction from east to west. The dyke cuts through the old red sandstone, and consists chiefly of sienite or sienitic greenstone perfectly analogous to many varieties of the Malvern Hills. It is in great part columnar, the ends of the columns being at right angles to the walls of the dyke. The strata in contact with the trap are much hardened; the mica appears to be driven off from the sandstone, the colour of which is changed to a dingy dark purple; and the associated marls and cornstone are converted into hard amygdaloids, with veins of carbonate of lime, crystals of iron pyrites, &c. &c.

Another dyke of trap traversing the old red sandstone, which is marked in Mr. Greenough's map, occurs at Bartestree near Hereford. It is a basaltic greenstone, with olivine, and the strata in contact are affected similarly to those of Brockhill near Abberley.

III. *Trap Rocks penetrating the Coal Measures.*

Clee hills.—The basalt of the Titterstone and Brown Clee Hills having been described, the author only refers to his former communications for the purpose of stating, that Mr. Lewis of Knowlbury

* Geol. Trans., 1st Series, vol. i. p. 281.
† *Ante*, p. 18.

has proved the existence of an eruptive wall of basalt which cuts off the coal of the Treen pits, precisely in the linear direction of that which has been called the Jewstone (basaltic) fault. The coal in the proximity of the basalt is much altered and of no value.

Wenlock and Coalbrook Dale.—The greenstones and amygdaloids which rise up at various points through the carboniferous limestone and coal measures of this tract, are marked by the author on the Ordnance map, but he suggests that their chief interest will be apparent when the survey of all the dislocations of these coal fields by Mr. Prestwich, shall have been completed.

Kinlet.—This is rather a peculiar trap, being a greenstone in which white spots of granular felspar are dotted through a base of dark hornblende. It rises into knolls, protruding through the coal measures, flanked by old red sandstone.

Arley and Shatterford.—This dyke of trap has been described by the Rev. J. Yates*, to which account the author adds some details respecting its structure, and the beds of coal, sandstone and shale upon its sides; the chief additional fact being, that the red sandstone which immediately surrounds this narrow zone of coal measures is not the *new* red sandstone of Bewdley and Kidderminster as formerly supposed, but a girdle of *old* red sandstone, with beds of cornstone, which is distinctly separated from the new red sandstone and folds round this peninsulated carboniferous tract.

Conclusion.—From the natural phenomena described in the preceding pages it appears,

1. That volcanic agency satisfactorily accounts for the appearance of all the varieties of trap rock which are associated with the grauwacke series, the old red sandstone, and carboniferous strata in the country under review.

2. That from the imperceptible passages which take place between the different varieties of these trap rocks it is difficult, from mere lithological characters, to assign a separate age to each.

3. That as some of the porphyritic and felspathic rocks, alternate conformably with strata of marine origin containing organic remains of a very early period, and as some of the layers in which such remains are imbedded have a base of true volcanic matter, the date of the origin of this class of rock is thereby fixed.

4. That these conformable alternations of trap and marine sediment establish a direct analogy between their mode of production and those replications of volcanic ejections and marine deposit which are now going on beneath the present seas; whilst they further explain the manner by which, in times of the highest geological antiquity, the porphyry slates were arranged in parallel laminæ with the sedimentary accumulations of that age.

5. That the existence of certain strata containing organic remains, yet possessing a matrix, composed in great measure of the same materials as the adjacent ridges of trap rock, has strengthened the inference that some of the ebullitions of these submarine volcanos were contemporaneous with the period in which these ani-

* Geol. Trans., New Series, vol. ii. p. 249.

mals lived and died, the finer volcanic ejections having, it is presumed, led to the formation of the volcanic sandstone.

6. That subsequent to these contemporaneous classes, other trap rocks have been forcibly intruded, amidst deposits of all ages, from the oldest grauwacke up to the strata of the coal measures, producing great derangement, fracture, and alteration in the beds which they penetrate, exhibiting, at the points of contact, siliceous schists, porcellanite, many crystallized substances, veins, quartz rock, &c.

7. Special attention is invited to that change by which sandstone has been converted into quartz rock, because it appears to explain how the so-called *primary* quartz rock may have been formed.

8. It is inferred that all the metalliferous veins in the country described are due to the presence of the contiguous trap rocks, and that therefore this inquiry has amply corroborated the theoretical speculations of M. Necker*.

June 4.—A paper was first read, entitled, "Observations on the Strata penetrated in sinking a Well at Diss, in Norfolk," by John Taylor, Esq., Treas. G. S.

The well alluded to in this communication affords the only details, hitherto made public, of the thickness and character of the chalk in that part of Norfolk in which Diss is situated.

The well was sunk by Mr. Thomas Lombe Taylor, and the following list gives the order and thickness of the beds:

Clay	50 feet.
Sand	50 —
Chalk, without flints, soft and of a marly nature	100 —
Chalk, with flints in layers of single stones, distant about a yard from each other	330 —
Grey chalk, with an occasional layer of white chalk, and free from flints	60 —
Light bright blue chalk, approaching to clay, with white chalk stones	20 —
Sand	5 —
	615

On penetrating the light blue chalk, the tools sunk rapidly for about 5 feet, and the water rose to within 47 feet of the surface, at which height it is stated to have continued.

A paper, entitled, "Observations on a Well dug at Lower Heath, on the South Side of Hampstead," by Nathaniel Wetherell, Esq., F.G.S., was next read.

The strata penetrated in making this well are stated by Mr. Wetherell to be as follows:

London clay	285 feet.
Rock	5 —
Plastic clay	40 —
	330

* Proceedings, vol. i. p. 392.

The London clay, for the first thirty feet, was of a loose texture, reddish brown colour, and contained a good deal of iron pyrites and selenite: for the next hundred and seventy feet it varied in colour from blue to dark brown, and contained many septaria; and the lower part was very sandy. At the depth of 260 feet a few fruits and seeds were procured,—the former resembling those found at Sheppey, and the latter those found at Highgate; but between 265 and 285 feet the clay abounded with vegetable remains. A classed list is given of the fossils obtained by the author; and among those not previously noticed, he mentions the remains of Asterias, a Pentacrinite, six species of bivalves, and two small, straight, tubular bodies, one round, the other square, having an internal radiated structure like that of a Belemnite, but without a central cavity.

The rock between the London and plastic clays was full of green particles, and contained numerous rounded flint-pebbles. The fossils obtained from it were chalky and friable, and among them the author found *Mya intermedia* and *Natica glaucinoides*, shells characteristic of the Bognor rock.

The plastic clay presented its usual mottled appearance, but no organic remains were noticed in it.

At the depth of 330 feet a bed of sand, containing small flint-pebbles, occurred, and the water gradually rose from it to within 200 feet of the surface.

A letter was afterwards read from Sir Philip Grey Egerton, Bart. F.G.S. to the Rev. Prof. Buckland, D.D., F.G.S., "On the Ossiferous Caves of the Hartz and Franconia."

This letter contains a detailed enumeration of the remains found by Sir Philip Egerton and Viscount Cole in the caves of Gailenruth, Kühloch, Scharzfeld, and Baumanns Höhle. In communicating these results, the author states that he has made the list as complete as possible, as from the extreme strictness with which the Müggendorf caves are now guarded, it is not probable that any large collection of bones will again find its way to this country. With respect to the caves of Kühloch and Rabenstein, he states, that the account which he gave in 1829 of their destruction *, has been fully verified by Lord Cole, who visited them last year; but in consequence of the absence of the Baron of Rabenstein at the time of their destruction, the author acquits him of having been implicated in the transaction; and adds, that this nobleman has proved himself a strenuous friend and patron of science, by the care with which he protects the newly-discovered cave of Rabenstein from depredation.

The author states that he found recent bones of pigs, birds, dogs, foxes, and ruminantia, in every cave which he examined; fragments of rude pottery in those of Scharzfeld, Baumanns Höhle, Gailenruth, and Zahnloch; and old coins and iron household

* Phil. Mag. and Annals, vol. vi. p. 92, 1829; and Quarterly Journal of Science, vol. vi. p. 213, 1829.

implements of most ancient and uncouth forms in that of Rabenstein. In the Gailenruth cave he did not find one bone gnawed by hyenas, but numerous bones of bears marked with short scratches, the effects, he conceives, of their having been the playthings of young bears; an idea first suggested to him by observing the amusement a ball of wood affords a bear in confinement.

Of the genus Ursus, Sir Philip Egerton states that he had found among the remains procured in the Gailenruth cave, two bones of the carpus, one of the metacarpus, one of the metatarsus, and part of the sternum; all required to complete Cuvier's account of the osteology of the animal; that in the collection from the same cave, he had found the large incisor of the right side of nearly ninety bears, and of all ages, from the cutting-tooth to the worn-down stump; that he had not a single humerus out of the many procured from various localities, with the perforation at the condyle for the cubital artery; and that out of 36 specimens in his collection, besides a greater number in Viscount Cole's, he had not noticed one containing the least trace of the small anterior false molar.

Sir Philip Egerton then gives a detailed list of every bone procured by himself and Lord Cole. This list it is impossible to give in an abstract; but it may be stated that the bones obtained from the cave of Gailenruth belong to *Felis Canis, Canis Vulpes*, Hyæna and Gulo; those from Kühloch to Hyæna, *Canis Vulpes* and Rhinoceros; those from Scharzfeld to Felis and Canis; and those from Baumanns Höhle to Felis.

A letter was also read from Hugh E. Strickland, Esq., to G. B. Greenough, Esq., P.G.S., "On the Occurrence of Freshwater Shells, of existing Species, beneath the Gravel near Cropthorne, in Worcestershire."

In a former letter, dated September 28th, 1833, Mr. Strickland stated that he had found in a gravel-pit near Cropthorne, freshwater shells of existing species, but that the circumstances under which he had noticed them induced him to hesitate in assigning them to the age of the gravel. The surveyor of the roads having, however, at the request of the Worcestershire Natural History Society, opened a new pit, Mr. Strickland is enabled in this letter to state, that the same species of shells had been found under horizontal beds of gravel and sand, which presented no sign of having been disturbed since their deposition. He also states that the remains of the hippopotamus, deer, and he believes ox, had been found in considerable abundance in the same pit.

A notice "On the Action of High Pressure Steam on Glass and other Siliceous Compounds," by Prof. Turner, M.D., Sec. G.S., was then read.

An opportunity having presented itself to the author, of including substances in a high pressure steam-boiler, he took advantage of it to try the effect which would be produced on glass; and he accordingly encased in wire gauze some specimens of plate and window-glass, and suspended them from the top of the boiler, so that they were surrounded by steam whenever the boiler was in action. They were kept in this situation for four months, during which time the boiler was commonly in action ten hours daily, except Sundays, its temperature being then at 300° Fahr. On opening the boiler at the end of the time specified, all the pieces of glass were found to have been more or less decomposed; and the plate-glass in particular, which is a glass of silex and soda, was far advanced in decomposition. Flat pieces, $\frac{1}{5}$th of an inch thick, were in some parts decomposed through their whole substance; while in others a layer of unchanged glass was found in the middle, covered on each side with a stratum of opaque white siliceous earth, having the appearance of chalk.

The author referred these changes to the influence of water on the alkaline matter of the glass. The white earthy portions were found to be entirely free from alkaline matter, which had been dissolved and removed by the water which condensed upon the glass at the successive heating and cooling of the boiler, or which may have been thrown upon it by splashing during ebullition. But the author considered that the actual loss was not due to the extraction of alkaline matter only, but that the silex of the glass had in some measure been dissolved along with the alkali. This was proved to have been the case by the apertures of the gauze envelope being filled up at the most depending parts by a siliceous incrustation, where also a stalactitic deposit of silica, about $\frac{1}{4}$ inch long, had formed.

A piece of window-glass included at the same time with the plate-glass, was also in a decomposing state, but in a much lower degree. A piece of rock-crystal confined in the boiler at the same time was wholly unchanged.

The author adduced these facts as illustrative of the action of water at high pressures on felspathic and other rocks containing alkaline matters.

At the close of this Meeting, which terminated the Session, the Society adjourned till Wednesday evening, the 5th of November.

May 7th.—After the ordinary business of the Society had been transacted, a Special General Meeting of this Society was held, when the President having stated, that in compliance with a representation made by His Royal Highness the President of the Royal Society, the Lords Commissioners of His Majesty's Treasury had been pleased to transfer to the Society additional apartments, lately in the possession of the Royal Society, and that a sum of not less than 500*l.* would be required to adapt the said apartments to the improvements contemplated:—

It was resolved unanimously,

I. On the motion of Charles Denham Orlando Jephson, Esq., M.P., seconded by William Henry Fitton, M.D.,—That the thanks of this Society be given to the Right Honourable the Lords Commissioners of His Majesty's Treasury, for the grant which they have been pleased to make to this Society, of additional apartments in Somerset House.

II. On the Motion of R. I. Murchison, Esq., seconded by Viscount Cole, M.P.,—That the thanks of this Society be given to His Royal Highness the President, and to the Council of the Royal Society, for their aid and co-operation, in obtaining from the Lords of His Majesty's Treasury a Grant to this Society of additional apartments in Somerset House.

III. On the Motion of Francis Baily, Esq., seconded by Henry Witham, Esq.,—That a Subscription be immediately entered upon to defray the expenses attendant on the Grant of the additional Apartments.

IV. On the Motion of James Mitchell, Esq., LL.D., seconded by Nicholas Dennys, Esq.,—That the thanks of the Meeting be given to the President and Council of the Society for their exertions in procuring the rooms.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1834—1835. No. 37.

November 5, 1834.—The Society assembled this evening for the Session.

Hugh Edwin Strickland, Esq., of Craycombe House, near Evesham; Sir William Molesworth, Bart., Member of Parliament for the Eastern Division of Cornwall, Pencarrow, Cornwall; and Herbert Mayo, Esq., of Cheshunt, Herts, were elected Fellows of this Society.

A paper was read "On a new Classification of Fishes, and on the Geological Distribution of Fossil Fishes," by Prof. Agassiz, of Neuchâtel.

The author begins by observing that the state of the science of Ichthyology had obliged him to undertake an examination of recent fishes for the sake of comparing them with the fossil species, and in doing so that he had arrived at a classification, in general, differing considerably from the various arrangements previously adopted by naturalists. One of the essential characters of fishes is, to have their skin covered with scales of a peculiar form and structure. This covering, which protects the animal without, is in direct relation with its internal organization, and Dr. Agassiz has found that by an attentive examination of the scales, fishes may be divided into more natural orders than had hitherto been adopted. In this manner he has established four orders, which bear some relation to the divisions of Artedi and Cuvier; but one of which, hitherto completely misunderstood, is almost exclusively composed of genera, whose species are found in only the most ancient strata in the crust of our globe. These four orders are, the *Placoïdians*, which comprehend the cartilaginous fishes of Cuvier, with the exception of the sturgeon; the *Ganoïdians*, which comprehend above fifty extinct genera, and to which we must refer the Plectognaths, Syngnaths, and Acipensers; thirdly, the *Ctenoïdians*, which are the Acanthopterygians of Cuvier and Artedi, with the exception, however, of those which have smooth scales, and with the addition of the Pleuronectes. Lastly, the *Cycloïdians*, which are principally Malacopterygians, but which comprehend, besides, all those families excluded from the Acanthopterygians of Cuvier, and from which we must take the Pleuronectes placed among the Ctenoïdians.

If we estimate the number of fishes now known to amount to about eight thousand species, we may state that more than three fourths of this number belong to two only of the above-mentioned orders; namely, the Cycloïdians and Ctenoïdians, whose presence has not yet been discovered in the formations inferior to the chalk. The other fourth part of living species is referrible to the orders Placoïdians and Ganoïdians, which are now far from numerous, but which existed during the whole period which elapsed since the earth began to be inhabited, to the time when the animals of the greensand lived. These remarkable conclusions to which M. Agassiz had come, from the study of more than six hundred fossils on the Continent, have been corroborated by the inspection of more than two hundred and fifty new species found in English collections.

The author next observes that in fishes more considerable differences may be remarked within narrow geological limits than among inferior animals. We do not see in the class of Fishes the same genera, nor even the same families, pervading the whole series of formations as takes place among zoophytes and testacea. On the contrary, from one formation to another, this class is represented by very different genera, referrible to families which soon become extinct, as if the complicated structure of a superior organization could not be long perpetuated without important modifications; or rather, as if animal life tended to a more rapid diversification in the superior orders of the animal kingdom, during equal periods of time, than in its lower grades. With respect to this, it is with fishes nearly as with mammifers and reptiles, whose species, for the most part but little extended, belong at a short distance in the vertical series to different genera, without passing insensibly from one formation to another, as is generally admitted to be the case with certain shells. One of the most interesting facts which Mr. Agassiz has observed is, that he does not know a single species of fossil fish which is found successively in two formations, whilst he is acquainted with a great number which have a very considerable horizontal extent. But the class of fish presents besides to Zoological Geology, the immense advantage of traversing all formations. Thus they afford us the only example of a great division of vertebrated animals in which we may follow all the changes experienced in their organization during the greatest lapse of time of which we possess any relative measure.

The fish of the tertiary formations approach nearest to recent fish, yet hitherto the author has not found a single species which he considers perfectly identical with those of our seas, except the little fish which is found in Greenland in geodes of clay, and whose geological age is unknown to him.

The species of the crag of Norfolk, the superior subapennine formation, and the molasse, are related for the most part to genera now common in tropical seas; such are the Platax, the large Carcharias, the Myliobates, with large palatal plates, and others. In the inferior tertiary formations, the London clay, the calcaire grossier of Paris, and at Monte Bolca, a third at least of the species belong to *genera* which exist no longer. The chalk has more than two thirds of its species referrible to *genera* which have now entirely disappeared. In it we already see even some of those singular forms which prevail in the Jurassic series. But as a whole the fishes of the chalk recall more forcibly the general character of the tertiary fishes than that of the species of the Jurassic series.

If we paid attention only to fossil fish in the grouping of geological formations on a large scale, the author thinks it would be more natural to associate the cretaceous with the tertiary strata than to place the former among the secondary groups. Below the chalk there is not a single genus which contains recent species, and even those of the chalk which have them, contain a much greater proportion of species which are only known as fossil. The oolitic series, to the lias inclusive, forms a very natural and well-defined group, in which also must be included the Wealden, in which Mr. Agassiz states he has not found a single species referrible even to the genera of the chalk. Henceforth, the two orders which prevail in the present creation are found no more; whilst those which are in a small minority in our days, appear suddenly in great numbers. Of the Ganoïdians, those genera which have a symmetrical caudal fin are found here, and among the Placoïdians those above all predominate which have their teeth furrowed on both the external and internal surface, and have large thorny rays. For it is now certain that those great rays which have been called Ichthyodorulites, belong neither to Silures nor Balistæ, but are the rays of the dorsal fin of the great Squaloids, whose teeth are found in the same strata.

On leaving the lias to come to the inferior formations, we observe a great difference in the form of the posterior extremity of the body in the Ganoïdians. All have their vertebral column prolonged at its extremity into a single lobe, which reaches to the end of the caudal fin, and this peculiarity extends even to the most ancient fishes. Another observation worthy of attention is, that we do not find fishes decidedly carnivorous before the carboniferous series; that is to say, fish provided with large conical and pointed teeth. The other fish of the secondary series below the chalk appear to have been omnivorous, their teeth being either rounded, or in obtuse cones, or like a brush.

The discovery of coprolites containing very perfect scales of fish which had been eaten, permits us to recognise the organized beings which formed the food of many ancient fish; even the intestines, and in some fossil fish of the chalk the whole stomach are preserved, with its different membranes. In a great number of fish from Sheppey, the chalk, and the oolite series, the capsule of the bulb of the eye is still uninjured; and in many species from Monte Bolca, Solenhofen, and the lias, we see distinctly all the little blades which form the branchiæ.

It is in the series of deposits below the lias that we begin to find the largest of those enormous sauroid fish whose osteology recalls, in many respects, the skeletons of saurians, both by the closer sutures of the bones of the skull, their large conical teeth, striated longitudinally, and the manner in which the spinous processes are articulated with the body of the vertebræ and the ribs at the extremity of the spinous processes.

The small number of fish yet known in the transition formations does not as yet permit the author to assign to them a peculiar character, nor has he discovered in the fossil fish of strata below the greensand any differences corresponding with those now observed between marine and freshwater fish, so that he cannot, on ichthyological data, decide on the freshwater or marine origin of the ancient groups.

This paper is accompanied by Tables of the fossil fish of different formations.

November 19th.—A paper was first read, entitled "An Account of the raised Beach, near Hope's Nose, in Devonshire, and other recent Disturbances in that Neighbourhood," by Alfred Cloyne Austen, Esq., F.G.S.

The ancient beach near Hope's Nose, noticed by Mr. Greenough in his geological map, is situated a little within the point of land so called, and rests upon a mass of transition limestone containing thin beds of shale. The distance between the ordinary line of high water and the lowest part of the deposit, is about 31 feet: its extent east and west is not more than 50 feet; and its thickness is 17 feet. How far it extends inland cannot be easily determined, as it is covered, in that direction, by an accumulation of detritus fallen from the neighbouring hill.

The deposit varies much in texture and composition. The lowest portion is a coarse conglomerate, containing blocks of considerable size; above this the grain becomes finer and the remains of shells of recent species, occur in greatest abundance. A little higher the particles are still finer, forming an exceedingly hard and compact stone, in which frequently the casts only of the shells are found. In the upper portion the beds are less compact, and at the highest they consist of uncemented sand, like that of a recent beach. The greater part of the deposit is formed from grauwacke rocks, but fragments of trap also occur, and in the lowest part chalk flints. On the weathered surface, the harder beds project in thin shelves, but which have sufficient strength to support a man.

A deposit which encircles the Thatcher rock, about three quarters of a mile S.S.W. of Hope's Nose, presents the same characters. These are the only instances which the author could discover of a raised beach on this part of the coast. The preservation of the deposits, he considers, is owing to their resting on masses of limestone, and that the abrupt terminations which the beach at Hope's Nose presents towards the east and west, are proofs that it was once more extensive.

The author premises his observations on the Watcombe fault by stating, that any section of the new red sandstone of South Devon will present innumerable lines of disturbance, and that attention to these will show they have been the origin of the hills and valleys of the district, though all superficial evidence of their existence has been destroyed by their being rounded off. But in the neighbourhood of Babbacombe, he says, there are several faults which at first sight offer a very different character. Of these he mentions two, that at Watcombe and another west of Petit Tor rock. The first presents a vertical change of level of about 200 feet; but it is not, like the faults before alluded to, rounded off, and therefore the author infers that it is of more recent origin.

Some observations are then offered on the position of the trap in the neighbourhood of Babbacombe; and it is shown, that in the hill to the east of the town it rests on shale, and is overlaid by beds of shale and limestone, the trap dipping to the south-west conformably with the stratified deposits. At its lower surface it adheres firmly to the shale; but at its upper no such adhesion occurs, though the bed which rests upon the trap is moulded into its outline. From this phænomenon, and the absence of all marks of disturbance, the author infers, that the trap was a submarine lava current, on which the superincumbent limestone and shale were subsequently deposited. In other instances, however, as in the hill between Torquay and Tor Abbey, the limestone appears to have been violently disturbed, the beds of new red sandstone on the flanks of the hill being in a vertical position.

In conclusion the author offers some remarks on the drainage and destruction of the lake which he supposes to have occupied the site of the Ballemarsh and Bovey Heathfield.

A paper, entitled, "Some Facts in the Geology of the Central and Western Portions of North America, collected principally from the statements and unpublished notices of recent travellers," by Henry Darwin Rogers, Esq., F.G.S., was then begun.

December 3.—Major-General Lord Greenock, F.R.S. Ed., of Carlton Place, Edinburgh; David Milne, Esq., F.R.S. Ed., Advocate, of York Place, Edinburgh; —— Coulthurd, Esq., Captain in the Bengal Artillery; John Rofe, jun., Esq., of Bernard Street; Rev. James Bowstead, Fellow and Tutor of Corpus Christi College, Cambridge; Charles Hastings, M.D., President of the Literary and Philosophical Society of Worcestershire, Worcester; and Rev. Josiah Bull, M.A., of Newport Pagnel, Buckinghamshire, were elected Fellows of this Society.

The reading of Mr. Rogers's paper was resumed and concluded.

Mr. Rogers states that he is indebted for the greater part of the facts contained in his communication to Mr. Sublette, a gentleman engaged for eleven years in the fur trade; but that he has also extracted from the journals of Long and Lewis, and Clerke and Nutthall, such observations as bear upon the structure of the country.

The district noticed includes the vast tract extending from the Mississippi to the Pacific, and from the 36th to the 49th degree of North latitude. The principal physical features of the country are the Rocky Mountains; and the immense plains which extend from the Mississippi to that range, circle round its southern termination, and are prolonged into Mexico, and northward to an unknown distance.

The Rocky Mountains consist, as far as they have been examined, of primary formations, and their eastern chain, the Black Hills, of gneiss and mica slate, greenstone, amygdaloid, and other igneous rocks. Chains of primary mountains, separated by sandy plains and volcanic tracts, constitute the country between the Rocky Mountains and the Pacific; but to the east of that range are several nearly horizontal formations, of the limits or the relative age of which little is known.

The country from the falls of the Platte to the mountains, and from the Missouri to the Arkansas and the Rio Colorado, as well as the plains included within the Rocky Mountains, is composed of a red saliferous sandstone, containing beds of clay; and Mr. Rogers is of opinion that the same formation extends into Mexico, and that the red sandstone described by Humboldt as occurring extensively in the southern parts of the continent, may belong to it. The general colour of the sandstone is red, but it is sometimes gray or white. The saline contents are principally muriate of soda, but other salts of bitter and cathartic properties likewise abound. Brine springs are of general occurrence; and rock-salt is found in large beds west of the Rocky Mountains, as well as on the Rio Colorado, and south of the great Salt Lake. The surface of the ground, especially of the banks of the ravines, is often also thickly encrusted with saline matter. Gypsum is likewise found in many parts of the country; and fossils are said to abound in the sandstone on the river Platte, but Mr. Rogers had not seen any of them. In the neighbourhood of the Rocky Mountains the formation is covered with a deposit of gravel and boulders, apparently derived from the adjacent hills; but at a distance from them it is overlaid by a bed of loose barren sand, the drifting of which the author conceives may partially conceal the existence of other formations, especially of that greensand which occurs so extensively on the Missouri above the river Platte.

At the eastern base of the Rocky Mountains and for a short distance up their declivity, are various conglomerates and gray and red sandstones, dipping at high angles; but these deposits are not considered to belong to the great sandstone formation, as they contain no salt.

In ascending the Missouri from its confluence with the Mississippi the banks are in many places composed of limestone cliffs, 200 and 300 feet high, containing Productæ, Terebratulæ, and Encrini: hills of this limestone occur also near the Chariton and in the same district is good bituminous coal.

Above the junction of the Platte with the Missouri are beds of sandstone and dark blue shale, and a little higher, adjacent to the Au Jacque, are high, perpendicular bluffs of a formation considered to be true chalk. This deposit extends for several miles up the Missouri, and it occurs further down the river about the mouth of the Omawhaw; but its lateral extent is not known. No flints have yet been noticed *in situ*, but pebbles and nodules of flints, similar to those so abundant in the valley of the Thames, are numerous lower down the river, even as low as the Mississippi. Mr. Rogers likewise has seen Belemnites reported to have been picked up in the same district.

From below the Big Bend to the Rocky Mountains, both on the Missouri and the Yellow-stone river, is a vast formation, said to be very rich in fossils, indicating an upper secondary group; and Mr. Rogers observes that the matrix in which the shells are imbedded resembles very closely some of the greensand-beds of Europe. The fossils mentioned in the paper are a Hamite, a Gryphæa considered to be the *Gryphæa Columba,* and *Belemnites compressus.* This formation has not been traced continuously over the whole area alluded to, but the same fossils have been brought from the beds of the Missouri and Yellow-stone rivers, and from their springs in the Rocky Mountains: they have likewise been found west of that range.

Above the Big Bend occurs also an extensive range of horizontal beds of lignite, sandstone, shale, and clay, forming bluffs 200 and 300 feet high, and continuous for several days' journey. Lignite is also found on the Cherry River, and along the whole of the country watered by the Powder River, in beds from 3 to 9 feet thick. This formation Mr. Rogers conceives to be more recent than that which contains the fossils, as the latter has a slight westerly dip, and therefore may underlie it.

Silicified trunks of trees are stated to have been noticed on the banks of the streams, and are considered by the traders to have fallen from the bluffs.

No recent volcanic production appears to have been yet brought from the country east of the Rocky Mountains, with the exception of the pumice which annually descends the Missouri; but nothing is yet known of the quarter whence it is derived. West of the mountains, however, from the Salmon River to beyond Louis's River, and for a considerable distance around the insulated mountains called the Butts, the country is said to be composed of lava traversed by a multitude of deep, extensive fissures, having a general direction from north-west to south-east, and nearly parallel to that of the mountains.

Volcanic mounds, cracked at the top and surrounded by fissures, are numerous over the whole region; but no lava appears to have flown from them, and Mr. Rogers conjectures that they were formed by the action of elastic or gaseous matter. In many places deep circular funnels, a few yards in diameter, penetrate the surface. For more than 40 miles the Columbia runs between perpendicular cliffs of lava and obsidian, from 200 to 300 feet high, which are traversed by great fissures, and present all the phænomena of dykes in the most striking manner. The Malador branch of the Columbia flows through a similar gorge.

In the course of the memoir Mr. Rogers corrects the accounts previously given of the great salt lake, which, he says, Mr. Sublette journied round, and ascertained to have no outlet, though it receives two considerable streams of fresh water. The length of the lake is estimated to be 150 miles and its breadth 40 or 50.

In conclusion, some observations are offered on the thermal springs which abound along the base on each side of the Rocky Mountains, and in the volcanic district. They are stated to vary in temperature from blood-heat to the boiling-point; and to form, from their earthy contents, large mounds, sometimes of a pure white, hard, siliceous nature, and at others of a substance which, on drying, becomes pulverulent. In the volcanic district some of the springs are said to be sour; and many sulphureous springs occur both in and west of the mountains. Lastly, pure sulphur has been occasionally seen above the Great Salt Lake, and at the eastern base of the mountains, but none in the volcanic district.

A letter was then read from H. T. De la Beche, Esq., F.G.S., and addressed to the President, on the Anthracite found near Biddeford in North Devon.

Mr. De la Beche says, the anthracite occurs along a strip of country about thirteen miles in length from east to west and about three quarters of a mile in breadth from north to south. It commences eastward at Hawkridge Woods on the banks of the Taw, and extends westward to Greencliff in Biddeford Bay, where the sea cuts off all further observation of its course in that direction. On the opposite side of the bay, however, a very carbonaceous slate is found in the cliffs among the greatly contorted strata of grauwacké between Clovelly and Hartland Point. There can be little doubt, Mr. De la Beche observes, that this carbonaceous slate belongs to the same system as the Biddeford beds, and thus it would be extended about eleven miles still further westward, where the sea again cuts it off. The anthracite between Hawkridge and Greencliff has been extensively worked at various times, and at the latter place is now worked for the sole supply of a limekiln. The beds of anthracite do not occur precisely in the same line with each other, so that one or two beds are not so far continuous, but swell out in particular places, the maximum thickness not exceeding 12 feet.

The letter was accompanied by a collection of fossil plants, all collected by Mr. De la Beche; and he says, there can be no question that the shales, slates, sandstones, and anthracite, among which they are found, belong to the grauwacké, the evidence being of the most clear and satisfactory kind*.

With regard to the position of these beds in the grauwacké of Devon generally, Mr. De la Beche states that, it may be considered at about two thirds of the whole, above that part where the grauwacké shades away into the mica slate, chlorite slate, and other non-fossiliferous rocks of the most southern part of Devon. It should, however, be observed that the grauwacké of Devon and Somerset is not complete, and that we nowhere can see what can be decidedly termed its upper portions. After very diligent search,

* The plants have been examined by Prof. Lindley, and he has decided that they are, as far as they can be determined, plants of the coal measures, viz. *Pecopteris lonchitica*, *Sphenopteris latifolia*, *Calamites cannæformis*, *Asterophyllites* resembling *A. longifolia*, another species, which may be *A. galioidis*, *Cyperites bicarinata*, and *Lepidophyllum intermedium*; also fragments apparently of Palm leaves, specimens of which Prof. Lindley states he has received from Bolton. The most abundant plant is too imperfect for its characters to be determined.

Mr. De la Beche observes, he has been unable to discover any of the interesting beds of the upper grauwacké noticed by Mr. Murchison in Wales and the adjoining English counties. On the north coast of Devon and its continuation into Somersetshire, precisely where some traces of them should be expected, older beds are brought up by contortion (Dunkeny Beacon), and the other high land of the coast is formed of beds apparently of the same age with those which extend from Hartland to the eastward, a great trough being formed, supporting a body of grauwacké, the chief portion of which is an argillaceous slate, calcareous matter being disseminated in the lowest portion of it, often in sufficient abundance to constitute limestone.

The letter was also accompanied by a collection of specimens illustrative of the cleavage of the grauwacké in the neighbourhood of Biddeford.

A paper was afterwards commenced on the physical and geological structure of the country to the west of the dividing range between Hunter's River (lat. 32° south) and Moreton Bay (lat. 27° south), with observations on the geology of Moreton Bay and Brisbane River, New South Wales, by Allan Cunningham, Esq., and communicated by William Henry Fitton, M.D., F.G.S.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Dec. 17th.—The reading of a paper, "On the physical and geological Structure of the Country to the west of the Dividing Range, between Hunter's River (lat. 32° S.) and Moreton Bay (lat. 27° S.); with Observations on the Geology of Moreton Bay and Brisbane River, New South Wales," by Allan Cunningham, Esq., and communicated by W. H. Fitton, M.D., F.G.S., begun at the Meeting on the 3rd of December, was resumed and concluded.

This paper was accompanied by a series of specimens collected by the author, who states that he had submitted it to the examination of Dr. Fitton, and that he is indebted to the notes of that gentleman for the geological descriptions embodied in the memoir.

After alluding to the "Wingen or Burning Mountain," situated on the south-eastern side of the "Dividing Range," the author states that the summit of that range, at the point where he crossed it, consists of greenstone slate, and the base of a quartzose conglomerate. Having descended the range, he traversed the low hills which form the eastern side of Liverpool Plains and consist of a similar conglomerate; and afterwards the hills to the north of the Plains composed of a very finely grained granite. Between the latitudes of 31° and 30° the country gradually rose from the level of Liverpool Plains, or 840 feet, to nearly 2000 feet above the level of the sea, and presented a broken irregular surface, often traversed by low ridges of clay slate. On the north of 30° the exploring party entered a fertile valley, called by Mr. Cunningham "Stoddart's Valley." The base of the ridges by which it is bounded, consists of serpentine, and their flanks and summit of hornstone; and the hills at the head of the valley of clay-slate. In the bed of Peel's River, which traverses the northern extremity of the valley, the author noticed a thin horizontal bed of calcareous sandstone, between strata of indurated clay or shale. The country for 50 miles to the north of "Peel's River" exhibited a moderately undulating surface, covered in some parts with fragments of cellular trap; and the hills which bounded the route on the westward, as far as the parallel of 29° 10′, consisted of a reddish coarse-grained sandstone, in nearly horizontal strata. Beyond this point Mr. Cunningham directed his journey to the north-east, and a little north of 29° he arrived at Mogo Creek, the banks of which were found to be composed of a coarse friable sandstone. Pursuing the same direction, the country for 40 miles presented a rugged surface, and the prevailing rocks were sandstone and clay slate; but occasionally the tops of the hills formed low terraces composed of a quartzose conglomerate. In the bed of a creek in lat. 28° 26′, and on the meridian of Paramatta, (151° east long.), a hard slaty rock was noticed; and the country beyond it was found to be composed, where it could be examined in the dry water-courses, of flinty slate. In lat. 28° 13′ the party entered upon a fertile district which extended for 18 miles, or to the foot of the "Dividing Range," in the parallel of 28°. At the base of these mountains Mr. Cunningham procured specimens of basalt containing olivine; at the height of 1877 feet above the level of the sea, the rock consisted of amygdaloid; and the summit, 4100 feet above Moreton Bay, of a brick-red cellular trap, the cells having an elongated form and parallel direction.

From this station the author directed his course back towards Hunter's River, but chose a route to the east of that by which he had arrived at the foot of the "Dividing Range." In a ravine about 20 miles from the extreme point of his journey, and on the confines of a mountainous region, a reddish granite occurred, and the prevailing formation in the hilly district itself was grey granite. Leaving this mountainous country and directing his course south-westward, Mr. Cunningham entered upon a region, composed of clay slate; and in lat. 29° he arrived at a deep gorge similarly constituted, and traversed by a rapid stream, in the bed of which he noticed large boulders of the gray granite. During the next 40 miles the only rocks observed were reddish granite and fragments of basalt. In lat. 29° 26′ large masses of a fine quartzose conglomerate occurred, and were afterwards found to be very generally scattered over the adjacent country. The boundary hills of "Wilmot Valley" are stated to be a fine-grained grey granite; and those which form the head of it, in lat. 30° 11′, of brownish porphyry, containing grains of quartz. The party having crossed these hills, traversed Liverpool Plains and the "Dividing Range" to Hunter's River, and thence returned to the station from which they originally set out.

Mr. Cunningham next offers some remarks on the geology of Moreton Bay and Brisbane River, both of which he visited in 1828, for the purpose of connecting his observations at the foot of the "Dividing Range" in lat. 28° with the sea coast.

The western shores of Moreton Bay, from the entrance of Pumicestone River to Red-Cliff Point, are faced by a reef of considerable breadth, a ledge of which at low water afforded specimens of chalcedony.

In ascending the Brisbane River, which falls into Moreton Bay, the first rock observed was talc or chlorite slate; and opposite the settlement, 16 miles from the mouth of the river, is a quarry of pink claystone porphyry, used for building. In the ravines further up occurs serpentine traversed by veins of asbestus and magnetic iron. Sixty miles from Moreton Bay, beds of hornstone crop out in the banks; and in the same part of the river a considerable seam of coal appears in its channel. A portion of the stem of a fossil plant was found in the vicinity of this seam of coal. At the "Limestone station" on "Brenner River," which falls into the Brisbane, Mr. Cunningham procured a series of specimens, which consists of yellowish hornstone, bluish grey, a gritty yellowish limestone, and indurated white marl, much resembling some of the harder varieties of chalk, and containing large masses of black flint, and of bluish grey chalcedony passing into chert. A bed of coal has likewise been noticed in the Brenner, and traced from that stream to the Brisbane. To the south of the "Limestone station" is a remarkable hill, called "Mount Forbes," consisting of trap; and 50 miles south of the penal settlement on the Brisbane is the Birman-range, from which the author procured specimens of compact quartz rock. From Mount Lindsay, likewise south of the Brisbane, he obtained specimens of granite.

To the collections formed by himself, in the districts above mentioned, Mr. Cunningham has added some specimens obtained by Capt. Sturt during an excursion from Bathurst to the marshes of the Macquarie, and thence to the Darling River. They include carbonate of copper from a white argillaceous cliff at Molong Plain; stalagmite from the bed of the Macquarie; pink clay from the cataract below Wellington Valley; porphyry from Mount Harris; hard, granular, quartz rock from Oxley's Table-land and Mount Hellvellin; granite from New Year's Creek; quartzose conglomerate, porphyry, sandstone, white clay, and selenite, from the Darling River; and lastly, specimens of compact limestone, containing corals, from a limestone range 16 miles north from Bathurst.

A paper was next read, entitled "An Account of Land and Freshwater Shells found associated with the Bones of Land Quadrupeds beneath diluvial Gravel, at Cropthorn in Worcestershire," by Hugh Edwin Strickland, Esq., F.G.S.

On two former occasions Mr. Strickland laid before the Society brief notices of the discovery, near Cropthorn, of the bones of extinct quadrupeds associated with shells of existing species:—the present paper contains the result of his continued researches. The deposit in which these remains were found, is situated on the road from Evesham to Pershore, and on the east side of the small rivulet which flows from Bredon Hill towards the Avon. In May 1834 the deposit presented a section about 70 yards in length and 8 feet 6 inches high in the middle. The lower part of it consisted of lias clay, on which rested a layer of fine sand, containing 23 species of land and freshwater shells, with fragments, more or less rolled, of bones of the Hippopotamus, Bos, Cervus, Ursus, and Canis. The sand passes upwards gradually into gravel, which extends to the surface, and differs in no respect from the other gravel of the neighbourhood, being composed principally of pebbles of brown quartz, but occasionally containing chalk flints, and fragments of lias Ammonites and Gryphites. The bones, though most abundant in the sand, are interspersed also through the gravel; but the shells are confined to the sand. Lists are given of the bones, and of the species of the shells, two of which are supposed to be extinct. The author from these phænomena assigns the deposit to the newer pliocene era; and from the fluviatile habits of some of the shells, he conceives that it occupies the site of an ancient river-bed, and not of a lake. In the course of his paper he points out the inferences which may be drawn from these deposits, respecting the greater change which has taken place in the mammifers of this island than in the molluscs, since the era when the gravel was accumulated; and the little variation which the climate appears to have undergone since the same epoch. In conclusion he notices the published accounts of similar deposits at North Cliff, near Market-Weighton, and at Copford, near Colchester, and states that he was informed at Bath, that freshwater shells had been discovered under gravel, in sinking for foundations in the lower part of the city.

A notice was afterwards read, "On the Bones of certain Animals which have been recently discovered, in the calcareo-magnesian Conglomerate on Durdham Down, near Bristol," by the Rev. David Williams, F.G.S.

The author observes that the calcareo-magnesian conglomerate of the neighbourhood of Bristol has hitherto been singularly deficient in organic remains; but is of opinion that the nature of the conglomerate will account for their absence. He mentions the recent discovery of bones in this deposit on Durdham Down, which Dr. Riley and Mr. Stutchbury have ascertained to belong to Saurians. These bones, he says, as well as the associated fragments of mountain limestone, are angular, and so intimately incorporated with the latter as to constitute a bone-breccia. He has ascertained that the bones belong to at least three animals, varying in their proportions, from those of the Dracena of Lacépède, to the lesser varieties of Monitors. He afterwards describes a fragment of a small jaw found by himself, which exhibits six distinct alveoli separated by bony partitions. One of the alveoli contains a young tooth, which had made its way to the summit of the jaw: it is hollow from the base to the apex, and consists of a very thin plate of ivory coated by a thinner sheathing of enamel. The form is triangular, the point sharp, and the margin on each side regularly crenated from the apex downwards. From these characters the author conceives that the animal to which the jaw belonged, may have formed a link between the crocodiles and the lizards proper.

January 7th, 1835.—James Pulleine Esq., King's Bench Walk, Temple; Thomas Starkie Thomson, Esq., of Primrose near Clitheroe; and the Rev. George Gleig, M.A., Chaplain of the Royal Hospital, Chelsea; were elected Fellows of this Society.

A letter from Dr. Bostock, F.G.S., addressed to George Bellas Greenough, Esq. P.G.S., containing an account of the analysis of a mineral water from the Island of St. Paul, in lat. 38° 45′ S. and long. 77° 53′ E., was first read.

The island of St. Paul is stated, on the authority of Capt. Ford and Mr. Houslip, to be of volcanic origin, very rugged in its outline, and to have the form of a bowl, 10 or 12 miles in circumference, into which the sea flows by a narrow opening, capable of admitting a boat. The surface of the island is, in many places, covered with pumice, and at night flames were observed to issue from various crevices in the rocks. With the exception of the island of Amsterdam, about 40 miles to the north of it, St. Paul's is at a great distance from any land.

In the hole from which the water was taken the thermometer stood at 212°.

Dr. Bostock then explains the manner in which he conducted the examination, and gives the following as the earthy constituents of 100 grains of the water:

Muriate of soda	2·3	grains.
Sulphate of soda	·053	
Muriate of lime	·340	
Muriate of magnesia	·059	
Loss	·038	
	2·790	

He afterwards compares these results with those obtained by Dr. Marcet from water procured from the middle of the South Atlantic; and from the great difference in the saline contents, infers that the water of the island of St. Paul is not merely the water of the neighbouring ocean in a state of dilution, or altered simply by mechanical filtration.

A paper "On the chalk and flint of Yorkshire, compared with the chalk and flint of the southern counties of England," by James Mitchell, LL.D., F.G.S., was then read.

The chalk of Yorkshire, Dr. Mitchell states, is distinguished from that of the southern counties by its great hardness, by its being occasionally of a red colour, by its being more distinctly stratified, and by its containing veins of calcareous spar. He says, that it is also distinguished by the upper part being always destitute of flints, while in the southern counties the absence of flints in the upper part is an exception.

The flints of Yorkshire are shown to differ from those of the southern counties by their being almost invariably of a tabular form, constituting regular and well-defined continuous layers; by being tougher, and breaking into short small fragments, unfitted for the manufacture of gun flints; by the colour being always greyish or whitish throughout the whole thickness; the crust not being of a different character from the body of the flint. Nodules of iron pyrites are stated to be common in the Yorkshire chalk, but in that of the South of England to be confined to the lower chalk without flints.

In conclusion the author points out the following resemblance between the Yorkshire chalk and that of the N.E. of Ireland, namely, the great hardness of both, and the common occurrence in both of iron pyrites and veins of calcareous spar.

A letter was next read from Woodbine Parish, Esq., addressed to George Bellas Greenough, Esq., P.G.S., accompanying a suite of specimens from the neighbourhood of Bognor.

The collection, referred to in this letter, contained a series of all the fossils hitherto described as occurring in the Bognor Rock, and a suite of specimens of *Choanites Kœnigii* obtained from the rolled shingle on the beach. Mr. Parish also points out for the first time the existence of chalk on the shore opposite Felpham, between high and low water mark. He states that it may be traced for upwards of a mile in the direction of Middleton; that at the point where it first appears, it is hard and thickly interspersed with flints, but that further on it becomes soft and the flints are less numerous. Mr. Parish procured from it many of the characteristic chalk fossils. He states also that near Middleton, chalk marl has been long dug at low water.

A notice on the want of perpendicularity of the standing pillars of the Temple of Jupiter Serapis near Naples, by Capt. Basil Hall, R.N., F.G.S., was afterwards read.

Capt. Hall observes that the three pillars of the Temple of Serapis now standing, each of which is formed of a single piece of stone, are not strictly perpendicular, but all slope towards the south-west, that is, towards the sea, and from the temple where the statue of Jupiter is supposed to have stood. It is well known the columns of ancient Greek temples, the Parthenon for instance, have an inclination inwards. The slope of the columns in that of Serapis is not great, but very decided, and was established by measurement and by observations on the angle formed by the reflection of the columns in the water, which covers the pavement of the temple at high tides. The floor of the temple is also slightly inclined, for Capt. Hall observed, that on the recession of the tide, the northern side was left dry, when the water was still some inches deep on the southern side.

January 21.—Edward William Brayley, Esq., F.L.S., Librarian to the London Institution, was elected a Fellow of this Society.

A paper was first read "On an outlying basin of Lias on the borders of Salop and Cheshire, with a short account of the lower Lias between Gloucester and Worcester," by Roderick Impey Murchison, Esq., V.P.G.S.

Having heard from Mr. Dod of Cloverly that frequent trials for coal had been made in a part of North Salop situated between the Hawkstone Hills and thet owns of Whitchurch and Market Drayton, the author visited that district during the autumn of last year. He found that the strata, supposed to be coal shale, belong to the lias, and that they range over a considerable area resting upon red marl and new red sandstone. With the assistance of the Rev. T. Egerton, F.G.S., he has ascertained that this lias occupies an elliptical basin, the length of which from S. W. to N. E. is 10 miles, and the breadth about 4 to 6, the surrounding strata dipping inwards at slight angles. The western boundary only is indeterminable, being concealed by gravel and turf bog. The formation is divisible into marlstone and lower lias. The first is clearly exposed in the hill of Prees, and contains the fossils which characterize it in Gloucestershire and Worcestershire, viz., *Avicula inæquivalvis, Gryphæa gigantea*, and *Pecten æquivalvis*, with an Ammonite, in great abundance, resembling *A. geometricus* of Phillips.

The lower lias crops out at various points along the exterior of the ellipse, particularly between Moreton Mill and Burley Dam; near the last of which places it is, in parts, bituminous and slaty, like the Kimmeridge coal. Near Cloverly and Adderley the lias shale has been penetrated by shafts in search of coal to the depth of 300 feet, and numerous fossils have been extracted, among which are, *Ammonites Bucklandi, A. Conybeari, A. planicosta, A. planorbis, A. communis?, A.* ——, published in Zeiten's Wirtemberg fossils, and four species of undescribed Ammonites; *Astarte elegans, Belemnites subclavatus* (Voltz, found in the lias of Boll.), Cidaris, *Gryphæa incurva, G. MacCullochii, Modiola minima*; Pecten and Pullastra (two unpublished species, both occurring at Brora); *Plagiostoma pectinoides*, first published from Brora; *P. giganteum, Pentacrinites scalaris*, Goldfuss; Rostellaria? Spirifer, Tellina, Unio, Turritella, and unpublished Serpulæ?

Among these fossils some are universally characteristic of the formation, others were first observed in the lias of the distant districts of Brora in Scotland, and of Boll and Banz in Germany. Some of the sinkings produced small pieces of jet or lignite like that of Whitby; others nearer the escarpment went through the lias, and reached brine springs in the subjacent red marl.

Having proved that this basin of lias reposes upon the new red sandstone, the author adverts to the almost unfathomable thickness of strata by which it must be separated from the coal-measures. Three fourths of this tract of lias are covered with thick accumulations of gravel, sand and boulders, the nature and origin of which will be pointed out on a subsequent occasion. With this sketch is connected an account of a new base line of the lower lias which the author has laid down upon the Ordnance map between Gloucester and Worcester. It crosses to the right bank of the Severn in the neighbourhood of Tewkesbury, by Forthampton and Bushley, the lias occupying Longden Heath as an outlier. The lowest strata of the formation are described as graduating into inferior green marls and white sandstone of the new red sandstone at Combe Hill, Bushley, Longden, Ripple, and Boughton Hill; the characteristic strata a little above the line of junction being thin, flag-like beds of blue limestone and shale, characterized by *Modiola Hillana*, Ostreæ, Spines of Echini, *Gryphæa gigantea, &c., &c.* This clear escarpment of the lower lias is of value, because the same strata are not well exposed in the coast sections at Whitby and Lyme.

A paper was afterwards read entitled, "A general view of the new red sandstone series, in the counties of Salop, Stafford, Worcester, and Gloucester." By Roderick Impey Murchison, Esq., V.P.G.S.

Viewing the new red sandstone which occurs in parts of Salop, Stafford, and Worcester, in the extended sense first applied to it by Mr. Conybeare*, as including all the deposits between the lias and the coal-measures, the author endeavours to divide the group into distinct subformations; an attempt which had not been made, the whole having been hitherto laid down upon maps as one formation. Following, as far as the structure of the country would allow, the divisions established by Professor Sedgwick for the N. E. of England, it is shown that the series is divisible into the undermentioned subformations:

	Foreign Equivalents.
1. Red and green marls........	*Keuper.*
2. Sandstone and conglomerates..	*Bunter sandstein, Gres bigarré.*
3. Calcareous conglomerates....	*Zechstein, &c. &c.*
4. Lower red sandstone	*Rothe todte liegende.*

I. "*Red and Green Marls.*"—These are best developed in Gloucestershire and Worcestershire, where they contain a subordinate white sandstone, undistinguishable from certain varieties of the Keuper-sandstone of the Germans. In the marls are situated most of the brine springs, both in these counties and in Salop and Cheshire, though some of them rise out of the inferior sandstone. But gypsum is not so abundantly developed as in the south-western districts of England, occurring rarely, and in thin stripes. There is no trace of the "muschelkalk" beneath these marls, and they uniformly graduate downwards into sandstone.

II. "*Red Sandstone and Conglomerates.*"—The country north of Shrewsbury affords the largest development of thick-bedded sandstones, of grey and reddish colours, in the hills of Hawkstone, Wern, Grinshill, Nesscliff, &c. Ores of copper and manganese, with sulphate of strontian, and chalcedony are of partial occurrence. This group extends into Staffordshire and the east of Shropshire, where it contains many bands of quartzose conglomerates, the disintegration of which gives a wild and sterile character to large tracts. In other parts, particularly north and south of Kidderminster, where the pure sandy beds prevail, are large districts of rye land, which exhibit an agricultural character quite distinct from that of any of the groups either above or below. In the southern parts of Worcestershire these red sandstones and conglomerates are concealed by a thick covering of gravel, and in Gloucester they are reduced to a very narrow band. The division into thick beds, false lamination, and want of cohesion, are the characters of this group.

III. "*Calcareous Conglomerates.*"—In North Worcester and Salop calcareous conglomerates, forming natural escarpments and dipping beneath the above sandstones, are supposed to occupy the place of the dolomitic conglomerate of the south-west, or magnesian lime-

* Outlines Geol. England and Wales, p. 278.

stone of the north-east, of England. They are largely burnt for lime to the east of the Lickey and Clent Hills, where they are of irregular thicknesses. These strata are repeated at Enville, the Bowells, and at Coton, &c., between Kidderminster and Bridgnorth.

The chief imbedded fragments are of limestone, which at Coton and the Bowells being sometimes oolitic, are supposed to have been derived from Orelton and the Clee Hills. Fragments of old red sandstone, quartz, and coal grits with impressions of plants, occur in the impure beds which pass into calcareous grits. This calcareous conglomerate can only be partially detected in the red sandstone of Apley, Nedge Hill and Lilleshall terraces, which form the eastern boundary of the coal-field of Coalbrook-dale; and similar slender bands, around the Dudley coal-field, may possibly be composed of the same conglomerate. In the west of Shropshire these strata swell out into a distinct ridge of about two miles in length, extending from Cardeston to Alberbury, where they have been mentioned in previous abstracts by Professor Sedgwick* and by the author, and where they put on many of the characters of the dolomitic conglomerate and contain nests lined with crystals of dolomite.

IV. "*Lower New Red Sandstone.*"—In Worcester and Salop the natural escarpment above alluded to exhibits sandstone and argillaceous marls, sometimes of great thickness, underlying the calcareous conglomerate. As these are seen in several places to pass down conformably into the coal-measures, the author identifies them with the lower new red of the North of England, which Professor Sedgwick has shown to be the equivalent of the rothe todte liegende of German geologists. Such relations are seen in the eastern parts of the Lickey Hills, on the southern and eastern face of the coal-field of Coalbrook-dale, and in parts of the Shrewsbury coal-field.

At Cantern bank near Bridgnorth and along a part of the bed of the Severn, these strata dip away conformably from the underlying coal-measures. Similar relations are seen at Wellbatch near Shrewsbury, and still better at Coedway near Alberbury, where the red sandstones and shales graduate upwards into the dolomitic conglomerate, and downwards into coal-bearing strata. On the whole this subformation, containing sandstone, shale, and grits, has in some parts much the external appearance of the old red sandstone, and in others of the coal-measures, and impressions of plants have been found in it near Lilleshall and at Wellbatch. As coal has been extracted in many parts of the North of England from beneath sandstone of this age, the author speculates on the probability of similar success attending *well-regulated* enterprises in Salop, Stafford, and Worcester. He alludes to a great sinking now going on between the edge of the Dudley coal-field and Birmingham, the shafts of which he believes are passing through strata of this age.

* Geol. Proceedings, vol. i. p. 345.

The author has defined the whole of the base line of the new red sandstone from May Hill in Gloucestershire to the Oswestry coal-field, and has made some changes in its direction, particularly in the country between Newent and the Malvern Hills, and between Kidderminster and Bridgnorth. He further describes the occurrence of several conglomerates along this base line, the most notable of which are Haffield Camp near Ledbury, Rosemary Rock near Knightwick bridge on the eastern flanks of the Abberley Hills, and on the sides of Stagbury and Warshill Hills near Bewdley. These conglomerates resembling that of Heavitree in Devonshire, are subordinate to red sandstone, and the fragments of trap which they contain have been derived from hills in their immediate vicinity. Felspathic trap rocks of this character have been formerly described in the Malvern and Abberley Hills, and similar rocks have this year been discovered by the author in Stagbury and Warshill Hills resembling in composition the rocks of the Clent and Abberley Hills. The conglomerates, however, which rest upon their flanks, include fragments of quartz, greywacke, old red sandstone, &c. Though occupying the base line of the series of new red sandstone, the author does not pledge himself that the conglomerates of these districts are the precise equivalents of the lower red sandstones which overlie and pass down into the coal-measures of Shropshire, for he shows that in the south of Worcestershire and in Gloucestershire there is not a sufficient expansion of the system to admit of such proofs. He is, however, disposed to think that the red sandstone which overlies the small patches of coal at Newent, may prove to be the representative of the lower new red. At two or three places on the eastern slopes of the Malvern Hills the conglomerates have been observed in inclined positions, and at some height above the adjoining plain. At Great Malvern they adhere in one spot to the steep flank of the sienite in a dislocated form, dipping east at an angle of 30° to 35°. This fact not having been previously noticed is considered to be worthy of record, as leading to the inference, that this chain of trappean hills may have undergone a movement of elevation subsequent to the deposit of the new red sandstone.

A letter was also read from Thomas Weaver, Esq. F.G.S. addressed to George Bellas Greenough, Esq. P.G.S.

In a communication read before the Society on the 4th of June 1830, Mr. Weaver stated that all the coal of the province of Munster except that of the county of Clare, belonged to the transition series*. In this letter, he says, "having devoted between three and four months continuous service to further research in the south of Ireland, I have to retract that statement, having been led to too rapid an inference by the apparent connexion between the southern portion of the coal-field and the transition series; and especially by finding the limestone, which there underlies the coal measures, to

* Geol. Proceedings, vol. i. p. 232.

contain some fossils hitherto considered distinctive of the transition epoch, in particular the Trilobites, which I have designated, some crinoidal remains, &c. But having in my later researches discovered between that limestone (in a part of its extent) and the transition series, a well-characterized formation of old red sandstone, the anomaly disappears, and we have in regular succession, the old red sandstone, carboniferous limestone, and the coal measures, which last I find also supported in other quarters by the carboniferous limestone, except where they directly conjoin the transition series. I am now, therefore, convinced that both the North and South Munster coal tracts are alone referrible to the great carboniferous order."

February 4th.—M. B. Cowie, M. D., of Mecklenburgh-Street, Mecklenburgh-Square; William Moody, Esq. of King's Bench Walk, Temple; Samuel Jones Lloyd, Esq. of New Norfolk-Street, Park-Lane, and Alexander Nasmyth, Esq., of George-Street, Hanover-Square; were elected Fellows of this Society.

A paper was read, "On certain Coal Tracts in Salop, Worcestershire and North Gloucestershire," by Roderick Impey Murchison, Esq. V.P.G.S.

Pursuing the inquiry in descending order, commenced at the last Meeting, the author calls attention to certain undescribed carboniferous districts, the outlines of which he has laid down upon the Ordnance Maps.

I. "*Shrewsbury or upper Coal-measures with freshwater Limestone.*"

The author takes this opportunity of showing, that the coal-measures near Shrewsbury, which he formerly described* as containing a subordinate band of lacustrine limestone, pass up conformably into the lower member of new red sandstone, and are thus proved to constitute the uppermost portion of the carboniferous series. He has this year discovered this freshwater limestone (with the same minute Planorbis, &c.,) in a thin zone of coal-measures extending from Tasley near Bridgnorth to Coughley near Broseley, where the strata, like those near Shrewsbury, also dip conformably beneath the lower new red sandstone. Mr. Prestwich has ascertained that some of the great beds of coal of the Broseley and Colebrookdale field are worked beneath this limestone.

II. *Western Coal-field of Salop.*

The Oswestry coal-field, lying on the western borders of Shropshire, is completely separated from that of Shrewsbury, and is the southern termination of the carboniferous zone, which extends from Flintshire by Ruabon and Chirk. It is of small extent, and little productive, containing only one bed of good coal. The millstone grit, which rises from beneath it on three sides, is remarkable for containing beds of cherty breccia, courses of sandy, encrinital limestone, and in the lower portion strata of thick-bedded, red sandstone, in parts undistinguishable from the new red sandstone. The carbo-

* Geol. Proceedings, vol. i. p. 472.

niferous limestone beneath this red sandstone, is exhibited on a very large scale in the fine escarpments of Llanymynech, Porth-y-wain and Treflach. The upper part is somewhat magnesian, and contains few fossils, with thin veins of copper ore; the lower is a fine subcrystalline limestone, in which are found *Producta hemisphærica*, the large basaltiform Coral, and many other fossils characteristic of the formation. Faults are numerous, and in the principal one running from north by east to south by west, the coal is upcast 180 yards. These dislocations increase as they rise upon the hill sides, and decrease as they range towards the plains of Shropshire.

III. "*Central and Southern Coal-fields of Salop.*"

The author mentions that he has accumulated many new facts respecting the coal-fields of the Clee Hills, since his communications in 1832, the principal of which are, That at the Titterstone Clee, the new works established by Mr. Lewis, have proved the existence of productive coal seams under the Hoar Edge, on the western side of the great basaltic dyke. He corrects the observation formerly made that some of the faults which affect the elevated tract of the Brown Clee Hills are the fissures of eruption of the basalt which crowns their summit. These faults, running from north to south and traversed by others trending from east to west, are all upcasts, and contain no basaltic matter, the chief eruption of which is supposed to have taken place at the north end of the Abdon Burf. Various details are given respecting this poor coal tract, which, though interesting in the theory of the formation of coal basins, cannot be included in an abstract. The mountain limestone is entirely absent, the coal resting on old red sandstone, as previously remarked by Mr. Wright of the Ordnance Survey.*

IV. *Forest of Wyre.*

In this tract are comprehended all the carboniferous strata ranging from two miles south-west of Bridgnorth to the Abberley Hills, the central and broadest portion of which is called the Forest of Wyre. The outline of this coal tract is very irregular, and the measures rest upon and are surrounded by the old red sandstone, except near Bewdley, where they are flanked by the new red sandstone, and on the sides of the Abberley Hills, south of the Hundred-house, where they have been deposited in thin patches upon transition rocks. Accounts are given of the different seams of coal and layers of ironstone which have been worked, near Deux Hill, Billingsley, Stanley, Mamble, Pensax, &c. The greater part of these works, including all the deep shafts, are abandoned, owing chiefly to the poor and pyritous quality of the coal. Sweet coal is of rare occurrence, though some thin beds occur at Lower Harcourt near Kinlet. These sulphureous coals are little used, except for drying hops and burning lime; but the sandstones, though only partially quarried, afford excellent building material. Some peculiar conglomerates, having a matrix of decomposed trap, occupy the lower beds of the series south of Bewdley. In general the strata

* Geol. Proceedings, vol. ii. p. 7.

are much disturbed, and the structure of the country is rendered obscure by protruded bosses of the underlying old red sandstone and its associated marls and cornstone. In some cases the old red sandstone (as on the Borle Brook), constitutes the sides of narrow ravines, on the flanks and in the hollows of which the coal is thrown off at high angles of inclination. At Kinlet the coal-measures are perforated by a wide and extensive mass of basalt, the structure of which has been previously described*, and in the neighbourhood of this rock they are much hitched and broken, the sandstones being in parts converted into a hard siliceous rock called White Jewstone. At Arley, on the Severn, coal-measures, surrounded by old red sandstone, extend in a peninsulated form from the left bank of the river, and are bisected by the trap dyke of Shatterford. Another large mass of trap consisting of concretionary compact felspar was last year discovered by the author at Church Hill, 5 miles south of Cleobury Mortimer, but its relations to the adjoining coal-field cannot be detected. The great fault at Stanley, near Higley on the Severn, has been caused by an upcast of the old red sandstone, which there occupies both banks of the river, abruptly cutting off the coal-measures. Allusion is then made to a short notice † of this tract, in which concretionary calcareous rocks are described as being *subordinate* to these coal-measures, but Mr. Murchison shows that these rocks are nothing more than protruding masses of cornstone of the inferior old red sandstone. He further describes, in detail, a section extending from one of these masses of concretionary limestone near Kinlet to Prescot Bridge. In this section there is a full development of the superior group of the old red sandstone, which although incoherent and of a yellow colour, and therefore unlike the prevailing rocks of that formation, is seen to pass upwards into a conglomerate, and dip under the true carboniferous limestone of Orelton. It is this tract of old red sandstone which separates the stinking coal-fields of Bewdley Forest from the productive coal-fields of the Clee Hills.

V. " *Coal-field of Newent, North Gloucestershire.*"

The carboniferous strata are here so little developed as scarcely to entitle them to the name of a coal-field, being composed of merely a few carbonaceous beds, interposed between the new and old red sandstones. In the vicinity of the town of Newent, where the formation is most expanded, four thin seams of coal were formerly worked, which were separated from each other by only a few yards of shale. In some cases the coal was extracted from beneath the new red sandstone. The extension of these carbonaceous strata is cut off in the south and south-west by the transition rocks of May Hill; while to the north they gradually taper away, and are absolutely seen to thin out between the escarpment of new red sandstone and the argillaceous marls of the old red; hence the author concludes that the Newent coal strata were originally deposited upon

* Geol. Proceedings, vol. ii. p. 92.
† Geol. Proceedings, vol. ii. p. 20.

old red sandstone, in a similar manner to those of the Brown Clee Hills, the Forest of Wyre, &c. &c.

In concluding his reports upon these detached coal-fields, the author gives the following as the positions which he has attempted to establish:

1st, The existence of a younger zone of coal, which contains a peculiar freshwater limestone, and passes upwards into the oldest strata of the new red sandstone, (Shrewsbury coal-field.); and downwards into the inferior coal strata of Coalbrook Dale.

2ndly, That the inferior coal strata were deposited in some parts upon mountain limestone and in others upon the old red sandstone and transition rocks.

3rdly, That the Clee Hill fields exhibit only the lower system, graduating down in two situations to mountain limestone, and in others resting upon old red sandstone.

4thly, That in the Brown Clee Hills, the Forest of Wyre, and at Newent, the carbonaceous matter was originally deposited upon the old red sandstone.

5thly, That in some of the poor and ill-consolidated coals, particularly in the upper zone, the traces of vegetable organization are so distinct, that even the generic and specific characters of the plants can be recognised in the coal itself.

Lastly, That wherever the mountain limestone has been interpolated between the bottom coal grits and the old red sandstone, it can invariably be traced to thin out and disappear within a very small area; and hence it is inferred, that as calcareous matter appears never to have been elaborated in these regions, except at wide intervals and in minute quantities, mighty convulsions are not necessary to account for the absence of the mountain limestone through such large carboniferous tracts.

The coal-field of Oswestry is not included in the application of these inferences; for, like the great coal basin of South Wales, it has been deposited upon a thick girdle of carboniferous limestone.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1834—1835. No. 39.

AT THE

ANNUAL GENERAL MEETING,

20th February 1835,

The following Report from the Council was read:—

It is a great satisfaction to the Council to commence their Annual Report to the Society by congratulating its Members on the acquisition of the additional apartments which His Majesty's Government have been pleased to make over to them since the last Anniversary. The benefits resulting from this new accommodation will be best understood by a reference to the annexed Report of the Committee appointed to examine into the state of the Museums.

The expense of the alterations has amounted to 1035*l.*, of which 500*l.* have been raised by voluntary subscriptions, and the remainder has been defrayed out of the ordinary income of the Society.

The improvements have been carried into effect under the direction and superintendence of Mr. Decimus Burton; and the Council cannot but advert to the thanks which are due to that gentleman for the liberality with which he has gratuitously devoted his valuable time and services to this object.

The Society continues annually to increase. At our last Anniversary the Council congratulated you on the number of its members being 716; they have now the further satisfaction of announcing that at the close of 1834 it amounted to 745. Forty-two new Members were elected in the course of the past year; on the other hand, there were ten deaths and three resignations.

With respect to the finances, the outlay required for the improvements in the Apartments has necessarily somewhat diminished the apparent balance of the Society's assets. The amount of the Society's property, consisting of cash at the bankers', money invested in the Public Funds, of arrears due to the Society, and of the stock on hand of unsold Transactions taken at a very low valuation, by the last account presented to you was valued at 2010*l.* 19*s.* 5*d.* This year it appears, in consequence of the expenses in question, to be reduced to 1735*l.* 15*s.* 10*d.*

On referring to the accounts of the general receipts and expenses for the year, including those incurred for the improvements, it appears that there has been an excess of expenditure over the receipts of 133*l*. 16*s*. 8*d*.; but as of this sum 113*l*. 14*s*. 3*d*. was for debts incurred in the previous year,

	£.	s.	d.
the actual excess of the expenditure for 1834 over the receipts is only	20	2	5
to which is to be added the amount of debts outstanding on the 31st December last	257	18	2
making the excess of the Society's liabilities at the close of last year	278	0	7

By the failure of Mr. Richter, who, for a short time, was the publisher of the Society's Transactions, a trifling loss may be sustained. The whole amount of his debt, however, does not exceed 25*l*., part of which may be recovered.

The estimates for the ensuing year will show that the expected income will about meet the probable expenditure, including a provision for the publication of the volume of the Transactions now in preparation, and for the payment of all outstanding debts; and this without taking credit in the estimates for such sums as may be received under the head of Compositions, which the Council trust they may be able to continue to invest in Government Securities, with the exception always of such sums as from time to time may be required to appropriate to the special object of carrying on the publications of the Society, in which a certain portion of capital must necessarily be at all times invested.

On the subject of publications, the Council have to announce that the Supplement to the Third Volume of the Transactions will appear at the same time as the first part of the Fourth Volume; and the Council have taken such measures as they trust will prevent the recurrence of delay in the publication in future.

In pursuance of a resolution of the Council of the 20th of January 1835, the Wollaston Medal, with the balance on one year's dividends, has been awarded to Gideon Mantell, Esq., for his various publications and long-continued labours on the comparative anatomy of fossils, especially for the discovery of two new genera of fossil reptiles, the Iguanodon and the Hylæosaurus.

It is with extreme regret that the Council announce that Dr. Turner has found himself obliged, in consequence of ill health, to resign the office of Secretary; and they cannot omit this opportunity of stating how fully entitled that gentleman is to the grateful acknowledgements of the Society for the zeal and ability with which he has at all times discharged the duties of his office.

REPORT of the Committee appointed to examine and report on the state of the Museums and Library.

4th February, 1835.

Museum.—The completion of the new arrangement made in the apartments of the Society, in consequence of the grant of additional rooms by His Majesty's Government, caused the Museum to be entirely dismantled during the last summer; so that the Curator was prevented from introducing into the collection the specimens presented since the last Anniversary. The Committee therefore can only call the attention of the Council to the increased space gained by the grant of the rooms lately obtained from the Government.

The Lower Museum has been enlarged by adding to it the room formerly appropriated, in part, to the Library, and by the removal to the new library of the collection of recent shells. By a more condensed arrangement of these shells, as also of the simple minerals, about eighty drawers have been emptied, and prepared for the accommodation of new specimens, of which they are capable of holding from 2000 to 2500. Nearly all this space will be required for the collections presented during the last eighteen months. Additional room, however, will be gained during the ensuing summer by diminishing the size of the tablets to which the collections of fossils in the English series are attached, the space hitherto allowed to each specimen being far greater than is necessary. By this arrangement the present cabinets may be made to contain about one fourth more fossils, and there is space in the Museum for additional Cabinets when they may be wanted.

The following are among the principal donations made during the last year to the English Collections:

1st. Suite of rocks and fossils from Herefordshire, Shropshire, and parts of Wales; from R. I. Murchison, Esq. V.P.G.S.

These specimens extend the series formerly presented by the same donor, and are important as supplying one of the principal deficiencies in the English Collection.

2nd. Bones and shells from the gravel and loam of Cropthorne near Evesham, Worcestershire; from Hugh Edwin Strickland, Esq. F.G.S.

Upper or Foreign Museum.—This room has been increased in size by throwing into it a large closet, formerly a store-room; and by the removal of the books formerly kept in it space is gained for the accommodation of eighty-six drawers, which would hold about 2000 specimens. The principal donations made to the Collection are—Specimens from the Eifel, presented by Leonard Horner, Esq.; Remains of the *Anthracotherium Velaunum*, Myoxus, and Crocodile from Puy en Velay, presented by Mons. Bertrand de Doué, For. Mem. G.S.; Tertiary Shells from the United States, presented by Henry D. Rogers, Esq. F.G.S., and T. A. Conrad, Esq.

Library.—The *Books*, with the exception of a small proportion, for which additional shelves must be provided, have been removed from the former library to one of the apartments lately obtained from His Majesty's Government. In this apartment the cabinets of simple minerals and recent shells have been placed.

The donations to the Library during the last year have equalled those of former years; and the Society continues to receive from the Board of Ordnance the maps of the English Trigonometrical Survey, and of the Townland Survey of Ireland. The East India

Company also continue to present the sheets of the Trigonometrical Survey of India in the order in which they are published.

All the *Charts* in the Society's possession, amounting to about 850, are now arranged; and an interleaved catalogue of the Admiralty list of charts has been prepared, which, with the necessary additions in manuscript, renders the entire collection easy of reference.

The *Maps* have likewise been arranged; and, as soon as the presses formerly recommended to contain them are ready, they will be disposed of in the same manner as the charts. The Committee wish to call attention to the wants of the Society in this department, and to express their regret that many important maps, recently published on the Continent, are not in the possession of the Society.

The Committee think it desirable to publish the following list of the *Transactions*, which they have been in the habit of receiving from various Philosophical Societies, and in which some *lacunæ* will be observed.

In connexion with this list of scientific Transactions the Committee have great pleasure in stating, that the Curator has in the course of the last vacation prepared a catalogue of Papers or Memoirs on Geology, alphabetically arranged according to the names of places, with a similar catalogue arranged according to the names of Fossils, and a third catalogue of Memoirs on Theoretical Geology, arranged according to the names of the authors; and that these catalogues are accompanied by references so as to form a complete index to all the volumes of Transactions, Journals, and other works, Geological or Miscellaneous, contained in the library. The Committee have the highest satisfaction in concluding their Report with the mention of so useful and meritorious a labour, and which adds so materially to the many valuable services rendered by Mr. Lonsdale to the Geological Society.

CHARLES LYELL.
W. H. SYKES.
JAMES YATES.

List of Transactions referred to in the above Report.

Philosophical Transactions. From the commencement to the end of the year 1700, abridged by John Lowthorp, M.A. and F.R.S.

——— From 1700 to 1720, abridged by Henry Jones, M.A.

——— From 1719 to 1733, abridged by Mr. John Eames, F.R.S., and John Martyn, F.R.S.

——— From 1772 to 1791, 1801 to 1807, 1824 to 1834.

Transactions of the Linnean Society, Vols. 9 to 16, and Part 1. of Vol. 17. (1808—1834.)

Transactions of the Horticultural Society, Vols. 1 to 7.

Memoirs of the Astronomical Society, Vols. 1 to 7. (1821 to 1834.)

Transactions of the Royal Asiatic Society of Great Britain and Ireland, Vols. 1 to 3. (1827 to 1834.)

Journal of the Royal Asiatic Society of Great Britain and Ireland, No. 1. (1834.)

Journal of the Royal Geographical Society, Vols. 1 to 4. (1832 to 1834.)
Transactions of the Medico-Botanical Society for 1832 and 1833.
Transactions of the Society of Arts, Manufactures, and Commerce, Vol. 1 to 50. (1783 to 1834.)
Reports of the First, Second, and Third Meetings of the British Association. (1831 to 1833.)
Transactions of the Cambridge Philosophical Society, Vols. 1 to 5. (1821 to 1834.)
Transactions of the Royal Geological Society of Cornwall, Vols. 1 to 4. (1818 to 1832.)
Transactions of the Plymouth Institution, Vol. 1. (1830.)
Transactions of the Royal Society of Edinburgh, Vols. 6 to 12. (1812 to 1834.)
Memoirs of the Wernerian Society, Vol. 1, Vol. 2 Part 1, and Vol. 5 Part 2.
Transactions of the Royal Irish Academy, Vols. 1 to 16. (1787 to 1830.)
Transactions of the Dublin Society, Vol. 2 Part 2 to Vol. 6. (1801 to 1810.)
Journal of the Geological Society of Dublin, Vol. 1, Parts 1 and 2. (1833 and 1834.)
Mémoires de la Société Impériale des Naturalistes de Moscou, Tome 5. (1817.). Nouveaux Mémoires, Tome 3, (1834.)
Bulletin de la Société Impériale des Naturalistes de Moscou, Tome 6. (1833.)
Transactions of the Berlin Academy from 1812 to 1832.
Memoirs of the Royal Academy of Munich, Vol. 5. (1817.)
Nova Acta Academiæ Curiosorum Bonnæ, Vol. 13 et 14. (1826—1829.)
Studien des Göttingischen Vereins Bergmännischer Freunde, Bände 1—3. (1824—1834.)
Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Tomes 5 et 6. (1832—1833.)
Memorie della Società Italiana delle Scienze residente in Modena, Tomo 20. Fascicolo Secondo delle Memorie di Fisica.
Mémoires de l'Académie Royale des Sciences de l'Institut de France, Tomes 5—12. (1826—1833.)
Mémoires présentés par divers Savans à l'Académie Royale des Sciences de l'Institut de France, Tomes 1—3. (1827—1832.)
Mémoires de la Société Géologique de France, Vol. 1. Part 1. (1833.)
Annales des Mines, Tomes 1—11 (1816—1825.)
—————— 3ieme Series, Tomes 1—6.
Mémoires de la Société Linnéenne du Calvados, Année 1824.
Transactions of the American Philosophical Society, held at Philadelphia, Vols. 1 to 6. (1789 to 1804.)
—————— New Series, Vols. 1 to 5. (1818 to 1834.)
Journal of the Academy of Natural Sciences at Philadelphia, Vol. 7, Part 1. (1834.)

Transactions of the Geological Society of Pennsylvania, Vol. 1. Part 1. (1834.)

Transactions of the Literary and Historical Society of Quebec, Vols. 1 and 2. Vol. 3. Part 1 and 2. (1829 to 1833.)

Transactions of the Agricultural and Horticultural Society of India, Vol. 1. (1829.)

Asiatic Researches, or Transactions of the Society instituted in Bengal, Vols. 1 to 17. (1788 to 1832.) Physical Class, Vol. 1. (1829 to 1833.)

Memoirs of the American Academy of Arts and Sciences, Vols. 3 and 4. (1809 to 1818.)

Transactions of the Literary and Philosophical Society of New York, Vol. 1. (1815.)

Memoirs of the Board of Agriculture of the State of New York, Vols 2 and 3. (1823 to 1826.)

Comparative Statement of the Number of the Society at the close of the years 1833—1834.

February 20th, 1834.

Fellows	31st Dec. 1833.	31st Dec. 1834.
Having compounded	76	84
Contributing	225	229
Non-residents	311	328
	612	641
Honorary	44	44
Foreign Members	57	57
Personages of Royal Blood	3	3
	716	745

The following Persons were elected Fellows of this Society during the Year 1834.

January 8th.—William Copland, Esq. of Edinburgh; Peter Bellinger Brodie, jun. Esq. of Lincoln's Inn Fields; George Cornwall Lewis, Esq. of Harpton Court, Radnorshire, and Henrietta-street, London; Benjamin Heywood Bright, Esq. of Stone-buildings, Lincoln's Inn; and Thomas Jameson Torrie, Esq. of Edinburgh.

January 22nd.—Alexander Trotter, Esq. of Orchard-street; and Robert Walters, Esq. of Lincoln's Inn Fields.

February 5th.—John Donkin, Esq. Civil Engineer, of Great Surrey-road, Blackfriar's-bridge; Edward Ord Warren, Esq. of Horkesley Hall, Colchester; Edw. Clark, Esq. of Mincing-lane; and James F.W. Johnston, Esq. Professor of Chemistry in the Durham University.

February 26th.—Charles Allsop, Esq. of Broombriggs near Loughborough; Williamson Peile, Esq. of Whitehaven; and James R.

Hope, Esq. B.A. Fellow of Merton College, Oxford, Chelsea Hospital.

March 12th.—Col. Pasley, C.B., Royal Engineers, Chatham; the Knight of Kerry; and Edward Hill, Esq. B.A. of Christ Church, Oxford.

March 26th.—William Palmer, Esq. of Essex-court, Temple; and Alexander Melville, Esq. of Upper Harley-street.

April 9th.—James Bryce, jun. Esq. M.A. Belfast; the Rev. Edward Tagart, of Addison-road, Kensington; William Hopkins, Esq. M.A. of St. Peter's College, Cambridge; The Rev. Christopher Sykes, of Roop near Hedon, Yorkshire; and Sir Charles Mansfield Clarke, Bart. M.D. of Saville-street.

April 23rd.—Sir Oswald Mosley, Bart. M.P. of Rolleston Hall, Staffordshire; and Edward J'Anson, jun. Esq. of Burntwood Grange, Wandsworth-common.

May 7th.—Richard Prime, Esq. of Walberton near Arundel; Lieut. William Henry Breton, R.N.; Capel Cure, Esq. of Devonshire-place; and Edmund Buxton, Esq. of Devonshire-place.

May 21st.—Thomas Clements Parr, Esq. M.A. of Christ Church, Oxford, Barrister-at-Law, Combe Lodge, Somersetshire.

November 5th.—Hugh Edwin Strickland, Esq. of Craycombe House near Evesham; Sir William Molesworth, Bart. M.P. of Pencarrow, Cornwall; and Herbert Mayo, Esq. of Cheshunt, Herts.

December 3rd.—Major-General Lord Greenock, of Carlton-place, Edinburgh; David Milne, Esq. of York-place, Edinburgh; Capt. Coulthurd, of the Bengal Artillery; Rev. James Bowstead, Fellow of Corpus Christi College, Cambridge; John Rofe, jun. Esq. of Bernard-street; Charles Hastings, Esq. M.D. Worcester; and Rev. Josiah Bull, M.A. of Newport Pagnel, Bucks.

December 17th.—James Wyatt, Esq. of Lime Grove, near Bangor.

The names of the Fellows deceased are as follows:—

Compounders, (None.)

Residents (5), Viscount Grenville; Earl of Hardwicke; Thomas Johnson, Esq.; John C. Powell, Esq.; Thomas Telford, Esq.

Non-residents (5), Mathew Culley, Esq.; Major Franklin; James Hardie, Esq.; Frederick Page, Esq.; Henry Jones Shrapnell, Esq.

The MUSEUM has received many Donations since the last Anniversary, among which are included the following:—

British and Irish Specimens.

Portions of Septaria from the London Clay at Brixton; and of Fossil Wood perforated by *Teredina personata*, from the Plastic Clay, Hengistbury, Hants; also Cast of a Palatal Tooth from the Chalk of Dorsetshire; presented by the Rev. Professor Buckland, D.D. F.G.S.

A series of Specimens of the Transition Formations, and the Greenstone, Porphyry, and Syenite of Herefordshire, Worcestershire, Shropshire, and parts of Wales; Specimens of Tufe from the Southstone Roche; and of Fossils from the Mountain Limestone and Greensand; presented by Roderick Impey Murchison, Esq. V.P.G.S.

Specimens from the Plastic Clay near Reading; presented by John Rofe, jun. Esq. F.G.S.

Fossil Corals from Aymestry; and a large Specimen of the polished Limestone found near Gwinfe in Carmarthenshire; presented by the Rev. T. T. Lewis.

Cast of an Ophiura from the Lias on the banks of the Severn; presented by Matthew Wright, Esq.

Specimens of Selenite from the London Clay near Herne Bay; presented by William Richardson, Esq. F.G.S.

Specimens of Grauwacke containing Casts of *Pentamerus oblongus*; presented by Mr. Rees.

Fossils of the Grauwacke Series of Shropshire; presented by W. Williams, Esq.

Grauwacke Fossils from the neighbourhood of Llandovery; presented by Professor Miller, F.G.S.

Cast of a Palatal Bone from the Chalk; Specimens from the London Clay at Hornsey; and from the Loam of Muswell Hill; presented by Nathaniel T. Wetherell, Esq. F.G.S.

Specimens of Rowley Rag, unaltered, decomposed and fused; presented by J. R. Corrie, M.D. F.G.S.

Specimens of the Hastings Sand; presented by Baden Powell, Esq. F.G.S.

Specimen of Slickensides, from Cornwall; presented by Richard Taylor, Esq. F.G.S. of Perran Arworthal.

A Fish from the Magnesian Limestone; presented by J. W. Colling, Esq.

Carbonate of Strontia, with Calcareous Spar and Brown Iron Ore, from the Forest of Dean; presented by Captain Yorke, R.N.

Minerals from the Trap of Scotland; presented by George Bellas Greenough, Esq. P.G.S.

Corals from the Shale Beds of the Mountain Limestone, county of Fermanagh; presented by Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

Fossils from the Greensand, Blackdown; presented by Viscount Cole, M.P. F.G.S., and Sir Philip de Malpas Grey Egerton, Bart. F.G.S.

Fossils from the neighbourhood of St. Ives; presented by J. R. Wright, Esq. F.G.S., and Henry Maclauchlan, Esq. F.G.S.

Casts of a Claw Bone of a Crocodile, and of an Iguanodon from Tilgate Forest; presented by Gideon Mantell, Esq. F.G.S.

Specimens from Bognor and from the Chalk near Felpham; presented by Woodbine Parish, jun. Esq. F.G.S.

Specimens from the ancient Beach at Hope's Nose near Babbacombe, and from the Watcombe Fault, Devonshire; presented by Robert Alfred Cloyne Austen, Esq. F.G.S.

Specimens of Granite traversed by Veins, from Dartmoor; presented by J. H. Deacon, Esq. F.G.S.

Specimens of Vegetable Remains from the Anthracite of North Devon; presented by Henry T. De la Beche, Esq. F.G.S.

Cast of a Molar Tooth of *Mastodon angustidens* from the Crag, Suffolk; also Shells from the Loam and Gravel at Cropthorne, Worcestershire; presented by Hugh Edwin Strickland, Esq. F.G.S.

Specimens from Jersey, Guernsey, and Sark; presented by W. C. Trevelyan, Esq. F.G.S.

Specimens from the neighbourhood of Ilfracombe; presented by Col. Harding.

Specimens from the Coal of the South of Ireland; presented by Thos. Weaver, Esq. F.G.S.

Casts from Flambro' Head of Spongeous Zoophites; presented by Mr. Leigh.

Shells and Bones from the Freshwater Deposit at Sutton, Suffolk; and a Specimen of the Calcareous Nodules accompanying the Shells; presented by Edward Charlesworth, Esq.

Porcelain Jasper from the Junction of the Sandstone and Trap Rock of Stirling Castle; presented by Richard Knight, Esq. F.G.S.

Foreign Specimens.

Fossil Plants from the Greensand of Niederschona near Freyberg; presented by M. Felipe Bauza, jun.

A Hippurite from Sicily; presented by M. le Conte Duchâtel.

Specimens from Australia; presented by Captain Henry Smyth, R.N.

Specimens from the Islot of Alcatraz, on the West Coast of Africa, from Gibraltar and from Keith's Reef between Sicily and the Coast of Africa; presented by Captain Belcher, R.N. F.G.S.

Fossil Plants, Insects, and Fishes, from Aix en Provence; presented by George Bentham, Esq. F.G.S.

Specimens of Lignite from Leira; presented by Richard Hollier, Esq. F.G.S.

Specimens from France; and a Hippurite from Untersberg; presented by Roderick Impey Murchison, Esq. V.P.G.S.

Fishes from Monte Bolca; presented by W. A. Mackinnon, Esq.

Specimens from the Eifel; presented by Leonard Horner, Esq. F.G.S.

Specimens of Recent Coral from the Straits of Sunda; and Native Iron from the mass in the British Museum, from Otumpa in the Chaco, South America; presented by Woodbine Parish, jun. Esq. F.G.S.

Specimens from the Tertiary Formations of Murcia; presented by Charles Silvertop, Esq. F.G.S.

Lava from Graham's Island; presented by Captain Stuart.

Specimens from the South of Spain; presented by Captain Cook, R.N. F.G.S.

Specimens from the Mines of Konigsberg and Norway; and of Artificial Cupriferous Iron-pyrites; presented by H. C. Ström, Esq.

Fish from Monte Bolca; presented by Samuel P. Pratt, Esq. F.G.S.

Casts of the Remains of *Felis spelæa* and *Gulo spelæus* from Gailen-

ruth; presented by Viscount Cole, M.P. F.G.S., and Sir Philip de Malpas Grey Egerton, Bart. F.G.S.
Magnetic Iron Ore from Sierra Leone; presented by David Mushet, Esq. Hon. Mem. G.S.
Specimens from Tampico; presented by Thomas Weaver, Esq. F.G.S.
A collection of Specimens taken from the Crater of the Water Volcano near Guatemala; presented by Col. Juan Galindo.
Fossil Crab (*Gonoplax Latreillii*) from India; presented by the Right Honourable the Earl of Cawdor, F.G.S.
Remains of the *Anthracotherium Velaunum*, Myoxus, and Crocodile, from Puy en Velay; presented by Mons. Bertrand de Doue, For. Mem. G.S.
Tertiary Shells from the United States; and Specimens from the Big Bend on the Missouri; presented by Henry D. Rogers, Esq. F.G.S.
Tertiary Shells from the United States; presented by T. A. Conrad, Esq.
Specimens from China; presented by John Russell Reeves, Esq.
Specimens from Australia; presented by Allan Cunningham, Esq.
Anthracite from the Lehigh Coal-mine, Pennsylvania; presented by F. Lambert, Esq.
Fossils from the Calcaire Grossier of France; presented by Joseph Prestwich, jun. Esq. F.G.S.
Casts of the Inferior and Maxillary Bones of the Mastodon and Tetracaulodon; presented by the American Philosophical Society held at Philadelphia.

Miscellaneous.

Specimens of Iron Tubes from a Steam-boiler; presented by John Taylor, Esq. Treas. G.S.
Deposits on the vertical Walls of the Boiler of a Steam Boat; presented by Charles Lyell, Esq. For. Sec. G.S.
Palate of an Eagle Ray (Myliobites) from Bermuda; presented by Leonard Streate Coxe, Esq. F.G.S.

The Library has been increased by the Donation of 144 Books and Pamphlets.

Charts and Maps.

The Townland Survey of the county of Tyrone; presented by Lieut.-Col. Colby, F.G.S. by order of the Lord Lieutenant of Ireland.
Sheets 53, 57, and 62 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.

The following LIST contains the NAMES of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received since the last Anniversary.

Ainsworth, William, Esq.
Allan, Robert, Esq.
American Philosophical Society.
Arts, Society of.
Asiatic Society of Bengal.
Athenæum, Editor of.
Athenæum Club, Committee of.
Austen, A. C. Esq. F.G.S.

Bauza, M. Felipe.
Beaufoy, Henry, Esq.
Beke, Charles T. Esq.
Belcher, Capt. Edw. R.N. F.G.S.
Bentham, George, Esq. F.G.S.
Berlin, Royal Academy of.
Berwickshire Natural History Club.
Black, Young and Young, Messrs.
Boblaye, Mons. E. Puillon.
Bohn, Mr.
Boué, Manie, For. Mem. G.S.
Brewster, Sir David, F.G.S.
British Association.
Broderip, Wm. John, Esq. F.G.S.
Brongniart, Mons. Alex. For. Mem. G.S.
Bronn, Dr. H. G.
Buch, M. Leopold de, For. Mem. G.S.
Buckland, Rev. Prof., D.D. F.G.S.

Cambridge Philosophical Society.
Cawdor, Right Hon. the Earl of, F.G.S.
Charlesworth, Edward, Esq.
Christol, M. Jules.
Colby, Lieut.-Col. F.G.S.
Cole, Viscount, M.P. F.G.S.
Colebrook, Lieut.-Col.
Colling, J. W. Esq.
Cook, Capt. S. Edw. R.N. F.G.S.
Corrie, John, M.D. F.G.S.
Coxe, Leonard Streate, Esq. F.G.S.
Cunningham, Allan, Esq.
Daubeny, Prof. C. M.D. F.G.S.
Deacon, J. H. Esq. F.G.S.
De la Beche, H. T. Esq. F.G.S.
De la Marmora, Chevalier.
Dickinson, John, Esq. F.G.S.
Doue, M. Bertrand de, For. Mem. G.S.
Duchâtel, M. le Conte.
Dufrénoy, M. For. Mem. G.S.

East India Company, The Directors of the.
Ecole des Mines.
Egerton, Sir Philip, Bart. F.G.S.

Faraday, Michael, Esq. F.G.S.

Galindo, Col. Juan.
Geneva, Natural History Society of.
Geological Society of Dublin.
Geological Society of France.
Geological Society of Pennsylvania.
Greenough, George Bellas, Esq. P.G.S.

Harding, Col.
Harlan, Richard, M.D.
Hausmann, Prof. I. Frederick, For. Mem. G.S.
Hitchcock, Prof. Edward.
Hoff, M. C. A. de, For. Mem. G.S.
Hollier, Richard, Esq. F.G.S.
Horner, Leonard, Esq. F.G.S.
Hullmandel, Mr.
Hutton, William, Esq. F.G.S.

Imperial Society of Naturalists of Moscow.
Ireland, His Excellency the Lord Lieutenant of.

Jackson, Col. J. R.

Kleinschrod, Mons. C. T.
Klipstein, A. M.D.

Knight, Richard, Esq. F.G.S.

Lambert, F. Esq.
Lea, Isaac, Esq.
Leeds Philosophical Society.
Leigh, Mr.
Lewis, Rev. T. T.
Lindley, John, Esq. F.G.S.
Linnean Society.
Lnoteky, Dr. John.
Loudon, J. C. Esq. F.G.S.
Lyell, Chas. Esq. For. Sec. G.S.

Mackinnon, Wm. A. Esq.
Maclauchlan, Henry, Esq. F.G.S.
Mammatt, Edward, Esq. F.G.S.
Mantell, Gideon, Esq. F.G.S.
Marcet, Mons. F.
Medico-Botanical Society.
Miller, Prof. W. Hallows.
Modena, Società Italiana delle Scienza residente in.
Murchison, R. I. Esq. V.P.G.S.
Mushet, David, Esq. Hon. Mem. G.S.

Nattali, Mr. A.

Ordnance, Master General and Board of.

Parish, Woodbine, jun. Esq. F.G.S.
Paxton, Mr. Joseph.
Phillips, John, Esq. F.G.S.
Phillips, Richard, Esq. F.G.S.
Powell, Baden, Esq. F.G.S.
Prague, President of the Museum of.
Pratt, Samuel P. Esq. F.G.S.

Rees, Mr.
Repertory of Patent Inventions, Editor of.
Reeves, J. R. Esq.
Richardson, William, Esq. F.G.S.
Rive, M. Aug. de la.
Rodds, Mr.
Rofe, John, jun. Esq. F.G.S.
Rogers, Henry D. Esq. F.G.S.
Royal Asiatic Society.
Royal Astronomical Society.
Royal Society of Edinburgh.
Royal Geographical Society.
Royal Society of Literature.
Royal Society of London.
Royal College of Physicians.
Royal College of Surgeons.

Saint Hilaire, M. Geoffroy.
Savi, Signor Paolo.
Scarborough Philosophical Society.
Schmerling, P. C. M.D.
Serres, M. Marcel de.
Silliman, Benjamin, M.D.
Silvestre, M.
Silvertop, Col. Chas. F.G.S.
Smyth, Capt. H. R.N.
Strickland, Hugh E. Esq. F.G.S.
Ström, H. C. Esq.
Stuart, Capt. John.
Sussex, His Royal Highness the Duke of.

Taylor, John, Esq. Treas. G.S.
Taylor, Richard, Esq. F.G.S.
Taylor, Richard, Esq. F.G.S. of Perran Arworthal.
Thomson, Thomas, M.D.
Trevelyan, W. C. Esq. F.G.S.
Turnbull, George, Esq.
Turner, Edward, M.D. Sec. G.S.

Vandermaelen, Mons. P. H.
Vincenzo, Signor Dottore.
Virlet, Théodore, M.

Waterton, Charles, Esq.
Weaver, Thomas, Esq. F.G.S.
Wetherell, Nath. T. Esq. F.G.S.
Williams, William, Esq.
Wright, John Robinson, Esq. F.G.S.
Wright, Matthew, Esq.

Yorke, Capt. R.N.
Yorkshire Philosophical Society.

Zoological Society.

List of PAPERS *read since the last Annual Meeting*, Feb. 21st, 1834.

February 26th.—On the Quantity of Solid Matter suspended in the Water of the Rhine; by Leonard Horner, Esq. F.G.S.

———— Observations on the Geological Structure of the neighbourhood of Reading; by John Rofe, jun. Esq. F.G.S.

March 12th.—Observations on the Temple of Jupiter Serapis at Puzzuoli near Naples; to which are added some Remarks on the Causes which produce Geological Cycles of great extent; in a letter addressed to William H. Fitton, M.D. F.G.S. from Charles Babbage, Esq.

March 26th.—A Letter from Charles Denham Orlando Jephson, Esq. M.P. F.G.S. addressed to George Bellas Greenough, Esq. P.G.S. On Variations of Temperature in a Thermal Spring at Mallow.

———— A Letter from William Henry Egerton, Esq. F.G.S., addressed to Charles Lyell, Esq. For. Sec. G.S., On the Delta of the Kander.

———— A Notice respecting some Fossils collected in Cutch by Capt. Smee of the Bombay Army; by Lieut.-Col. W. H. Sykes, F.G.S.

———— On the Gravel and Alluvial Deposits of those parts of Herefordshire, Shropshire, and Worcestershire which consist of Old Red Sandstone, with an account of the Puffstone or Travertin of Spout-house, and of the Southstone Roche near Tenbury; by Roderick Impey Murchison, Esq. V.P.G.S.

April 9th.—A short Notice of the Coast Section from Whitstable in Kent, to the North Foreland in the same county; by William Richardson, Esq. F.G.S.

———— On the several Ravines, Passes, and Fractures in the Mendip Hills and other adjacent boundaries of the Bristol Coal-field, and the Geological period when they were effected; by the Rev. David Williams, F.G.S.

———— On the Tertiary Formations of the kingdom of Murcia in Spain; by Charles Silvertop, Esq. retired Brigadier in the Spanish Service, F.G.S.

———— On the Geology of the Bermudas; by Lieut. Nelson of the Royal Engineers, and communicated by George Bellas Greenough, Esq. P.G.S.

May 7th.—On the Distribution of Organic Remains in the Lias Series of Yorkshire, with a view to facilitate its Identification, by giving the situation of its Fossils; by Mr. W. Williamson, jun. of Scarborough.

———— Observations on the Loamy Deposit called Loess, in the Valley of the Rhine; by Charles Lyell, Esq. For. Sec. G.S.

May 21st.—Upon the Trap Rocks, and the effects produced by them upon the Stratified Deposits in Shropshire, Herefordshire, &c.; by Roderick Impey Murchison, Esq. V.P.G.S.

June 4th.—Observations on the Strata penetrated in sinking a Well at Diss in Norfolk; by John Taylor, Esq. Treas. G.S.

——— Observations on a Well dug at Lower Heath, on the south side of Hampstead; by Nathaniel Wetherell, Esq. F.G.S.

——— A Letter from Sir Philip Egerton, Bart. F.G.S., addressed to the Rev. Prof. Buckland, D.D. F.G.S., On the Ossiferous Caves of the Hartz and Franconia.

——— A Letter from Hugh E. Strickland, Esq. F.G.S., addressed to George Bellas Greenough, Esq. P.G.S., On the Occurrence of Freshwater Shells of existing Species, beneath the Gravel near Cropthorne, Worcestershire.

——— A Notice on the Action of High Pressure Steam on Glass, and other Siliceous Compounds; by Prof. Turner, M.D. Sec. G.S.

November 5th.—On the New Classification of Fishes and on the Geological Distribution of Fossil Fishes; by Prof. Agassiz.

November 19th.—An Account of the Raised Beach near Hope's Nose in Devonshire, and other recent Disturbances in that neighbourhood; by Alfred Cloyne Austen, Esq. F.G.S.

November 19th and December 3rd.—A Paper, entitled Some Facts in the Geology of the Central and Western Portions of North America, collected principally from statements and unpublished Notes of recent Travellers; by H. D. Rogers, Esq. F.G.S.

December 3rd.—A Letter from Henry T. De la Beche, Esq. F.G.S., addressed to George Bellas Greenough, Esq. P.G.S., On the Anthracite found near Bideford, North Devon.

December 3rd and December 17th.—A Paper on the Physical and Geological Structure of the country between Newcastle, (New South Wales,) and the Dividing Ridge in 28° 3′ south lat. and 15° 24′ east long.; by Allan Cunningham, Esq.

December 17th.—An Account of Land and Freshwater Shells found associated with the Bones of Land Quadrupeds beneath Diluvial Gravel at Cropthorne in Worcestershire; by Hugh Edwin Strickland, Esq. F.G.S.

———— On the Bones of certain Animals which have been recently discovered in the Calcareo-magnesian Conglomerate on Durdham Down near Bristol; by the Rev. David Williams, F.G.S.

January 7th, 1835.—A Letter from Dr. Bostock, F.G.S., addressed to George Bellas Greenough, Esq. Pres. G.S., containing an account of the Analysis of a Mineral Water from the Island of St. Paul, in lat. 38° 45′ south and long. 77° 53′.

———— A Paper on the Chalk and Flint of Yorkshire, compared with the Chalk and Flint of the southern counties of England; by James Mitchell, LL.D. F.G.S.

———— A Letter from Woodbine Parish, jun. Esq., addressed to George Bellas Greenough, Esq. P.G.S., accompanying a suite of Specimens from the neighbourhood of Bognor.

———— A Notice on the want of Perpendicularity of the standing Pillars of the Temple of Jupiter Serapis near Naples; by Capt. Basil Hall, R.N. F.G.S.

January 21st.—On an Outlying Basin of Lias on the borders of Salop and Cheshire, with a short account of the Lower Lias between Gloucester and Worcester; by R. I. Murchison, Esq. V.P.G.S.

——— ——— A Memoir on a General View of the New Red Sandstone Series in the counties of Salop, Stafford, Worcester, and Gloucester; by Roderick Impey Murchison, Esq. V.P.G.S.

February 4th.—On certain Coal Tracts in Salop, Worcestershire, Stafford, and North Gloucester; by Roderick Impey Murchison, Esq. V.P.G.S.

Sums actually Received and Expended,

RECEIPTS.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Balance in hand January 1, 1834:									
Banker (including 41*l*. 8*s*. 0*d*. Wollaston Fund)				723	1	8			
Accountant				40	0	0			
							763	1	8
Arrears:									
Admission Fees				94	10	0			
Annual Contributions				59	17	0			
							154	7	0
Ordinary Income:									
Annual Contributions				481	19	0			
Admission Fees:									
Residents	132	6	0						
Non-Residents	189	0	0						
				321	6	0			
							803	5	0
Compositions, 7 at 31*l*. 10*s*. 0*d*.				220	10	0			
1 at 28*l*. 7*s*. 0*d*.*				28	7	0			
							248	17	0
Subscriptions to Alteration Expenses							396	18	0
Transactions sold at the Society	45	15	0						
Received from Messrs. Treuttel and Co. for copies sold during 1832	40	16	0						
Ditto sold at the Apartments during 1833	7	10	0						
				94	1	0			
Proceedings				12	14	0			
							106	15	0
Wollaston Donation							32	10	4
Dividends, 500*l*. 3 per cent. Consols, 12 months							15	0	0
							£2520	14	0

* This Compounder paid in January the Annual Contribution of 3*l*. 3*s*. 0*d*. See By-Laws, Section 6, Art. 9. p. 9.

during the Year ending December 31, 1834.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Salaries and Wages	75	0	0			
House Expenses	10	2	6			
Taxes	8	5	0			
Tea and Waiters	6	4	5			
Scientific Expenditure	9	6	4			
Proceedings	1	1	0			
Transactions, vol. iii. Part 2	1	17	6			
Stationery	1	17	6			
				113	14	3
Alteration Expenditure				915	9	1
General Expenditure:						
Household Furniture	10	1	2			
Repairs of House	0	12	0			
House Expenses	189	1	3			
Taxes, Parochial *23l. 5s. 0d.* ——, King's ... *37l. 7s 6d.*	60	12	6			
Insurance	6	0	0			
				266	6	11
Salaries and Wages:						
Curator and Assistant	150	0	0			
Clerk	37	10	0			
Porter, Housekeeper, and Servant	75	0	0			
				262	10	0
Scientific Expenditure				25	18	8
Stationery and Miscellaneous Printing				33	13	11
Tea for Meetings				43	1	1
Cost of Publications:						
Transactions	130	8	0			
Proceedings	64	13	9			
				195	1	9
Contribution refunded				3	3	0
Award of Wollaston Fund to M. Agassiz				32	10	4
Balance in hand Jan. 1, 1835:						
Banker (including *41l. 8s.* Wollaston Fund)	589	5	0			
Accountant	40	0	0			
				629	5	0
				£2520	14	0

Valuation *of the Society's Property; 31st December* 1834.

Property.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 41*l.* 8*s.* 0*d.* Wollaston Fund. (See Balance sheet)				629	5	0
Arrears due to the Society:						
Admission Fees	54	12	0			
Annual Contributions	480	13	0			
				535	5	0
Subscriptions to Alteration Expenditure, due December 31				67	4	0
Estimated value of unsold Transactions				536	10	0
——— Proceedings				6	0	0
500*l.* Stock, 3 per cent. Consols				455	0	0
Due for copies of Transactions sold in the Society				5	12	0
——— Proceedings sold in the Society				0	6	0
				£2235	2	0

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.*]

JOHN TAYLOR, Treasurer.

Debts.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Salaries and Wages	75	0	0			
Taxes	9	15	0			
Current Expenses for December	17	13	10			
Collector's Poundage	35	13	0			
Dixon, Balance of Account for Alterations	99	9	4			
Jukes, Gas Fittings	4	12	0			
Burton, D., Esq., for Plans	15	15	0			
				257	18	2
Cash belonging to the "Wollaston Fund"				41	8	0
Arrears not likely to be received				200	0	0
Balance in favour of the Society				1735	15	10
				£2235	2	0

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, WOODBINE PARISH, CHARLES STOKES, } Auditors.

Feb. 4, 1835.

Estimates *for the ensuing Year*, 1835.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31, 1834. (See valuation of Society's Property.)				535	15	0
Ditto of Subscriptions to Alteration Expenditure				67	4	0
Due for Transactions sold at the Society				5	12	0
Due for Proceedings sold at the Society				0	6	0
Ordinary Income for 1835 (estimated):						
Contributions of 160 Fellows				504	0	0
Admission Fees:						
Residents (20)	126	0	0			
Non-Residents (15)	157	0	0			
				283	10	0
Sale of Transactions				250	0	0
—— Proceedings				15	0	0
Dividends on "Wollaston Donation Fund"				32	10	0
Dividends on 500*l.* 3 per cent. Consols				15	0	0
				1708	17	0
Balance against the Society				7	11	6
				£1716	8	6

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31, 1834. (See valuation of Society's Property.)				257	18	2
General Expenditure:						
Repairs of House	20	0	0			
Taxes	70	0	0			
Insurance	6	0	0			
House Expenses	170	0	0			
Household Furniture	50	0	0			
				316	0	0
Salaries and Wages:						
Curator and Assistant	200	0	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant	125	0	0			
Collector's Poundage	25	0	0			
				425	0	0
Scientific Expenditure, Bookshelves, Map Presses, &c.				75	0	0
Stationery and Miscellaneous Printing				50	0	0
Tea for Meetings				50	0	0
Cost of Publications:						
Transactions	250	0	0			
Proceedings	60	0	0			
				310	0	0
Arrears not likely to be received				200	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				£1716	8	6

The Reports having been read, it was Resolved :—

That these Reports be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows of the Society.

The President then delivered the following Address:

Gentlemen,

In the Report which has just been read to you, it is stated in what manner the Council have adjudicated the proceeds of the Wollaston Fund for the present year. To carry into effect that award is the pleasing duty which I now have to perform. It is to me as well as to Mr. Mantell a subject of deep regret that he cannot attend to receive the prize in person. I shall deliver it, with your permission, to Mr. Lyell, who will officiate as his representative on this occasion.

Mr. Lyell.—In the name of the Geological Society I beg to commit to your care the proceeds for the present year of a fund bequeathed to us by one of the most eminent philosophers to whom this country has given birth, and by him directed to be applied to the furtherance of geological science. The Council are of opinion that they cannot upon the present occasion more conscientiously discharge the duty imposed upon them, than by awarding this prize to Mr. Mantell. Zealously engaged as he is in the practice of an arduous profession, we, his fellow labourers in this Society, have witnessed with great satisfaction for a series of years his unceasing endeavours to unravel the geological phænomena of the interesting district around him. By long experience Mr. Mantell has acquired so much skill in the dissection, if I may call it so, of fossils, from amidst the matrix that conceals them, that many of the finest specimens in that rich and beautiful collection which his liberality has opened to the public, may almost be considered as the works of his hand: his active researches in different branches of natural history, and more especially his investigations in comparative anatomy, pregnant with inferences and analogies illustrative of the early history of our planet, are convincing proofs of the energy and activity of his mind, of his determined love of knowledge, of his parsimony of time, of his unbounded prodigality of labour. His discovery of the Iguanodon in 1828, and his determination of the place which it occupied in the scale of animated beings, prove his sagacity and acquaintance at that early period with the principles of anatomical and zoological science. So strange to the eye of the naturalist were the first discovered remains of this gigantic animal, that Cuvier himself knew not to what genus recent or fossil they could with any propriety be assimilated. Mr. Mantell discerned its relation to the Iguana, and the fortunate and wholly unexpected disinterment which has lately taken place at Maidstone of a considerable assemblage of the fossil bones of this creature, together with the impression of a tooth, confirm in many respects his early conjectures. The Hylæosaurus, also, another extinct genus, was first brought to light by Mr. Mantell's labours, and correctly illustrated by the application of his anatomical knowledge. I will only add, in the way of congratulation, that his perseverance in these interesting researches are not remote from the habits, or at variance with the duties of his profession; for, as you are well aware, the examination of the human body is one department of that wide and beautiful field of comparative anatomy in which he finds amusement; and to become well acquainted with the œconomy and physiology of man, it is necessary to study the structure of other animals. We hope and trust, that Mr. Mantell may long possess health and strength to advance further and further still in his honourable career, and we request you, Sir, to convey to him our earnest wish that in every department of life he may meet with that success which his industry and talents so eminently deserve.

The President then presented, in the name of the Society, a purse of guineas to Mr. Lyell to be by him conveyed to Mr. Mantell, and informed him that the remaining portion of the proceeds of the fund had been laid out on a Medal, which would likewise be forwarded to him.

It was afterwards Resolved:—

1. That the thanks of this Society be given to George Bellas Greenough, Esq., retiring from the office of President.

2. That the thanks of this Society be given to William John Broderip, Esq., and Henry Thomas De la Beche, Esq., retiring from the office of Vice-President.

3. That the thanks of this Society be given to Professor Turner, M.D., retiring from the office of Secretary.

4. That the thanks of this Society be given to Charles Lyell, Esq., retiring from the office of Foreign Secretary.

5. That the thanks of this Society be given to the Rev. William Daniel Conybeare, Charles Giles Bridle Daubeny, M.D., Major Shadwell Clerke, Davies Gilbert, Esq., and Capt. Alexander Robe, retiring from the Council.

6. That the thanks of this Society be given to Decimus Burton, Esq., for the valuable service which he has rendered gratuitously to the Society.

The Meeting then proceeded to ballot for the Officers and Council for the ensuing year; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected:—

OFFICERS.

PRESIDENT.

Charles Lyell, jun. Esq. F.R.S. & L.S.

VICE-PRESIDENTS.

Sir Philip de Malpas Grey Egerton, Bart. M.P. F.R.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.
Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.
Henry Warburton, Esq. M.P. F.R S. & L.S.

SECRETARIES.

William John Hamilton, Esq.
Woodbine Parish, jun. Esq. F.R.S.

FOREIGN SECRETARY.

Henry Thomas De la Beche, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S.

COUNCIL.

George William Aylmer, Esq.
Francis Baily, Esq. F.R.S. & L.S.
Arthur K. Barclay, Esq.
William John Broderip, Esq. F.R.S. & L.S.
William Henry Fitton, M.D. F.R.S. & L.S.
George Bellas Greenough, Esq. F.R.S. & L.S.
Henry Hallam, Esq. F.R.S.
John Forbes Royle, Esq. F.L.S.
Rev. Adam Sedgwick, Woodwardiae Professor in the University of Cambridge, F.R.S. & L.S.
Lieut.-Col. W. H. Sykes, F.R.S. & L.S.
John Henry Vivian, Esq. M.P. F.R.S.
Sir Richard Vyvyan, Bart. M.P. F.R.S.
Rev. James Yates, F.L.S.

An Address delivered at the Anniversary Meeting of the Geological Society of London, on the 20th of February, 1835, by the President, G. B. Greenough, *Esq. F.R.S. &c.*

Gentlemen,

I rejoice to see you assemble in these long-desired apartments: the increased facilities now afforded to us of pursuing the objects of our institution demand on our part a corresponding increase of exertion. Let it not be imagined that in accepting a boon from the Government we have not incurred an obligation. Our claim rested entirely on the sense which the public entertain of our deserts. The full and accurate knowledge, which it has been our aim to acquire and publish, of the subterranean resources of all parts of the world, cannot fail to be useful: so long as the utility of our establishment is distinctly felt, independently of its bearings upon what to us appear the higher considerations of science, so long may we rely on the continuance of public support; but our claim to that support would vanish at once, if we should relax our exertions, and fail to realize those expectations which our hitherto well-sustained activity has kept alive in the breast of our benefactors.

Gentlemen, you are well aware that all the accommodation which you now enjoy has not been derived, however, solely from the beneficence of the Government, set in motion by the Royal Society. On our first taking possession of this house the repairs and alterations occasioned on our part an immediate outlay of 1500*l.*, and 1000*l.* more have now been expended in improving and furnishing the new apartments, and in availing ourselves of such other advantages as their acquisition has enabled us to command. The Council considering it imprudent that so large a sum should be deducted from the capital of the Society, 500*l.* of that amount have been provided by a voluntary subscription.

The alterations planned by Mr. Decimus Burton have been executed under his direction within the specified time, and in accordance with the estimates. With what skill they have been executed has not escaped the notice of the Building Committee; with what success is apparent to you all. You have been informed that Mr. Burton has declined to accept any remuneration for his professional services, but I cannot deny myself the pleasure of again recording this new instance of his public spirit and characteristic liberality.

The concluding part of the third volume of our Transactions is in the press, and the recent arrangements of the Council induce me to hope that not this part only, but also the first part of the fourth volume will be ready for delivery in the course of the present year.

The Number of our Fellows has received an addition of forty-two and a diminution of ten; of those whom we have lost, three only are known to me as Contributors to the Transactions or as Geological Authors.

To the liberality of Mr. Matthew Culley, the chief of a family greatly celebrated for the practical improvements they have introduced into agriculture, our Museum is indebted for a large series of primitive rocks collected in the remoter parts of Sutherlandshire, as also for some fine specimens of the fossil fishes which occur at Banniskirk, situated eight miles south of Thurso in Caithness. The geological relations of these last have been since investigated by Mr. Murchison and Professor Sedgwick, and their zoological characters determined by M. Agassiz*. Mr. Culley also transmitted to us an account of the prodigious power occasionally exerted by rivulets when swoln by heavy rain.

Major James Franklin was a younger brother of Captain Sir John Franklin, R.N.; he commenced the survey of Bundelcund in India in 1813, and continued it during four years, after which he joined the army in the field, under the Marquis of Hastings. In December 1818, Captain Franklin returned to the duties of his survey, and shortly afterwards was promoted to the rank of Assistant Quarter-Master General. In 1820, he commenced at Calcutta the construction of his maps. He afterwards made a careful survey of Sincapore and the adjacent strait. Having repaired to England in 1823 for the benefit of his health, he soon learned by communication with members of this Society, how much the value of his surveys would have been enhanced by geological descriptions. On his return to India in 1826, his first care was to supply this desideratum: he solicited, though unsuccessfully, the appointment of Geologist to the trigonometrical survey then carrying on in India, and strenuously recommended that all officers employed on that service should be qualified and encouraged to collect materials for the construction of a geological map of the entire Peninsula. Declining health brought him again to England in 1829, where he remained till his death, which took place in the summer of last year. He transmitted to us a paper on the geology of a portion of Bundelcund † and other districts in Central India; and to the Asiatic Society of Bengal a description of the Diamond Mines of Panna, published in the Transactions of the respective Societies. Among his MSS. have been found Observations on several Iron Mines, and on the mode in which the ore extracted from them is manufactured in Central India, together with an account of different beds of coal in that country.

Mr. James Hardie evinced in early life a taste for natural history. Educated at Edinburgh, he founded the Plinian Society in that city, and contributed largely to its Museum. In 1784 he embarked for India, and served in the Bheal campaign; he was afterwards appointed the Residency Surgeon at Odeypoor, and made a survey of the neighbourhood. In his visits to Calcutta he acquired the friendship of the most distinguished geologists of the East; he became a member of the Medical and Physical Society, and contributed many papers to their Transactions. A survey of his route on one

* Proceedings of the Society, May 1829.

† Transactions of the Geological Society, 2nd Series, vol. iii. Part I.

occasion from Calcutta to Bombay, and thence to Odeypoor, will be found in the Transactions of the Asiatic Society, of which he was also a member. In 1830, he made a voyage round the Indian Archipelago, with a view to the recovery of his health. He passed six months at Java, and paid much attention to the geology of that island. On his return to Scotland he presented his collection to the Museum at Edinburgh. Professor Jameson recommended him to the East India Company as a fit successor to the appointment held by the late Dr. Turnbull Christie. Mr. Hardy repaired to Paris in 1833 for the purpose of prosecuting his geological studies, and died there in May following at the age of 31.

In reviewing the geological labours of the year I shall advert principally, but not exclusively, to those of our own members, and the order of precedence will be regulated by the nature of the respective papers, without any reference to date.

Mr. Murchison, in prosecution of the work in which he has been so long and actively engaged, has communicated to us his observations on the detritus that covers the old red sandstone in Herefordshire and its vicinity. All the detritus, he says, seems to be derived from neighbouring rocks. Granite boulders are nowhere found within its area, but they occur of large dimensions and of various sorts upon its northern confines; he states generally that they appear to have come from the North. Many, if not all them, may I believe be identified with the granitic rocks of Westmoreland and Cumberland. Several of those I have observed on the north of Shrewsbury have the character of the Irton rather than of the Shap granite. The detritus of the old red sandstone is ascribed to the operation of different causes, some of which may perhaps require further study.

From Mr. Strickland we have received three communications respecting certain bones of extinct quadrupeds associated at Cropthorne in Worcestershire, with existing species of shells. On a base of lias clay reposes a layer of fine sand containing twenty-three species of land and freshwater shells, together with rolled and broken bones of the Ox, Deer, Dog, Bear, and Hippopotamus. Upwards this sand passes into gravel undistinguishable from the so-called diluvium. These shells are found at five or six different localities within the Vale of Evesham. Two of the species are thought to be extinct. The inference drawn from all the phænomena is that this deposit occupies the site of a former river-bed or lake; that since its formation mammiferous animals have migrated more than molluscous, and that the climate has remained nearly stationary.

Mr. Edward Charlesworth has placed in our Museum some valuable specimens collected at Sutton in Suffolk, valuable because they establish the existence of similar phænomena there also. The specimens consist of bones, (one of which appears to belong to the elephant,) and of freshwater shells, including an extinct species of Cyclas. Five or six feet below the surface a layer of calcareous nodules may be traced, he says, for about half a mile along the banks of the

Stour; the nodules are very numerous and found only with the shells. Let us hope that the interest excited by these notices may lead some competent naturalist to undertake a detailed examination of the "Crag," our imperfect acquaintance with which, again and again pointed out from this Chair, continues to be what I may justly call one of the Opprobria of English Geology.

The changes which have taken place in the boundaries of the land and sea on the north-eastern coast of Kent have been brought under our notice by Mr. Richardson.

Mr. Wetherell has transmitted to us a detailed account of a Well recently sunk on the south side of Hampstead; its depth is 330 feet; under 285 feet of clay was found a rock five feet thick, which in external character and fossil contents agrees with the Bognor, and rests on plastic clay. At the depth of 160 feet specimens were brought up of what would be called in Sheppy Island fossil fruits: the local distribution of these remarkable bodies is very limited. From the examination of Mr. König, it would appear that a few only are of vegetable origin. By far the greater part belong to a distinct class, which, in Mr. König's new division of the natural order of Polypi, are distinguished by the appropriate name of Carpomorphi.

Mr. Rofe has found in the neighbourhood of Reading the Bognor rock, occupying the same position which Mr. Wetherell assigns to it at Hampstead. It is strange that in a quarry of which so many sections have been given, this rock should have remained so long unnoticed. Mr. Rofe has also observed, that in the wells at Reading the level of the water depends not on the Kennet which is the nearest river and flows over tenacious clay, but on the more distant Thames which flows over gravel resting upon chalk.

M. Boué has recently pronounced the plastic clay formation destitute of fossils, but it certainly does contain them in England.

Mr. Woodbine Parish has detected chalk in a part of the Sussex coast, where its existence had not been before observed. He has traced it from Felpham to the distance of about a mile; it runs in the direction of Middleton, where chalk marl has been obtained at low water.

Dr. Mitchell has pointed out to us in what respect the chalk of the North of England differs from that of the South. The difference consists in its greater hardness, its occasional redness, its well defined stratification, the absence of flint nodules in its upper portion, and the continuity of layers of flint in its lower; in many of these characters it resembles the chalk of Antrim.

The occurrence of Hippurites in the chalk of Sussex appears to require confirmation.

A well recently sunk at Diss in Norfolk, after penetrating two beds of clay and sand, the aggregate thickness of which amounted to 100 feet, penetrated through the great body of the chalk, which proved to be 500 feet in thickness; the tools passed afterwards through five feet of sand, when water flowed in, and rose to within 47 feet of the surface. Mr. Taylor, our Treasurer, to whom we are indebted for this information, states that the proprietor was encouraged to perseverse in so expensive an undertaking by the account which he had seen of a similar well in Cambridgeshire, drawn up by Mr. Lunn and published in our Transactions. The confidence which he placed in that analogy (though the places are many miles distant from one another,) has been fully justified by the event, and the success of the experiment furnishes a striking example of the value of records of this nature.

Dr. Fitton's paper on the strata of the South-east of England, between the chalk and Oxford oolite, together with the memoirs of Dr. Buckland and Mr. De la Beche on the coast of Dorsetshire, are in great part printed.

The Wealden and Purbeck beds are generally supposed to have been deposited in an estuary, but what may have been the form, direction and extent of that estuary, it is not easy to conjecture. Similar beds occur at Lady Down in Wiltshire, and at Swindon; and the Vivipara, one of their characteristic fossils, appears towards the top of Shotover. The discovery of this formation in the neighbourhood of Beauvais excited much interest among the naturalists, assembled there about three years ago, and several species of the Wealden fossils seem to prove its existence at Loch Staffin in the Isle of Sky.

And here, while considering the district of the Weald, allow me to direct your attention for a moment to a subject temporarily, and let us hope, only accidentally connected with it. I refer to the repeated, though slight shocks of earthquakes, which have been experienced during the last eighteen months in the neighbourhood of Chichester. When we recollect the prodigious area over which the earthquake of Lisbon was felt, comprehending one fourth of the entire northern hemisphere, we can hardly suppose it possible that the cause of such phænomena can be seated so near the surface of the earth as to come at all within the range of our observation. It is, however, a singular coincidence, that in 1734, 1747, 1749, 1755, and the three following years, earthquakes were felt in this same part of England, and that on those occasions, as well as now, the direction of the shocks is supposed to have nearly coincided with the great line of fault.

On the oolite district we have received no additional intelligence. The boundaries of the several clay-beds in the midland and northern counties is as yet ill defined, and the same remark will apply to many of the stone-beds in Lincolnshire, Leicestershire, and Rutlandshire. The anomalies of the Stonesfield slate are still unexplained, and it is very desirable that figures should be published of the fossil remains found in it, and more especially the coleopterous insects.

Mr. Murchison has discovered an outline of lias at Longdon Hill, near Upton, and improved the boundary line of that formation in the neighbourhood of the Severn. The lias marl or lower lias rock, ill exhibited along the Yorkshire coast, and on the coast of Dorsetshire imperfectly developed, in Worcestershire and Gloucestershire swells into importance, and may be traced continuously for a distance of twenty or thirty miles, passing insensibly here, as in Germany, into the red marl.

A much more unexpected discovery has been made, by the same indefatigable observer, of the same beds in another situation, viz. between the Hawkstone Hills and the towns of Whitchurch and Market Drayton, seventy miles apart from the lias range in the Midland counties. This outline is known to extend about ten miles in length, and from four to six in breadth; its greatest extent is from north-east to south-west; its western boundary is obscure. The strata have a slight dip inwards towards a common centre. The visit of a geologist to this spot has had the effect of stopping an inconsiderate speculation; the bituminous character of the lower beds had been supposed to indicate the proximity of coal, and a shaft had been sunk to the depth of three hundred feet in search of that mineral, in a place which I need hardly say afforded not the slightest chance of success.

The escarpment here exposed presents to view the junction of the middle and lower part of the formation. With most of its fossils we are familiar, but six or seven of the species met with are new in England, though some of these occur in a corresponding position at Brora in Sutherlandshire, and others are figured in the valuable work which Mr. Zieten is now publishing on the Organic Remains of the Kingdom of Wurtemburg. A shaft sunk at Kentsrough has reached the brine springs and gypsum of the subjacent formation.

Mr. Williamson, jun., has given us a detailed account of the lias near Scarborough, to which I shall have occasion to advert again.

Mr. Murchison has described to us the new red sandstone on the confines of England and Wales; the formation here, as in the north-eastern counties, may be divided into

1. Red and green marl;
2. Sandstone and conglomerate;
3. Calcareous and dolomitic conglomerate;
4. Lower red sandstone:

corresponding to 1. the Keuper; 2. Bunt sandstein; 3. Zechstein; 4. Rothe todte liegende of the Germans.

Limestone is sparingly distributed in this district. No trace has been met with of the muschelkalk, and the magnesian limestone occurs only in the shape of a sandstone conglomerate.

1. The red and green marls afford brine-springs in Gloucestershire, Worcestershire, Shropshire, and Cheshire, but with a small proportion of gypsum.

2. The beds immediately beneath are largely developed in the north of Shrewsbury, in Staffordshire and Salop; the district which they occupy is wild and barren, owing to the prevalence of decomposed quartzose conglomerates. Where sand predominates it is more fertile, and the country assumes a character perfectly distinct from that which belongs to the upper and lower beds.

3. The fragments of the calcareous conglomerate are occasionally of oolitic limestone, sometimes of old red sandstone, or of some mem-

ber of the coal series. This division is unimportant on the east of Coalbrooke Dale, but in the western part of Salop it swells out and corresponds with the dolomitic conglomerate of Bristol. At Cardeston it is from eighty to one hundred feet in thickness; its escarpment, with partial interruptions, may be traced from Alberbury and the Brythins round the carboniferous promontory of Salop and the Clent Hills, and it forms a distinct ridge between Bridgenorth and Kidderminster.

4. Beneath this, in Salop and Worcestershire, is found a thick deposit of reddish sandstone (rothe todte liegende); it passes upwards into dolomitic conglomerate, and downwards into the coal-measures in conformable beds, so that there is great reason to suppose that unwrought coal lies beneath. Mr. Murchison has determined the extent of this rock, which occasionally towards the bottom contains trappean conglomerates like those of Heavitree in Devon, or feldspatic rocks like those of the Malvern and Abberley range.

The dolomitic conglomerate just mentioned has in another county engaged the attention of the Rev. David Williams: he has discovered for the first time Saurian reptiles in this deposit. Mr. Conybeare had before noticed the occurrence of a part of the skeleton of a supposed gavial near the bottom of the red sandstone in Worcestershire.

The obscurity which for so many years continued to involve the red sandstone deposits both in England and on the Continent was first cleared away by Professor Sedgwick. We now know that the proper position of the rothe todte liegende of the Germans is immediately beneath the magnesian limestone, and that it is the same rock which Mr. Smith described as the Pontefract sandstone. It is much to be regretted that Mr. Hoffmann in the beautiful map and sections which he published of North-western Germany, has designated by one name, as if they were only parts of one and the same deposit, the red sandstones and conglomerate that lie under the carboniferous series, and those that lie above it. This grouping together of formations so widely separated in nature is very objectionable. With a view to distinctness it is essential that the rothe todte liegende shall not be classed as heretofore, sometimes with the old red sandstone, sometimes with the new, sometimes with both, sometimes with the coal-measures, but that it should hold the rank of a substantive and independent formation. The barbarous phrase, which has just been employed to designate it, though tolerated in Germany, will never, it is hoped, be naturalized here. The name by which it is known at Tarnowitz is too local. Many other names have been proposed when one would have sufficed. By M. de Beaumont it is called Grès des Vosges; by Mr. Smith, the Pontefract rock; by Professor Sedgwick, the Plumpton; and by Dr. Hibbert, the Roslyn sandstone. Assuming that all these names are synonymous, the last appears for many and obvious reasons the most worthy of adoption.

This important rock, which, in richness of soil, in undulation of surface, and in the luxuriant growth of its timber, closely resembles in many places the old red sandstone of Herefordshire, lies in general, sometimes conformably, sometimes unconformably, upon coal-measures, and even contains occasionally beds of that substance. But in the neighbourhood of Shrewsbury, and also at Tasley and Coughley near Bridgnorth, Mr. Murchison has shown that this lower red sandstone overlies unconformably and passes down into a zone of coal-measures containing a peculiar fresh-water limestone. The great coal-beds of Brozeley and Coalbrook Dale are wrought beneath it.

I had occasion myself to observe during the last summer, in the neighbourhood of Nuneaton in Warwickshire, a limestone similar in aspect, lying under a two-foot bed of sulphureous coal. The limestone is about fourteen inches in thickness, and exhibits veins of galena in calcareous spar. At the first pit I visited there was but one bed of limestone, but at another on the same estate is a second bed which also contains galena, and on its surface numerous impressions of plants. The interval between the two beds is occupied by a sandstone not unlike the Pennant rock in appearance, and what is here called a chance coal. Immediately beneath the lower one is another bed of coal four feet in thickness.

In three papers which Mr. Conybeare has lately published on the relations of our principal coal-fields*, he considers it probable that coal will be discovered hereafter in many districts as yet unexplored. He dwells upon our uncertainty as to the boundary of the carboniferous beds in the midland counties, and recommends that a survey should be undertaken expressly with a view to determine this problem: "It is little to the credit," he observes, "of a nation like ours, so peculiarly dependent on this branch of her mineral resources, that we continue to acquiesce in a state of ignorance so easily removed. We here see a strong instance of our want of a regular school of mining, such as is possessed by many countries."

Mr. Elias Hall has published a geological map of Lancashire, a county hitherto comparatively neglected, and, I am sorry to add, very indifferently represented in all the geological maps of England. Mr. Hall is entitled to great praise for his intrepidity and perseverance; had he not possessed these qualities in an eminent degree, he never would have entered, as it were alone and single-handed, on so irksome and laborious an investigation. That the work is in many respects imperfect must be admitted, but considering the apparent disproportion of his means to his end, it is surprising that the author should have achieved so much: what he has left incomplete or inaccurate will be readily supplied and corrected by the supplemental labours of more fortunate observers, when the physical features of this extensive tract shall have been accurately delineated by the Ordnance Department.

For a detailed account of the carboniferous tracts in Salop and

* Lond. and Edinb. Phil. Mag. and Journ. of Science, vol. iv. pp. 161 and 346, vol. v. p. 44.

the adjacent counties we are indebted to Mr. Murchison. The following are the conclusions which his paper tends to establish.

1. In the Shrewsbury coal-field the presence of a younger series of coal-measure than has hitherto been noticed, characterized by the freshwater limestone above alluded to.

2. The recurrence of these beds at Coalbrook Dale, over an older series of coal-measures which at one spot repose on mountain limestone, at other places either on the old red sandstone or on transition rocks.

3. The absence of these upper beds at the Titterston Clee hills, where the lower beds rest in two places on mountain limestone, but generally on old red sandstone, as they do invariably on the brown Clee hill, in the forest of Wyre and at Newent.

4. In some of the poor and ill-consolidated coal-beds, particularly in the upper part of the series, the characters of the fossil plants, both generic and specific, can be recognised in the coal itself.

5. The mountain limestone where it does occur in this part of the country is of inconsiderable thickness, and wedge-shaped, so that it shortly disappears entirely. Its absence, therefore, is not to be imputed to mighty convulsions, but to partial and scanty deposition in the first instance.

At Shaftoe, near Wallington, in Northumberland, Mr. Trevelyan* has observed among the constituents of the millstone grit, the lowest bed of the regular coal-measures, transparent fragments of garnet; they occur there rather abundantly. He has also remarked in other northern coal-fields small portions of hornblende in a similar situation.

The Rev. Mr. Williamson has directed attention to certain ravines in the Mendip hills, and other heights which bound the coal-field of Bristol. These ravines cross the ridges transversely so as to connect the opposite valleys, being occupied in part by horizontal beds of dolomitic conglomerate and lias; he infers that the fractures took place before these rocks were deposited, and that the bone-caves were formed at the same period.

Dr. Lloyd first observed fossil fishes in the old red sandstone. Mr. Murchison finds the observation true over a considerable extent of country; they belong chiefly to the genus Cephalaspis of Agassiz; they have also been described by Dr. Fleming, as having been met with in the old red sandstone of Forfarshire. They appear not to be diffused through the formation generally, but to be confined to the middle portion of it, the cornstone.

The nature of the pebbles imbedded in the Old Red Conglomerate varies according to its locality. In Scotland they are very frequently of gneiss, as is the case in the neighbourhood of Baden-Baden.

In an Account of the Trap Rocks of the Border Counties, and their effects on the Stratified Beds with which they are in contact, Mr. Murchison has separated the objects of his examination into three

* Lond. and Edinb. Phil. Mag. and Journ. of Science, vol. vi. p. 76, (1835.)

classes: 1. the Trap-Rocks which penetrate transition beds; 2. those which penetrate the old red sandstone; 3. those which penetrate the coal-measures. He refers the whole to igneous action, and considers them to be of the same age as the rocks with which they are respectively associated, rocks which he readily admits to be sedimentary, since, though composed of volcanic materials, they contain organic remains. The igneous action he conceives has taken place under water, and the finer volcanic ejections, arranged by Neptunian agency, have led to the formation of volcanic sandstones. His views upon this subject appear to be in exact accordance with those of Mr. de la Beche.

Treating of the relations between igneous and fossiliferous rocks, Mr. de la Beche observes*, that though frequently posterior, the former are in many cases contemporaneous with the strata in which they at present occur, appearing to have covered an inferior bed, and to have been subsequently covered themselves by a tranquil deposit of transported matter, as lava may flow over a sandy bottom and afterwards be covered up by sand or mud. Trappean rocks, he continues, are in various parts of Europe much associated with the lower parts of the grauwacke series, sometimes in a manner which leaves no doubt that some of them have not been included among the strata after their consolidation, while others have clearly forced a passage through the grauwacke and previously formed masses of trap. Beds of greenstone or porphyry, he says, sometimes fine off among the grauwacke strata, taking the character of an arenaceous deposit, as if such portions constituted a deposit of trappean ashes, thrown out at the same time that the trappean rock itself was produced. Brent Tor, north of Tavistock, remarkably exemplifies some of these appearances.

The researches of your Vice-President in the counties of Devon and Somerset have been carried on this year with increased energy. Of the eight sheets of the Ordnance Map upon which he has been engaged, four were published last spring, three others are complete, the eighth is nearly complete, and an explanatory memoir with sheets of sections applying to the whole are to be published before our next anniversary. Let us hope that this work so admirably begun may not be suffered to terminate here.

Gentlemen, we had many of us an opportunity of witnessing at the late Meeting of the British Association the increasing interest and success with which geology is pursued in Scotland, and we felt more especially grateful on that occasion to Lord Greenock and the Highland Society, for the exertions which they have recently made to unravel the structure of their native land, and more especially the nature of its coal-fields. It is not my intention to detail to you all the proceedings of that Society, but I must not refrain from attributing mainly, if not solely, to their exertions the provision which the Government have lately made for the immediate

* Researches in Theoretical Geology, p. 384.

publication of Dr. MacCulloch's geological map of Scotland. Whatever may be the intrinsic excellence of that work, it must be eminently useful, if considered only as a nucleus, round which will immediately congregate those ample stores of geological knowledge which at present lie latent in the minds and cabinets of our northern brethren. Nor will Ireland be backward in furnishing her contingent. The coloured copy of Arrowsmith's map of that portion of the United Kingdom which Mr. Griffith has undertaken to lay before the British Association in August next, will bring within our reach an abundant supply of geological information, which though it has been in his possession for many years past, a natural repugnance to combining geological correctness with geographical inaccuracy has hitherto induced him to withhold.

The exertions of the Geological Society of Dublin have been continued, and cannot fail to diffuse over the whole of Ireland a taste for those studies which at a very early period reflected so much lustre on the name of Kirwan.

It will be in your recollection that Mr. Weaver presented to us some time since a valuable Memoir on the Geology of the south-western part of that country. In one part of the Memoir the coal-measures of the county of Kerry were referred to the transition series; the correctness of this statement was questioned at the time, and various inquiries were instituted and persevered in, without leading however to any very decisive result. Since the commencement of the session, the author on reexamining the district, has with great candour acknowledged himself to have been in error. More diligent investigation brought into view a well-characterized band of old red sandstone, intervening in one part of the coal-field, between the carboniferous and the transition strata.

Mr. Jephson has transmitted to us an account of a remarkable spring at Mallow in the county of Cork, the temperature of which varies from 67° to $71\frac{3}{16}$°. It breaks out in limestone.

An ample and able account of the recent progress of our science on the Continent will be found in the Report of M. Boué to the Geological Society of France. I shall, therefore, confine my observations on this head almost exclusively to the Papers which have been read at our evening meetings.

The first in order relates to the loamy deposit, called in the valley of the Rhine, Loes, a term as yet scarcely naturalized among us, and which, I believe, is correctly represented by the word Silt. This paper, from the pen of Mr. Lyell, has since been published entire in Jameson's Journal.

Intimately connected with this is a communication by Mr. Horner, on the nature and quality of the solid matter actually suspended in the water of the Rhine. To ascertain them the author made experiments during the months of August and November, bringing up about a gallon of water from different depths and drying slowly the solid matter obtained from it. With whatever attention to accuracy such experiments are conducted, they must, I conceive, be multiplied almost indefinitively before we can arrive in safety at any general conclusion upon so intricate a problem.

From Colonel Silvertop we have received a description of certain tertiary deposits, which in the kingdom of Murcia, in Spain, occupy extensive plains, bounded by discontinuous ridges of nummulitic limestone, transition rocks and mica-slate : the author divides these deposits into four districts, and each of these is separately treated. M. Deshayes refers their imbedded fossils to the second and third deposits of tertiary formation.

In a work on Spain, published during the past year by Captain Cooke, will be found a brief account of the mines and rocks of that hitherto partially examined country.

I may also be permitted to notice among the additions which have been made to our library, an excellent Memoir by M. le Chevalier Albert de la Marmora, on the constitution of the Balearic Islands.

No communication has been made to us from Asia since the last Anniversary.

A paper by Mr. Cunningham describes the physical structure, and to a certain extent, the geological composition of the country between Hunter's River and Moreton Bay, in Australia, and is accompanied by a valuable map and section and a small collection of rock specimens. The additions made during the expedition referred to by Mr. Cunningham are important, and the geological notices, though slight, will be welcomed by future inquirers.

Mr. Rogers, who laid before the British Association at Edinburgh an able sketch of the "Geology of North America," has more recently favoured this Society with an account of the strata situate on the banks of the Misouri and Mississippi rivers, and further, in the district of the Rocky Mountains. It may be said of all these papers that they are in a great degree compilations, but compilations so executed are perhaps among the most valuable documents that can be transmitted to us. No general views could ever be opened if every author were to confine his descriptions and reasonings to those minute tracts which have fallen within the sphere of his own personal examination. Every system and theory is necessarily founded upon details industriously collected from various quarters.

Besides these communications, we have received from America recently two works, in which the same subject is treated with great clearness and in considerable detail: the one entitled "Contributions to Geology, by Isaac Lea, accompanied by six plates of Shells," of which some at least are not very accurately figured; the other "A Synopsis of the Organic Remains of the Cretaceous Rock, with nineteen lithographed plates of Shells, by Dr. Morton." These works, together with the papers of Mr. Conrad published previously in the American Journal of Science and the Journal of the Academy of Natural Sciences of Philadelphia, illustrated also with lithographic plates, have rendered the upper formations of the United States as intelligible as those of our own country.

Dr. Morton notes the generic accordance of the Testaceous Mollusca on the east and west shores of the Atlantic; but independently of genera, there are at least twenty-four species common to both. In like manner some identities have been traced in the tertiary deposits of Europe and America. The *Pecten quinquecostatus* in particular occurs equally in the cretaceous group on both sides the Atlantic; nor is the analogy confined to Testacea; it extends to the Saurian reptiles. The animals whose remains are found in chalk formerly inhabited the seas of the two continents, and whatever cause bared the eastern, appears to have acted simultaneously on the western mass; not a rush of currents, but a subsidence or elevation.

In the county of Onondago, in New York, is a lacustrine deposit still forming, in which thousands of tons might be obtained of bleached shells. The shells at the mouth of the Potomac river, belonging to the newer Pliocene beds, retain their colours; twenty-nine of the species are the same with those which now live, and of these there are seven only which are not known to inhabit the coast of America.

From the upper marine deposit of Dr. Morton, which corresponds to the lower tertiary of Mr. T. A. Conrad, and to the older pliocene of Mr. Lyell, numerous specimens were exhibited to us in the course of last session by Mr. Finch. Of fifty-six species of shells observed by Mr. Conrad in this deposit, which extends through Maryland, Virginia, and the county of Cumberland, in New Jersey, one third still exist on the coast of America, but some species in a more southern latitude than that in which they are found fossil.

The Miocene beds, if they occur, have hitherto escaped detection. The Eocene, the middle tertiary of Mr. Conrad, which in England is known as the London clay, and in France as coarse limestone, assumes in America the character of siliceous sand, and in that form has been traced in a north-eastern and south-western direction from Alabama, through South Carolina, Georgia, and Florida, as far as the Gulf of Mexico. Two hundred and nineteen species of shells found in this deposit have been described by Mr. Lea, but among them all, there is perhaps not one entirely analogous to any living species. Several of these shells belong to genera unknown upon the coast of America, some to genera found fossil in Europe, some to genera entirely new. It may be doubted whether any of the species correspond with any of the eocene fossils of Europe, but the number of turreted shells and generic resemblance satisfactorily establish the epoch to which they belong.

It appears from the observations of M. Dufrénoy that in the chalk of the Pyrenees fifty species, in a list of about two hundred, have the character of tertiary shells. A corresponding gradation in the fossil contents of the tertiary and cretaceous formations is observable in America. The Chalk, or rather the Chalk-Marl, of the new continent occupies large tracts in New Jersey, Delaware, and Alabama, and contains among other organic remains teeth of the

Mosasaurus, in no respect differing from those collected at Maestricht.

Mr. Rogers recovers the Chalk formation on the banks of the Missouri, and about the mouth of the Omawhaw; its transverse limit is not known. No flints appear in the beds, but flint nodules, like the English, occur plentifully lower down the river, even to the Mississippi.

The Ferruginous Sand of America reposes in the northern states of the Union as in Sweden and along the Carpathian mountains, upon primary rocks; in the southern, upon limestone, perhaps our mountain limestone; it forms an irregular crescent, extending nearly three thousand miles, through Jersey, Delaware, Maryland, Virginia, the two Carolinas, Georgia, Alabama, Mississippi, Tenessee, Louisiana, Arkansa and Missouri.

Dr. Morton and Mr. Rogers refer this formation to the Green-Sand of England with more confidence perhaps than their observations warrant. Sands red and green occur in Europe both above the chalk and below it. Zoological evidence rather militates against their conclusion. With one or two exceptions all the species are peculiar to the western continent. *Pecten quinquecostatus*, the only shell which is quoted as being common to the sands of the United States and this country, occurs also at Maestricht, and Baculites are characteristic of the upper part of the chalk. From the occurrence of great quantities of lignite in this formation, from the remains discovered in it of the Scolopas, a bird which inhabits the sea-shore, and from the locality of the beds in reference to the ancient coast line, Mr. Rogers infers that the deposit took place in shallow water, along a coast, which like the present, presented a very extensive range of soundings; to this circumstance he attributes the difference of the American and European species of sea shells at the same period.

With greater probability, as far as the evidence of fossils is concerned, Mr. Rogers attributes to the Green-Sand Formation of England a deposit traced from below the Big Bend to the Rocky Mountains both on the Missouri and the Yellow River, characterized by Hamites, *Gryphæa Columba*, and *Belemnites compressus*. Above the Big Bend horizontal beds of lignite, sandstone, shale and clay, occur continuously for several days journey. The author considers this formation to be of more recent birth; it contains, near the Cherry River, beds of lignite from three to nine feet in thickness.

The New Red Sandstone, with its usual accompaniments of sand and gypsum, appears to be in North America developed very extensively. According to Mr. Rogers, it comprehends all the country from the falls of the Platte to the great salt lake, or rather sea, on the western side of the Rocky Mountains, and from the Missouri to the Arkansas and Rio Colorado. The same formation is supposed to extend into Mexico, and to be the red sandstone described by Humboldt as occurring so extensively in the southern provinces.

On ascending the Missouri from its junction with the Mississippi the cliffs are found to consist of Limestone, characterized by Productæ, Terebratulæ and Encrini. The hills near Cheriton are composed of this limestone, and good beds of bituminous coal occur in the same district.

The relative position of the vast deposits of Coal and Anthracite which have been discovered in America is not yet satisfactorily ascertained. The great coal-field of Pennsylvania is said to occur in the higher beds of grauwacke, but what are so called may possibly be shown hereafter to correspond to the limestone shale and millstone grit of Derbyshire. When skilfully treated, this anthracite is considered better than the best bituminous coal of England and the United States. Vegetable impressions are rare, and I do not find that any of the Species have been identified with the English, but the Genera, I believe, are the same. The next great deposit of anthracite, that of Rhode Island, lies rather lower in the series, and the anthracite of Worcester is said to occur in an imperfect mica slate, associated with gneiss. Dr. Meade states, that at Rhode Island the veins of coal are separated by various coloured sandstones of the transition series, yet fine specimens of indurated talc and green asbestus in capillary crystals are also interspersed through the shale, and form the immediate cover of the coal.

The Rocky Mountains, as far as Mr. Rogers could collect from the information of Mr. Sublette, a person engaged for eleven years in the fur trade, and from the journals of Long and Lewis and Clarke and Nuttal, are Primitive. The eastern chain, called the Black Hills, consists of gneiss, mica slate, and greenstone, with amygdaloid and other volcanic substances. Volcanic mounds are frequently seen on the west of the mountains between the rivers Salmon and Louis; for the distance of more than forty miles the Columbia river flows between perpendicular cliffs, from two to three hundred feet in height, composed of lava and obsidian. The Malador branch of the Columbia takes its direction through a similar gorge, and thermal springs abound in this part of the country.

On the various organic remains of North America, a Paper by Dr. Harlan, which first appeared in the Transactions of the Geological Society of Philadelphia, has been republished in Jameson's Journal.

A valuable Communication on the Bermudas, with which we have been favoured by Lieutenant Nelson, R.E., has taught us that in explaining the formation of strata our homage is not exclusively due to Neptune, Vulcan, and Pluto, but that Æolus must also be regarded.

This cluster of islands consists entirely of coral, of what kinds it is unnecessary to specify here, though the author has bestowed upon this part of the subject a large share of attention. Confining myself to what relates more especially to geological science, I may state the following as the most important conclusions which Lieutenant Nelson's observations tend to establish: 1. That the coral animal does not build above water. 2. That coral islands now in process of forming may and do attain a considerable height, say 260 feet above the level of the sea, without the assistance of volcanoes, earthquakes, or any other violent catastrophe. 3. That this height has in Bermuda been attained by a mere accumulation of sand and shells, continually blown up and advancing from the coast into the interior. 4. That drift sand is capable of arranging itself in strata. 5. That of the strata so formed some may be consolidated, others unconsolidated, and that the two may alternate. 6. That strata of drifted sand do not present horizontal surfaces. 7. That wind is capable of giving to strata the figure of a dome or saddle, or a waved and contorted appearance, or an arrangement round centres, or a high degree of inclination. 8. That in coral islands bays are original indentations, not the effects of subsequent abrasion. 9. That the surface of a country may be diversified by hill and dale, though it has never undergone diluvial action. 10. That under favourable circumstances denudation may be occasioned by wind as well as by water. 11. That the ripple-mark, which Mr. Scrope* ascribes to a vibratory movement of the lower stratum of water, agitated by winds or currents, may also be owing to wind. 12. That crevices or fissures may be the results of contraction or unequal expansion, and are not necessarily accompanied by violence. 13. That the reticulation of such crevices does not disprove their being contemporaneous. 14. That caves may be produced in strata by the undermining action of the sea. 15. That limestone may be consolidated without the application of either heat or pressure.

The Bermuda Islands furnish a striking example of the intermixture of land and sea shells with the bones of birds and tortoises, and likewise with vegetable remains. Some of the specimens which accompany the paper have a structure distinctly oolitic, and in some I observe the delicate red tint which is met with in the chalk beds of Yorkshire, or the oolite of Dijon. The cause of this, and still more, the origin of the sand, the detritus of rubies which occurs in one part of the shore, are curious subjects of inquiry. It is also remarkable that breccias should be found at Bermuda, similar to those of Nice, the island of Cerigo, and Gibraltar.

A paper on the arrangement of Fossil Fishes, read at the first meeting after the recess, and ably commented upon by its author, M. Agassiz, received from you more than usual marks of approbation. M. Agassiz informed us, that as yet he had not found any species identical with those of our present seas, with the exception of one small fish which has been discovered in Greenland imbedded in geodes of clay, the geological age of which is undetermined. In the newer tertiary formations, viz. the Crag and superior Apennine beds, the species for the most part exhibit a relation to the genera which dwell within the tropics, but in the older tertiary, viz. the London clay, the marine limestone of Paris and the rock of Monte Bolca, at least a third of the shells belong to genera that are extinct. In the Chalk more than two thirds belong to extinct genera, and if the grouping of strata were regulated only by ichthyological

* Proceedings of the Geological Society, No. xxi. 1831.

considerations, this rock would be more properly classed with the tertiary formations than the secondary. Below the Chalk not one recent species has been met with; in the Wealden Beds, the Oolitic Beds, and the Lias, even the genera are all different from those in the chalk. Below the lias, two out of the four orders, under which M. Agassiz comprehends all the fishes that are known, viz. the Cycloidean and the Ctenoidean, entirely vanish, while the other two orders, rare in our days, suddenly appear in great numbers, together with large sauroid and carnivorous fishes. Of the fishes that occupy the Transition Rocks few have been brought to light, and no peculiar character has yet been affixed to them. In general the more ancient fishes are the best protected by scales. Those which are more ancient than the green sand exhibit none of those marks by which we can determine in the fishes of our own times whether the water in which they live be fresh or salt; the species always changes with the formation, and frequently, as we see, the genus also. It would appear, therefore, that greater changes take place in the higher order of animals than the lower in equal periods of time.

Your award of the Wollaston medal to this eminent naturalist has led to the most advantageous results. By that award M. Agassiz having been induced to come over to this country, has received in all quarters that distinction which his superior knowledge and personal character and deportment justly deserve. With a view to enable him to devote a larger portion of time to the study of fossil Ichthyology in Great Britain, the Association for the Advancement of Science voted to him at Edinburgh the sum of 100*l*. During his subsequent excursions in various parts of England and Ireland he had ample opportunities of visiting whatever collections have been made in that department of natural history to which he devotes himself; and every one was happy to transmit to our apartments at his request any specimens which he wished to figure. In the very short space of time to which his stay in this country was necessarily confined, M. Agassiz was enabled to add to the very large number of species which he had already examined, no less than two hundred that were entirely new to him; these were placed, immediately as they arrived, in the hands of an artist from Neufchatel, acting under M. Agassiz's direction. Such are the facilities and advantages which Associations like ours supply to those whom our motto designates as true sons of science!

Sir Philip Egerton has drawn out for us a Catalogue of a rich Collection of Specimens formed by himself and Lord Cole in the caves of Franconia and the Hartz Mountains. In the cavern at Galenreuth, now closed against visitors, it was their good fortune to obtain several bones of the fossil bear, which the late Baron Cuvier required to complete the skeleton of that animal. Many of them appear to have been scratched, but none gnawed. In all these caverns, recent bones referrible to various animals, accompany the fossil; and in some of them have been found old coins, iron implements, and fragments of rude pottery.

To a work which I shall have occasion to bring under your notice hereafter, Mr. Broderip, our Vice-President, has appended a Table, showing the situation and depth at which the different genera of shells are found in seas and estuaries. The importance of such a table, though professedly incomplete, must be evident to you all; and I hope we shall receive from the same quarter further proofs of the advantage which our science is capable of receiving by allying itself with practical zoology. One of my predecessors has adverted to various circumstances which may determine different fossils to different localities, producing an abundant supply in one place, and a comparative dearth in another. In this point of view, Mr. Broderip's table will be found of great use. By referring to it we discover at once what genera in the present creation are confined to shallows; what genera are to be expected at depths varying from a few feet to three or four hundred, and even more: which are those that attach themselves to marine plants, drifted wood, coral, crustacea, loose stones, or rocks; perforate the shells of other animals, coral, wood, or arenaceous and calcareous deposits; or dwell on beds of mud or sand. A knowledge of the habits of recent Testacea must materially assist our investigations into the habits of corresponding fossil genera.

The Geographical Range of different fossil Animals is a subject of great interest, coinciding as it must do with the range of those conditions which were essential to their birth and preservation. To Col. Sykes we are greatly indebted for bringing under our notice a Collection of fossils made by Captain Smee in the district of Cutch. On comparing these remains with the fossils of the oolitic series in England, we observe, not without surprise, that one agrees in every respect with the *Gryphæa dilatata*, that another agrees equally with the young shell of *Trigonia costata*, that a third bears a close resemblance at least to the *Ammonites Harveyii*, while others are identical with the *Ammonites Wallickii*, which is found in the range of the Himalaya. I hope the interest which these species have excited will lead to a more extended investigation of the tract from which they were procured.

Among the illustrations which will accompany a Geological Account of Gurhwal and Sirmou, drawn up by Mr. Royle, is a plate representing certain Shells collected by Mr. Gerard in the elevated valley of the Spiti; these shells may also be identified generically with those of the secondary formations in Europe. Besides these, are given the head and teeth of a small species of Deer, and the tooth of a Rhinoceros, obtained by Messrs. Webb and Trail from the lofty region on the north of the Snowy Mountains; and several teeth of a carnivorous animal, a saurian, and fish, discovered by Mr. Cauntly at the southern base of the Himalayan chain.

A list of Fossils found in the Lias of Yorkshire by Mr. Williamson, jun. of Scarborough, will be valuable to us as a local monograph, and still more so as a type to which we may refer the fossils of the same formation in other parts of the country. The author is of opinion that every particular layer is characterized by peculiar organic remains, a statement which must be received with caution; it may be true where the district examined is very small, but published lists, which deserve the greatest confidence, establish beyond all doubt that those species which abound in a formation belong to various beds, and that those species which at one locality are most numerous fail altogether in another.

Mr. Mammatt, one of our Fellows, has embodied the result of forty years experience in a splendid Work on the Coal-field of Ashby de la Zouch, illustrated with beautiful engravings.

It is a work of considerable labour, and independently of its local interest, contains some remarks on fissures, joints, and "slines," which coming from a practical observer are well entitled to attention. It is to be regretted that the specimens from which the drawings were taken have been too frequently imperfect or indistinct. In other branches of natural history, so intimate are the relations of the several parts, that from the examination of an unknown tooth and a few other bones, the expert physiologist has been enabled in some instances to construct in imagination an unknown animal, the fidelity of which, to nature, subsequent discoveries have established. The laws which determine vegetable forms are more indefinite and obscure; if fragments of plants are to be engraved, they require to be selected with great judgement, and should be confined to those parts of the object which are best defined and most characteristic. Seen from another point of view, however, these plates become immediately valuable; for though the objects engraved were too indistinct perhaps to enable us to determine the genus, class, or order to which they belong, a correct delineation of them may be sufficient to enable us to identify them with objects found in other coal-fields, perhaps in very distant parts of the world.

The author adopted at an early period the opinion that "Strata are characterized by their Fossils," and he appears to think, that in the coal-field under his consideration, each bed of shale has vegetable impressions of its own. By the precision with which the work is executed, the justice of this opinion is at once put to the test; the successive strata are numbered in regular order, and the names of the plants (where they have names) are attached to the numbers to which they respectively belong. Now, in looking over the list, with a view to the determination of the question before us, I observe *Stigmaria fucoides* at No. 25, 55, 223, 232; *Sigillaria Organum* at No. 37 and 118; *Sigillaria oculata* at No. 74 and 79; *Asterophyllites longifolia* at No. 16, 330, and 370; and *Neuropteris gigantea* at No. 112, 147, 249 a, and 406.

A series of Vegetable Impressions transmitted to us by Mr. De la Beche has given rise to a good deal of discussion. The plants have been examined by Mr. Lindley, and identified at once with those usually found in the Newcastle and other regular coal-fields; they form the roof of certain beds of coal or culm which have long since been observed and worked in the neighbourhood of Bideford in Devonshire, and extend from the shore inland to the distance of about fourteen miles, being about three quarters of a mile in breadth. Along the coast very distinct sections are exposed, both of these beds and their associates. The associated beds have hitherto been generally referred, and with the utmost confidence to the transition epoch. Many of them appear to me identical with those in the Hartz Mountains, to which the name of grauwacke was in the first instance applied, and which may therefore be considered as the types of that formation. Mr. Smith, indeed, in his geological map of England, refers the Bideford district to the red and dunstone of Brecon and the south-east part of Scotland; whether he applies that term to the old red sandstone exclusively, or to the old red sandstone and grauwacke conjointly, I do not know; at all events, neither he nor any other person has ever expressed a suspicion that the beds under our consideration may be more modern than the limestone of Derbyshire; nor am I aware that such suspicion is entertained even now by any one who has seen them in situ.

Mr. Ainsworth, an active naturalist, who is gone out with Captain Chesney on an expedition to the Euphrates, has published an Account of certain Caves at Ballibunnian on the coast of Kerry. In the bay which bears that name, the cliffs which rise to the height of a hundred feet, are composed of two beds (varying from thirty to forty feet in thickness) of compact ampelite, divided by seams of the same slate but fissile and anthracitous, and pouring out streamlets of water containing iron and salts in solution. Near Hunter's Path are seven beds of anthracite; the laminar and slaty rocks belonging to the great transition clay-slates repose on compact sonorous argillaceous limestone, and considerable beds of quartz occur in the midst of the slate formation; this coast, therefore, seems to be very analogous to that of Bideford: it is desirable to ascertain whether the beds of anthracite are here also accompanied by impressions of plants, and whether they can be identified with those of the independent coal districts.

The distinctness of the Bideford section, and the great experience which Mr. De la Beche possesses in geological surveying, make it highly improbable, I think, that the plants which he has presented to us can belong to any other formation than that to which he has referred them: that the same fossils, vegetable as well as animal, are confined to one particular epoch, and cannot be found in more than one part of the general series, are presumptions, which if countenanced, as to a certain extent they are, by limited experience, more enlarged experience may not unnaturally be expected to overthrow, unless indeed we choose to suppose, amid all the obscurity that surrounds us, that our knowledge has already reached a maximum, and that nothing more can ever be visible than that which we have been accustomed to see; but the case which Mr. De la Beche has stated is not altogether a new case; it does not even contradict our present experience. Coal measures, with their usual plants, have been before found in undoubted grauwacke at the Bocage in Calvados, and you have heard, from one of my predecessors, that they occur in the same relative position at Magdeburg; that they occur in sandstone beds that alternate with mountain limestone in our own country; and that on the southern flank of the Alps they had been discovered by M. Elie de Beaumont in beds of the age of lias.

Two Communications have been presented to us, one from the pen of Mr. Babbage, the other of Captain Basil Hall, R.N., on the Temple of Serapis at Puzzuoli, one of the most extraordinary buildings in Europe; beautiful as a work of art, interesting as an object of antiquity, but to the geologist more especially valuable, as exhibiting a variety of complex natural phænomena, which, though they have taken place in times comparatively modern, it is exceedingly difficult to explain according to the known laws of nature.

Of the solutions which have been proposed by different authors*, not fewer than twenty in number, and most of them authors of eminence, it is impossible to give even a summary within the time allowed me. The merit of Mr. Babbage's paper, as far as original observation is concerned, consists principally in his notice of various stalactitical deposits, and his examination of their different characters and modes of production.

Mr. Babbage describes in detail all the appearances of this temple, and then inquires into the causes of the extraordinary revolutions which it must be admitted on all hands to have undergone: the principal difficulty, you are aware, is to account for the erosion of the columns by lithophagous animals, from the height of 11 feet to 19 above their base, the remaining parts being intact.

Mr. Babbage is of opinion that the building stood at first very nearly at its present level. Assuming that since that period it has both subsided and risen again, and that considerable changes have taken place in the relative levels of the land and sea in its vicinity; he explains these circumstances by supposing the edifice to have been built upon the surface of matter at a high temperature, which matter contracted afterwards by slow cooling; that at a still subsequent period a fresh accession of heat produced a new expansion, and that in this way the temple was gradually restored to its original level.

To suppose and illustrate his reasoning, the author has constructed a Table (founded on experiments made in America,) showing in feet and decimals what would be the amount of expansion in beds of granite from 1 to 500 miles thick at various temperatures; together with a formula for calculating the amount of expansion in similar volumes of marble and sandstone; this Table has a collateral claim to notice, as being the first worked out by the calculating engine with a view to publication.

It appears to me, that in applying the calculation, it is very necessary to take into account three elements which have been overlooked.

1. How far under the supposed conditions expansion would be counteracted by pressure?

* Among these may be mentioned Barthelemy, Boué, Brieslak, Brocchi, Cochin, Billiard, Daubeny, Desmarest, Desnoyers, Forbes, Goethe, Hoff, De Jorio, Lyell, Pini, Prevost, Nicolini, Raspe, and Dr. Robertson.

2. What space of time would be required to heat or cool such enormous masses of substances, which are very imperfect conductors of caloric, to the required temperatures*?

3. How far the explanation given of the phænomena of the Serapeum is applicable to others in its vicinity? The admitted fact that certain buildings which have also subsided still remain below the level of the sea, while others have been raised to unequal heights above it, makes it unlikely that any uniform cause, while it produced upon them such various effects, should yet have stationed the pavement of this temple in the self-same spot which it occupied at the time of its original construction.

The Letter from Capt. Basil Hall contains remarks on the position of the three columns of the temple which are still standing; they appear from his observations not to be exactly upright, but to bulge over a little, all in one direction, but not to the same degree. The outermost, in consequence of the tilt, has been brought into such a position that the top of the column is in a line with its base, an extraordinary accident. These remarks do not diminish our difficulties. The tilting may have been occasioned by such subsidences as all buildings are liable to, which are not founded upon solid rock, or it may be referred to earthquakes or original carelessness, or to the skill of the architect, who, by giving a deviation from the plummet line to the axis of the columns (so slight indeed as not to catch the eye,) strengthened his edifice against some lateral thrust, a practice known to have been employed at Athens, and referred to in the letter. Captain Hall has indeed put his veto on this last hypothesis, by saying that the inclination of the columns takes the opposite direction to that which would be required for the supposed purpose; but this cannot be known, I imagine, unless we know also the details of the original structure, and especially the position and construction of the roofs.

Shortly after this temple had been examined by Mr. Babbage, an attempt to drain it effectually was made by the Neapolitan Government: the stagnant water which infected the air of the neighbourhood was partly supplied from the mineral spring, partly from rain, partly from the sea: the experiment failed for reasons which it is not necessary to mention. Signor Nicolini, President of the Royal Academy of Naples, who was entrusted with the conduct of the work, and has published an account of it, discovered a rich mosaic pavement a hundred palms in length at the depth of sixteen palms below the level of the stagnant water, whence it appears that the

* On a statement of Mr. Scrope's, that a current of lava after it had been ejected nine months, was still flowing on the flanks of Etna at the rate of a yard per day, Mr. de la Beche observes, "If lava can retain its elevated "temperature when thus exposed, what length of time may we not allow for "its doing so within the pipe of the volcano itself, surrounded on all sides by "matter greatly heated, and like itself an exceedingly bad conductor of heat? "Even in those cases where centuries elapse between the great eruptions "of any given volcano, the lava is probably liquid beneath at no very con-"siderable depth."

sea must have risen sixteen palms since that pavement was laid. The existence of two pavements of different dates shows further that great changes of level took place before the present temple was built: but Signor Nicolini goes further, he advances a confident opinion that the level of the Mediterranean, in relation to the land, is even now changing.

In support of this doctrine, he not only refers to the phænomena of the temple of Serapis, but points out others in its neighbourhood, all tending to the same conclusion: he states, that in the year 1808 he spent ten days or more in sketching at this spot, and never once saw the pavement flooded, whereas during the last five years he has never once found it dry; that in 1790 the old road near the Serapeum being subject to be flooded, a new one was made at a higher level; and that at the commencement of the new road there is now visible, two palms below the sea level, the pavement of an old landing-place; that boats now pass near the promontory of Puzzoli over a mass of tufa, which derived its name of "The Table," from having been formerly used as such by sea-faring people; that the ground floor of the Aspizio dei Capuccini is now under water; and that near Pizzo Falcone modern marks are seen on the tufa many inches under the level of the sea at low water.

Before I quit this branch of the subject, I would wish to suggest to future visitors of this temple, the following topics of inquiry.

What parts of the building have undergone repair? Can the date of these repairs be deduced from the nature of the materials employed, or the character of the workmanship?

Where is the pavement out of level, and to what amount? Are the subsided parts under the lines of thoroughfare, or can their sinking be traced to imperfect construction? Is the foundation such as an architect would call secure? Does it stand on stratum No. 6 of Mr. Babbage's section?

Were there roofs to the bath-rooms?

Would the fragments No. 6, 7, 8, form one column, or more than one? Was the original number of large (*cipollino*) columns greater than four?

Is the tufaceous deposit on No. 7 the same as that on the walls?

Are all the water lines horizontal?

Brick-work is found in the strata which buried the temple. What is the character of this brick-work? Is it reticulated?

Draw up a detailed and exact account of the strata.

What is the nature of the thermal spring? Evaporate a few gallons of the water, and send the deposit to the Society.

The plan which accompanies Mr. Babbage's paper being copied from that of Jorio, it is desirable, in order to prevent confusion and save expense, that this plan, with the numbers attached to it, should be adopted in any future description.

In the concluding part of the paper, Mr. Babbage proceeds to show in what manner existing causes may possibly elevate continents and mountain ranges, and a similar train of reasoning seems to have presented itself to Mr. De la Beche's mind about the same time. The justice, or at least the relevancy of the reasoning, depends on the establishment of many postulates which in the present state of our knowledge can be regarded only as matters of surmise: but I treated this subject so much at large on a former occasion, that I will not detain you with any further observations upon it now.

A Paper by Dr. Turner, our Secretary, informs us of some experiments which have been made on the action of high-pressure steam upon glass, and other siliceous compounds. The glass was suspended within the boiler of a steam-engine, encased in wire gauze at a temperature of about 300° commonly for ten hours a day. At the end of four months all the pieces were decomposed, and the plate-glass especially, consisting of silex and soda, was in some pieces corroded entirely through. Window-glass was less acted upon, and rock crystal wholly unaltered. Dr. Turner ascribes these changes to the influence of the water on the alkali of the glass, the white opaque matter with which the decomposed pieces were coated being siliceous earth entirely free from alkali; but some portions of the silex also must have been dissolved, for the apertures of the gauze were in some instances closed by a siliceous incrustation, and a small stalactite of silica was found depending from the lowest part. He points out the bearing of these results on the agency of water under high pressure on felspathic and other rocks containing alkalies, and in this point of view they are of great interest.

I hail with unfeigned pleasure the arrival of every paper which makes geology a science not merely of observation, but experiment. In the condition in which we stand at present, the geology of the laboratory is as essential to our progress, as that of the open air.

The Metamorphoses of rocks which are so continually pressed upon our notice are capable of explanation by chemists only. Of those metamorphoses I will only observe, that they appear to me to be attributed too exclusively to Plutonic action. The phænomena which startle and delight us in the vicinity of whin dykes, we regard in Neptunian rocks without emotion.

The Account recently published by Professor Hoffmann of the marble of Carrara is very striking. The result of his examination is, that this pure saccharine limestone in which no trace has been discovered of organic matter, although in its cavities are occasionally found pellucid crystals of quartz, is only transformed oolite. Mr. De la Beche's researches along the gulf of Spezia, an account of which is published in the Transactions of the Geological Society of France, had already prepared us for such an announcement: yet it seems strange when we reflect on the wide expanse of serpentine which is seen in its neighbourhood, that the Carrara marble should not be magnesian. In the Isle of Skye veins of serpentine sometimes penetrate the lias, where, in the vicinity of numerous whin dykes it assumes the whiteness and occasionally the sparkling grain of statuary marble, and here again the marble is unadulterated by magnesia: the origin of the serpentine is somewhat less mysterious since the limestone in its unaltered state is micaceous. M. Dufrénoy in a late number of the "Annales des Mines," has described a similar

Transformation of lias into saccharoid limestone seen in the Pyrenees. I think it unnecessary to detail to you the descriptions which Mr. Murchison has given of the Change of structure, or even of substance that take place at the Malvern Hills and at sundry other places in Wales, and on the confines of Wales frequently, though not always, in the vicinity of trap and sienite, because they are in general the same as have been observed repeatedly in other districts. The phænomena at Old Radnor the author remarks are very analogous to those of the Val di Fassa in the Tyrol. It may, however, be proper to mention, not as a novelty, but as a circumstance the frequent occurrence of which is little attended to, that in Carmarthenshire the line of altered rock produced by the proximity, or as it is called the protrusion of a mass of porphyritic trap, is parallel to the strike of the grauwacke so altered. At Caer Caradoc, the Wrekin, the Stiperstones, and elsewhere, a stratified sandstone is at its junction with trap, converted into quartz rock. One other circumstance deserves to be noticed; the range of the Stiperstones, along which these Plutonic appearances present themselves, is flanked on either side by metalliferous deposits, but not of the same kind, the copper ores being all found on one side of the range, the lead ores on the other. An analogous case will be seen in Humboldt's account of the country situate between the Oural and Altaic chains. A fault or fissure is there traceable through not less than 16° of longitude, forming a crest or water-shed; the rocks are nearly the same as those of Shropshire: they comprehend a granite (unconnected with gneiss,) clay-slate, grauwacke-slate, augitic porphyry, and transition limestone, once compact but now granular. Malachite and red Copper ore are found on one side of the ridge, argentiferous galena on both.

Such are the Plutonic phænomena, for an explanation of which we rely chiefly on the assistance of chemistry; but there is another train of phænomena which renders a close and intimate alliance between this science and our own, no less desirable. The spontaneous generation, shall I call it? of agate, of chert, of hornstone, of flint, in the midst of sedimentary calcareous deposits, apparently through the instrumentality of animal or vegetable matter, in which little or no silex is to be met with, is one of those mysterious operations of nature which can nowhere be satisfactorily accounted for unless in the laboratory. The coralline agates of Antigua, the entrochal cherts of Derbyshire, the siliceous shells of Blackdown or Fontainebleau, the chalcedonic alcyonia of Pewsey, pieces of fossil wood either imbedded in strata or loosely scattered over sandy deserts, the flinty casts of echini and other substances in the midst of our chalk, all these suggest a course of experimental investigation which we are entitled to hope, if undertaken in earnest, would not be undertaken in vain.

Gentlemen, I have great satisfaction in announcing to you, that at the opening of the present Session of the Royal Society, one of the Royal Medals was awarded to our Foreign Secretary as the author of the most important discoveries or series of investigations sufficiently established or completed to the satisfaction of the Council within the last five years, and for which no honorary reward had been previously received. The Council of the Royal Society, premising that they decline to express any opinion on the controverted positions contained in Mr. Lyell's work, entitled "Principles of Geology," state the following as the grounds of their award.

1. The comprehensive view which the author has taken of his subject, and the philosophical spirit and dignity with which he has treated it.

2. The important service he has rendered to science by especially directing the attention of geologists to effects produced by existing causes.

3. His admirable description of many tertiary deposits, several of these descriptions being drawn from original observations.

Lastly, The new mode of investigating tertiary deposits, which his labours have greatly contributed to introduce; namely, that of determining the relative proportions of extinct and still existing species, with a view to discover the relative ages of distant and unconnected tertiary deposits.

Of the Work so honoured by the Royal Society, the third edition has been lately published: in this edition some opinions formerly expressed have been modified or renounced, and much new matter has been introduced; the phænomena of springs and Artesian wells have been more fully treated; the theory of elevation has been entered into more at large, the author still controverting that theory. A chapter, almost entirely new, points out the probable causes of volcanic heat; objections are advanced against the doctrine of the central fluidity of the earth, and especially the intense heat attributed by some writers to the internal nucleus. Mr. Lyell considers how far chemical processes in the interior of the earth may generate volcanic heat, and what may be the effect exerted by currents of electricity. Sir Humphry Davy's theory of an unoxidated metallic nucleus is considered, and it is suggested that compounds resulting from the action of water upon metallic bases may be again deoxidated by the hydrogen set free in that process. The author has also given a more complete view of his opinions respecting the origin of caverns, and the manner in which they have been filled with breccia and the bones of animals. In illustrating this subject, he refers particularly to the recent discoveries of MM. Virlet and Boblaye in the Morea. His sketch of the principal secondary formations is also considerably enlarged.

Two other publications have issued from the press during the last year, which are eminently deserving of your attention. The first of these, entitled "A Treatise on Primary Geology," originated in great measure from a discussion that took place at a Meeting of the Geological Section of the British Association at Cambridge, and was drawn up with a view to the further consideration of the chief questions which it embraces, at the subsequent Meeting of the same body at Edinburgh.

Dr. Boase begins by describing the composition and relation of the several Primary Rocks, combining the accounts of geologists in various parts of the world with the results of his own laborious investigations in Cornwall. I regret, that within the limits to which I am restricted, it is impossible for me to do justice to the merits of this important work; I must confine my observations to a few of its most characteristic features. Dr. Boase is of opinion that the connexion between Unstratified and Stratified Rocks shows that they had a common and contemporaneous origin. He observes that granitic masses are as complex in their composition as stratified rocks, and form sometimes distinct regular beds, highly inclined and alternating with one another; that the elvans, or insulated beds of granitic rock, always partake of the nature of the containing slate, and have the same basis; that the difference between the granite and killas, or elvan, in Cornwall is often feebly marked, and still more feebly the difference between the granite and gneiss of Scotland and Germany; as little difference is there between the granite of the Alps and the talc slate adjoining. Where the granite changes its character, a corresponding change, he says, takes place in the slate. The elvans are connected on either side with the granite they intersect by the most intimate mineral gradations, or contain irregular portions or masses of the common granite, with which they coalesce; both are penetrated by crystals of felspar; both are striped with shorl. At Pednimerer Meer one of the parallel layers of granite runs through the elvan. In Scotland different beds of granite will intersect a common mass, and pass by minute mineral transition into one another, or into the characteristic granite of the district.

Dr. Boase considers that the Primitive Shisti are improperly said to be *stratified*. Pini has expressed the same opinion in two separate memoirs; the supposed planes of stratification are, in his view of the subject, mere transverse fissures. Prof. Phillips, Mr. Scrope, Dr. Fleming, Prof. Sedgwick, have all felt and expressed the difficulty of distinguishing in these shisti planes of cleavage, and planes of stratification. In the days of my geological apprenticeship I took great pains to observe and record dip and direction, and fondly hoped to obtain so large a number of accurate data on this subject as might enable me to arrive at last at some general and important result. I threw these data into tables, which only bewildered me. Suspecting the accuracy of my early observations, I repeated them again and again, guarding myself on every occasion more and more against probable sources of error; still I found my results perpetually varying, till at last my patience was exhausted, my Clinometer discarded, my registers destroyed. Let it not be supposed, however, that my observations were useless; they taught me a salutary distrust.

Dr. Boase remarks that all the Slate rocks are composed of rhomboidal concretions, which are developed on a large scale by disintegration. Mr. Scrope had anticipated this remark, and generalizes it. He says the stratification of rocks of all kinds, where the strata are separated by seams, is produced by concretionary process.

Now, then, which of all the planes are the planes of dip? Dr. Boase, like the Woodwardian Professor, selects those which run with the laminæ, and yet the layers of massive crystalline and granitic rocks often lie the other way. But this seems to be very much a matter of taste; different observers selecting for the scene of their measurements different planes. Some pay great attention to the laminæ, others neglect them; nay, the same observer shall sometimes select as strata one series of planes, sometimes another.

Professor Phillips, in a passage which is too long to be quoted, has expressed the same idea in language equally expressive.

Dr. Boase presents to those who differ from him on this subject the following alternative: either Stratification implies a successive deposition of sedimentary matters held in suspension, in which case *none of the primary shisti are stratified*; or merely parallel planes without regard to the cause of their production, in which case *not only the primary shisti are stratified but granite also.*

In the thirteenth chapter will be found some excellent observations on the nature of Inclined Strata, tending to show that these last are not necessarily the effect of disturbance, but are to be attributed, in the Primary Slates, to original structure, and in many of the Secondary, partly to this cause, and partly to deposition upon inclined surfaces.

The difficulty I have been considering is by no means confined to Primary Slates. Mr. Conybeare has observed on the coast of Sully, in Glamorganshire, that the Lias splits spontaneously into blocks of regular figure, corresponding to that of a crystal of calcareous spar. If this be the case, where are we to look for the seams of Stratification? I have felt for very many years, and I still feel that the indistinctness of this term is one of the most dangerous stumbling blocks we have to encounter. If we would found upon this distinction the grand classification of rocks into Neptunian and Plutonic, surely we ought to have some test by which to determine whether rocks are *stratified or not.* If, looking to the theory of M. Elie de Beaumont, we would know whether strata are conformable or disturbed, surely we ought to be placed in a condition to determine what *Strata* are. On taking leave, as I must do, of Dr. Boase's work, I again recommend it to your attentive perusal; it is written with great candour as well as earnestness, and will be found a useful corrective of many opinions which appear, to me at least, to have been too inconsiderately adopted.

Mr. De la Beche, one of your Vice-Presidents, to whose pen and pencil our science has been for a series of years continually and largely indebted, has published a small volume, entitled "Researches in Theoretical Geology". The main tendency of this volume is to establish the importance and practicability of subjecting geological opinions to the tests of chemistry and natural philosophy. The Author goes over much ground, keeping always the same direction, having apparently no other objects in view than the acquisition and communication of sound knowledge, the detection and exposure of error, and the discovery and establishment of truth. Unshackled by authority, unenslaved by preconceived opinions, unseduced by the love of novelty, free from all vanity of authorship, concise, methodical, exercising his judgement continually, his fancy seldom, the author may not obtain that popularity which with less merit he might have easily commanded; but such a work cannot fail to be appreciated here.

After taking a general view of the Solar System, and considering certain apparent agreements and disagreements in the condition of some of the Planets, Mr. de la Beche applies his observations entirely to the Earth, which he supposes to have been originally in such a state that its component particles had a free passage among one another. The principal Constituents of Land, Water, and Air, sixteen in number, are made up of Substances commonly termed simple: viz. oxygen, hydrogen, nitrogen, carbon, sulphur, chlorine, fluorine, phosphorus, silicium, aluminum, potassium, sodium, magnesium, calcium, iron and manganese. Adopting Laplace's hypothesis, that the sun, planets, and their satellites, have resulted from the Condensation of gaseous matter, he ascribes the Condensation of our own planet to the gradual Radiation of Heat into space. He shows how Sedimentary Rocks may be deposited so as to present, from the first, inclined planes, and that we should therefore be cautious in referring to subsequent displacement all deviations from a horizontal level: he forms an estimate of the Destruction of Land by Breakers, of the wear and tear of Running Waters, of the transport of detritus by Rivers.

The mean Density of the crust of the earth is usually reckoned at 2·5. From a reference to the lists, which the author has drawn out, of the specific gravities of many rocks, of the various simple minerals which enter into their composition, and of certain recent shells, it would seem that 2·6 would be nearer the truth.

The Author investigates the Chemical Changes which Rocks undergo after their formation, and the subject of Concretions, such as *Ludus Helmontii*, &c. He remarks on the importance of attending to the Cleavage of Rocks, whether igneous or aqueous, and their Transformation: he considers the great Breaks of the Surface in reference to the effect which would result from its gradual cooling; and, from the contortions and Fractures of Mountain Chains, infers the Intensity of the forces that have acted upon them: he shows that certain Thermal Springs may be occasioned by the Condensation of volcanic discharges of gas and vapour, and ascribes the Uniformity of their Temperature to the Constancy of such condensation: he then treats of Volcanic Action and the gradual Rise of large tracts of Land.

When explaining the Formation of Valleys, Mr. De la Beche contends that the "Bursting of Lakes," as it has been termed, could not take place in the way supposed. The Area, comprised within soundings, that is, within the 100 fathom line, round the British islands, is delineated on a map, in order to show, that within that area at least, no Valleys are produced by Tides and Currents; whence it would follow, that such effects cannot be satisfactorily referred to such causes. Under the head of Faults, which are treated of at some length, the author shows with what facility "Craters of Elevation" may be formed, and expresses surprise that so much discussion should have taken place on so simple a case; he sees no difference between many Metalliferous Lodes and Faults.

The subject of Organic Remains is next investigated, and the Modification produced by various physical causes on the distribution of Life, particularly Animal Life in the sea. Diagrams are given to show that Shells, contemporaneously enveloped by rocks now forming, would probably not be of the same Species, even under the same parallels of latitude; but that the Species would be determined in some measure by the relative depth of the water at different places, on the influx of rivers, and other causes. Attention is particularly called to the manner in which Organic Remains may be entombed in a series of deposits along a gradually rising coast.

Under the head of Mineralization of Organic Remains, the Author shows that these bodies are not merely changed in character but in reality. One substance being substituted for another, a cast for an original, the Change varies in these bodies in proportion to their respective Solubility. Carbonate of lime being more soluble than phosphate, shells change much more rapidly than bones. Silica in shells follows the same law as in agates, entering their cavities by infiltration.

The Author now gives a general Sketch of the various Rocks that are known to us; he remarks that the Primary differ chemically from the Secondary, and endeavours to account for the phænomena connected with animal and vegetable life, as exhibited in the several formations, upon the theory of a gradual Loss of Heat by Radiation. Upon this theory he would explain the Scanty Supply of Limestone in the earliest Rocks. The effect of great heat would be to expel from water the carbonic acid necessary to hold the carbonate of lime in solutions; and consequently Calcareous matter could not be deposited from heated water. He observes also that the Conditions for an uniform distribution of animal and vegetable life, would be more uniform in a thermal than in our actual Seas, and, therefore, if the Ocean had become gradually cooler, we should expect to find, as we do, genera and species more diversified.

The terms, Eocene, Miocene and Pliocene, are objected to, as prejudging an important question. Unless equal conditions obtained at equal times in all places, the Miocene rocks of one country may be of the same date as the Pliocene of another. The Author closes his remarks on Erratic Blocks by observing, that, like the great contortions and dislocations of strata, they teach us, while we duly appreciate the continued and more tranquil effects which are daily before our eyes, that we must not dismiss from our consideration Forces of greater Intensity; still bearing in mind, that however great these last-mentioned forces may be when measured by the ideas commonly entertained on such subjects, they are still insignificant when considered with reference to the entire spheroid on the surface of which they act.

Gentlemen, I have now brought to a close the account, which, in conformity with the practice of the Society, I proposed to lay before you, of the labours and achievements of last year. It therefore only remains for me to resign the chair. When I consented to resume the office of President, many of you are aware that a consciousness of the precarious state of my health made me diffident of my powers to discharge that office with becoming energy and effect. The generous support which I have received from the Council and the Fellows at large, has, I am willing to believe, in some degree concealed from your observation several deficiencies, of which I myself have been fully aware, and the Society has continued to flourish. The only merit I claim is, that of having, upon all occasions *endeavoured* to promote your interests; but a brighter prospect now opens upon you, and you will find an ample guarantee for more brilliant anticipations of success in the youth, the spirit, the abilities and the character of my successor.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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February 25.—The Rev. William Thornton, of Brockhall, in Northamptonshire; Viscount Adare, F.R.S., of Adare, in the county of Limerick; and Thomas G. Parry, Esq., of Trinity College, Cambridge; were elected Fellows of this Society.

A paper was first read, "On the Volcanic Strata exposed by a Section made on the site of the new Thermal Spring discovered near the town of Torre del Annunziata, in the Bay of Naples; with some remarks on the Gases evolved by this and other Springs connected with the Volcanos of Campania;" by Professor Daubeny, M.D., F.G.S., &c.

The discovery of a spring near Torre del Annunziata having occasioned the removal of a considerable portion of a cliff, a clear section has been exposed of the volcanic strata constituting that part of the base of Vesuvius. The entire height of the cliff is 68 feet, and it presents the following details:

Vegetable mould, mixed with decomposed lava, 5 to 10 feet.

Hard, compact, cellular lava, with occasionally considerable cavities, and scoriform at the bottom, 5 feet.

In one of the cavities of this stratum, Dr. Daubeny states, on the authority of Colonel Robinson, that a considerable quantity of carbonate of magnesia was found: and Dr. Daubeny also found in the same lava a white coating, which appeared to contain a very large proportion of it. The author further states that Colonel Robinson has since informed him, that in endeavouring to find the origin of the magnesia, he had excavated to the depth of 40 feet, two miles up Vesuvius, in the direction of the spring, and had found large pieces of pumice, the cavities of which were completely filled with carbonate of magnesia.

Under the bed of lava, the cliff is principally composed of strata of rapilli and scoriæ, of various shades of red, grey, and black, sometimes agglutinated by volcanic sand. In the upper portion the beds are blended together, but in the lower they are, for the greater part, tolerably distinct. In the midst of these strata is an irregular bed of compact tuff, terminating abruptly at each extremity; and at a lower level are one or two other beds of similarly constituted tuff, but traceable only for a few feet. These beds of tuff, Dr. Daubeny is of opinion, were formed on dry land, by rain or torrents, as eight or nine feet lower in the cliff, is an admixture of vegetable mould containing stems of reeds, similar to those now growing in the neighbourhood; and about one foot still lower are the roots and part of the trunk of a fir, in an upright position, in the soil in which the tree must have grown. Intermixed with the earth, found at this level, fragments of tiles, a piece of hewn timber, and other traces of human art are said to have been discovered; and at a somewhat higher level, a cypress, also in an upright position. In driving a horizontal gallery, at a level nearly 10 feet below that of the fir, vestiges of walls and buildings with fresco paintings, as well as fragments of Roman pottery, and a considerable quantity of cut marble, were discovered, proving the overwhelming, if not of another town, of at least several buildings, by an eruption of Vesuvius. The position of these buildings corresponds with that of a place mentioned under the name of Oplonti in the *Tabula Theodosiana*, and it is remarkable that the large square building represented in that ancient map, opposite to the word Oplonti, indicates in other places a thermal spring, which the recent excavations made in this spot prove to have existed there in the time of the Romans. The catastrophe which overwhelmed the cypress and fir, above alluded to, Dr. Daubeny conceives happened prior to 572, because near Bosce-tre-case, about two miles to the north of Torre del Annunziata, and on the slope of Vesuvius, was lately discovered, a few feet below the surface, a bag of Roman gold coins, evidently almost fresh from the mint, and bearing that date; while he conceives that it may have been effected by the great eruption of 472. Considering, however, that the buildings underneath must have been overwhelmed by some eruption antecedent to that which covered the trees (these latter appearing to have grown in the very materials which enveloped the former), he is disposed to assign the formation of the beds constituting the lower part of the cliff to the eruption of 79; but he adds, it is remarkable that an event which covered the neighbourhood of Torre del Annunziata to the depth of more than 30 feet, should not have added sensibly to the accumulation of volcanic materials over Pompeii.

The spring of Torre del Annunziata possesses a temperature of about 87° of Fahrenheit, and, according to the analysis of Professor Ricci of Naples, abounds chiefly in the bicarbonates of soda, magnesia, potass, and lime, with sulphate and muriate of potass, muriate of soda, and muriate of magnesia. The quantity of carbonic acid gas discharged is so great as to maintain the water constantly in a violent ebullition, and to render the air in the stone cylinder through which it escapes unrespirable. The same gas also rises in bubbles through the sea, near the spot; and there are patches of land upon the cliff, upon which, owing to the disengagement of this gas, no plant can be made to grow. Dr. Daubeny then points out the presence of oxygen and nitrogen gas, not only in the spring of Torre del Annunziata, but in those of St. Lucia in Naples, at the Lago di Amsanti, the Agua Santa on Mount Vultur, and the Lago di Solfatara near Tivoli; the proportion of oxygen varying from 9 to 16 per cent., and of nitrogen from 84 to 91. With reference to the origin of the nitrogen gas of these and other springs, Dr. Daubeny states that he is ready to admit the possibility that it may, in many instances, be separated from the water, and not be derived from an independent source.

To those, however, who refuse to admit volcanic action to be a process of oxygenation, he says, such a mode of explaining the emission of nitrogen would seem to remove the difficulty only one step further, since it still remains to be shown why spring water, which is in general impregnated more fully with oxygen than nitrogen gas, should, in these cases, disengage chiefly the latter. He also adds, that in none of the warm springs in the neighbourhood of Naples does nitrogen appear to be evolved in any notable quantity; and that the warm springs of Ischia are destitute of all gaseous impregnation: and in conclusion, whilst admitting that the hot springs of Campania furnish no positive confirmation of the connexion between volcanic processes and the evolution of nitrogen, the author contends, on the other hand, that they suggest no facts which can set aside the evidence in favour of that position, which the production of ammonia within the volcano itself appears to furnish.

A letter was afterwards read, from Lieut. Freyer, R.N., addressed to Charles Lyell, Esq., P.G.S., on the appearance of elevation of land on the west coast of South America.

The localities alluded to in this letter are Arica, lat. 18° 26′ south, the Island of San Lorenzo in the Bay of Callao, and Valparaiso.

Mr. Freyer states, that on his first arrival at Arica he was struck by finding shells, in very great abundance, at considerable heights above the present level of the sea. To the north of the town the coast is low, with a shingly beach and sandy plains, no rock being exposed; but he here found shells of existing species ten or twelve feet above high-water mark. On the south are interesting sections, consisting of innumerable thin beds of red sandstone and gypsum, resting upon shale, in which fragments of fossil shells were noticed. The bold promontory called the Morro of Arica is formed by the dislocation and elevation of this sandstone to the height of about 400 feet, by a mass of basalt, porphyry, and pitchstone, which pass insensibly into each other. Near the summit of the Morro the sandstone contains layers of a salt, consisting of chlorine 31·6, sodium 31·6, sulphuric acid 14·0, lime 9·45, potash and magnesia 9·0, insoluble (silex) 4·0*. South of the Morro the sandstone and gypsum beds have a small southerly dip, and form indistinct terraces towards the shore. On these terraces, wherever the rock is exposed, Balani and encrusting Millepora are found. At the height of about twenty or thirty feet above the sea they are as abundant, and almost as perfect, as on the shore; at upwards of fifty feet they still occur, but abraded by the sand constantly blowing over them; and there are traces of them at still greater heights. In the island of San Lorenzo in the Bay of Callao, Mr. Freyer found, at considerable heights, Concholepas, *Pecten pur-*

* The author states that this analysis was made by his friend Major Emmett, R.E.

pureus, Sigaretus concavus, with other shells, in great abundance, and retaining their colour almost as freshly as those living in the adjacent sea. Mr. Freyer states that he did not visit Conception, but that he had seen cargoes of the lime made from the shells found at great heights in its neighbourhood.

With respect to Valparaiso he regrets he did not more attentively examine the neighbourhood; but he says, that to the east of the town the shelly beach is now far above the reach of the tides, and that rocks were pointed out to him which he was assured were under water previously to the earthquake of 1822.

March 11.—Richard Atkinson, Esq., M.A., of Trinity College, Cambridge, and Old Square, Lincoln's Inn; and the Rev. Ralph Lyon, M.A., of Trinity College, Cambridge, and Sherborne, Dorsetshire; were elected Fellows of this Society.

A paper was first read, entitled "Description of a Bed of recent Marine Shells near Elie, on the Southern Coast of Fifeshire;" by William John Hamilton, Esq., Sec. G.S.

The author commences his memoir by describing the geological structure of the neighbourhood of Elie, a small fishing-town about eighteen miles north-east from Edinburgh. The promontories which form the two extremities of the bay of Elie, consist of amygdaloid and basalt, the latter exhibiting sometimes a columnar structure. Between these headlands the beach is low, and composed of alternating, thin beds of sandstone and shale, with occasionally seams of coal and strata of limestone, the whole belonging to a carboniferous system, and inclined at high angles in different directions, and without any regularity. Basalt occurs in numerous places, extending in long reefs far into the sea; the beds of sandstone and shale dipping from them on both sides: but at one point in the western part of the bay the strata are said to dip under the basalt.

About two miles to the eastward of Elie is a small promontory, near the extremity of which is situated the bed of marine shells. The extent of the deposit across the promontory does not exceed eighty yards; but its range inland could not be ascertained. The bed rests unconformably upon strata of sandstone and shale containing masses of ironstone, and consists principally of coarse sand, with rounded fragments of the sandstone and ironstone. The shells are sometimes imbedded in clay, but are more frequently scattered irregularly through the deposit, and belong, without exception, to existing species. The point at which they were first noticed, is about five feet above high-water mark, and the shells were very much broken. As the bed gradually rose towards the north-east, they were more numerous, and better preserved; the greatest height at which they were noticed, by the author, being twelve or fourteen feet above the level of high tide, and on the east side of the promontory. The deposit passes upwards into fine sand and comminuted shells. The strata, on the basset edges of which the shelly bed rests, Mr. Hamilton conceives were thrown into their highly inclined position by the agency of the neighbouring trap, and before the accumulation of the gravel and sand;

but that in consequence of the angle presented by the latter, and the distribution of their component materials, a subsequent elevatory movement has taken place, to which he ascribes the difference of level between the deposit and the present shore.

A paper was afterwards read, entitled "Observations on the Diluvium of the vicinity of Finchley, Middlesex;" by Edward Spencer, Esq., F.G.S.

The district occupied by this deposit extends from Muswell Hill to Finchley Common, a distance of about three quarters of a mile: its breadth is about 150 yards, and its average thickness is from 15 to 20 feet. The best point for examining the deposit is at the gravel-pits in the lane leading from Muswell Hill to Colney Hatch. It presents, immediately beneath the vegetable soil, a bed about 14 feet thick, consisting of marl and waterworn fragments of granite, porphyry, micaceous sandstone, mountain limestone, coal, lias, oolite, and chalk, with many of the characteristic fossils of these formations. The most abundant pebbles are lias and chalk; the latter being in so great quantity as to give the whole accumulation a chalky character. Flints are likewise sufficiently numerous to be extracted for repairing the roads.

This bed is separated by a well-defined line from another of red gravel, about six feet thick, resting upon London clay. It is composed of rounded chalk flints and sand, and saurian vertebræ are occasionally found in it; but no remains of Mammalia have been noticed either in it or the superior bed. Mr. Spencer states that there appears to be, in the whole of the deposit, a total absence of the small rounded pebbles of Lickey quartz, which are plentiful on the summits of the neighbouring hills of Highgate and Hampstead: and in conclusion he suggests that the current of water which brought the materials of the upper bed into their present situation flowed from the north.

March 25.—William Tite, Esq., Honorary Secretary of the London Institution, of Upper Bedford Place; Robert Phippen, Esq., of Badgworth Court, near Cross, Somersetshire; Lieut. Cautley, of the Bengal Artillery, Superintendent of the Doab Canal; William Hulton, Esq., of Hulton, in Lancashire; and George Edward Eyre, Esq., Barrister at Law, Lincoln's Inn Fields; were elected Fellows of this Society.

A paper was read, entitled "Remarks on the Structure of large Mineral Masses, and especially on the Chemical Changes produced in the Aggregation of Stratified Rocks during different periods after their deposition;" by the Rev. Adam Sedgwick, F.G.S., Woodwardian Professor in the University of Cambridge.

§ 1. *Introduction.*

The first section of the paper is devoted to some general considerations of the changes produced both by igneous and aqueous agents. Changes of the former class may be effected in a comparatively short period, and can sometimes be imitated in a laboratory. But changes of the latter class have often been effected during indefinite periods of time, and under circumstances which admit not of imitation. In such cases it is by observation only, and not by direct experiment, that we can hope to rise to a rational explanation of the phænomena. The author then gives some examples of both kinds of change here considered.

§ 2. *Globular Concretionary Structure.*

The author remarks, that although this kind of structure, as seen in aqueous rocks, can seldom be imitated, yet it may be explained, in most cases, compatibly with the known modes of material action, and the phænomena may be correctly classified. He then proceeds to give examples of the structure in question.

1. *Chalk Flints.*—They are posterior to the existence of the beds in which they are found. The free siliceous matter of the formation has not been uniformly diffused, but accumulated in distinct concretions; and therefore illustrates the principle contended for in the paper.

2. *Globular Calciferous Grit, &c.*—The author dwells at considerable length on the internal structure of calciferous grits, and explains their *chatoyant* lustre by the independent crystallization of carbonate of lime through definite spaces. He then points out several cases of such rocks with a regular spheroidal structure, and with the laminations of original deposit passing, without interruption, through the several spheroids; and he infers from such phænomena that the globular structure was superinduced during the passage of the stratified mass into a solid state.

3. *Globular Magnesian Limestone.*—For a detailed account of this structure, he refers to a former memoir in the Society's Transactions, and endeavours to confirm, by new arguments, the conclusion he drew from the phænomena, viz., that all the complicated concretions in the formation of the magnesian limestone, have been produced since the original deposition of the beds*.

4. *Rocks of Globular Structure subordinate to the Old Slate Formations of North Wales.*—He describes these rocks in considerable detail, and divides them into two classes, both of which he is disposed to arrange among stratified rocks altered by igneous action; and he remarks, that whether this opinion be true or false, the phænomena illustrate a great principle in the segregation of mineral masses.

5. *Nodular Ironstone, &c. in Beds of Shale.*—These, again, are posterior to the deposition of the beds; for it is shown (especially by some examples derived from Yorkshire) that the laminations of deposit may be traced through the nodules themselves. In this case the segregation of the nodule has often been occasioned by the presence of an extraneous body. Other examples are given of a similar chemical segregation from a similar cause; and the section concludes with an enumeration of some appearances exhibited in the mineral structure of petrifactions.

* See Geological Transactions, Second Series, vol. iii. p. 94, *et seq.*

§ 3. *Slaty Structure, Cleavage, &c.*

The subjects introduced in this section of the paper are described in considerable detail. The author first compares the structure of the great Cumbrian zone, of green slate and porphyry, with the structure of the principal chain of North Wales, and shows their perfect analogy. In one respect, however, the two regions are remarkably contrasted. The Cumbrian system has few contortions or undulations, probably in consequence of the great abundance of alternating beds of porphyry; whereas a transverse section through the Welsh chain, exhibits a continued series of longitudinal anticlinal and synclinal lines. He also compares the structure of an upper slaty series in Westmoreland and Lancashire, with a corresponding upper series in North and South Wales, pointing out the circumstances in which they agree and in which they differ.

In all these regions occur many beds with a slaty cleavage, which is entirely distinguished from a jointed structure by its indefinite subdivision, and it is *never found to coincide with the true plane of stratification.* These planes of stratification and cleavage sometimes dip to the same point, and sometimes to opposite points of the compass; they are stated to be inclined to each other, sometimes at an angle less than 10°; on the average at an angle of 30° or 40°, and in no instance at 90°. Where the slaty structure is well developed, the strike of the cleavage planes coincides nearly with the strike of the beds; and this important rule holds true in countries where the beds themselves are thrown into a series of anticlinal and synclinal planes. The author adds, that there are regions in North and South Wales, thirty miles in extent, and many miles in breadth, where the cleavage planes (notwithstanding the numberless contortions of the beds) preserve an undeviating direction and dip. He states that in many large slate quarries there is no indication whatsoever of the true bedding; but *whenever the slates have a striped structure, the stripes* (so well known in the Cumberland and Welsh roofing slates) *are parallel to the true beds.* To this rule there is *no exception* in the regions described; and in thousands of instances the stripes are seen to be parallel to the alternating masses of 'coarse greywacké', and to calcareous beds with organic remains.

The author then describes a flaggy, passing into a finely laminated, structure, parallel to the bedding. He points out the manner of distinguishing this from a true slaty structure, which may readily be done in a quarry, and, generally, even in examining hand specimens.

In this view, a laminated structure and a slaty structure differ so entirely in their origin, that however nearly they may resemble each other in some instances, they ought never to be confounded under the same name.

Finally, he distinguishes cleavage planes from the contorted laminæ of argillaceous schists; and endeavours to prove, by a long series of sections derived from various parts of North and South Wales, that the introduction of a crystalline cleavage was the last chemical change superinduced on the slaty deposits before they became entirely solid.

He then speculates on the enormous amount of force necessary to produce a crystalline cleavage through whole mountain chains of mechanical rocks; and supposes it due to an accumulated intensity of crystalline action in a nearly homogeneous mass, every part of which is exposed to the same conditions of aggregation while passing into its ultimate solid form. He illustrates this principle by contrasting the structure of the enormous calcareous deposits of the Alps with the structure of the thin interrupted limestone formations of England.

The foliated uneven layers of old, crystalline schists (such as chlorite schist, and mica schist) are briefly noticed, and considered generally to form portions of beds, and not of cleavage planes: but to this rule he gives some remarkable exceptions.

In all slate rocks, besides the cleavage planes, there are found one or more sets of cross-joints, which often separate the rock into regular rhombohedral solids. Even in hand specimens of such solids we may detect which is the cleavage plane, because, parallel to that plane (and to that plane only) the mass admits of indefinite subdivisions. The direction of one set of joints is generally inclined at a great angle to the direction of the beds: and, hence, as the prevailing strike of the slate rocks of England is north-east, we may expect the prevailing strike of one set of joints to be nearly north-west.

This portion of the paper concludes by recommending a more consistent use of technical language in the description of slate rocks than is commonly met with in the published works on this part of geology.

§ 4. *Jointed Structure.*

Rocks, both aqueous and igneous, have undergone a mechanical tension while passing into a solid form; and, in consequence, many of them have become subdivided by a number of parallel fissures, producing a jointed structure. Jointed pillars of basalt and prismatic granite are considered as examples of this structure. A jointed structure of this kind may in some instances be derived from an original globular structure; but the prismatic and cuboidal blocks of granite are not considered as due to such a cause, and the concentric crusts into which such blocks are found to decompose, are regarded as the natural effects of decomposition on a mass of homogeneous structure. This conclusion is supported by the fact, that artificial pillars of granite (or even of oolitic limestone) sometimes decompose in concentric cylindrical crusts.

In the preceding cases a jointed structure is, both in its origin and in the mineral phænomena it presents, entirely distinguished from a slaty cleavage. Some granitic rocks (without a vestige of true bedding) have, however, an imperfect cleavage. The granite of St. Austell Moor is described as made up of highly inclined parallel laminations ranging about magnetic east and west; and on some parts of the region, the laminations, on approaching the schistose rocks, are extremely fine, and seem to form a passage between the killas and the granite. Such an appearance is, however, the exception, and not the rule. Again, the prismatic joints of the granite sometimes partially affect the neighbouring slate rocks. But facts like these only prove that the granite and the contiguous schists passed into their ultimate solid state at the same time, and under similar conditions, and throw no difficulties whatever in the way of the igneous theory of granite. Some writers, by confounding such joints with beds of deposit (to which they bear no analogy), have been led into most preposterous conclusions.

Many of the great parallel veins of St. Austell Moor are described as veins of segregation; yet some of them are metalliferous. Most of the metalliferous veins and cross courses of Cornwall are, however, considered by the author as veins produced by mechanical disruption; but on this hypothesis, the direction of such veins would (in part at least) be affected by the structure and direction of the rock: and from these considerations he thinks that we might (independently of any direct observations) expect in some parts of the county a system of veins running nearly magnetic east and west, and a great system of cross-joints nearly at right angles to that direction.

Before concluding the paper, he briefly notices the principal directions of the great cross courses and veins traversing the mountain limestone of Derbyshire and Flintshire. The *cross courses* are nearly in the direction of the beds, the *veins* nearly at right angles to them: and these two directions harmonize very exactly with the theory which refers both sets of fractures to a mere mechanical disruption of the rock.

April 8.—Edward Bellasis, Esq., Barrister at Law, New Square, Lincoln's Inn; and Henry English, Esq., of New Broad Street; were elected Fellows of this Society.

A paper was first read, entitled "Notice on the Junction of the Portland and the Purbeck Strata on the Coast of Dorsetshire;" by William Henry Fitton, M.D., F.R.S., &c.

The occurrence of silicified trunks of trees in the upright position, with their roots in a thin bed of carbonaceous clay and coarse gravel, a few feet above the top of the oolite, in the Isle of Portland, was mentioned some years ago by Mr. Webster*. Since that time Dr. Buckland and Mr. De la Beche have inferred that both these trunks and the Cycadeæ described by the former † as occurring in the same stratum, must actually have grown in the places where their remains are found ‡; and, more recently, Professor Henslow has ascertained the existence of two other beds of clay, between that which includes the trees and Cycadeæ and the Portland stone. The author of the present notice was so fortunate as to visit the island, during the last summer, at a moment when the remains of Cycadeæ were found in one of these *lower* beds, and to see some of them before they were disturbed. The bed in which they occur is between those which are called by the quarry-men "Cap" and "Skull-cap", both of which consist of freshwater limestone; the latter being separated from the Portland stone by no more than two or three inches of clay. The Cycadeæ in this lower bed were in some cases of very large horizontal dimensions, and, like those in the dirt above the "Cap", were in

* Geological Transactions, Second Series, vol. ii. p. 42.

† Ibid. p. 395. ‡ Geological Proceedings, vol. i. p. 219.

the upright position, and apparently in the places where they originally grew.

The author found thin beds of clay, with more or less admixture of mechanically divided matter, alternating in several other instances with the fissile limestone at the lower part of the Purbeck formation. Even the "Cap", which in Portland is generally a continuous mass of limestone six to eight feet thick, without stratification, includes, in other places at its lower part, alternations of thin strata of clay.

The "Cap" is for the greater part compact; but it includes cavities lined with botryoidal carbonate of lime, and in other respects resembles very strongly the *travertine* of Italy. In the clay or dirt beneath it, no trees are found along with the Cycadeæ, in the Isle of Portland; but the author observed near Poxwell, on the north-east of Weymouth, part of a silicified trunk, in a bed of "dirt", which he thinks may, not improbably, be inferior to the "Cap", and, consequently, the same with the *lower* of the two beds which in Portland afford the Cycadeæ.

The author ascertained, on attentive examination, that casts of one or more species of Cypris exist throughout the whole series of the slaty limestone beds above the Portland stone; the boundary of the two formations being, as Mr. Webster had supposed, immediately below the "Skull-cap": and, generally, the portion of the Purbeck formation which adjoins that of Portland, may be said to consist of freshwater limestone, alternating with thin beds of clay and mechanically worn matter;—two of which beds, at least, contain the remains of plants standing in the places where they grew: the whole reposing upon strata which abound remarkably in marine shells.

The top of the Portland series, in which these shells are so abundant, has many points of resemblance to the recent agglomerated limestones of Bermuda, and of the shores of Australia, and other places in low latitudes; a fact which accords with the supposition that this portion of England was for some time in the condition of a bank, very near the surface,—or of an island of small height above the sea.

The inferences from the new facts mentioned in this paper, the author remarks, do not invalidate the conclusions of previous observers; showing only that land must have existed and produced vegetation, above the present site of Portland Island, *before* the deposition of the upper of the two beds, which contains the trees and Cycadeæ. The whole of the freshwater strata seems to have been the deposit of a lake, or an estuary, of freshwater, in which (whatever was the cause of the alternations), the waters must have deserted the strata previously accumulated at their bottom, at two successive periods at least; in each case during a space of time sufficient for the growth of Cycadeæ; and in the latter of the two cases, of trees also,—upon the surface of the land thus exposed.

In conclusion, the author suggests, that the Isle of Portland should be visited from time to time, and frequently, by geologists; since all the principal appearances of interest are presented by that part of the strata which it is necessary to remove, in order to obtain the valuable stone: so that new phænomena are continually brought to light, and as rapidly defaced, during the course of the operations at the quarries.

A paper was afterwards read, entitled "Observations on the Ichthyolites of Gamrie in Banffshire, and on the accompanying Red Conglomerates and Sandstones," by Joseph Prestwich, Jun., Esq., F.G.S.

In the summer of 1826, Mr. J. Christie of Banff, in company with Mr. Dockar of Findon, discovered the thin stratum of clay which contains the Gamrie ichthyolites, previously noticed in the bed of a small brook; but as those gentlemen did not determine the geological situation of the stratum, the author, at the suggestion of Mr. Murchison, undertook, in a recent visit to Scotland, to investigate its relative position.

The formations of which the district consists are, micaceous and argillaceous schists, old red sandstone, a red conglomerate, and lias clay and sand.

The bed containing the ichthyolites the author found to belong to the upper part of the red conglomerate, and he gives the following section of the deposit:

Soil:

1. Loose conglomerate of angular fragments of argillaceous schist, imbedded in a reddish brown, slightly micaceous sand	35 feet.
2. Red clay....................................	2
3. Grey clay, with ichthyolites disposed in nodular layers about six or eight inches apart........	4
4. Grey, slightly micaceous shale	12
5. Red conglomerate of quartz and clay slate	5
6. Coarse, micaceous, deep red sandstone........	3
7. Loose conglomerate	12

Beneath the last stratum are other beds of conglomerate, which gradually become coarser and harder, and inclose a few rolled masses of gneiss.

The ichthyolites, though most abundant in the bed of grey clay (No. 3.), are not confined to it, remains of fishes occurring in the subjacent sandstones and conglomerates; and it is only when the sandstones are entirely replaced by the conglomerates that the fish exuviæ disappear. This distinction the author assigns to the apparent turbulent state of the water which brought the conglomerates together, and the comparatively tranquil condition of that which deposited the sandy strata.

With respect to the geological position of this system of sandstones and conglomerates, the author shows that it rests unconformably on the old red sandstone, and that it is overlaid by outliers of lias; he is further of opinion that it belongs to the age of the coal measures, and, probably, of the millstone grit. This conclusion is likewise in accordance with the opinion of M. Agassiz respecting the age of the deposit, deduced from the characters of the ichthyolites.

The author, in addition to this account of the bed containing the fish, gives a detailed description of the old red sandstone, the schistose formation, and the trap rocks of the district. He gives a detailed account, also, of the faults, and shows by sections, that those between Findon and Gamrie, and near Gamrie church, are older than the lias, because they are overlaid by that formation, without affecting it.

April 29.—John Wiggins, Esq., of Tavistock Place; George Vaughan, Esq., of Cumberland Terrace, Regent's Park; Lord Abinger, Lord Chief Baron, of Spring Gardens; and Christopher Puller, Esq., Barrister at Law, Park Street; were elected Fellows of this Society.

A paper was first read, entitled "Remarks to illustrate Geological Specimens from the West Coast of Africa," by Captain Belcher, R.N., F.G.S., &c.

The points whence the specimens were obtained are the Isles de Los, in lat. 9° 27′ north; the reef of Young Gonsalez; and Cape Blanco, lat. 20° 47′ north.

The Isles de Los are stated to be composed principally of porphyritic hornstone; but at the water's edge that rock is said to be intersected by a granitic compound of quartz, felspar, and hornblende. Tumbo Point, situated on the main land, opposite the Isles de Los, consists of the same compound, as well as the coast for several miles to the northward. When in mass this rock is said to affect considerably the magnetic needle.

From the mouth of the Sangareeah or Debreekah nearly to Cape Verga, in lat. 10° 11′, the coast consists of sand banks; but at Cape Verga the granitic compound reappears. Off this Cape is a reef, composed of masses of hard, calcareous sandstone and granular limestone. The banks or shoals in the vicinity are frequently composed of a jaspery gravel, and indurated ferruginous sand, apparently derived from the reef off Young Gonsalez. The reef at the entrance of the river Cappacches, and the whole of the coast to Rio Nunez, are composed principally of a ferruginous sandstone, passing into a breccia. In the Rio Nunez, basalt is stated to occur at the first falls above Debucko; and at "the barrier", about thirty-five miles from the mouth of the river, the strata are said to be much disturbed, and the sandstone to assume a prismatic structure. For five miles from this point the banks were apparently composed of reddish and yellowish clay. At "Five-miles' Bend" is a precipitous bank, stated to consist of slate, spotted in some places with greyish steatitic matter; and hence to one mile above Cassassez, no rock occurs, but at the latter place the sides of the river and its bed are said to be composed wholly of basalt, which is generally columnar. The peninsula of Cape Blanco is formed of calcareous sandstone, in which shells occasionally occur; and the surface of the cliff, seventy feet above the level of the sea, is stated to be covered with immense quantities of shells, agreeing with those found in the bay.

On some parts of the coast are ledges composed of strata of various colours, dipping at a high angle towards the south, and often worn in forms resembling that of a mushroom.

A paper was next read, entitled "A Description of Specimens collected on the Island of Ascension by the Rev. W. P. Hennah;" communicated by the Rev. Richard Hennah, F.G.S.

The bays on the west and north sides of the island consist of a rock formed of comminuted fragments of shells and corals, and occasionally of masses of lava, the whole being cemented by carbonate of lime, and covered by a loose sand of the same materials. Those parts of the rock which are exposed to the action of the waves have a polished surface, and are often covered by a coating of calcareous matter which presents a peculiar appearance, like some varieties of lichen. On the east and south sides of the island the shore is deep, and calcareous accumulations are totally wanting. With the exception of this recent limestone, the whole of the island consists of volcanic products, presenting many varieties of lava, obsidian, ashes, and occasionally fragments of trachyte. Caverns and oven-shaped hollows are stated to be of common occurrence, and the former to be lined with stalactitic matter. Two craters are mentioned by the author, and he says that the beds of ashes occur only on the leaward side of the island.

A paper was afterwards read, "On a Bed of Gravel containing Marine Shells of recent species, at 'The Willington', in Cheshire;" by Sir Philip Grey Egerton, Bart., M.P., V.P.G.S.

"The Willington", the residence of Major Tomkinson, is situated at the western base of the "Forest Hills", four miles north of Tarporley, and about nine miles in a direct line from the nearest point on the shore of the Mersey. The "Forest Hills" belong to the new red sandstone formation, and at this point have an elevation of 120 or 130 feet above the Mersey, or from 50 to 60 feet above the adjacent valley. In the summer of 1834 a bed of gravel was exposed close to their base, to the extent of three or four yards, and to the depth of one; and the author ascertained that it was between seventy and eighty feet above the level of the Mersey. It presented so different a character from the usual gravel of Cheshire, that it attracted the attention of the workmen. It was composed principally of fine-grained gravel and pebbles from one to six inches in diameter, intermixed with sand and fragments, and sometimes perfect shells of existing marine species. The pebbles had undergone considerable attrition, but presented a flattened, not a spheroidal form. They consisted chiefly of granite, slate, chert, porphyries, greenstone, amygdaloid, new red sandstone, coal-measure sandstone, and quartz pebbles, identical with those of the conglomerate beds of the new red sandstone of the district. The shells, which were thickly disseminated through the whole deposit, were in an extremely friable condition, and belonged to *Turritella terebra*, *Cardium edule*, and *Murex erinaceus*, as well as to a thin smooth bivalve, the genus of which could not be determined. The extent or thickness of the deposit the author was not able to ascertain, though he was informed that in making a well at the "Willington", twelve yards of gravel and sand were penetrated before the new red sandstone was reached; he could not, however, learn if any Testacea had been noticed in making the well.

The shelly bed was separated by a well defined line from an overlying deposit, twenty feet thick, of the ordinary diluvium of Cheshire, and consisted principally of sand, containing pebbles and boulders of granite, slate, greenstone, and other rocks.

From "The Willington" the country slopes very gradually to the Gowey, a small sluggish stream which conveys the drainage of this part of Cheshire to the river Mersey, and empties itself into that river near the village of Ince. The author then quotes some extracts from the Red Book of St. Warburgh's Abbey, given in "Ormerod's Topographical Account of Cheshire," stating that in Wyrall, in the manor of Ynes, the sea had removed thirty caracates of land, and was daily destroying more: the author also states that, according to popular tradition, the sea once occupied a large portion of the valley at the foot of the Forest Hills.

From the above details, and from a careful examination of all the facts he could collect, he gives the following, as the conclusions at which he has arrived:

1st. That the bed of gravel was deposited on the shore of the ancient sea, at that period extending to the base of the Forest Hills.

2nd. That this has occurred since the existence of some of the species of shells now inhabiting our seas.

3rd. That an alteration in the relative levels of land and sea, to the amount of seventy feet, has taken place since its deposition.

4th. That it has been covered by an accumulation of diluvium twenty feet in thickness.

A communication was lastly read, entitled "Notice of a newly discovered gigantic Reptile;" by the Rev. William Buckland, D.D., F.G.S., &c.

The remains noticed in this communication were discovered near Buckingham in a bed of clay immediately above the cornbrash; and the author states that their preservation is owing to the zeal of William Stowe, Esq., of that town. The principal bone is a caudal vertebra of a reptile larger than the Iguanodon. It measures about six inches in its longitudinal diameter, and six inches in the vertical and largest transverse diameters of its articulating faces. Both these faces are slightly convex, and are smallest on the lower side, and depressed on the upper, to form the channel for the spinal marrow. The body of the vertebra is much compressed towards its centre, and the transverse processes are reduced to a small tubercle on each side. On the inferior margin of the articulating surfaces are large oblique facets for the reception of a powerful chevron bone. The form of this vertebra differs essentially from the subquadrangular form of the caudal vertebræ of the Iguanodon, and it has no perforations on the inferior part of its body, like those which enter the lower side of the body of the vertebræ of the Plesiosaurus.

Other bones, of corresponding size, and considered by Dr. Buckland as belonging probably to this genus, have been found at Bradwell, a few miles north-east of Buckingham, on the continuation of the same formation.

tomical knowledge. I will only add, in the way of congratulation, that his perseverance in these interesting researches is not remote from the habits, or at variance with the duties of his profession; for, as you are well aware, the examination of the human body is one department of that wide and beautiful field of comparative anatomy in which he finds amusement; and to become well acquainted with the œconomy and physiology of man, it is necessary to study the structure of other animals. We hope and trust, that Mr. Mantell may long possess health and strength to advance further and further still in his honourable career, and we request you, Sir, to convey to him our earnest wish that in every department of life he may meet with that success which his industry and talents so eminently deserve.

The President then presented, in the name of the Society, a purse of guineas to Mr. Lyell to be by him conveyed to Mr. Mantell, and informed him that the remaining portion of the proceeds of the fund had been laid out on a Medal, which would likewise be forwarded to him.

It was afterwards Resolved :—

1. That the thanks of this Society be given to George Bellas Greenough, Esq., retiring from the office of President.
2. That the thanks of this Society be given to William John Broderip, Esq., and Henry Thomas De la Beche, Esq., retiring from the office of Vice-President.
3. That the thanks of this Society be given to Professor Turner, M.D., retiring from the office of Secretary.
4. That the thanks of this Society be given to Charles Lyell, Esq., retiring from the office of Foreign Secretary.
5. That the thanks of this Society be given to the Rev. William Daniel Conybeare, Charles Giles Bridle Daubeny, M.D., Major Shadwell Clerke, Davies Gilbert, Esq., and Capt. Alexander Robe, retiring from the Council.
6. That the thanks of this Society be given to Decimus Burton, Esq., for the valuable service which he has rendered gratuitously to the Society.

The Meeting then proceeded to ballot for the Officers and Council for the ensuing year; and on the glasses being closed, the scrutineers announced that the following gentlemen had been duly elected:—

OFFICERS.

PRESIDENT.

Charles Lyell, jun. Esq. F.R.S. & L.S.

VICE-PRESIDENTS.

Sir Philip de Malpas Grey Egerton, Bart. M.P. F.R.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.
Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.
Henry Warburton, Esq. M.P. F.R.S. & L.S.

SECRETARIES.

William John Hamilton, Esq.
Woodbine Parish, jun. Esq. F.R.S.

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Henry Thomas De la Beche, Esq. F.R.S. & L.S.

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George William Aylmer, Esq.
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Arthur K. Barclay, Esq.
William John Broderip, Esq. F.R.S. & L.S.
Rev. William Buckland, D.D. F.R.S. Professor of Geology and Mineralogy in the University of Oxford.
William Henry Fitton, M.D. F.R.S. & L.S.
George Bellas Greenough, Esq. F.R.S. & L.S.
Henry Hallam, Esq. F.R.S.
John Forbes Royle, Esq. F.L.S.
Rev. Adam Sedgwick, Woodwardian Professor in the University of Cambridge, F.R.S. & L.S.
Lieut.-Col. W. H. Sykes, F.R.S. & L.S.
John Henry Vivian, Esq. M.P. F.R.S.
Sir Richard Vyvyan, Bart. M.P. F.R.S.
Rev. James Yates, F.L.S.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1835. No. 41.

May 13th.—George Thomas Nicholson, Esq., of Waverley Abbey, near Farnham, was elected a Fellow of this Society.

A paper was first read, "On the Cretaceous and Tertiary Strata of the Danish Islands of Seeland and Möen;" by Charles Lyell, Esq., P.G.S.

The author commences with a short account of the succession of deposits formerly supposed by Dr. Forchhammer to exist in the Danish islands. In a memoir published in the "Edinburgh Philosophical Journal of Science" for July 1828, Dr. Forchhammer had described the white chalk of Seeland as covered by a coralline limestone, and had imagined the white chalk of Möen to be a formation higher in the series than this coralline limestone. He had also considered certain deposits of blue clay, sand, and gravel, seen in the cliffs of Möen, as alternating with the white chalk.

Mr. Lyell examined, in company with Dr. Forchhammer, the cliffs of Seeland and Möen, during the summer of 1834, and the following are the results at which he has arrived. The two formations of which Denmark and Danish Holstein chiefly consist, are, chalk, and an overlying tertiary deposit. Part of the latter resembles in composition the argillaceous and sandy beds of the English crag. Another part corresponds with deposits usually called diluvial, especially those associated with the English crag, in parts of Norfolk. Large erratic blocks are also strewed over the surface of Denmark, connected with, and sometimes buried in, the gravel or "diluvium". In some sections on the banks of the Elbe, the yellow tertiary sands are divided regularly into thin strata, and are exposed for a thickness of about 200 feet. Unstratified masses of blue clay, of great thickness, are also there seen, in which gravel, containing every kind of rock, from granite to chalk, occurs.

There is often an abrupt passage from the stratified to the unstratified parts of the formation, which the author compares to the Norfolk and Suffolk crag, from its general appearance, but without pretending to decide its relative age in the tertiary series. Fossils are rare, except those washed out of older strata. A few recent shells have been found near Segeberg, and at other points, and two of extinct species at Schulan on the Elbe.

The white chalk of Denmark is characterized by the same fossils as those of the upper chalk of France and England, and occurs at Stevensklint in Seeland, and in the cliffs of Möen. On the coast at Stevensklint, and at several places in the interior of the same island, particularly at Faxoe, a newer limestone occurs, consisting, for the most part, of fragments of coral, cemented together by a chalky matrix. It is separated from the white chalk by a thin seam of bituminous clay, containing marine shells and impressions of plants. The limestone contains beds of flint, like those of the white chalk, but more cherty, and usually in continuous layers; and these are sometimes disposed diagonally to the general lines of stratification. The author presumes that this coral limestone, which he calls the Faxoe limestone, may be the equivalent of the Maestricht beds, as, like them, it contains some fossils identical with those of the chalk, intermixed with others which belong to genera more usually characteristic of tertiary formations.

The shells at Faxoe are chiefly in the state of casts, and among them are several species of Cypræa, Conus, Mitra, and Voluta, as also an Ammonite, a Patella, a Fusus, and a Cerithium. Upon the whole, there are in the collection of Prince Christian of Denmark 132 species of fossil shells from the Faxoe beds, of which 26 have been ascertained by Dr. Beck to be identical with chalk species, while the rest are distinct from them, but do not agree with known tertiary shells.

Lastly, the author considers the relations of the chalk of Möen with the tertiary strata of that island. The white cliffs of Möen are from 300 to 400 feet in height, consisting of chalk and parallel layers of nodular flint, the strata having been violently disturbed; so that instead of being nearly horizontal, as at Stevensklint, they are curved, and often vertical, and, upon the whole, more deranged than the chalk of Purbeck and the Isle of Wight.

The range of lofty cliffs in Möen is divided into separate masses by ravines, which often intersect them from top to bottom, but are in great part filled up with tertiary clay and sand, masses of which appear to have subsided bodily into large fissures and chasms of the fractured chalk. In consequence of these disturbances the chalk has been made to alternate on a great scale with interposed and unconformable strata of clay and sand. These alternations cannot be explained by supposing the detritus of the superincumbent strata to have been washed in by running water into clefts; but masses of the tertiary beds seem rather to have been engulfed. Several drawings illustrating these dislocations accompany the memoir, and the appearances are compared to those exhibited by the chalk, nearly enveloped by crag, near Trimmingham in Norfolk, although the entanglement of the two formations there, is on a smaller scale.

Dr. Forchhammer now agrees with the author in the principal conclusions above enumerated, and has discovered the disturbed chalk of Möen in the South of Seeland, as also the Faxoe beds overlying chalk in Mors, an island of the Lym Fiord.

A paper was afterwards read, "On a peculiarity of Structure in the Neck of Ichthyosauri, not hitherto noticed;" by Sir Philip Grey Egerton, Bart., M.P., V.P.G.S.

Miss Anning of Lyme Regis discovered, a short time since, in a thin bed of lias shale, near that town, a large portion of the skeleton of a new gigantic species of Ichthyosaurus. Among these interesting remains are the anterior cervical vertebræ, together with an occipital bone, and it is to the peculiarity of structure which they present that Sir Philip Egerton principally confines his observations. The occipital bone, he says, on the authority of Mr. Owen, proves very satisfactorily the permanent separation of the basilar element of the occiput in individuals of the fullest growth and largest size, evincing a very languid circulation in this family of reptiles. The atlas and axis of Ichthyosauri, the author states, are usually found adhering together, the connexion between them being so intimate that it is rarely possible to disunite them; and when this has been effected, the surfaces have borne the appearance of fracture more frequently than that of natural division. In one instance in which he succeeded in separating the two bones, the articulating surfaces were nearly even, and without cup. This union of the two vertebræ appears to have received additional strength from a small bone which articulated with the under circumference of the atlas and axis, showing, as the author observes, that in the anterior region of the spinal column strength and not latitude of motion was required. This bone is a nearly circular, solid, umbonated disc; the central projection being on the inferior or external surface, while the upper is depressed anteriorly and posteriorly for the purpose of articulating with the atlas and axis, the two surfaces being divided by a transverse elevation corresponding with the line of union of the vertebræ. The atlas and axis have their circumferences prolonged in the form of two tangents meeting at an obtuse angle on the under surface. These processes are truncated, and form, when the vertebræ are in apposition, a triangular depression for the reception of the two articulating surfaces of the interspinous bone. Sir Philip Egerton states that Mr. Owen has informed him, that a bone somewhat analogous in position, although not in form, occurs in some recent saurians. The apparently two succeeding vertebræ present, at the lower part of their articulating surfaces, an alternating elevation and depression, fitting into each other so exactly, as to limit, to a great extent, the motion between the bones. Some of the other cervical vertebræ are also remarkable for the flatness of their surfaces, the intervertebral cavities being nearly obliterated. In conclusion, the author says, that the conditions under which the atlas and axis are found; the existence of an auxiliary bone connecting the two; the form of the articulating surfaces of the cervical vertebræ, and the consequent contraction of the intervertebral cavities, all tend to prove that the extent of motion in the cervical region of Ichthyosauri was extremely limited, at the same time that its strength was proportionally increased.

May 27th.—A paper was first read, "On certain Lines of Elevation and Dislocation of the New Red Sandstone of North Salop and Staffordshire, with an account of Trap Dykes in that Formation, at Acton Reynolds, near Shrewsbury;" by Roderick Impey Murchison, Esq., V.P.G.S.

The author refers to former memoirs, read before the Society, in which he pointed out the existence of certain bedded trap rocks, interstratified with transition deposits, and of other intrusive trap rocks which have been subsequently injected amid these stratified masses. The Breiddin Hills, west of Shrewsbury, afford examples of both these classes of trap rock, in ridges running from west-south-west to east-north-east, and also indicate, upon their flanks, that elevations have taken place along these lines, subsequently to the deposition of the adjoining coal measures. The author has lately discovered that still more recent movements of elevation have been propagated along the same line of fissure, posterior to the consolidation of the new red sandstone. He was led to this observation by the unexpected discovery of three small trap dykes beneath the house of Sir A. Corbet, Bart., at Acton Reynolds, which were accidentally laid open upon clearing out the foundations of that mansion.

These dykes cut like walls through the new red sandstone, and are made up of a peculiar greenstone and a mottled concretionary felspar rock, both of which rocks occur in the Breiddin Hills. Besides this similarity in structure, the principal dyke has precisely the same direction as the Breiddin Hills, and hence the author was induced to examine the intervening tract of fifteen miles by which these trap rocks are separated. The result has been the detection of an anticlinal line throughout that space, along which the strata of the new red sandstone are thrown off, both to the south-south-west and north-north-east, or at right angles to the line of eruption of the trap. The clearest and most unequivocal point in the course of this anticlinal line is seen in Pim Hill, six miles north of Shrewsbury, in the centre of which the sandstone is compact, white, and unstratified, with slickensides, coatings of earthy oxide of manganese, traces of copper ores, vertical fissures, &c., whilst strata of unaltered sandstone dip away from this common centre, both to the south-south-west and north-north-east. This point of altered rock lies exactly upon the line connecting the Moel y Golfa ridge of the Breiddins with the trap dyke of Acton Reynolds. The line of elevation is further traceable for about fifteen miles, to the east-north-east of Acton Reynolds, usually throwing the strata into only dome-shaped masses; but the Rev. T. Egerton has observed it passing the Liverpool and Birmingham canal thirty miles distant from the Breiddin Hills.

The author is of opinion that the hilly range of new red sandstone extending from the Ness Cliff Hills, by the south of Wem, into the Hawkstone and Hodnet Hills, and then prolonged by the south of Market Drayton into the high grounds of Ashley Heath (parallel to the line extending from Moel y Golfa through Acton Reynolds), has been affected by similar elevatory forces acting along a line proceeding from the focus of the principal ridge of the Breiddins, or that on which Rodney's Pillar stands; and in corroboration of this, he alludes to the veined and metalliferous character of the red sandstone along this line, in which copper ores, manganese, &c. are of partial occurrence. Immense accumulations of coarse gravel and clay obscure the flanks, and sometimes hide, for vast spaces, the disturbed and denuded strata of red sandstone along the chief anticlinal line.

Attention is then directed to the position of the lower strata of the new red sandstone, around the coal-fields of Colebrook Dale and South Staffordshire; and in confirmation of opinions expressed in former communications, the author cites several examples near Wolverhampton and Dudley, particularly one at Sedgely, where the coal itself is thrown up at an angle of about 40°, the strike being north and south, with the lower new red sandstone conformable to it; and from these evidences he concludes that the principal lines of fracture along the margin of these coal-fields took place after the deposition of the new red sandstone series, and that, therefore, the break so prevalent in the South-west of England, between the upper part of the coal measures and the new red sandstone, can no longer be considered as of general application in English geology.

From the amount of dislocation which has taken place throughout all this region, accompanied by an enormous destruction of masses of new red sandstone, and from the protrusion of so many points of trap rock, some of which cut through that formation, the author is disposed to think that the recently described outlier of Lias at Cloverly and Prees, in Shropshire, *may* have been originally connected with the chief escarpment of lias in Warwickshire and Worcestershire, there being in the large accumulations of gravel in the intermediate country, many lias shells, which may have been derived from the destruction of once continuous strata of that formation.

In conclusion, he recapitulates what in former memoirs read to the Society he has endeavoured to show—

1st, That certain trap rocks have been evolved during the formation of the transition rocks:

2ndly, That others have burst forth subsequently to the consolidation of these older strata, throwing them into vertical and broken forms, and producing metalliferous veins in them:

3rdly, That this period of activity was anterior to the formation of the coal measures, as is proved by the strata of the latter resting unconformably upon the highly inclined edges of the transition rocks.

Carrying on the inquiry from this point, the present memoir demonstrates, 4thly, that igneous agency evolving precisely similar products has been renewed at a much later period upon one of these lines of ancient eruption; and, finally, that the great disruptions around the flanks of the central coal-fields of England took place after the accumulation of the new red sandstone.

A paper was afterwards read, "On the Crag of part of Essex and Suffolk;" by Edward Charlesworth, Esq.; communicated by Edward William Brayley, Esq., F.G.S.

After stating that the only direct information respecting the crag is to be found in the works of Mr. R. C. Taylor and Mr. Woodward, on Norfolk, and in Mr. Lyell's Principles of Geology, the author quotes an extract from Prof. Phillips's Guide to Geology, to show the state of knowledge respecting the formation up to the period of preparing his memoir.

Mr. Charlesworth then proceeds to point out that the crag consists, in parts of Essex and Suffolk, of two well-defined beds; the upper characterized by its ferruginous colour, and the lower by the presence of corals; and he proposes for them the terms of "red crag" and "coralline crag".

The best localities for examining these beds are, Ramsholt, on the eastern bank of the Deben; Tattingstone, between the Orwell and Stour; Sudbourn Park, twenty miles to the east of Tattingstone; and Orford.

The "red crag" at these localities varies from four to nineteen feet in thickness, and the "coralline crag" from seven to twelve feet.

The most striking peculiarity of the coralline crag is stated to be its uniform character, presenting none of those variations in colour or stratification which are constant in the upper beds. It is composed of highly calcareous sand, containing numerous Testacea, none of which appear to have been rolled, and the species often occur in groups. The corals are most abundant at Orford and Sudbourn.

For his general information respecting the organic remains in the two beds, the author states that he is indebted to Mr. Wood, of Hasketon, near Woodbridge, who has formed a very large collection of crag shells, and has been, as well as the Rev. G. R. Leathes, for many years aware of the existence of the two beds. Mr. Wood's collection is stated to contain the following species:

Annulata......	13	Conchifera......	189
Cirripeda	11	Mollusca	257

in all 450, including 50 species of minute Cephalopods. Of these species, about 80 are said to be peculiar to the red crag, upwards of 200 to the coralline, and the remaining 150 to be common to the two. One of the most marked distinctions between the Testacea of the upper and lower deposit is the total absence in the latter of the *Fusus contrarius*, and the Buccina and Murices, so abundant in the former. In the coralline stratum the remains of Echinidæ are numerous, belonging to several genera. In the red crag, fish teeth are very common, but they are of rare occurrence in the coralline; and the remains of Mammalia appear to be confined to the upper bed. The author then enters into an inquiry respecting the relative age of the red and coralline crag; and from the difference in their zoologieal contents, he concludes that the two beds were deposited under different conditions, at different periods.

June 10.—John Cowley Fisher, Esq., of Woodhall, near Cockermouth, Cumberland, and Frederick Ayrton, Esq., Lieutenant in the Bombay Artillery, were elected Fellows of this Society.

A paper was first read, entitled "Note on the Trappean Rocks associated with the (New) Red Sandstone of Devonshire;" by Henry T. De la Beche, For. Sec. G.S.

The author remarks, that white trappean rocks are not found among the (new) red sandstone series of Somersetshire and the more northern portions of Devonshire: the southern portions of the latter county afford many examples of the association of trappean rocks with the lower parts of this series, particularly near Tiverton, Thorverton, Silverton, Kellerton Park, Crediton, and Exeter.

When hastily viewed, the trappean rocks might be mistaken for masses of igneous matter which have been intruded, in a state of fusion, among the beds of red sandstone. A more detailed examination of the various facts connected with their mode of occurrence leads, however, in the opinion of the author, to the inference that they have been produced by volcanic action during the formation of the lower parts of the (new) red sandstone series; in fact, that the trappean rocks in question are the remains of melted rock, either ejected from, or retained within the pipes of, volcanos which were in a state of activity during the production of the lower part of the (new) red sandstone series of Devonshire.

The author endeavours, in the first place, to point out the relative geological age of the red sandstones and conglomerates with which these trappean rocks are associated in Southern Devon, by showing, that in their continuation to the northward, along the skirts of the grauwacke to the shores of the Bristol Channel, they pass into a series of beds which is crowned by magnesian limestone and conglomerate, equivalent to the magnesian limestone and conglomerate of the Mendip Hills and the vicinity of Bristol. The beds beneath the magnesian conglomerate, which very rarely passes into a magnesian limestone, from the absence of pebbles derived from older rocks, consist, for the most part, of red or claret-coloured sandstones, with an occasional seam or bed of conglomerate, the cementing matter of which is not calcareo-magnesian. Their thickness is necessarily variable, from the uneven surface of grauwacke, upon which the sandstones rest unconformably; but it amounts to about one hundred and fifty feet in the vicinity of Wiveliscombe. The author points out, by the aid of sections, that the magnesian conglomerate may readily rest upon the grauwacke, and conceal the lower red sandstone series by overlapping it, and that therefore it becomes exceedingly difficult to obtain an average thickness of these lower red sandstones, which, if we consider the magnesian conglomerates of the Mendip Hills as an equivalent of the zechstein of Germany, would be equivalent to the *rothe todte liegende* of the same part of Europe, and therefore be of the same geological age as the lower red sandstones of the North of England described by Prof. Sedgwick, and the beds noticed by Mr. Murchison.

Having thus obtained the relative geological age of the beds with which the trappean rocks are associated, the author proceeds to point out the occurrence of beds of sand among the more common red sandstone, which presents every appearance of having been volcanic sands ejected from a crater, and which became subsequently mixed with common detrital matter then depositing. It is stated that though the trappean rocks may sometimes be seen, as in the vicinity of Exeter, to rest as if they had overflowed the grauwacke which the (new) red sandstone series skirts, they are generally separated from the grauwacke by conglomerates, or sandstones, which do not contain the detrital remains of trappean rocks. Hence the author considers that the (new) red sandstone series of the district generally was, to a certain extent, in the course of formation when the volcanos came into activity.

A description is given, accompanied by a section, of the manner in which the trappean rocks of Washfield, near Tiverton, are associated with the (new) red sandstone of the same locality, and it is inferred from the facts detailed, that events there succeeded each other in the following order: 1. An original subaqueous valley or depression in the grauwacke. 2. A deposit of detrital matter derived from the subjacent grauwacke. 3. An eruption of igneous substances, in the manner of modern volcanos, beneath very moderate pressure. 4. The deposit of detrital matter, in a great measure derived from the neighbouring grauwacke, mingled with fragments of trappean rocks, many of which may have been ejected, as fragments now frequently are, from volcanic craters. 5. Denudations at various geological epochs since the period of the (new) red sandstone, which have left the rocks as we now find them.

It is noticed as a fact, which the author conceives to be of difficult explanation without the aid of this volcanic hypothesis, that in the localities where the trappean rocks, associated with the red sandstone, occur, there are numerous angular fragments, some of considerable magnitude, even equal to one or two tons in weight, intermingled with the conglomerates, which do not resemble any trappean rocks discovered, in place, within the district. These fragments principally consist of reddish brown quartziferous porphyry, the base being felspathic, and the contained crystals being those of quartz and glassy felspar, the latter often attaining a large size. Though quartziferous porphyry is observable in place in some situations, as, for instance, to the northward of Dunchideock, near Exeter, it does not contain the large crystals observable in numerous fragments of porphyry included in the red conglomerates. The author, therefore, is inclined to consider, that these angular fragments have been ejected from volcanic vents, and that, falling upon the detrital matter then in the course of deposition around such vents, they became included among it. It is remarked that these fragments, as well as those of the more common, scoriaceous, and other trappean rocks, found in place, do not form component parts of the red conglomerates beyond somewhat moderate distances, measured from situations where the existence of volcanic vents, during the early part of the (new) red sandstone epoch, may be considered a probable inference, from the various, observed phænomena.

A memoir was next read "On the range of the Carboniferous Limestone flanking the primary Cumbrian Mountains; and on the Coalfields of the N.W. Coast of Cumberland, &c.;" by the Rev. Adam Sedgwick, F.G.S., Woodwardian Professor in the University of Cambridge, and Williamson Peile, Esq., F.G.S., of Whitehaven.

The authors first briefly describe the general relations of the zone of carboniferous limestone (surrounding the primary Cumbrian system) to the central carboniferous chain, and show that this zone has been separated from the central chain by a great *downcast fault*, described in a preceding memoir. In illustration of this, they give a transverse section from the carboniferous limestone ridge, south of the river Lowther, to the chain of Cross Fell, proving that this low limestone ridge is not connected with the elevated chain, but with some dislocated masses which appear at its base, and dip towards the valley of the Eden.

They then give a detailed account of the range of the carboniferous limestone from the neighbourhood of Kirkby Stephen to Egremont. Beyond the latter place, patches of limestone are also stated to occur at Mousehole, Kirksancton, and Hodbarrow-Point, giving indications of at least a partial extension of the carboniferous series along the S.W. coast of Cumberland. Lastly, they notice the prolongation of the limestone (chiefly in great detached tabular masses) through Low Furness and a part of Westmoreland, till the broken zone reaches the great *downcast fault* at the base of Ingleborough.

They afterwards describe, in considerable detail, the sections exhibited by the carboniferous zone between Kirkby Stephen and Egremont. It is stated that the lower part of the carboniferous limestone corresponds, on the whole, with the great scar limestone of Yorkshire; but it is, here and there, more subdivided by thin beds of shale and by coarse beds of sandstone. Near Hesket Newmarket two or three beds of coal (some of which have been considerably worked) appear in the lower part of the series, offering an analogy to the structure of the central carboniferous chain on its approaching the Scotch frontier. They are stated to thin off in the range towards the west, and the formation to resume its more ordinary characters. The authors then give a section from the rivulet below Cleator through Bigrigg-moor, by which they show, (1.) that the limestone series is there greatly diminished in its aggregate thickness; (2.) that it contains *subordinate* irregular *beds* of red hæmatite (now extensively worked); (3.) that it is separated from the new red sandstone by thin bands of magnesian conglomerate.

They afterwards describe several sections in an upper division of the series, intermediate between the great *scar limestone* and millstone grit. The principal details are derived from the Westmoreland range of the limestone, and from the works in the neighbourhood of Caldbeck Fells. In these localities thin beds of coal alternate with the shale and limestone, and have been worked to a considerable extent.

The millstone grit is ill exhibited along the line of range; but may in some places be concealed under the great accumulation of alluvial matter on the confines of the new red sandstone. The great upper coal formation commences near Rosley, and is greatly expanded in its extension towards the west, so as to occupy the whole coast from St. Bee's Head to Maryport. But all details respecting it are referred to a subsequent communication.

In the concluding portions of the paper the authors briefly notice the unconformable position of the carboniferous series on the primary Cumbrian slates, and the occasional masses of old red sandstone and conglomerate by which, in the eastern part of the range, the two systems are separated from each other.

Considered in its greatest generality, the carboniferous series is divided into four groups: 1. The great scar limestone; 2. Alternations of limestone, shale, and coal; 3. Millstone grit; 4. Great upper coal formation. The 1st and 4th preserve their characters in a great measure unchanged in all the great carboniferous deposits of England and Wales; the 2nd and 3rd undergo modifications which are briefly enumerated. In Flintshire, Yorkshire, and Cumberland the richest metalliferous veins appear to be in the 2nd group.

A paper was afterwards read, "On the occurrence near Shrewsbury of Marine Shells of existing species in transported Gravel and Sand, resting upon a peat bog which contains imbedded Trees;" by Joshua Trimmer, Esq., F.G.S.

In November of last year Mr. Trimmer noticed, that in widening the road about five miles from Shrewsbury, towards Shiffnal, some very black timber was extracted from beneath a bed of loam and gravel; and having subsequently examined the spot, he has communicated his observations in this paper.

Two sections have been cut, to the depth of 15 feet, and are distant from each other about 600 yards. The eastern excavation is 360 yards long, and consists, proceeding from east to west, of 200 yards of sandy loam and gravel; 40 yards of sand resembling sea-sand, the laminæ crossing each other in various directions; 60 yards of reddish loam, with curved laminæ near its junction with the sand, and horizontal at the lower part, the upper portion not being laminated; and lastly, 60 yards of sandy loam and gravel. Fragments of shells occur in every part of the section, but are most abundant in the veins of fine gravel which pervade the sand: among them the author found *Turritella terebra*, *Cardium edule*, and *Tellina solidula*.

The western excavation contained fewer shells, and presented near the eastern termination of the southern side: cultivated soil, 1 foot; whitish and reddish finely laminated loam, 6 to 8 feet; peat, with prostrate trunks of oak trees, 6 inches to 2 feet; black clay, 4 inches; whitish sandy gravel, 12 to 18 inches, passing beneath the level of the road into reddish sandy gravel. Still nearer the eastern termination, the section presented thin beds of laminated loam and sand resting on peat. On the southern side this excavation consisted of fine cultivated soil, 1 to 2 feet; sandy loam, with occasionally boulders of several varieties of granite, some more than 2 feet long, and patches of peat, containing fragments of oak, beech, and fir, 6 feet; blackish loam, enveloping the upper part of a fir-tree, 6 inches; peat, enveloping the lower part of the fir-tree, 2 feet: the base of this tree was not visible, nor had any trees still rooted been noticed by the workmen. The patches of peat in the bed of loam the author conceives were derived from the tearing up of part of the peat bog.

From these details the following changes are inferred:

1st, A surface of dry land, consisting of gravel derived from the neighbouring rocks, either while the district was submarine, or during the rise of the strata, or by subsequent denudation, or by these causes united.

2ndly, The surface was covered with a forest of birch, oak, and fir.

3rdly, The forest was destroyed, or it decayed, and a peat bog was formed.

4thly, A rush of sea buried the bog beneath a mass of loam and gravel, containing fragments of existing marine shells and granite boulders.

In conclusion, the author draws attention to the natural sections on both sides of the Severn, west of Shrewsbury, about one mile above the Welsh Bridge, in one of which he obtained, after much search, a few fragments of shells; and he begs geologists in general, both in England and Ireland, to institute a patient examination of the superficial gravel of their neighbourhood for fragments of shells, however, comminuted.

A paper was also read, entitled, "Description of some Fossil Crustacea and Radiata;" by William John Broderip, Esq., F.G.S. F.R.S., &c.

Lord Cole and Sir Philip Egerton having placed in the author's hands some fossils which they had lately found in the lias at Lyme Regis, a detailed account is given, in the memoir, of those which he considers to be new.

Crustacea.

The first specimen described consists of the anterior parts of a macrourous Decapod, between Palinurus and the Shrimp family, but of a comparatively gigantic race; and its organization being considered by the author to be *sui generis*, he has assigned to the fossil the name of *Coleia antiqua*, with the following generic characters:

"*Antennæ*. Base of mesial antennæ (*antennæ internæ*) not extending beyond the anterior spine of the thorax; each antenna terminated by two annular setæ. External antennæ provided with a large and rude scale, and having a spine on the exterior of the penultimate joint: the terminal setæ large, but the length undetermined.

"*Eyes* pedunculated, directed outwards, approaching in their situation and form to those of Palinurus.

"*Feet*. First pair long, slender; the cubit (*cubitus*) with small spines or serratures on the internal margin, and terminated externally by three strong spines.

"*Hand* (*manus*) elongated, slender; digits slightly incurved, filiform, unarmed, pointed.

"*Thorax* thin (divided transversely by furrows indicating the different regions), tuberculate, spinous at the sides, and with three deep emarginations anteriorly, the middle one the largest; each of the four anterior angles produced into a strong spine."

The collection contained the remains of other macrourous Decapods. One of these specimens consisted of a fragment of the post-abdomen, approaching nearest in sculpture to Palinurus, and equaling in size the sea crawfish: and two others are peculiarly interesting from their exhibiting the tips of the four larger branchiæ, and of the four smaller ones below, pointing towards the situation of the heart, and proving, the author observes, that this Crustacean did not belong to the Amphipoda, but to the highest division of the Macroura, of the arctic forms of which it reminds the observer.

Radiata.

Ophiura Egertoni. *Oph. radiis tereti-subulatis, disco subplano, rotundato.*

This species, Mr. Broderip states, approaches very nearly to the recent *Ophiura texturata,* and differs from *Ophiura Milleri* of Phillips, in as much as, among other differences, the disk of the latter is lobated according to the figure given in the "Geology of the Yorkshire Coast." There is no description, but there is authority for considering the figure to be correct, though it is stated to have been drawn from separate parts. The specimens were found about half a mile west of Bridport harbour, in masses of micaceous sandstone fallen from the cliffs.

Cidaris Bechei. *Cid. testâ subglobosâ, mamillis parvulis, spinis elongatis, aculeatis.*

This fossil the author considers may be identical with that figured in the Geological Transactions, Second Series, vol. ii. Pl. IV. as an Echinus.

A letter from Sir Philip de Malpas Grey Egerton, Bart., M.P., V.P.G.S., addressed to the President, "On the Discovery of Ichthyolites in the South-western Portion of the North Staffordshire Coal-field," was then read.

The part of the coal-field in which the ichthyolites occur is called Silverdale, and consists of the following beds:

Superficial covering.

1. Argillaceous shale, generally of a lightish colour and soft texture.
2. Ditto, of harder texture, and more calcareous.
3. Ditto, black, and highly fissile.
4. Ditto, more compact, containing nodules of ironstone.
5. Ironstone, extensively wrought.

Beds 1 and 2 abound in vegetable remains, and the upper portion may be distinguished by the frequent occurrence of *Stigmaria ficoides.* The ichthyolites are principally contained in No. 4, and consist of teeth, palatal bones, and scales, belonging to the Placoidian order, and to the Sauroid and Lepidoidian families of the Ganoidian order of M. Agassiz.

Some of the scales correspond precisely with those of the Megalichthys, described by Dr. Hibbert, from Burdiehouse near Edinburgh*: but the plants associated with the ichthyolites, the author states on

* Transactions of the Royal Society of Edinburgh, vol. xiii. pl. 8. fig. 3. and pl. 11. figs. 2, 7, 8.

the authority of Professor Lindley, are entirely dissimilar from those found at Burdiehouse.

In No. 3 nodules occur, which Dr. Turner has ascertained to agree chemically with coprolites, though they do not present the external characteristic markings.

A paper was next read, "On the Bones of Birds from the Strata of Tilgate Forest in Sussex;" by Gideon Mantell, Esq., F.G.S.

Mr. Mantell states that soon after his attention was first directed to the fossils of the Wealden, he discovered in the strata of Tilgate Forest several slender bones, which, from their close resemblance to the tarso-metatarsal bones of certain Grallæ or Waders, he was induced to refer to birds. The correctness of this opinion was afterwards doubted, in consequence of the thin fragile bones found at Stonesfield, and considered as belonging to birds, being ascertained to be those of Pterodactyles. Having subsequently discovered a few specimens of more decided character, Mr. Mantell submitted them to the inspection of Baron Cuvier, during his last visit to England, who pronounced them to belong to a Wader, probably to a species of Ardea. Still it was doubted whether these remains did really belong to those of birds; but the author's attention having recently been directed to the subject, he placed his specimens in the hands of Mr. Owen, of the College of Surgeons. This gentleman, after a careful examination, pointed out that one bone decidedly belonged to a Wader, being undoubtedly the distal extremity of a left tarso-metatarsal bone, presenting the articular surface or place of attachment of the posterior or opposable toe. Other specimens of long bones Mr. Owen conceives may have belonged to a more erpetoid form of bird than is now known. From this examination, Mr. Mantell's previous views of the existence of birds below the chalk have been fully established, and, as the author observes, these are the oldest remains of the class at present known. The memoir concludes with a description of the bones, consisting of a tarso-metatarsal of a Wader, a tibia (?), a metatarsal bone, a humerus, and an ulna.

The next paper read was entitled, "Remarks on the Coffin-bone (distal phalangeal) of a Horse, from the Shingle Bed of the Newer Pliocene Strata of the Cliffs near Brighton;" by Gideon Mantell, Esq., F.G.S., &c.

The deposits which partially fill up the valley of the chalk, and constitute the subsoil of the central part of Brighton, as well as the line of cliffs extending from Brunswick Terrace to Rottingdean, are divided by Mr. Mantell into the following beds:

Top, 1. Elephant bed; an obscurely stratified mass, formed chiefly of chalk detritus, with a large intermixture of ochreous clay, and containing remains of the elephant, horse, buffalo, and deer. This bed forms the greater portion of the cliff.

2. An ancient shingle beach, consisting principally of pebbles and boulders of chalk flints, interspersed with boulders of many varieties of primary, secondary, and tertiary rocks.

3. Sand resting upon chalk.

The coffin-bone described in the paper was obtained from a fallen mass of the upper part of the shingle bed (2.), and in addition to that specimen the author procured an *astragalus, os calcis,* two canon bones, and a phalangeal. On comparing the coffin-bone with that of a young horse which had never been shoed, no difference was perceptible, the outlines of each presenting the same beautiful form, and proving that no hereditary change has taken place in the feet of the domesticated race.

An extract was lastly read, of a letter from Dr. Daubeny.

In this letter Dr. Daubeny gives the analysis of the mineral spring lately discovered near Oxford, and announced to the Society by Dr. Buckland, at the Meeting held on the 29th of April.

Dr. Daubeny says the water at the time the analysis was made (March 26th) contained more sulphuric salts than any other spring in this country. The following were the saline contents of a pint of the water:

Chloride of sodium........	70·82
——— calcium	7·25
——— magnesium	2·40
Sulphate of soda	52·40
	132·87

This being the last Meeting of the Session, the Society adjourned, at its close, to Wednesday, November 4th.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1835—1836. No. 42.

Nov. 7, 1835.—The Society assembled this evening for the Session.

William Sisson, Esq., of Parliament-street; and William Forster, Esq., of Bridport, were elected Fellows.

A paper was first read, entitled "A notice on the Fossil Beaks of four extinct species of Fishes, referrible to the genus Chimæra, which occur in the oolitic and cretaceous formations of England," by the Rev. William Buckland, D.D., F.G.S., &c.

About six years ago, Sir Philip Egerton procured from the Kimmeridge clay of Shotover Hill, near Oxford, five fossil bodies of most curious configuration, in some degree resembling beaks of cuttle-fishes and turtles, but not reducible to any known form in either of these families. In 1832 the Rev. C. Townsend of Great Milton, Oxfordshire, discovered in the Portland stone of that village another series of bones, resembling those found in the Kimmeridge clay, but very much larger, and evidently of a different species. In Mr. Mantell's collection are also three similar bones, one from the chalk marl of Hamsey, and two from the chalk near Lewes, but belonging to two other distinct species of the same genus *.

After fruitless research through the best collections in London, the author showed his specimens, but in vain, to some of the most distinguished anatomists of Germany, at the meeting of the Naturforscher at Bonn in September last. Professor Carus made the nearest approximation to their true nature, by suggesting that the two smaller bones might be the beaks of a Tetrodon.

In pursuance of this suggestion, Dr. Buckland compared his fossils with the Tetrodons in several museums on the Continent, but with no successful result. At last, in the museum at Leyden, he found a skeleton of the Chimæra, and immediately perceived in the upper and lower jaws of this fish the object of his long research. The two intermaxillary bones corresponded with the pair of fossil tooth-like bones from the Kimmeridge clay; the superior maxillary bones corresponded with a second pair of bones from the same clay; and the inferior maxillary bones presented the form of the inferior maxillary bones of the

* Since the above communication was read, M. Agassiz has found, in the collection of G. B. Greenough, Esq., and in the Museum of the Geological Society, remains of two other species. The specimen in the possession of the Society was procured from the gault near Cambridge.

four fossil species from the Portland stone, Kimmeridge clay, chalk marl, and chalk. To these four species Dr. Buckland gives the following names: to that found in the Portland stone, *Chimæra Townsendii*; to that in the Kimmeridge clay, *C. Egertonii*; to that in the chalk marl, *C. Agassizii*; and to that in the chalk, *C. Mantellii*. In an appendix to the paper, Prof. Agassiz gives the following as the distinctive characters of each species:

C. Townsendii: inferior maxillary very large, short and proportionally much thicker; groove of the symphysis of its two branches shallower, and curve of dental edge broader than in the other species; exterior surface convex, and furrowed longitudinally, intermaxillary much curved.

C. Egertonii: inferior maxillary short and flat: snout truncated, and in proportion very large: curve of the dental edge very wide: groove of the symphysis very deep: intermaxillary very much bent, and the dental edge truncated and square: superior maxillary irregularly triangular, much elongated, and contracted insensibly towards its dental extremity, which is bifid.

C. Agassizii: form of inferior maxillary square, more regular, and surface of symphysis flatter than in the other species; dental edge slightly open.

C. Mantellii: inferior jaw straighter and thinner; exterior surface perfectly smooth and flat; snout much elongated and pointed; curve of the dental edge wider than in the other species.

A paper was next read, "On the recent discovery of Fossil Fishes (*Palæoniscus catopterus*, Agassiz,) in the new red sandstone of Tyrone, Ireland;" by Roderick Impey Murchison, Esq., V.P.G.S.

A small specimen of new red sandstone, presenting the first impressions of fishes found in this formation in the British Isles, having been exhibited before the Geological Section of the British Association at the late meeting in Dublin, Mr. Murchison, in company with Prof. Sedgwick, Lord Cole, and Mr. Griffith, visited the spot where it had been obtained.

The quarry is at Rhone Hill, in the parish of Killyman, about three miles east of Dungannon. The new red sandstone in which it is excavated is a prolongation of the deposit which occupies large tracts in the county of Antrim, and extends into this part of Tyrone, where it surrounds a small, slightly productive coal-field, but reposes for the greater part upon mountain limestone. The eastern flank of the district is covered by a vast thickness of clay, containing lignite, the exact age of which is not known; and the surface generally is very much overlaid by loose detritus, consisting of sand and gravel, derived from the adjacent formations. Large blocks of syenite and greenstone, referrible to a northern origin (Antrim), are scattered here and there.

The beds of new red sandstone exposed in the quarry dip about 15° to the N.N.E., and consist, in the upper part, of red and green marls, passing down into a dark red, thickly bedded, siliceous sandstone, with a few irregular, highly micaceous way-boards of a deep purple colour. The surface of some of the beds exhibits ripple-marks. The quarry, which is the property of Mr. Greer, is from 25 to 30 feet deep, and the fishes are found only in the bottom beds, but are in great abundance*.

Dr. Agassiz afterwards gave a systematic enumeration of the fossil fishes which he has found in English collections. He commenced by detailing the general results of his researches, from which it appears, that the discovery in England of three hundred new species has corroborated the laws of development which he had previously determined in the succession of these animals during the different changes which our globe has undergone, with the exception of the discovery in the chalk of two species belonging to two genera which he had before observed only in the oolitic series, and of a species of one of those genera in the lower tertiary strata.

The secondary systems (*terrains*) of England are the richest in fossil fishes; and Dr. Agassiz stated that the number of specimens which he has seen in English collections is astonishing. The species which he has determined are about 400; but the specimens too imperfect to be described, at present, announce the existence of a still greater number.

Their geological distribution presents the following details:

In the *Silurian system* of Mr. Murchison there are five or six species which exhibit the first appearance and organization of this long series of vertebral animals, the species of which become more and more numerous, and more and more diversified, as well in their forms as in the details of their organization.

The *old red sandstone*, including the Caithness schist and the Gamrie deposit, contains twenty species.

In the *coal measures* there are fifty-four species; in the *magnesian limestone* sixteen.

The *oolitic series* is particularly rich in ichthyolites, the number of species from the lias to the Wealden inclusive being one hundred and fifty.

The *greensand and chalk* are also very rich in fossil fishes, and even much richer than their equivalents on the Continent. The number of English species is fifty.

In the *London clay* the species perfectly determined are about fifty; but it is certain, from the fragments preserved in different collections, that this formation incloses the remains of a much greater number. M. Agassiz stated that the London clay, particularly in Sheppey, will be, for a long time, an inexhaustible mine.

The *crag* contains five or six species peculiar to it, and belonging to genera which do not inhabit our northern seas.

As an example of what remains to be done in the study of fossil fishes, and of the importance of these researches to zoology and geology, M. Agassiz afterwards described two singular genera found in the lias. One is the animal which has been described under the name

* A slab, presented to the Geological Society by Mr. Greer, exhibits, on a surface not exceeding two feet square, above 250 fishes.

of Squalo-raia, discovered at Lyme Regis; the other a new genus, called by M. Agassiz *Gyrostris mirabilis*, and is probably the largest known fish. This fossil was discovered at Whitby; but there have hitherto been found only some detached bones of the head, of the branchial arcs, and some portions of vertebræ and fins: traces of the same fish have been recently observed at Lyme Regis.

Nov. 18.—Thomas Sopwith, Esq., of Newcastle upon Tyne; Mr. Frederick John Bell of Oxford-street; David Urquhart, Esq., of Grafton-street, Bond-street; and Lieut.-Colonel Aitcheson of the Fusilier Guards, were elected Fellows of this Society.

A letter was first read from Dr. Pingel of Copenhagen to the President, containing a notice of some facts showing the gradual sinking of part of the west coast of Greenland.

The first observations which led to the supposition that the west coast of Greenland had subsided, were made by Arctander between 1777 and 1779. He noticed, in the firth called Igalliko (lat. 60° 43′ N.), that a small, low, rocky island, about a gun-shot from the shore, was almost entirely submerged at spring tides, yet there were on it the walls of a house 52 feet in length, 30 feet in breadth, 5 feet thick, and 6 feet high. Half a century later, when Dr. Pingel visited the island, the whole of it was so far submerged that the ruins alone rose above the water.

The colony of Julianahaab was founded at the mouth of the same firth in 1776; and near a rock, called the Castle by the Danish colonists, are the foundations of their storehouse, which are now dry only at very low water.

The neighbourhood of the colony of Frederickehaab (lat. 62° N.), was once inhabited by Greenlanders; but the only vestige of their dwelling is a heap of stones, over which the firth flows at high water.

Near the well-known glacier which separates the district of Frederickehaab from that of Fiskenæss, is a group of islands called Fulluartalik, now deserted; but on the shore are the ruins of winter dwellings, which are often overflowed.

Half a mile to the west of the village of Fiskenæss (lat. 63° 4′ N.), the Moravians founded, in 1758, the establishment called Lichtenfeld. In thirty or forty years they were obliged once, perhaps twice, or move the poles upon which they set their large boats, called Umiak, or Women's boats. The old poles still remain as silent witnesses, but beneath the water.

To the north-east of the mother colony, Godthaab (lat. 64° 10′ N.), is a point called Vildmansnæss by St. Egede, the venerable apostle of the Greenlanders. In his time, 1721—1736, it was inhabited by several Greenland families, whose winter dwelling remains desolate and in ruins, the firth flowing into the house at high tide. Dr. Pingel says that no aboriginal Greenlander builds his house so near the water's edge.

The points mentioned above the writer of the letter had visited; but he adds, on the authority of a countryman of his own highly deserving of credit, that at Napparsok, 10 Danish miles (45 miles English) to the north of Nÿ-Sukkertop (lat. 65° 20′ N.), the ruins of ancient Greenland winter houses are to be seen at low water.

Dr. Pingel is not aware of any instance of subsidence in the more northern districts; but he suspects that the phenomenon reaches at least as far as Disco Bay, or nearly to 69° north lat.

Some notes by Capt. Fitzroy, R.N., read at a Court Martial at Portsmouth, Oct. 19th, 1835, on Capt. Seymour and his Officers for the loss of His Majesty's Frigate Challenger, wrecked on the coast of Chili, near the port of Conception, and communicated to the President by Capt. Beaufort, R.N., Hon. Mem. G.S., were then read.

These notes refer to the effects produced by the earthquake of Feb. 1835, in the currents on the coasts of Chili, from the Island of Mocha to the parallel of Conception. Capt. Fitzroy also mentions that the island of Santa Maria was elevated ten feet.

A letter dated Valparaiso, 22nd of March 1835, from R. E. Alison, Esq., addressed to the President, on the earthquake of Chili of the 20th of February 1835, was then read.

The earthquake began at quarter past 11 A.M. by a gentle heaving or undulation of the earth; but the motion increased in a few seconds to so great a degree that no person could stand. It destroyed the cities of Conception and Chillan, with the ports of Talcahuano and Maule, as well as above twenty smaller towns, and an immense number of country houses. It was felt to the southward as far as the Indian territory opposite the island of Chiloe; to the northward beyond Copiapo; at Mendoza on the east of the Andes; by the crew of a ship 100 miles to the westward of the coast, and at Juan Fernandez 300 miles from it.

At the port of Talcahuano the same phenomena occurred which accompanied the destruction of Penco in 1730 and 1751. Forty minutes after the first shock the sea suddenly retired so far that part of the bottom of the Boca chica, the smaller or southern entrance of the bay, could be seen; but the sea afterwards returning through the same channel with a great bore, flowed 20 feet over the town, carrying everything before it. This phenomenon was repeated three times. Mr. Alison says that the sea was reported to have receded, or rather the land to have risen, 2 or 3 feet, a difference having also taken place in the soundings in the bay; and that a rock, which was invisible previously to the earthquake, was afterwards near the surface.

Large fissures are stated to have been made in the earth, and water to have burst from some of them: the earth is also said to have opened and closed; and near Los Angeles several hills to have disappeared, and others to have opened and vomited steam and black smoke. The harbour of the island of Santa Maria was destroyed, and the sea retired between 300 and 400 yards, while the reefs which surrounded the greater part of the island are said to have entirely disappeared.

At the island of Juan Fernandez phenomena occurred similar to those which accompanied the destruction of Talcahuano. About a league from the shore the sea appeared to boil, a high column of water was thrown into the air, when the sea retired so far that a number of old anchors and brass guns became visible; but it soon returned with great violence, carrying off all the houses of the convicts. A volcano also burst forth at the point where the sea was first agitated. The brig Glanmalin was in the latitude of Talcahuano, and about 100 miles to the westward of it, at the time of the earthquake, when the crew felt a shock as if the vessel had struck upon a rock.

Mr. Alison also mentions the existence near Valparaiso of the recent marine shells 1400 feet above the level of the sea, and of recent marine shells being dug near Conuco for the purpose of making lime. In the bay of Valparaiso, he says, a rock which in 1817 could be passed over in a boat, is now dry, except at spring tides.

"Geological notes made during a survey of the East and West Coasts of South America, in the years 1832, 1833, 1834, and 1835, with an account of a transverse section of the Cordilleras of the Andes between Valparaiso and Mendoza;" by F. Darwin, Esq., of St. John's College, Cambridge; communicated by Prof. Sedgwick, were afterwards read.

Prof. Sedgwick began by observing that the notes were extracted from a series of letters (addresssd to Professor Henslow), containing a very great mass of information connected with almost every branch of natural history; and that he had selected for the occasion those remarks only which he thought more especially interesting to the Geological Society.

Mr. Darwin's first letter contained some account of St. Jago (one of the Cape Verde Islands), which he visited early in 1832; and he considered that he had good evidence of its recent elevation, as he found on its surface beds of *recent shells and corals* considerably above the actual level of the sea.

In various portions of the notes he shortly described the vast extent of primary rocks along the shores of Patagonia, the existence of highly crystalline schists in the Falkland Islands, alternating with micaceous slaty sandstone, exhibiting the casts of bivalves (Terebratulæ), and encrinital stems, and a rock near Cape Famine containing some sort of Ammonites. On the line of the western coast of South America, from Chiloe to Tres Montes, he found a widely extended formation of mica-slate, traversed and burst through by a grand transverse chain of granite, and penetrated by innumerable dykes of great complexity of mineral structure.

From the position of the tertiary deposits, which exist on both sides of the Southern Andes, he concludes that the primary chain must have had a great elevation anterior to the tertiary period: and he thinks that a rough approximation may be made to the date of the commencement of the volcanic period, by observing the first association of streams of lava, with certain tertiary groups on the Patagonian side.

A considerable portion of the extracts was devoted to a description of the great tertiary groups on both sides of the chain of the Andes. Some of the details respecting the eastern side were derived from observations made on the Rio Negro, and on the line of a transverse section from Rio Santa Cruz to the base of the Cordilleras. These exhibit the structure of what Mr. Darwin calls the great southern tertiary formations of Patagonia.

The lowest of these formations appears to be of great extent and thickness, and in one instance was found to contain a bed of ancient lava, which seemed to mark the commencement of the eruption from the craters of the great chain of the Andes. It is characterized by a great oyster, and by other shells and corals, *some* of which belong to species now living on the neighbouring coasts. Over it is a deposit which Mr. Darwin describes as chiefly composed of rolled porphyry pebbles, which he had himself traced for more than 700 miles. Overlying all the rest, and at a greater elevation above the level of the sea, were beds of recent shells, identical in species with the littoral shells of the neighbouring shores. Among these, he more especially notices a widely extended bed of Muscles, which still retain their blue colour, and emit an animal smell when thrown in the fire. From these facts, he thinks the tertiary deposits of Patagonia may be separated into distinct periods, somewhat similar to those derived by Mr. Lyell from a comparison of the newer deposits of Europe: and in making the transverse section, he thought that he saw traces in the valley of Santa Cruz of an ancient channel, which must have traversed a great portion of the south part of the continent before the elevation of the tertiary groups.

In noticing the groups on the western side of the Andes, he describes an old tertiary deposit (eocine or miocene?) south of Rio Maypo, and abundance of recent shells 1300 feet above the same level. He also describes the association of lava with beds containing recent shells in the island of Chiloe. Among other facts, he notices the appearance of pitchstone among the beds of lava, and the occurrence of a forest growing over a bed of recent oysters 350 feet above the actual level of the sea, All these *recent shells* are the *littoral shells* of the neighbouring shores; from which he concludes that the elevation must have been gradual, or by successive hitches, similar to those by which the coast of Chili and, more recently, the coast of Chiloe have been unquestionably elevated.

In addition to these very remarkable notices, Mr. Darwin mentions other *tertiary deposits* at Chiloe and Conception, composed of beds of sandstone and carbonaceous shale without shells, but containing many silicified trunks of dicotyledonous trees, and alternating with beds of lava.

During the progress of the four years' survey (in addition to the traverse above mentioned), Mr. Darwin crossed from Rio Negro to Buenos Ayres by Sierra de la Ventana, a chain almost unknown to geographers. He found two immense collections of large bones (of Mastodons) near Santa Fé, but in a condition not to admit of their being removed. He also found bones of a species of Mastodon at Fort St. Julian, S. lat. 50°, and more than 600 miles from the former localities. In one instance the bones appear to have been associated with marine shells. In the gravel of Patagonia he also found many bones of the Megatherium and of five or six other species of quadrupeds, among which he has detected the bones of a species of Agouti. He also met with several examples of the polygonal plates of the Megatherium, which at first induced him to regard the animal as a gigantic Armadillo. A very large collection of these fossils has been sent to England, and are in the custody of Professor Henslow till Mr. Darwin's return.

Professor Sedgwick concluded by reading extracts from two letters describing a section transverse to the Andes, extending from Valparaiso to Mendoza. The Cordillera is here composed of two separate and parallel chains. The western chain is composed of sedimentary rocks, distinctly stratified, and resting on granite. The sedimentary rocks (composed of red sandstone, conglomerate, gypsum, &c.) are violently contorted, and dislocated along parallel north and south lines, and as they approach the granite, become so crystalline that they cannot be distinguished from the porphyritic dykes by which they are traversed.

Following the line of section, Mr. Darwin found, at the Pass of Puquenas, elevated 12,000 feet above the sea, that the red sandstone was replaced by a black rock, like clay slate and pale limestone, containing numerous impressions of shells; a Gryphæa? is the most abundant; but he also found Ostrea, Turritella, Ammonites, and a small bivalve (Terebratula?).

At the Portillo Pass is a conglomerate resting on micaceous sandstone, and traversed by great veins of granite. But at the Uspellata Pass (in the eastern chain), he found highly crystalline and felspathic rocks, regularly bedded, and resting on granite, the peaks of which reach the elevation of 14,000 feet. A wider examination of the overlying groups convinced him, not only that they were more recent than the western chain (being partly made up of its *debris*), but that they were of the same age with certain tertiary formations above noticed. For example, he discovered along the line of section, in the eastern chain, beds of sandstone, with silicified trunks of dicotyledonous trees, and beds of carbonaceous shale, resting on an ancient stream of lava, and surmounted by black augitic lava, 2000 feet thick; over all these were five grand alternations of black volcanic rocks and sedimentary deposits, amounting to several thousand feet in thickness. This series, in its structure and fossils, is considered as identical with certain tertiary deposits of Patagonia, Chiloe and Conception; for it loses its mineral character only where it approaches the granite; in which case it is shattered, contorted, and traversed by great veins rising out of the central mass; and its several beds, as well as the fossils they contain, become entirely crystalline. Mr. Darwin further states, that this singular overlying group contains very numerous veins of copper, silver, arsenic, and gold, which may be traced down to the granite; and as a general conclusion, he expresses his conviction that the granite (now rising into central peaks 14,000 feet in elevation), must have been in a fluid state since the tertiary group, above described, was deposited.

Dec. 2nd.—Edward Lewis Richards, Esq., of Rolls Chambers, Chancery Lane; Rev. Edward Thomas Daniel, of Park-street, Grosvenor-square, and Balliol College, Oxford; John Hare, Jun., Esq., of Bristol; M. Vander Maelen, Proprietor of the Geographical Society of Brussels; and Henry Leach, Esq., of Milford Haven, Pembrokeshire; were elected Fellows of this Society.

A letter was first read from Capt. Belcher, R.N., F.G.S., addressed to Woodbine Parish, Esq., Sec. G.S., dated 10th of March, 1835, inclosing two others from Lieut. Bowers, R.N., and H. Cuming, Esq.

These letters referred to the effects produced at Valparaiso by the earthquake of November 1822.

Capt. Belcher says that he had carefully searched the Remark-Books of His Majesty's vessels stationed on the Chilian coast, between September 1822 and March 1823, but had not found a notice in any way connected with the Port of Valparaiso. He therefore infers that no British ship of war was present; but he thinks that if the disturbance produced by the earthquake of November 1822 had been of a nature to alter the soundings, or even induce the residents to attach importance to any known changes, they would have formed a subject of special communication by the commanders of ships of war.

Lieut. Bower states in his letter, dated 7th of March 1835, that he was not at Valparaiso at the time of the earthquake, but arrived from England in February 1823, and found everything in the same situation as when he quitted it twelve months previously. He adds, that since the earthquake, the water has gradually receded from the part situated between the landing place and the market place, and that a row of stores and substantial dwellings had been erected where the sea formerly flowed.

Mr. Cuming's letter is dated 5th of March 1835.

The writer arrived at Valparaiso in January 1822, and resided there constantly until 1827, and from the latter period, with occasional absences, till May 1831. At the time of the earthquake, he lived in the Plaza Mayor, near the landing place at the Arsenal, and his house was destroyed by the first shocks. He did not go to the beach during the night, but was informed that the sea had retired a considerable distance, and had returned with great force. On the morning of the 20th he noticed the effects, but found nothing more than a high tide. He never heard of the rocks having been heaved up, or of the permanent retirement of the sea, until the publication of Mrs. Graham's work, to the statements contained in which neither he nor his friends could subscribe.

Mr. Cuming's pursuit of conchology and natural history generally, caused him to visit frequently the rocks and inlets with which the northern and southern parts of the Bay abound; but though the rocks were covered with Fuci, Patellæ, Chitons, Balani, &c., yet he never perceived the least difference in their appearance from the date of his arrival to his finally quitting Valparaiso. He mentions particularly, as points which he often examined, the Caleta, the Quebràda de Dios, and the Cruz de Reyes. He also never found the least trace of the above productions, except in situations covered by the tide.

After the earthquake, Mr. Cuming resided in a house in the Arsenal, where the spring tides came up to the same mark as they did previously to that event. He refers especially to the tides of 1822 and 1823.

Another circumstance which convinced Mr. Cuming that no change of level had taken place was the existence of a small detached rock opposite the Estanco, half-way between the Custom house and the Market place, and about fifty yards from the walls at half tide. From this rock he had often taken *Concholepas Peruviana* previously to the earthquake, and subsequently it retained the same position.

The vessels occupied the same anchorage as they did before November 1822; and nautical men affirmed that there was not the least difference in the depth of the water in any part of the Bay.

The opinion that a change had taken place in the relative level of land and sea, Mr. Cuming conceives originated in the accumulation of detritus at points where the tide flowed anterior to the earthquake, and on which houses, and even small streets have been since erected. Though these accumulations appear to have been going on between 50 and 80 years, yet they were small previously to the violent rains in June 1827, which brought down into the bay the loose granitic soil of the hills and the ravines. This detritus has since been thrown up by the tides, and formed into a firm open space exceeding 250 feet in breadth, on which the buildings have been erected.

The quantity of matter thus carried into the Bay has not affected the anchorage, and Mr. Cuming, when dredging within two hundred yards of low-water mark, never found a grain of decomposed granite, or any kind of recent soil, but fine sandy mud, well stocked with several species of shells of mature growth.

Both to the northward and southward of Valparaiso, where the coast is open, namely, at Lagunilla, Vina del Mar, Con-Con, and Quintero, the sea has thrown up high banks of sand, many feet above the level of the land behind them, and reaching inland from 1000 to 2000 feet, and at Quintero to a much greater extent. At this place the sand contains beds of shells "in a semi-fossil state." Mr. Cuming visited these localities previously to the earthquake, and often subsequently, but never saw a shell beyond the range of high water, except those in the state above mentioned, and the owners declared that no change had taken place.

Mr. Cuming also states that about 70 years since, he believes at the same time that Conception was visited by an earthquake, Valparaiso was also visited. The sea retired to a very great distance, and the reflux was so violent that it destroyed all the houses, carrying the boats and canoes to the church of San Francisco, which is about a quarter of a mile on a gradual ascent from where the tide usually flows.

A paper on the effects of the Earthquake-waves on the Coasts of the Pacific, by Woodbine Parish, Esq., Sec. G.S., was afterwards read.

In this memoir the author has collected all the historical notices which he has been able to discover respecting the effects of the marine inundations which have accompanied the earthquakes on the coast of Chili and Peru.

Father Acosta, in a work written in 1590 *, mentions an earthquake on the coast of Chili which caused the sea to rise out of its bed some leagues, leaving ships dry far inland. He also states among the effects of the earthquake at Lima on the 9th of July, 1586, that after the shock of the earthquake, the sea rose mightily out of its bed, and bursting over the shore nearly two leagues, overwhelmed all the shore, and left the shrubs and trees, as it were, swimming in the waters.

Frezier † says, that on the 26th of November, 1605, the sea, being agitated by an earthquake, suddenly flooded, and bore down the greater part of Areca.

Ulloa‡, describing the earthquake at Lima on the 20th of October, observes that during the second concussion the sea retired considerably, and returning in mountainous waves, totally overwhelmed Callao, and the neighbouring parts. Lionel Wafer§, who felt the same earthquake in latitude 12° 30′ S., and 150 leagues from the coast, speaking of its effects, says, the ships in the road of Callao were carried a league into the country, and drowned man and beast for 50 leagues along the shore. Wafer also describes a similar catastrophe at Santa, about three degrees to the north of Callao. In passing from the shore to the town, distant about 3 miles, he crossed a small hill, and in a valley between it and Santa he saw three ships, about 60 or 100 tons each, lodged there, and very ruinous. These vessels, he was informed, were deposited during the earthquake of 1678. The water, it is said, retired for 24 hours, and then came in, tumbling and rolling with such violence that it carried these ships over the town, which then stood on the hill Wafer had crossed.

In 1746 Callao was again destroyed by an earthquake-wave, vast heaps of sand and gravel occupying its position ||. All the ships in the harbour, except four, foundered. One of these, the San Firmin man-of-war, was found in the low grounds of the Upper Chacara, opposite to the place where she rode at anchor, and near her the St. Antonio; another of these vessels rested on the spot where before stood the Hospital of St. John, and the ship Succour was thrown up towards the mountains. Ulloa says that this terrible inundation extended to the ports of Cavallos and Guanape; and the towns of Chancay and

* Historia Natural y Moral de las Indias por el Padre Joseph de Acosta; Madrid 1792 (sexta edicion).

† A Voyage to the South Sea and along the Coast of Chili and Peru in the years 1712, 1713 and 1714, by M. Frezier, Engineer in Ordinary to the King of France; London, 1717.

‡ A Voyage to South America by Don Juan and Don Antonio de Ulloa, &c., translated by Adams, 5th edit.; London, 1807.

§ Lionel Wafer's Voyage to Magellanica, &c., &c., in 1685.

|| A true and particular Relation of the dreadful Earthquake which happened at Lima and Callao on the 28th of October 1746, published by command of the Vice-Roy, and translated from the original, &c.; London, 1748.

Guara, and the Valleys della Barranca, Sape, and Patevilca underwent the same fate as the city of Lima.

The inundation at Penco (Conception) in 1730, is mentioned by Ulloa and Molina*; and on the 6th of May 1751, that city was totally destroyed by a similar visitation. This earthquake was felt at the Island of Juan Fernandez, where the sea overwhelmed the houses along the shore.

Mr. Parish notices the earthquakes at Arequipa in 1582, and at Lima in 1697, 1699, 1716, 1725, 1732, 1734, and 1745, but no mention is made of any irruption of the sea; he also alludes to the effects of the earthquake at Valparaiso in 1822, and at Conception in 1835.

* The Geographical, Natural, and Civil History of Chili, translated from the Italian of the Abbé Ignatius Molina; London, 1809.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1835—1836. No. 43.

Dec. 16.—Lord Charles Harvey, of Trinity College, Cambridge; James Brogden, Esq., M.A., of Trinity College, Cambridge, and of Lower Brook-street; George Woods, Esq., of East Dulwich; Henry Thomas, Esq., of Cushion-court, Broad-street; Edward Charlesworth, Esq., of North Buildings, Finsbury Circus; the Rev. Leonard Jenyns, M.A., F.L.S., of Swaffham-Bulbeck, Newmarket; Charles Cardale Babington, Esq., M.A., F.L.S., St. John's College, Cambridge; Charles James Fox Bunbury, Esq., of Great Barton, Suffolk; and James Edmonstone, Esq., of George-square, Edinburgh, were elected Fellows of this Society.

A paper, entitled "Notes on the Geology of Denmark," by Dr. Beck of Copenhagen, and communicated by the President, was first read.

The only part of the Danish dominions in which gneiss and granitic rocks like those of Scandinavia appear, is in the north-east of the Island of Bornholm. To the south and south-west of these formations in the same island, are beds considered to be of the age of the Silurian system of Mr. Murchison; and on the eastern side of it are strata of the cretaceous period, all the intermediate groups being wanting.

Respecting the exact age of the lower part of the cretaceous beds in Bornholm, much difference of opinion has existed. By some it has been referred to the old carboniferous formation, on account of the presence of large quantities of coal, and impressions of ferns; by others to a lignite deposit of a very new or diluvial period; by M. Alexander Brongniart to the age of the lias; by Dr. Pingel to the iron sand of Messrs. Conybeare and Phillips; and by Dr. Beck to the English strata, from the Hastings sand to the upper green sand inclusive. The fossil ferns found in these beds belong to the genus Pecopteris, and some of the species have been named by M. Adolphe Brongniart. The seed-vessel of a monocotyledonous plant of common occurrence in these strata, and considered by Dr. Beck to belong to the family Restiaceæ, is identical with one in Mr. Mantell's collection obtained at Heathfield in Sussex. The few shells associated with the ferns which the author has examined are marine; and he conceives that these Bornholm beds were deposited in the sea at some distance from the mouth of the river which formed the Wealden system of England.

To the south of these coal-bearing strata are beds of siliceous and calcareous sand, containing between 30 and 40 species of shells, which also occur in the upper green sand of England: and in the neighbourhood of Arnager is a small patch of greyish white chalk with very few flints, but abundance of fossils, agreeing with those of the lower white chalk without flints at Southerham near Lewes.

In Denmark Proper the oldest formation belongs to beds of the cretaceous series, younger than those in the island of Bornholm. The lowest strata consist of pure white, soft chalk, with many layers of black, nodular flints, and contain more than 300 species of fossils. Among these remains, Ammonites are extremely scarce, Marsupites are unknown; and the remains of fishes, except teeth of the shark family, are very rare: but small zoophytes and microscopic foraminifera are very abundant; and, in some instances, animals of the sponge tribe, replaced by flint or chalcedony, but retaining their form, constitute complete beds. This portion of the chalk series forms, very generally, the lower part of the strata in Seeland and Jutland, and the whole of the cliffs of Moen. But in Moen masses of gravel and sand have, in consequence of great disturbances, become entangled with portions of disrupted chalk, in the manner explained by Mr. Lyell in a paper lately read before the Society*.

This white chalk is immediately overlaid, in Seeland and elsewhere, by the Faxoe beds, consisting almost entirely of hard, yellowish limestone, susceptible of a polish. They contain some of the characteristic fossils of the white chalk and some which are peculiar, belonging to the genera Arca, Modiola, Venus, Trochus, Fusus, Voluta, Oliva, Cypræa, Nautilus, &c.; while in the quarries at Faxoe (Seeland) they are composed so largely of zoophytes that they may justly be regarded as a coral reef. This division of the cretaceous series attains at Faxoe a thickness of more than 40 feet, but it is only between 2 and 4 feet thick at Stevensklint, where it may be traced for 3 or 4 miles resting upon the white chalk and covered by other strata of this series. The Faxoe beds appear also in some places in Jutland as in the Island of Mors, the cliffs near Grenaa, &c.

These beds have been imagined to be perfectly parallel to those of Maestricht, but the organic remains differ considerably; and are more analogous to those found at Künruth near Liege. Among the fossils common to the last locality and the Faxoe beds, are *Baculites Faujasii*, *Nautilus fricator* (Beck), *Fusus elongatus* (Beck), and *Terebratula subgigantea* (Schlotheim). Dr. Beck also states that the *Nautilus Danicus* is not identical with the *Nautilus aganiticus* of the lias, though Von Buch considers that it is: he likewise states that he has not been able to identify any of the Faxoe fossils with those of the oolitic series, or with the shells of Gosau, or with any of the tertiary fossils hitherto described.

The cretaceous beds which immediately cover the Faxoe deposit in Stevensklint, consist of a whitish and hardish chalk, including so great a number of broken and almost pulverised zoophytes that the rock is sometimes entirely composed of them. The bivalves and echinoder-

* Proceedings, No. 41. Vol. II. p. 191.

mata are chiefly the same as those of the white chalk, but the univalves, so common in the Faxoe beds, are wanting, while many of the smaller corals which occur in those beds occur also in this upper limestone, The flint of these superior strata is sometimes in continuous layers as in Stevensklint, sometimes in nodules, and differs from the flint in the white chalk in being more opake, and having a less conchoidal fracture. Sometimes it is replaced by a bluish grey stone, composed of silex and lime, and called in Danish "bleger."

Dr. Beck infers from the organic remains that the chalk of Saltholm; of the cliffs in Jutland, ranging from Rugaard by Daugbjerg and Mönsted, and terminating in the neighbourhood of Hjerm; as well as the chalk of the south of Thyholm, that resting upon the white chalk in part of Mors and in the north of Thÿ; and the chalk of the cliffs of Bulbjerg and the islet Skarreklit belongs to this uppermost bed.

Upon the chalk in various districts in Denmark is a breccia of angular fragments of chalk and flint cemented with carbonate of lime. The chalk hills of Denmark present generally the same rounded, smooth outline as in many parts of England, with this distinction, that in Denmark they are crowned very commonly with small mammilliform hillocks of gravel, sand, and erratic blocks. As the sandy beds sometimes contain shells identical with those now living in the German Ocean, it is evident that the chalk in Denmark has been submerged since the existence of the living species of Testacea.

In Bornholm, Moen, and Seeland, the strike of the cretaceous strata is dependent on the strike of the most ancient granitic rocks in Scania; but in Jutland it is not parallel to them, and evidently was not caused by the same system of movements.

In the central parts of Jutland is an extensive formation several hundred feet thick, referred by Dr. Beck to tertiary strata probably older than the erratic blocks. It consists in some localities of white micaceous sand, in which occasionally occur traces of brown coal, and near Skanderberg is a considerable layer of it. In other districts the formation is composed of clay, which also contains mica, flat masses of hydraulic limestone, like the septaria of the London clay, and occasionally a few organic remains, consisting of scales of fishes apparently belonging to the Cyprinidæ; the elytra of beetles, the cases of the larvæ of Phryganæa, and an hymenopterous insect which the author has called *Cleptis Stenstrupii.* In the neighbourhood of Thisted at Thye, the north of Mors and in the island Fűür, Dr. Beck observed, in 1831, dislocations which affect equally these tertiary strata and the chalk.

To the tertiary period belong also the beds discovered by Professor Forchhammer in the island of Sylt, on the western shores of Holstein. Some of the few shells hitherto detected in them Dr. Beck has ascertained to agree with characteristic fossils of the London clay, and others, as *Voluta Lambertii,* with shells of the crag.

To the same older tertiary period the author is inclined to refer the strata containing Valvata, Gyrogonites, &c., detected at Segeberg, and the deposit between Altona and Geuchstad in which Mr. Lyell discovered a valve of a Cardita.

Newer than any of the above-mentioned formations are the deposits of gravel, sand, and loam, often several hundred feet thick, which generally cover the older strata, and constitute almost the whole surface of Denmark. In and upon these beds, the erratic blocks so common in that kingdom first appear. They consist principally of the commoner varieties of the gneiss and granitic schists of Scandinavia; but in the neighbourhood of Copenhagen Dr. Beck has observed blocks of transition limestone, basalt with olivine, and the well-known secondary sandstone of Hör. In the northern part of Jutland he has also noticed blocks of Elfadal porphyry, and the blue zircon-syenite of Fredericksvaern in Norway. The gravel beds with erratic blocks rarely contain any fossils, but when shells do occur, they are often absolutely identical with living species. Dr. Beck has, however, found at Moen a specimen of Pleurotoma, which he believes to be tertiary, and there and at Himlingoie several specimens of Turritella not hitherto known as living.

From the difference of the fossils, together with the manner in which the gravel beds are disposed upon the chalk, he infers that the older strata have been elevated and submerged more than once.

Dr. Beck says that space does not permit him to give his views respecting the erratic blocks, and he merely states that their deposition took place after the beginning of the tertiary period, and went on during the accumulation of blue marl and sand, from which he has obtained more than 70 species of shells now living in the German Ocean; and that he has proofs, of which he intends to give a more detailed account hereafter, that the transportation of these blocks continues on the coast of Jutland.

In conclusion the author mentions the existence of several, small, lacustrine formations in the interior of Jutland and of Moen, containing remains of Lymnæa, Physa, Helix, &c.; and an extensive formation of sand cemented by oxide of iron.

An extract from a letter addressed to the President by H. Edwin Strickland, Esq., F.G.S., dated Athens, 26th Oct., 1835, was then read.

Mr. Strickland noticed first at Trieste the vast formation of secondary limestone which appears to extend thence uninterruptedly into Greece; and of which the Ionian Islands are almost wholly composed. In Corfu, however, are several obscure and complicated patches of tertiary deposits, and in Cephalonia is a Pliocene formation of vast thickness, containing abundance of fossils. Mr. Strickland then describes the currents of sea-water which constantly flow into the land near Argostoli in the island of Cephalonia. This extraordinary phenomenon occurs about a mile north of Argostoli at the very extremity of the rocky promontory which separates that town from the large bay on the west. The promontory is composed of the hard, white, secondary limestone, the strata dipping about 30° to the east; and at this spot it contains several species of shells which in general are rather rare. The streams of water have been noticed for many years rushing in between the rugged masses of rock of which the coast consists, but it was only about two years since that they excited the attention of the English. Mr. Stevens of Argostoli, desirous to turn them to advantage, was induced to stop up three of these holes, and by excavating a channel at the principal one, has been enabled to obtain a sufficient supply of water to turn a mill. The channel which has been made is about three feet wide, and the average depth of the current is six inches. In the mean state of the tide the fall is about 3 feet, the usual rise of the tide being 6 inches, but during southerly winds it is considerably more. After passing the wheel the current flows for 6 or 7 yards, and is then partly absorbed in swallow holes and partly disappears under the rocks. The water at the bottom of the excavation is greatest at high tides, the quantity of water then flowing in being greatest. A small freshwater spring enters the excavation on the land side, and when the sea is effectually stopped out, renders the water at the bottom of the excavation quite fresh in the course of a day; raising it at the same time several inches to a certain point, where it rests. This circumstance, Mr. Strickland thinks, may be explained by the less specific gravity of the fresh water requiring a higher column to overcome the obstacles met with in its subterranean course. In order to ascertain the direction of the current, Col. Brown has had an excavation made, by which it appears that the stream does not pass under the sea at the opposite side of the promontory. Mr. Strickland, in explanation of the constant flowing into the land of these streams, objects to the proposition that the subterranean current may be absorbed by the incumbent soil and evaporated at the surface, as it occurs in an island of small extent: but agrees to the supposition that an earthquake has at some period opened a communication between the sea and the region of volcanic fire; that the water being there converted into steam, is afterwards condensed in its upward course, and forms those hot-springs which exist in various parts of Greece.

A paper on the occurrence of fossil vertebræ of fish of the shark family in the Loess of the Rhine, near Basle, by Charles Lyell, Esq., F.G.S., was afterwards read.

Mr. Lyell described in a memoir communicated to the Society in May, 1834,* the geographical extent of the Loess or ancient silt of the Rhine, as far as he had then examined it. In tracing its southern limits during last summer, he found it in considerable force at Basle, and still higher on the Rhine at Waldshutt, where it contains the usual land and freshwater shells. Beyond this point he did not trace the deposit; but from the information he received, he believes that it terminates between Waldshutt and Schaffhausen. He here alludes only to the loamy portion, which can be identified by its fossils; for the gravel beds with which the loess sometimes alternates in its lower part, are probably of much greater extent, and are not easily to be

* See Proceedings of the Geological Society, No. 41. Vol. II. p. 191; and Jameson's Journal, Vol. 19.

separated from any other ancient gravel in which bones or shells have not been discovered.

The loess at Basle crowns the summit, and is found on the sloping sides of several low hills which bound the valley of the Rhine; but it is best seen one or two miles to the south of the town, in the hills called Bruder Holz, where it rests upon nearly horizontal beds of molasse. The loess has here an elevation of more than 1100 feet above the sea; for it is found in places which are more than 300 feet above the Rhine at Basle, according to the measurement of Prof. Merian, who has also determined that the Rhine at Basle is about 760 French feet (809 English) above the level of the sea.

The principal section examined by Mr. Lyell is near the northern extremity of the Bruder Holz below the church of the village of Binningen. The loess in this place is of its usual yellowish grey colour, and is filled with terrestrial and freshwater shells. The lower beds alternate with strata of sand and gravel, and in one of the loamy strata of this part of the series, he found the vertebræ of fish, together with the following loess shells: *Succinea oblonga, Pupa muscorum, Clausilia parvula, Helix cellaria, H. plebeium, H. arbustorum, H. rotundata, Bulimus lubricus,* and a small Planorbis, all recent shells.

The vertebræ, M. Agassiz says, belong decidedly to the Squalidæ or shark family, perhaps to the genus Lamna. The one is a caudal and the other an abdominal vertebra, each about a quarter of an inch in diameter. They are in such a state of preservation, and of such a colour as might be expected in bones preserved in loess, and as they were in a bed of fine loam in which there were no extraneous fossils, nor any fragments of rock washed out of other formations, there is no reason to suspect that they could have been derived from the tertiary molasse; and M. Agassiz also states that he has seen nothing like them in the molasse of Switzerland. It may seem very extraordinary that the first remains of fossil fish obtained from this freshwater silt should belong to a marine genus, but M. Agassiz has informed Mr. Lyell that both in the Senegal and the Amazon certain species of the shark and skate families (Squalus and Raia, Linn.) have been known to ascend to the distance of several hundred miles from the ocean, and analogous facts are referred to in Margrave and Piso's Natural History of India.

A notice on the occurrences of selenite in the sands of the plastic clay at Bishopstone near Herne Bay, by William Richardson, Esq., F.G.S., was lastly read.

The perpendicular cliff in which the selenite occurs is about a hundred feet in height, and consists of the following strata:

Vegetable mould.	
Reddish marl or brick earth........	5 feet.
London clay..............	20 to 30 —
Sand and sandstone...............	60 —

The selenite is found in the sand, which, as far as the author could determine, contains no iron pyrites or lime except in a few well-defined lines of testaceous remains. The superjacent clay abounds in pyrites, and is thickly studded with transparent crystals of sulphate of lime, but no connexion could be traced between the two deposits, and the sands for five or six feet underlying the clay contain no selenite.

January 6, 1836.—William Anstice, Esq., of Madeley Wood, Shropshire, was elected a Fellow of this Society.

A notice on the transportation of rocks by ice, extracted from a letter of Capt. Bayfield, R.N., addressed to Charles Lyell, Esq., P.G.S., was first read.

Capt. Bayfield says that both on the lakes of Canada and in the St. Lawrence he has seen fragmentary rocks carried by ice. The St. Lawrence is low in winter, and the loose ice accumulating on the extensive shoals which line each side of the river is frozen into a solid mass, being exposed to a temperature sometimes 30° below zero. The shoals are thickly strewed with boulders, which become entangled in the ice; and in the spring, when the river rises from the melting of the snow, the packs are floated off, frequently conveying the boulders for great distances. It is also well known that stones are carried by the ice. Anchors laid down within high-water mark to secure vessels hauled on shore for the winter, are cut out of the ice on the approach of spring, or they would be carried away. In 1834 the Gulnare's bower-anchor, weighing half a ton, was transported some yards by the ice, and so firmly was it fixed, that the force of the moving ice broke a chain cable as large as that of a 10-gun brig, and which had rode the Gulnare during the heaviest gales in the Gulf. The anchor was cut out of the ice or it would have been carried into deep water and lost.

With respect to rocks being transported by icebergs, Capt. Bayfield's testimony is equally conclusive, as he passed three seasons in the vicinity of the Strait of Belleisle. In an iceberg which he examined, boulders, gravel, and stones were thickly imbedded; and he saw others which owed their dirty colour to the same cause. Some of these immense ice-islands, Capt. Bayfield thinks, had been detached from the coast very far to the northward, perhaps from Baffin's Bay. The northern current brings similar masses in great numbers down the coast of Labrador every year, and they are very frequently carried through the straits, and for several hundred miles to the S.W. up the Gulf of St. Lawrence.

A paper "On the syenite veins which traverse mica slate at Goodland cliff and chalk at Torr Eskert, to the south of Fair Head in the county of Antrim," by Richard Griffith, Esq., F.G.S., and P.G.S. of Dublin, was afterwards read.

The part of Antrim to which this paper refers is situated between Fair Head on the north, and Cushleake mountain on the south. The base, or oldest formation of the district, consists of inclined strata of mica slate passing into gneiss, and containing subordinate beds of hornblende slate and schistose limestone. Upon the mica slate repose nearly horizontal and unconformable strata of coal measures, new red sandstone, and chalk; and the whole of these secondary deposits are surmounted by an overlying mass of rudely columnar trap, the northern extremity of which forms the magnificent promontory of Fair Head.

Besides the hornblende schist, which is interstratified with the mica slate and dips conformably with it, there are other rocks containing hornblende, which appear to be imbedded in the slate, but which are really intruded veins. On the sea-shore at Torr Point are two of these veins, consisting of syenite and syenitic green-stone; and they may be traced passing obliquely along the face of the stupendous and, for the greater part, perpendicular cliff of Goodland. On the sea-shore they appear so regular and conformable, both in strike and dip, to the strata of mica slate, that they might be considered as integral portions of it; but on minute inspection the syenite is found to mould into the rough and saw-like edges of the strata of mica-slate; and on tracing the veins as they gradually ascend the cliff, they are found to pursue undulating courses, neither parallel to each other nor to the laminæ of the slate, in some places approaching within four feet, and in others being more than 20 feet apart. To the south of the fault which traverses the cliff about 150 yards from Torr Point, the veins reappear at a higher level than on the north of the line of dislocation; and between the two previously noticed is a third and smaller one. Where first seen, this small vein is in contact with the upper surface of the lower vein, from which it gradually diverges and approaches the upper, but afterwards again descends towards the lower vein.

The mass of the two larger veins consists of dark green, crystallized hornblende, brownish red felspar, and occasionally quartz; and regular transitions may be traced from syenite to greenstone. When viewed at a distance they present a rudely columnar structure. The centre vein contains much black hornblende, some black quartz, and presents a concretionary structure, the oval-shaped masses being enveloped in a congeries of pinchbeck brown mica. A tendency to this structure is observable also in the upper vein.

Owing to the covered nature of the ground, the syenite veins of the coast cannot be traced continuously to Torr Eskert, but by laying down the line of the veins of Goodland cliff on the Ordnance Map, and making due allowance for their average inclination and the elevation of the hill, Mr. Griffith entertains no doubt that the syenite in the chalk of Torr Eskert is a prolongation of one of the syenite veins in the slate of the cliff.

The syenite which traverses the chalk cannot be distinguished from that of the mica slate, and passes also in syenitic greenstone. At one point the author had a portion of the surface soil removed, and obtained the following section:

Top.	Compact chalk	5 feet
	Syenite	5 —
	Chalk, irregular bed from 9 inches to	1 foot
	Mica slate....................	

The lower bed of chalk contains quartz pebbles, green sand, and numerous, red, siliceous grains, some of which resemble garnets. The syenite presents large masses separated by chalk containing quartz-pebbles, green sand, and numerous fragments of fossils. These remains have nearly a vertical position when *in situ*, and Mr. Griffith consequently infers that they are not in the position in which they were deposited.

The irregularities on the surface of the chalk are accurately filled with the syenite: the chalk in immediate contact with the vein is usually compact, sometimes crystallized; and pebbles of quartz similar to those in the green sand and chalk are found occasionally in the syenite. The author noticed a small reniform mass of syenite imbedded in the chalk—the grain of the included portion being finer than that of the syenite in general. Small particles of chalk were likewise noticed in the syenite, and the union of the two rocks is so perfect that the chalk appears to be an integral portion of a compound deposit. Among other peculiarities exhibited at the junction of the two formations, the author mentions spheroidal masses of syenite included in the chalk; and, in conclusion, he says, that if the views which he has put forward have been substantiated, a new and important fact is added to those already described, which may ultimately lead us to attribute a comparatively recent origin not only to syenite veins and primary greenstone, but also to crystalline rocks generally when associated with schistose strata.

A letter from H. T. De la Beche, Esq., addressed to the President, and dated Truro, the 18th of December, 1835, was then read.

This letter was accompanied by a collection of fossils from the schistose rocks of the North of Cornwall, and presented to the Society on the part of the Ordnance Geological Survey.

Mr. De la Beche says that in the grauwacke of Western Somerset, Devon, and Cornwall natural divisions may be made, founded on marked characters. How far these divisions may coincide with those in Prof. Sedgwick's Cambrian system he has no means at present of judging; but he is of opinion that the whole of the district is older than the Silurian formations of Mr. Murchison.

Some of the organic remains obtained at Dinas Cove, in Padstow Harbour, belong to a system of beds consisting of slates, sandstones, and conglomerates, which encircles the northern flank of Dartmoor, then makes a great curve south of Launceston, bends afterwards northward round the Rough Tor and Brown Willy granite, and lastly, again inclines southward, crossing the Padstow river to the sea on the western coast. In various parts of this line the system is fossiliferous, particularly where limestone occurs or calcareous matter abounds. The Tintagel slate, long since shown by Dr. Buckland and the Rev. John Conybeare to contain organic remains, belongs to this system. Part of the fossils which accompanied the letter were procured from Trevelga Island (Lower St. Columb Porth), and Towan Head near New Quay, from the same series of beds, which, in consequence of an east and west anticlinal line ranging by St. Eval, St. Issey, and St. Breocks Downs, is folded over to the south, and constitutes the schistose system of St. Columb Major, St. Columb Minor, New Quay, &c.

The remainder of the fossils was obtained by Dr. Potts at the western entrance of Bodmin, and by Mr. De la Beche from the vicinity of Liskeard, on a prolongation of the same strata.

Altered or metamorphic rocks, having frequently the appearance of gneiss, mica slate, hornblende rock, &c., occur in the neighbourhood of Tintagel and Camelford; and Mr. De la Beche says, that a little care in tracing these rocks shows that they are altered portions of strata which possess the usual and varied characters of grauwacke. In conclusion he observes, that there is every reason to believe that two movements have taken place of the land in Somerset, Devon, and Cornwall, one to a height of 30 or 40 feet above the present sea-level, and another to an uncertain depth beneath it, since the vegetation of the land and the molluscous inhabitants of the neighbouring sea were the same as they now are.

January 20, 1836.—Arthur William Tooke, Esq., A.M., of Russell-square; J. Jukes, Esq., B.A., St. John's College, Cambridge; Richard Zacchary Mudge, Esq., F.R.S., Capt. in the Royal Engineers, Highwood Hill, Middlesex; and Philip Worsley, Esq., of Great Ormond-street, were elected Fellows of the Society.

A paper was read "On the geological structure of Pembrokeshire, more particularly on the extension of the Silurian system of rocks into the coast cliffs of that county." By Roderick Impey Murchison, Esq., V.P.G.S.

This memoir was prefaced by an account of the origin of the terms Silurian and Cambrian Systems as applied to the older sedimentary deposits. Having occupied several years in establishing a fixed order of succession amid the strata of age anterior to the old red sandstone, and having finally named the formations in descending order, the Ludlow rock, Wenlock limestone, Caradoc sandstones, and Llandeilo flags, the author was urged by many leading geologists to propose a new, comprehensive name for this group, and thereby to prevent the confusion which had so long prevailed by the use of the words "Transition" and "Grauwacke." He adopted the term Silurian System, because the territory in which the successive formations above mentioned are exhibited, was formerly occupied by the ancient, British people the Silures. The Silurian rocks are underlaid by vast masses which rise up into the mountains of North, and the western part of South Wales, and to these Professor Sedgwick, connecting his labours with those of Mr. Murchison, has assigned the name of "Cambrian System." A portion of last summer was employed in tracing these rocks from Caermarthenshire into Pembroke, and in doing this the author was led to attempt a general survey of the county, examining the strata from the youngest to the oldest, dwelling, however, specially on the deposits of the "Silurian System."

Owing to its peninsulated form and the transverse fissures proceeding from Milford Haven into the heart of the county, Pembrokeshire affords great facilities for the comprehension of its mineral structure, and as the chief masses range from E. to W., sections from S. to N.

expose the formations of which it is composed in descending order from the coal-measures to the Cambrian System. The points of novelty in the descriptions of the author apply to the persistence of the carboniferous deposits along the coast of St. Bride's Bay, where they are not separated by any mass of greywacke as indicated in former maps, the parts producing culm*, lying simply to the N. and S. of a highly dislocated promontory of carboniferous grit. The contortions and innumerable faults of these coal-measures being pointed out, attention is then called to some of the probable results of such movements in the singular accumulations of finely fractured stone coal in small basins called "slashes," and to other vertical downcasts of the mineral termed "sloughs." The shale of these culm deposits resembling in some respects certain strata of the upper Silurian rocks, might to an unpractised eye appear undistinguishable; but even where the order of superposition is not to be detected, essential differences are invariably to be observed, in the coal shales never containing those organic animal remains which are so abundant in the Silurian system, whilst the latter never contains a single plant similar to those which abound in the former. Instances are cited where by dislocations the coal measures are thrown into positions apparently conformable to old greywacke rocks of the Cambrian system, and hence the author surmises, that if the millstone grit and carboniferous limestone were not present in many adjoining parts to test the true age of these coal measures, mistakes might easily result from such juxta-positions. Cherty and siliceous sandstones (the millstone grit) rise in dome shapes to the west of Haverford, and occupy large portions of the coal tract underlying the productive culm measures and capping the mountain limestone.

Carboniferous Limestone.—In this formation, besides the very accurate outline expressed in Mr. De la Beche's map†, the author remarks the existence of a double trough of the lower limestone shale overlying the old red sandstone in East Angle Bay; and he particularly adverts to the peculiar mineral character of these beds in Pembrokeshire in containing yellow and light coloured sandstones alternating with shale. The fossils of this lowest member of the carboniferous system are numerous, many having been furnished by the Earl of Cawdor; and as far as they have been yet examined they appear to differ specifically from all the fossils of the inferior systems. The coal measures and mountain limestone of Pembroke are singularly subject to great faults; one of the most remarkable of which occurs between Johnston and Haverfordwest, where the carboniferous limestone is thrown into a position by which it appears to overlay the coal.

Old Red Sandstone.—The upper strata of this great formation pass upwards in many places into the shale and sandstone of the carboni-

* All the coal of Pembroke is stone coal, and it is usually in the laminated condition of culm.

† The survey of the county was much facilitated by the possession of Mr. De la Beche's map of South Pembroke, which, though differing in some points from that completed by the author, is mentioned by him as a work of great merit for the period of its publication.

ferous limestone, and the lowest members graduate into the Silurian system. The great mass consists of sandy shale, here termed the "red rab," associated with red sandstones and grits; but lithological variations from the usual types in Herefordshire have led to the belief that large districts (Cosheston, Williamston, Benton, &c.) consisted of greywacke. These are yellow, grey, and greenish micaceous sandstones which the author proves to be interlaced with the "red rab," and to occupy the same position as similar varieties of the rock previously described in Hereford, Radnor, &c. Some of the coarse grits (Canaston wood) are undistinguishable from the "greywacke" grit of the oldest rocks of the Cambrian system. Calcareous matter is very sparingly exhibited, imperfect concretions or very impure "cornstones" appearing only at wide intervals. The fishes so profusely detected by the author in the range of the formation through Salop, Hereford, and Monmouth, have not been observed. Amid the many faults affecting this formation, those by which the strata ranging from Caermarthen into Pembrokeshire have been powerfully bent and broken, and thrown into a westerly direction (Tavern Spite, &c.), are perhaps the most striking.

Silurian System.—Though the order of superposition and the organic remains clearly attest the age of the rocks of the Silurian system, the masses differ so much in mineral aspect from those selected as types that it is rarely possible to subdivide them into the Ludlow, Wenlock, Caradoc, and Llandeilo formations; but adopting the classification proposed, the author has laid down their course upon the map as two sub-groups consisting of "upper and lower Silurian rocks*."

The former parting with their mudstone characters are for the most part hard and siliceous, containing little calcareous matter, and are never subdivided by zones of limestone as at Aymestry and Wenlock. The lower Silurian rocks, on the contrary, are amply displayed in all their characteristic forms, the limestones of the Llandeilo formation expanding to greater thicknesses (Llanpeter-Felfry, Llandewi, &c.) than in any other part of their course, and containing many beautiful fossils, including two unpublished species of Trilobites, common to Caermarthenshire. The chief mass of the Silurian system ranges from E. to W. across the county, passing by Haverfordwest, till its western extremity subsides beneath the coal measures of Druson Haven and St. Bride's Bay. Other bands of it rise from beneath the old red sandstone at Orlanton, Hoten, and Johnston; whilst a most remarkable zone is heaved up in an anticlinal line extending across the most southern promontory of the county (Castle Martin Hundred), from Fresh Water East to Fresh Water West. The most perfect succession of the rocks of which the system is composed, is exhibited in the bold coast cliffs of Marloes Bay, extending for a distance of two miles, in which space the uppermost strata, rising at angles of 35° to 40° from beneath the old red sandstone of Hook Point, are succeeded by conformable, underlying masses, until the whole graduates down and passes into the rocks of the Cambrian system in Wooltack Park and Skomer Island. The Ludlow and Wenlock

* See Lond. & Edinb. Phil. Mag., Vol. VII. p. 46, Silurian System.

formations can be here defined; the latter containing many well-known fossils. The lower Silurian rocks are still more largely developed; a vast thickness of fossiliferous sandy strata being quite identical with the "Caradoc sandstones," whilst the Llandeilo flags with *Asaphus Buchii* and *A. Bigsbii* (a new species of the author) occur in the haven called Moseley-wick Mouth. This coast section is 150 miles distant from the N. eastern extremity of the Silurian system.

The Cambrian System.—If divided by a line passing from E. to W., the northern half of Pembroke is exclusively composed of the older rocks of the Cambrian system, consisting, in descending order, of

a. Dark-coloured incoherent schists, with few stone bands, no calcareous matter, and scarcely any traces of organic remains. These occupy a great breadth, and, as in Caermarthenshire, they form the beds of passage between the Silurian and the Cambrian systems (sometimes without any break).

b. Hard grits and flagstones, coming strictly within the definition of greywacke of German mineralogists.

c. Hard purple sandstones and schists, identical with the slaty greywacke of the Longmynd, Salop, (the Lammermuir hills, Scotland, may be cited as a good and well-known type of these rocks).

d. Slates coarse and fine, with quartz veins and concretions.

At St. David's, Pantiphilip, and Scillyham, where the roofing-slates are quarried, the author has detected what he believes to be a coincidence between the laminæ of deposit as indicated by differently coloured layers of sediment, and the lines of slaty cleavage; though in the great majority of cases in Pembroke the rocks of this system, whether consisting of sandstone, schist, or hard slate, exhibit the divergences between the lines of true bedding and slaty cleavage, so clearly and ingeniously explained by Professor Sedgwick. The author therefore thinks it right to point to these exceptions to the observations of Prof. Sedgwick, because if strictly scrutinized the phænomena are not placed in opposition to them, since it was his belief upon the spot, that the crystallizing action which gave to these masses their hard slaty properties produced the flaglike laminæ of the beds.

Trap Rocks.—Of these there are distinctly two classes: 1, Bedded, and synchronous with the formation of the older rocks; 2, Posterior and intrusive. Of the former there are no examples like those cited in West Salop, Montgomery, and Radnor, (see former memoirs,) of alternation with the strata of the Silurian system, being all confined to the Cambrian rocks. The tract extending from Fishguard to St. David's and the Isle of Skomer offer illustrative examples of both these classes of trap. In addition to the varieties of sienite, compact felspar rock (corneen of De la Beche), greenstone, &c., of which these rocks are composed, the author has detected crystallized chromate of iron and albite in St. David's Head,—small veins of copper ore also occur between Solfach and St. David's. Among the more remarkable changes effected by the intrusive trap, he adverts to jaspidified schists inclosed between a large bifurcated mass of trap proceeding from Trafgarn. Having traced the Silurian system in a course of 120 miles from the Wrekin to Caermarthen in ridges more or less parallel running from *N.E.* to *S.W.*, the author has shown in former memoirs that this strike of the strata uniformly coincides with the direction of linear outbursts of volcanic matter. In Caermarthenshire vast dislocations and transverse breaks are exhibited by which the strata are for short distances thrown into E. and W. directions, but on the whole the south-westerly course is maintained. A ridge of intrusive rocks recently discovered, ranging between the rivers Towey and Taf (Castel, Cogan, &c.), having the same course, serves to explain how that dominant direction has been there preserved. In entering Southern Pembroke, however, the whole of the strata from the coal measures to the Cambrian rocks are thrown into an E. and W. direction, accompanied by violent contortions and powerful faults; whilst in northern parts of the county the old N.E. and S.W. direction prevails. As these converging lines are accompanied by linear, parallel ridges of trap rock, the author is confirmed in his belief that the forces which evolved the latter have been the proximate cause of such directions; and he further refers the extraordinary convulsions and dismemberments to which the strata in Pembroke have been subjected, to the interference of two great lines of elevation dependent upon volcanic activity. In accordance with phænomena observed in other parts of S. Wales, it is remarked that all the superficial detritus is of local origin, the southern or lower part of the county being partially strewed over with the debris of the rocks which rise into mountains on the north coast. After some observations on the blown sands, and the period of their formation, the author recapitulates the value of the Pembrokeshire coast sections in exhibiting the "Silurian System" precisely in the same geological position assigned to it from examinations in the interior; and concludes by stating it as his opinion, that as this one county is shown to contain rocks in the true coal measures and in the old red sandstone, as well as in the Silurian and Cambrian systems, which from their lithological characters have been mistaken for "greywacke," the use of that word as expressing the age of rocks is no longer consistent with the advanced state of geological science, and that if used, the name should either be rigidly restricted to some of the very oldest sedimentary deposits, or simply employed as a mineralogical definition of peculiar grits which actually reoccur in strata formed in many succesive epochs.

Feb. 3.—James Thompson, Esq., F.R.S., of Primrose Hill near Clitheroe; James Winter Scott, Esq., M.P., of Rotherfield Park, Hants, and Grafton-street; and George Warde Norman, Esq., of Bromley, Kent, were elected Fellows of this Society.

A paper on "The Gravel and Alluvia of S. Wales and Siluria as distinguished from a northern drift covering Lancashire, Cheshire, N. Salop, and parts of Worcester and Gloucester," by R. I. Murchison, Esq., V.P.G.S., was read.

The first part of this memoir describes the detritus in the Welsh and Silurian territories. The surface of this region is completely exempt from the debris of any of those far-transported rocks which constitute what has been called "diluvium" in other parts of England; all the loose materials in S. Salop, Herefordshire, and the adjoining Welsh counties having been derived from the Silurian and trap rocks of the adjacent mountains. These mountains range from N.E. to S.W., presenting inclined planes to the S.E., on the surfaces of which the broken materials are distributed. Four of the rivers which descend from the higher parts of Wales flow to the S.E. in accordance with the prevailing lines of drift, traversing the ridges of Silurian rocks through fissures which have resulted from dislocations of the strata. These are the Teme, the Onny, the Lug, and the Wye, all tributaries of the Severn. That great river, on the contrary, does not follow the "line of drift" to the S.E., but escapes from the mountains to the north by a lateral gorge under the Breidden Hills; and after a circuit in the Vale of Shrewsbury passes eastward through a narrow transverse rent in the upper Silurian rocks and coal measures of Coalbrook Dale; and taking its final course southward, from Bridgnorth to the Bristol Channel, forms the eastern limit of the country covered by the Welsh or Silurian detritus. The drainage of the Teme, Onny, Lug, and Wye, is described in detail, with a view of showing, that in the valleys in which these rivers descend from the mountains, the materials change with each successive ridge, the larger fragments being transported only short distances; and that as the gravel advances into the plains, it becomes more finely comminuted; Herefordshire and the low countries being chiefly covered with local debris of the old red sandstone. The author specially distinguishes this drift, which is extensively spread over valleys and slopes, and sometimes found in high situations, from the detritus which has been carried down by rivers under the atmosphere, conceiving that the former accumulations have been washed down the surfaces of the inclined strata; because wherever the latter dip to the S.E., so are the materials invariably found to have been propelled in that direction. In no instance has any fragment been found on the west which can have been derived from rocks on the east. He therefore believes that at those periods when the Silurian and older rocks were raised from beneath the waters, great quantities of coarse and fine detritus were drifted down these slopes; and that as the rocks on which the loose materials have been deposited are replete with dislocations, and penetrated at many points by ridges of trap rock, it is to be inferred, that during and after the evolution of this volcanic matter, great and successive elevations of the bottom of the sea took place, throwing up the drifts to the various heights at which we now find them. As soon as the land was raised from beneath the sea, the present rivers, it is conceived, began to flow; passing through the ridges by gorges produced by great lateral cracks the result of elevation; and that these streams have since merely transported to short distances those broken materials which were previously gathered together by subaqueous drift. To prove that the drifted matter of each district within this region may be referred to *disturbances purely local*, it is shown that although wherever the hills have been elevated from N.E. to S.W. the lines of drift are from N.W. to S.E., yet in those contiguous tracts which have been elevated in other directions the course of the drift *changes* immediately with the variation of the *strike*. Thus on the exterior margin of the great coal-field of S. Wales vast quantities of materials resulting from the breaking up of the carboniferous series have been dispersed to *the N.E., N.*, and *N. West*, directions *excentric* from the broken margin of that elevated tract.

In Pembrokeshire, again, where the prevalent lines of strike are from E. to W., the drift has been carried southwards. Conceiving that the great masses of these drifts have been formed at various periods *under the sea*, either in gulfs, estuaries, or straits, and have been raised up at different periods when the solid strata were elevated, the author then proceeds to consider the probable conditions of the surface of this portion of the country for some time after such emersion, and yet at a period comparatively remote. He instances many flat embayed tracts which, from the equable surface of the sand and gravel, are supposed to have been for some time under water, occupying lakes which have been drained by the deepening of gorges issuing from these bays; since it is shown that a very slight difference of level in the beds of rivers at several gorges would effectually bar up the present streams, and pond them back into lacustrine expanses. Hence he infers that slight additional movements of the land, aided by the excavating process of the rivers themselves, may have operated in draining these flat tracts. A large part of Herefordshire watered by the Wye is supposed to have been under such waters, which have since escaped by the picturesque gorges of Ross and Chepstow. The Vale of Radnor is a similar case; now drained only by a feeble rivulet. But the clearest examples of successive lacustrine expanses are exhibited in the descent of the Teme; first in the tract still called "Wigmore Lake;" from whence the superabundant waters have escaped through the upper Silurian rocks in the gorge of Downton on the rock; and next in various expansions and contractions between Ludlow and the Abberley Hills, where they have been again barred up by that ridge until the gorge at Knightwick Bridge was deepened, opening out a channel for their escape into the great Valley of the Severn. The finely levigated sand, marl, and mud, at small heights above the present stream point to this anterior lacustrine condition. The period of the final desiccation of these river-lakes, and the reduction of the rivers to their present channel, is supposed to have been contemporaneous with that recent elevation which in raising the land to greater heights brought up large adjacent portions of the bottom of the sea, and to the consideration of which the second part of the memoir is devoted under the head of "*northern drift.*"

In the region of Welsh and local drift attention is specially called to the length of time during which existing causes have been in undisturbed action, as proved by the magnificent mass of Travertino formed and still forming at the Southstone rock; whilst he also points to the discovery of shell marl in a bog near Montgomery, containing several species of *Lymnæa*, which has evidently been formed in the manner described by Mr. Lyell in his memoir on the marl loch of Forfarshire.

Northern Drift.—Detritus differing entirely from that which covers Wales and Siluria, is spread over large parts of Lancashire, Cheshire, and N. Shropshire, ranging up to the edges of the region above mentioned. The materials of this drift consist of granites, porphyries, and other hard rocks, which have been derived from the mountains of Cumberland, a few perhaps from those of Scotland. The drift further contains much sand and clay, with many pebbles of smaller size, which varies exceedingly in different districts. Thus, in N. Salop, near the great outlier of lias, described by the author*, fragments of that formation are added to the mass, and as it advances to the south the materials become still more varied; the fragments, however, of the northern granite and porphyries always existing to identify the drift. Its distinguishing feature is the reoccurrence at intervals of large blocks or boulders, of northern origin, a large proportion of which lie at various heights on the slopes of the mountains skirting the N. Welsh coal-field, and encumbering the northern flanks of the Wrekin and of Haughmond Hill; while a few have been propelled to the edge of the Silurian rocks south of Shrewsbury. They prevail in vast quantities in the high inland district between Wolverhampton and Bridgnorth, from which latitude they begin to diminish in size; but coarse gravel, composed of the same materials, is prolonged southwards like the tail of a delta through Worcestershire, until it dies away in the fine silt and gravel of the Vale of Gloucester. *Not a fragment of any such detritus enters into the region of Welsh and Silurian drift*; but in the environs of Shrewsbury certain mounds of the latter are capped by clay and boulders of the northern drift, which is thereby shown to be of subsequent formation. The best proof of the recency of the epoch during which this northern drift was accumulated is, that it contains sea shells of *existing species*. These were formerly noticed at Preston, in Lancashire, by Mr. Gilbertson; and by the author at the height of 350 feet above the sea. In Cheshire they have been observed by Sir P. Egerton at heights of about 70 feet†. Mr. Trimmer has cited similar shells on Moel Tryfane‡, now ascertained to be 1392 feet above the sea, and has recently detected them near Shrewsbury. Mr. Murchison has collected evidence of their diffusion over a wide area in Shropshire, tracing them at intervals from Marington Green, N.W. of Shrewsbury, by the Wrekin and Wellington, to the high grounds between Bridgnorth and Wolverhampton, at least 60 *miles inland*, and at heights varying from 300 to 600 feet. He has also been enabled to add several species to those mentioned in any former list. These shells having been examined by good conchologists (including Dr. Beck, of Copenhagen,) prove to be identical with species now inhabiting adjacent seas, viz. *Buccinum reticulatum*, *B. undatum*, *Dentalium entalis* (Linn.), *Littorina littorea*, *Tellina soldula ? Venus* ——, *Astarte* ——, *Cardium tuberculatum*, *C. edule*, *Cyprina islandica*, *Turritella ungulina* (Beck), (*Turbo ungulinus*, Linn.,) *Donax* or *Mactra*.

It was a prevalent the belief that large boulders were usually lodged

* Proceedings of the Geological Society, Vol. II. p. 114.

† *Ibid.*, Vol. II. p. 189. ‡ *Ibid.*, Vol. I. p. 331.

upon the surface of the gravel and sand; but cuts which have been made through mounds of these materials at Norton, near Shrewsbury, have proved that the larger blocks occur at considerable depths below the surface mixed up with shells, sand, gravel, and clay. This is the locality described by Mr. Trimmer* as indicating the existence of dry land anterior to the deposit of the shells and gravel, by the occurrence of a peat bog, which he supposed to have been formed out of the remains of a submerged forest; the stumps of the trees of which were said to be still rooted in their parent soil, and standing in their growing posture. Having examined the spot (accompanied by Dr. Du Gard), Mr. Murchison has obtained clear proofs that the supposed trees were stakes with sharpened points which had been driven down into a patch of subjacent clay; the other remains consisting of a plank and smaller stakes which had been laid horizontally. This woodwork formed the support of the old road, which in making the new one had been cut down beneath the ancient foundations. The patch of clay into which the piles were driven, lying in a depression between two hillocks of gravel, must have given rise to a wet and boggy spot, which having been rendered passable by piling and damming, the dry materials of the contiguous hillocks were doubtless shovelled in to complete the road, thus giving rise to the deceptive appearances of marine drift overlying the supposed forest.

Though the collocation of the boulders, sand, gravel, loam, clay, and shells is in parts very irregular, yet the materials are sometimes finely laminated: the whole, it is presumed, may have been thus brought together at the bottom of a sea, as the mass is not unlike many raised sea-beaches, with one of which, at the mouth of Carlingford Bay, Ireland, recently visited by Professor Sedgwick and himself, the author compares it.

From the evidences afforded by these recent shells it is inferred, that the tracts covered by them must have lain under the sea during the modern period; whilst from the continuation of the granitic drift from the high grounds east of Bridgnorth into the Vale of Worcester, Mr. Murchison conceives that the sea must at the same time have covered the Valley of the Severn from Bridgnorth to the Bristol Channel, thus separating Wales and Siluria on one side, from England on the other. Having shown that the Welsh and Silurian mountains were partly raised at an earlier period, he points out the Abberley and Malvern Hills, as constituting the western side of a strait of the sea, the eastern shore of which was the Cotteswold Hills. He deduces the principal proof of the preexistence of this eastern coast from the observations of Mr. H. Strickland, which show the transport from the east and north-east of fluviatile and land shells mixed with the remains of extinct quadrupeds in banks of coarse gravel, following the drainage of the Avon near to where that river empties itself into the Severn; and he asserts, that the terrace-like deposits of Cropthorne are exactly those which would have been accumulated at the mouth of a river, if the materials had been carried onwards beneath the waters of the adjoining strait of the sea, illus-

* Proceedings of the Geological Society, Vol. II. p. 200.

trating his views by the analogies of other rivers and estuaries. He therefore presumes that the deposit of Cropthorne may have been coeval with that of the northern drift. After an explanation of the theories hitherto proposed to account for the transport of large boulders to distant points, the author states that the evidences in question seem to him to be subversive of the diluvial hypothesis which imagines that the blocks were carried over the land, it being proved that here, at least, they were accumulated *under* the sea. He does not think we have yet been furnished with a full explanation of any method by which such blocks can have been transported to distances of 100 miles: for supposing them to have been derived from the shores of Cumberland, and that they extended in a delta from thence, it would appear that assuming the slightest degree of inclination, viz. 3°,—which could give adequate momentum to the ordinary power of running water acting upon these loose materials,—the southern part of the delta (even at a distance of 50 miles from Cumberland,) must, as suggested by Mr. Lonsdale, have lain at the vast depth of 13,000 *feet* beneath the sea, in which case all Wales would have been equally submerged; though we have proof that the mountains of that country *had* risen to a certain height previous to the accumulation of the northern drift. It is further submitted that under the physical features of the region when this drift was formed, i. e. when a great arm and strait of the sea separated England from Wales, submarine currents alone could not have been powerful enough to propel these large blocks, though the question is one which ought to be more completely disposed of by those versed in the laws of dynamics. Mr. Murchison next takes into consideration the theory of the transport by ice. After allusion to the views of Esmarck, De l'Arrivière, Haussman, &c., it is shown that Mr. Lyell has thrown great additional light on this subject by his observations on Sweden and the Alps, by which it really appears that under certain limitations "ice floes" may have been "veræ causæ" in the transport of large blocks, depositing them under seas and lakes at great distances from the source of their origin. In the Salopian case, however, *though it is possible* such means may also have been employed, there are many arguments which weaken the application of the hypothesis, such as the *rounded* and *worn* exterior of the boulders, and their diminution in size and quantity from north to south. It might also be contended that we have no right to infer the existence of a colder climate in our latitudes in those days; but this objection does not appear unanswerable, since it might be replied, that if at the period of the *northern drift* England, Ireland, and the continent of Europe were united by a lofty chain of mountains, there might have been a temperature sufficient to have formed annually large bodies of ice on the shores of Cumberland. Passing however from this difficult question of the method of transport, Mr. Murchison states that the greatest of the anomalies hitherto presented by these boulders is obviated, when we dispel from our minds the idea of their having been carried over preexisting lands. Having once ascertained that large distributions of them took place *under the sea*, the different heights at which we now find them may, he supposes, be satisfactorily accounted for, by *movements of elevation and depression acting upon the bed of the sea with unequal measures of intensity, raising up shells, gravel, and boulders which were accumulated at the same period, to the respective levels which they now occupy*, doubtless producing many of the cracks and fissures with which the solid strata are replete, and leaving denuded valleys between the points so elevated.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1836. No. 44.

AT THE

ANNUAL GENERAL MEETING,

19th February, 1836,

The following Report from the Council was read:—

The Council has this year again to congratulate the Society upon a gradual increase in the number of its Members,—a fresh evidence of the interest taken by the public in Geological science. Forty-five new Fellows have been elected; the deaths and resignations are 16. Upon the whole, the Society, which at the end of 1834 consisted of 745 Members, at the end of 1835 was increased to 774.

The appearance of its finances is no less satisfactory.

The expenditure in the past year has been under the estimates submitted to the Society.

The stock of the Society has been increased by the purchase of 300*l.* more 3 per cent. Consols; and upon the whole its property, last year valued at 1735*l.* 15*s.* 10*d.*, is now calculated to be worth 2102*l.* 18*s.* The further details of the state of the Society's finances are fully set forth in the annexed accounts.

The probable expenditure in 1836 is estimated at about 1820*l.*

Out of the proceeds of the Wollaston Fund at the Society's disposal, the Council has thought fit this year to present a Medal to M. Agassiz, to mark their high sense of the value of his work of last year upon fossil fish; and to award to M. Deshayes the sum of 25*l.* as some assistance to him in his labours on fossil conchology.

The following is the Report of the Committee appointed to examine into the state of the Library and Museums.

REPORT of the Committee appointed to examine and report on the state of the Museums and Library.

Museum.

The labours of the Curator during the summer have been exerted in re-arranging the fossils belonging to the crag, London clay, chalk, upper green-sand, and gault. The specimens have now been put up in the manner suggested by the Museum Committee of last year, with the effect, that though the number of specimens has been materially increased, they do not occupy a greater number of drawers than previously, space being at the same time left for future additions. The specimens have all been fixed on wood, covered with white instead of black paper as formerly, which admits of the name being directly written on the paper, and dispenses with the use of labels. Their appearance is neat, and well adapted for consultation and study. The Committee have noticed with much satisfaction that the selection of the specimens, as well as their order and position, has been studiously made with a view to show the mutual relations of allied species, to illustrate varieties of the same species, and to exhibit internal structure. To render the collection more effective in these respects, it is desirable that donors should not consider duplicates unnecessary, since two shells, apparently identical, often, on close examination, present slight varieties which more fully display the characters of the species.

The Committee beg to observe that the fossils of the Crag are very defective.

The principal donors to this portion of the Museum have been Dr. Fitton, Miss Benett, Viscount Cole, and Sir P. Grey Egerton.

The specimens in the collections below the Gault remain in the same state as at the last report; but the valuable series presented by Dr. Fitton will render the Wealden and Portland formations nearly complete. The specimens are in preparation, and will in a short time be introduced into their proper cabinets.

The fossil fishes have been named by M. Agassiz; but the collections are very far from being complete, particularly those from the lias of Dorsetshire.

Coal-Measures and Inferior Strata.—The Society has received two small collections of fossils from Mr. De la Beche, presented in the name of the Ordnance Geological Survey. The Committee look with pleasure to this donation from a branch of the public service, from which great additions to the department of organic remains may be anticipated.

Fossil fishes from the Coal-measures at Wardie and from other localities have been presented by Lord Greenock, F.G.S.

The Society is indebted to Mr. Murchison for a suite of fossils from the Silurian System of Rocks; and to the Earl of Cawdor for fossils from the lower limestone shale and upper Silurian beds of Pembrokeshire.

The principal donations of foreign specimens, are fossils from the Virgin Islands, collected by M. Schomberg for the Royal Geographical Society, and presented by that Society; and the collections made in India by Mr. Royle, and presented by himself.

The Committee have the satisfaction to observe, in noticing the fossils presented through M. Schomberg, that donations have been repeatedly presented by the Royal Geographical Society of specimens collected by their agents.

The Committee cannot close their Report on the Museum without expressing the pleasure they derived from the excellent state of preservation of the whole Museum, and from the unwearid zeal and discriminating skill displayed by the Curator in arranging the collections.

Library.

The Society has received many valuable additions to the Library. About 100 volumes and pamphlets have been presented during the year, including the Transactions and Journals of the Royal Society, the Astronomical Society, Zoological Society, British Association, Royal Asiatic Society, Cambridge Philosophical Society, Linnæan Society, Royal Geographical Society, Royal Society of Edinburgh, Muséum d'Histoire Naturelle, Berlin Academy, American Philosophical Society, Geological Society of France, Academy of Natural Sciences of Philadelphia, Natural History Society of Geneva, and of the Royal Society of Lisbon.

The Board of Ordnance continues to present to the Society the Maps of the English Trigonometrical Survey, and of the Townland Survey of Ireland. The Committee deem it necessary to call attention to the presentation of the Charts of the Depôt-Général de la Marine of Paris, in return for a set of the Society's Transactions presented by the Council.

EDWD. TURNER.
J. FORBES ROYLE.

Comparative Statement of the Number of the Society at the close of the years 1834—1835.

Fellows.	31st Dec. 1834.	31st Dec. 1835.
Having compounded	84	90
Contributing	229	232
Non-residents	328	348
	641	670
Honorary	44	44
Foreign Members	57	57
Personages of Royal Blood	3	3
	745	774

The following Persons were elected Fellows of this Society during the Year 1835.

January 7th.—James Pulleine, Esq. M.A. Cambridge, of King's Bench Walk, Temple; and Thomas Starkie Thomson, of Primrose, near Clitheroe.

January 21st.—Edward William Brayley, Esq. Librarian to the London Institution.

February 4th.—A. B. Cowie, M.D. of Mecklenburgh-street; William Moody, Esq. of King's Bench Walk, Temple; Samuel Jones Loyd, Esq. of New Norfolk-street, Park-lane; and Alexander Nasmyth, Esq. of George-street, Hanover-square.

February 25th.—The Rev. William Thornton, of Brockhall, Northamptonshire; Lord Adare, of Adare, in the county of Limerick; and Thomas G. Parry, Esq. of Trinity College, Cambridge.

March 11th.—Richard Atkinson, Esq. M.A. of Trinity College, Cambridge, and of Old-square, Lincoln's Inn; and the Rev. Ralph Lyon, M.A. of Trinity College, Cambridge, and of Sherborne, Dorset.

March 25th.—William Tite, Esq. Honorary Secretary to the London Institution; Lieut. Cautley, of the Bengal Artillery, Superintendent of the Doab Canal; William Hulton, Esq. of Hulton in Lancashire; and George Edward Eyre, Esq. of Lincoln's Inn Fields.

April 8th.—Edward Bellasis, Esq. of New-square, Lincoln's Inn; and Henry English, Esq. of New Broad-street.

April 29th.—John Wiggins, Esq. of Tavistock-place; Geo. Vaughan, Esq. of Cumberland-terrace, Regent's Park; Lord Abinger, of Spring-gardens; and Christopher Puller, Esq. M.A. Barrister-at-Law.

May 13th.—George Thomas Nicholson, Esq. of Waverley Abbey, near Farnham.

June 10th.—Frederick Ayrton, Esq. Lieut. of the Bombay Artillery; and John Cowley Fisher, Esq. of Woodhall, near Cockermouth, Cumberland.

November 4th.—William Sisson, Esq. of Parliament-street; and William Forster, Esq. of Bridport.

November 18th.—Thomas Sopwith, Esq. of Newcastle-upon-Tyne; Frederick John Bell, Esq. of Oxford-street; David Urquhart, Esq. of Grafton-street, Bond-street; and Lieut.-Col. Aitchison, of the Fusileer Guards, Piccadilly.

December 2nd.—Edward Lewis Richards, Esq. of Pyle, Glamorganshire; The Rev. Edward Thomas Daniell, of Park-street, Grosvenor-square, and of Balliol College, Oxford; John Hare, jun. Esq. of Bristol; Henry Leach, Esq. of Milford Haven, Pembrokeshire; and M. Vander Maelen, Proprietor of the Geographical Institute at Brussels.

December 16th.—Lord Charles Harvey, of Trinity College, Cambridge; James Brogden, Esq. M.A. of Trinity College, Cambridge, and of Lower Brooke-street; George Woods, Esq. of East Dulwich; Henry Thomas, Esq. of Cushion-court, Broad-street; Edward Charlesworth, Esq. of 3, Devonshire-square; Rev. Leonard Jenyns, M.A. of Swaffham Bulbeck, Newmarket; Charles Cardale Babington, Esq. M.A. of St. John's College, Cambridge; Charles James Fox Bunbury, Esq. of Great Barton, Suffolk; and James Edmonstone, Esq. of George-square, Edinburgh.

The names of the Fellows deceased are as follows:—

Compounders none.

Residents (6), H. H. Goodhall, Esq.; Viscount Milton; William Smith, Esq.; H. Trollope, Esq.; Sir George Tuthill, M.D.; Pelham Warren, M.D.

Non-residents (6), David Douglas, Esq.; Alexander Logan. Esq.; Grenville Lonsdale, Esq.; Edward Mammatt, Esq.; J. R. Underwood, Esq.; John Vetch, M.D.

The Museum has received many Donations since the last Anniversary, among which are included the following:—

British and Irish Specimens.

A Specimen of flexible Magnesian Limestone from Sunderland, and Fossils from the Lower Greensand; presented by John Willimott, Esq. F.G.S.

Fossils from Blackdown; presented by Sir Philip Grey Egerton, Bart. M.P. V.P.G.S., and Viscount Cole, M.P. F.G.S.

Fossils from the Silverdale Mines, Staffordshire; presented by Sir Philip Grey Egerton, Bart. V.P.G.S.

Specimens from Portland; and Fossils from the Strata below the Chalk in Buckinghamshire and Oxfordshire; presented by William Henry Fitton, M.D. F.G.S.

British Minerals; presented by J. H. Holdsworth, Esq. F.G.S.

Specimens from the Pennant Grit and Dolomitic Conglomerate near Bristol; presented by George Cumberland, Esq. Hon. Mem. G.S.

A Specimen of Silicified Wood from Chicksgrove quarry; a Fossil Fish from Ladydown, Vale of Wardour; Fossils from the Mountain Limestone near Frome, and from Wiltshire, Blackdown, and Bognor; presented by Miss Benett, of Norton House near Warminster.

Casts of an Occipital Bone, and the anterior Cervical Vertebræ of the Ichthyosaurus lately found at Lyme Regis; presented by H. Warburton, Esq. M.P. F.G.S.

Fossils from the Coal-measures near Keighley in Yorkshire; presented by the Rev. Thomas Drury.

Bones from the Diluvium at Lawford; presented by the Rev. William Thornton, F.G.S.

Spirolinites in Chalk Flints from Stoke near Chichester; presented by the Marquis of Northampton, F.G.S.

Specimens from the Arigna Mines; presented by John Rofe, jun. Esq, F.G.S.

A Trilobite from the Dudley Limestone; presented by John Rofe, Esq.

Fossils from the Inferior Oolite of Leckhampton-hill, and from the neighbourhood of Cheltenham; presented by Capt. Mudge, Royal Engineers, F.G.S.

Fossils from the Chalk at Gravesend; presented by Joseph Prestwick, jun. Esq. F.G.S.

Specimens from the Elephant bed in the neighbourhood of Brighton, and of Fishes from the Chalk of Sussex; presented by Gideon Mantell, Esq. F.G.S.

Ammonites perarmatus from the Coral Rag; and Fossils from the Chalk and Upper Greensand; presented in the name of the late Mrs. Kenyon, by J. Kenyon, Esq. F.G.S.

Fossils from the Chalk and the Plastic Clay near Chatham; presented by G. S. Nicholson, Esq. F.G.S.

A Slab of New Red Sandstone, with impressions of Fishes, from Rhonchill near Dungannon; presented by Thomas Green, Esq.

Specimens of Boulders from the Gravel at Ballingdon Hill, Essex; presented by J. Brown, Esq.

Fossils from the Chalk of Beachy Head and from the Hastings Beach; presented by Woodbine Parish, Esq. Sec. G.S.

Fossil Fishes from the Coal Measures of Wardie near Newhaven; Stoney Hill near Musselberg; and the Edmonstone Colliery near Stoney Hill; presented by Major-General Lord Greenock, F.G.S.

Remains of a recent Sheep imbedded in indurated Clay; presented by Messrs. Francis, White, and Francis.

Fossils from the Limestone Shale of Pembrokeshire; presented by the Earl of Cawdor, F.G.S.

Specimens of Selenite from the Sands of the Plastic Clay at Bishopstone Cliff near Herne Bay; presented by William Richardson, Esq. F.G.S.

Fossils from the Grauwacké Slate of Cornwall; presented by H. T. De la Beche, Esq. For. Sec. G.S., in the name of the Ordnance Geological Survey.

Fossils from the Grauwacké Slate near Bodmin; presented by Dr. Potts.

Earthy Phosphate of Iron from Boyland near Long Stratton, Norfolk; presented by Mr. Samuel Woodward.

Specimens of the Sienitic Veins in the Mica Slate at Goodland Cliff, and the Chalk of Torr Eskert, county of Antrim; presented by R. Griffith, Esq. F.G.S.

Fossils from Bognor; presented by James Laird, M.D. F.G.S.

Specimens of Sandstone, with vegetable impressions, from the neighbourhood of Whitfield; presented by the Rev. J. H. Scott, F.G.S.

Fossil Plants from the Coal Measures at Barnsley, Yorkshire; presented by William Taylor, Esq. F.G.S.

Foreign Specimens.

Franklinite from New Jersey; and Shelly Ironstone from Lake Möllor, between Hamburgh and Lubeck; presented by John Willimott, Esq. F.G.S.

Casts of Bones of the *Megalonyx laqueatus* from Big-bone Cave in Tennessee; presented by Richard Harlan, M.D.

Shells of existing species from the newer Pliocene Deposits in the Baltic; and Rock Specimens from Teneriffe: presented by Charles Lyell, jun. Esq. P.G.S.

Specimens from Chili, Peru, and the Island of Fernandez; presented by H. Cuming, Esq.

Specimens from the Island of Ascension, the Mauritius, &c.; presented by the Rev. W. P. Hennah.

Impressions of Fern Leaves on Shale from the Grit Formation near Hoderitz; presented by M. John B. Batka of Prague.

Minerals and Rock Specimens from Norway; presented by M. H. Ström.

A collection of Specimens from the Virgin Islands made by M. Schomburgh, by direction of the Royal Geographical Society; presented by the President and Council of the Royal Geographical Society.

Specimens from the Cerro de Pasco, collected by Don Mariano Rivero; presented by the Collector.

Specimens from Beauvais; presented by Gideon Mantell, Esq. F.G.S.

A Specimen of Elba Iron Ore; presented in the name of the late Mrs. Kenyon, by John Kenyon, Esq. F.G.S.

Fossils from Neuchâtel; presented by Prof. Agassiz.

Specimens from the Volcanic districts of the Rhine; presented by Lieut. Nelson, Royal Engineers.

Fossils from Cerigo; presented by Lord Nugent.

Fossil Vegetable Remains from the Coal Mines at Sydney, Cape Breton; presented by J. B. Ford, Esq.

A set of Teeth of the Gangetic Crocodile; presented by N. T. Wetherell, Esq.

Fossils from Malta; presented by — Collins, Esq.

Fossils from Van Diemen's Land; presented by Richard W. Hay, Esq.

Specimens from the Isle of Ascension; presented by Mrs. Warren, in the name of the late Dr. Warren.

Foreign Minerals; presented by J. H. Holdsworth, Esq. F.G.S.

Miscellaneous.

A Specimen Basket; presented by Capt. Chapman, R.N.

The Library has been increased by the Donation of about 100 Books and Pamphlets.

Charts and Maps.

Nos. 46, 52, and 63 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.

N. E. Quarter Sheet of the 63rd Sheet of the Ordnance Survey of England, coloured Geologically, by Henry Still, Esq.; presented by H. Still, Esq.

Ordnance Townland Survey of the counties of Fermanagh, Down, and Armagh; presented by Lieut.-Col. Colby, by direction of His Excellency the Lord Lieutenant of Ireland.

A Mineralogical and Geological Map of the Coalfield of Lancashire, with parts of Yorkshire, Cheshire, and Derbyshire, by Elias Hall; presented by Mr. Elias Hall.

The Depôt Générale de la Marine of Paris has presented the following collections of Charts:—

1. Le Pilote Français, 3 volumes; 2. Exposé des Travaux relatifs à la Reconnaissance des Côtés Occ. de France; 3. Mémoire sur les Attérages des Côtés Occ. de France; 4. Le Pilote de la Corse (34 Cartes et Plans en feuilles); 5. L'Atlas de la Martinique (9 Cartes et Plans en feuilles); 6. Description nautique des Côtés de la Martinique; 20 Cartes et Plans en feuilles.

Esquise Orographique de l'Europe, par O. N. Olsen, en 1830; presented by M. O. N. Olsen.

Carte Géologique du Départment de la Manche, par M. A. De Caumont; presented by M. A. De Caumont.

A rough sketch by Nöggerath of the part of the Eifel between Adenau and Witlick; presented by Lieutenant Nelson, Royal Engineers.

The Third Part of the Third Volume, and the First Part of the Fourth Volume of the Society's Transactions have been published since the last Anniversary.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received during the past year.

Academy of Natural Sciences of Philadelphia.
Agassiz, L. LL.D.
American Philosophical Society held at Philadelphia.
Analyst, the Editor of.
Athenæum Club.

Bahama Society for the Diffusion of Knowledge.
Baily, Francis, Esq. F.G.S.
Batka, Herr J. B.
Beaufort, Capt. R.N. Hon. Mem. G.S.
Beke, Charles T. Esq.
Benett, Miss.
Birt, W. R. Esq.
Boblaye, M. Puillon de.
Brayley, E. W. jun. Esq. F.G.S.
Breton, Lieut. R.N. F.G.S.
Brewster, Sir David, F.G.S.
British Association.
Broderip, W. J. Esq. F.G.S.
Bronn, Dr. H. G.
Broun, J. Esq.

Cambridge Philosophical Society.
Cawdor, Earl of, F.G.S.
Charlesworth, Edw. Esq. F.G.S.
Clark, George, Esq.
Clarence Club.
Colby, Lieut.-Col. F.G.S.
Cole, Viscount, F.G.S.
Collins, — Esq.
Connell, Arthur, Esq.
Cumberland, George, Esq. Hon. Mem. G.S.
Cuming, H. Esq.

Daubeny, Charles G. B. M.D. F.G.S.
De Caumont, M. A.
De la Beche, H. T. Esq. For. Sec. G.S.

Depôt Général de la Marine of Paris.
D'Omalius d'Halloy, M.
Drury, Rev. Theodore.

Egerton, Sir Philip Grey, F.G.S.
English, Henry, Esq. F.G.S.

Faraday, Michael, Esq. F.G.S.
Featherstonaugh, G. H. Esq. F.G.S.
Fischer de Waldheim, Gotthelf.
Fitton, W. H. M.D. F.G.S.
Foord, J. B. Esq.
Forchhammer, Dr. G.
Francis, White, and Francis, Messrs.

Geological Society of Dublin.
Geological Society of France.
Grateloup, M.
Green, Thomas, Esq.
Greenock, Major-General Lord, F.G.S.
Griffith, Richard, Esq. F.G.S.
Gumprecht, Herr T. E.

Hay, Richard W. Esq.
Hall, Mr. Elias.
Harlan, Richard, M.D.
Hastings, Charles, M.D. F.G.S.
Hawkins, Thomas, Esq. F.G.S.
Henslow, Rev. J. S. F.G.S.
Herschel, Sir John, F.G.S.
Hibbert, Samuel, M.D. F.G.S.
Hitchcock, Prof.
Hœninghaus, M. Fredk. Wm.
Holdsworth, T. H. Esq. F.G.S.
Hopkins, William, Esq. F.G.S.
Horticultural Society.

Institute of British Architects.
Ireland, His Excellency the Lord Lieutenant of.

Jäger, Dr. G. F.
Jenyns, Rev. Leonard, F.G.S.

Kenyon, John, Esq. F.G.S.
Kielmeyer, Herr C. von.
Kirby, Rev. William, F.G.S.

Laird, James, M.D. F.G.S.
Leeds Philosophical Society.
Lhotsky, Dr. John.
Linnean Society.
London Institution.
Loudon, John Claudius, Esq. F.G.S.
Lyell, Charles, Esq. jun. P.G.S.

Main, Mr. James.
Manchester Mechanics' Institution.
Mandelsloh, Count Fredk. de.
Mantell, Gideon, Esq. F.G.S.
Marcel de Serres, M.
Mariano Rivero, Don.
Master-General and Board of Ordnance.
Mather, Wm. W. Esq.
Morton, Samuel George, M.D.
Mudge, Capt. R. E. F.G.S.
Muséum d'Histoire Naturelle de Paris.

Nattali, Mr.
Necker, L. A. M. For. Mem. G.S.
Nelson, Lieut. R. E.
Nicholson, G. S. Esq. F.G.S.
Northampton, Marquis of, F.G.S.
Nugent, Lord.

Olsen, Capt. R.N.

Parbury and Co.
Parish, Woodbine, Esq. Sec. G.S.
Paxton, Mr. J.
Pentland, J. B. Esq.
Phillips, John, Esq. F.G.S.
Phillips, Richard, Esq. F.G.S.
Potts, Dr.
Prestwich, Jos. jun. Esq. F.G.S.

Rennie, George, Esq. F.G.S.
Repertory of Patent Inventions, Editor of.
Richardson, William, Esq. F.G.S.
Rofe, John, Esq.
Rofe, John, jun. Esq. F.G.S.

Ross, Sir John, R.N.
Royal Asiatic Society of Great Britain and Ireland.
Royal Academy of Lisbon.
Royal Academy of Science at Berlin.
Royal Astronomical Society.
Royal Geographical Society.
Royal Society of London.
Royle, John Forbes, Esq. F.G.S.
Royal College of Surgeons.

Scharf, Mr. G.
Scott, Rev. J. H. F.G.S.
Sheepshanks, Rev. Rich. F.G.S.
Sherwood and Co., Messrs.
Silliman, Benjamin, M.D. Hon. Mem. G.S.
Société de Physique et d'Histoire Naturelle de Paris.
Sopwith, Thomas, Esq. F.G.S.
Sowerby, Mr. G. B. jun.
Statistical Society of London.
Sternberg, Count, Hon. Mem. G.S.
Still, Henry, Esq.
Strickland, Hugh Edwin, Esq. F.G.S.
Ström, H. C. Esq.
Studer, Herr B.

Taylor, William, Esq. F.G.S.
Taylor, Richard, Esq. F.G.S.
Thornton, Rev. William, F.G.S.

Virlet, M. Theodore.
Von Buch, Herr Leopold, Hon. Mem. G.S.

Warren, Mrs.
Walker, Frederick, Esq. F.G.S.
Warburton, Henry, Esq. F.G.S.
Wetherell, N. T. Esq.
Whewell, Rev. William. F.G.S.
Willimott, John, Esq. F.G.S.
Woodward, Mr. Samuel.

Yarrell, William, Esq.
Yates, Rev. James, F.G.S.
Yorkshire Philosophical Society.

Zoological Society.

List of Papers *read since the last Annual Meeting,* February 20, 1835.

February 25th.—A Paper on the Volcanic Strata exposed by a Section made on the site of the New Thermal Spring discovered near the Town of Torre del Annunziata in the Bay of Naples, with some remarks on the Gases evolved by this and other Springs connected with the Volcanos of Campania; by Prof. Daubeny, M.D.

———— A Letter from Lieut. Freyer, R.N. addressed to C. Lyell, Esq. P.G.S. on the Appearance of Elevation of Land on the west coast of South America.

March 11th.—Description of a Bed of Recent Marine Shells near Elie on the Southern Coast of Fifeshire; by William John Hamilton, Esq. Sec. G.S.

———— Observations on the Diluvium of the vicinity of Finchley, Middlesex; by Edward Spencer, Esq. F.G.S.

March 25.—Remarks on the Structure of large Mineral Masses; and especially on the Chemical Changes produced in the Aggregation of Stratified Rocks during different periods after their Deposition; by the Rev. Professor Sedgwick, F.G.S.

April 8th.—Notice on the Junction of the Portland and the Purbeck Strata on the coast of Dorsetshire; by William Henry Fitton, M.D. F.G.S.

April 8th.—Observations on the Gamrie Ichthyolites, and on the accompanying Red Conglomerates and Sandstones; by Joseph Prestwich, jun. Esq. F.G.S.

April 29th.—Remarks to illustrate Geological Specimens from the West Coast of Africa; by Capt. Belcher, R.N. F.G.S.

———— A Description of some Specimens collected on the Island of Ascension by the Rev. W. P. Hennah, and communicated by the Rev. Richard Hennah, F.G.S.

———— On a Bed of Gravel containing Marine Shells of recent Species, at "The Willington" in Cheshire; by Sir Philip Grey Egerton, Bart. M.P. V.P.G.S.

———— Notice of a newly discovered Gigantic Reptile; by the Rev. Wm. Buckland, D.D. F.G.S.

May 13th.—On the Cretaceous and Tertiary Strata of the Danish Islands of Seeland and Moen; by Charles Lyell, Esq. P.G.S.

———— On a peculiarity of Structure in the neck of Ichthyosauri not hitherto noticed; by Sir Philip Grey Egerton, Bart. M.P. V.P.G.S.

May 27th.—On certain Lines of Elevation and Dislocation of the New Red Sandstone of North Salop and Staffordshire, with an account of Trap Dykes in that Formation at Acton Reynolds near Shrewsbury; by Roderick Impey Murchison, Esq. V.P.G.S.

———— On the Crag of part of Essex and Suffolk; by Edward Charlesworth; communicated by Edward William Brayley, Esq. F.G.S.

June 10th.—Note on the Trappean Rocks associated with the (New) Red Sandstone of Devonshire; by Henry T. De la Beche, For. Sec. G.S. &c.

———— On the Range of the Carboniferous Limestone Flanking the Primary Cumbrian Mountains, and on the Coalfields of the north-west coast of Cumberland, &c.; by the Rev. Adam Sedgwick, F.G.S. Woodwardian Professor in the University of Cambridge, and Williamson Peile, Esq. F.G.S. of Whitehaven.

———— On the occurrence near Shrewsbury of Marine Shells of existing Species in Transported Gravel and Sand resting upon a Peat Bog which contains Imbedded Trees; by Joshua Trimmer, Esq. F.G.S.

———— Description of some Fossil Crustacea and Radiata; by William John Broderip, Esq. F.R.S. F.G.S. &c.

———— A Letter from Sir Philip de Malpas Grey Egerton, Bart. M.P. V.P.G.S. addressed to the President, On the Discovery of Ichthyolites in the south-western portion of the North Staffordshire Coalfield.

———— On the Bones of Birds from the Strata of Tilgate Forest in Sussex; by Gideon Mantell, Esq. F.G.S.

———— Remarks on the Coffin-bone (distal phalangeal) of a Horse, from the Shingle Bed of the newer Pliocene Strata of the Cliffs near Brighton; by Gideon Mantell, Esq. F.G.S.

———— A Letter from Prof. Daubeny, M.D. F.G.S. to the President, On the Mineral Spring lately discovered near Oxford.

November 4th.—A Notice on the Fossil Beaks of four extinct Species of Fishes referrible to the genus Chimæra, which occur in the Oolitic and Cretaceous Formations of England; by the Rev. William Buckland, D.D. F.G.S. Professor of Geology and Mineralogy in the University of Oxford.

——————— On the recent discovery of Fossil Fishes (*Palæoniscus catopterus,* Agassiz,) in the New Red Sandstone of Tyrone, Ireland; by Roderick Impey Murchison, Esq. F.G.S.

——————— A Systematic Enumeration by M. Agassiz of the Fossil Fishes hitherto discovered in England.

November 18th.—A Letter from Dr. Pingel of Copenhagen to the President, containing a Notice of some facts showing the Gradual Sinking of the Coast of Part of Greenland.

——————— Some Notes by Capt. Fitzroy, R.N. read at a Court Martial held at Portsmouth, October 19th, 1835, on Capt. Seymour and his Officers for the Loss of the Challenger Frigate, wrecked on the coast of Chili, near the Port of Conception; communicated to the President by Capt. Beaufort, R.N.

——————— Memoir on the Geological Relations of the South of Ireland; by Thomas Weaver, Esq. F.G.S.

——————— Some Geological Notes made during a Survey of the east and west coasts of South America in the years 1832, 1833, 1834, and 1835, with an account of a Transverse Section of the Cordillera of the Andes between Valparaiso and Mendoza; by T. Darwin, Esq. of St. John's College, Cambridge; and communicated by Prof. Sedgwick, F.G.S.

December 2nd.—A Letter from Capt. Belcher, R.N. F.G.S. addressed to Woodbine Parish, Esq. Sec. G.S. dated 10th of March, 1835, inclosing two others from Lieut. Bowers, R.N. and H. Cuming, Esq.

——————— A Paper on the Effects of the Earthquake Waves on the coasts of the Pacific; by Woodbine Parish, Esq. Sec. G.S.

December 16th.—Notes on the Geology of Denmark, by Dr. Beck of Copenhagen; communicated by the President.

——————— An Extract from a Letter addressed to the President by Hugh Edwin Strickland, Esq. F.G.S. On Currents of Sea Water Flowing into the Land near Argostoli in the Island of Cephalonia.

——————— A Paper on the Occurrence of Fossil Vertebræ of Fish of the Shark Family in the Loess of the Rhine near Basle; by Charles Lyell, Esq. P.G.S.

——————— A Notice on the Occurrence of Selenite in the Sands of the Plastic Clay at Bishopstone near Herne Bay; by William Richardson, Esq. F.G.S.

January 6th, 1836.—A Notice on the Transportation of Rocks by Ice, extracted from a letter addressed to Charles Lyell, Esq. P.G.S.; by Capt. Bayfield, R.N.

——————— A Letter from H. T. De la Beche, Esq. For. Sec. addressed to the President, dated Truro, the 18th of December, 1835, On the Fossils of Schistose Rocks of the North of Cornwall.

——————— A Paper on the Sienite Veins which Traverse Mica

Slate at Goodland Cliff, and Chalk at Torr Eskert, to the South of Fair Head, in the county of Antrim; by Richard Griffith, Esq. F.G.S. & P.G.S. of Dublin.

January 20th.—A Paper on the Geological Structure of Pembrokeshire; more particularly on the Extension of the Silurian System of Rocks into the coast Cliffs of that county; by Roderick Impey Murchison, Esq. V.P.G.S.

February 3rd.—A Paper on the Gravel and Alluvia of South Wales and Siluria as distinguished from a Northern Drift covering Lancashire, Cheshire, North Salop, and parts of Worcester and Gloucester; by Roderick Impey Murchison, Esq. V.P.G.S.

Sums actually Received and Expended,

RECEIPTS.

	£.	s.	d.	£.	s.	d.
Balances in hand January 1, 1835:						
Banker (including 41*l.* 8*s.* 0*d.* Wollaston Fund)	589	5	0			
Accountant	40	0	0			
				629	5	0
Arrears:	£.	s.	d.			
Admission Fees	44	2	0			
Annual Contributions	166	3	6			
				210	5	6
Ordinary Income:	£.	s.	d.			
Annual Contributions	548	12	6			
Admission Fees: £. s. d.						
Residents 119 14 0						
Non-Residents 126 0 0						
	245	14	0			
				794	6	6
Compositions				189	0	0
	£	s.	d.			
Subscriptions to Alteration Expenditure during the year	35	11	0			
Ditto Arrears	39	2	0			
				74	13	0
	£.	s.	d.			
Transactions sold during 1835	216	7	0			
Ditto during 1834, paid for in 1835	0	16	0			
				217	3	0
Proceedings				10	14	0
Wollaston Donation Fund, Interest on 1084*l.* 1*s.* 1*d.*				32	10	4
Dividends, 500*l.* 3 per cent. Consols, 12 months	15	0	0			
Ditto 300*l.* 3 per cent. Red, 6 months	4	10	0			
				19	10	0
				£2177	7	4

during the Year ending December 31, 1835.

PAYMENTS.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Bills outstanding:				£.	s.	d.	£.	s.	d.
Salaries and Wages				109	19	6			
House Expenses				9	15	2			
Taxes				9	15	0			
Tea and Waiters				6	6	9			
Scientific Expenditure				0	19	11			
Sewers Rates for 1833 and 1834				6	0	0			
Repairs of House				0	7	0			
Stationery				0	18	6			
Alteration Expenditure				119	16	4			
							263	18	2
General Expenditure:				£.	s.	d.			
Household Furniture				26	10	3			
Repairs of House				13	0	1			
House Expenses				168	11	2			
Taxes, Parochial	19	15	0						
——, King's	21	19	8						
				41	14	8			
Insurance				6	0	0			
							255	16	2
Salaries and Wages:				£.	s.	d.			
Curator and Assistant				200	0	0			
Clerk				75	0	0			
Porter, Housekeeper, and Servant				125	0	0			
Collector's Poundage				38	7	6			
							438	7	6
Scientific Expenditure							89	13	9
Stationery and Miscellaneous Printing							48	15	6
Investment in the Funds							273	7	6
Tea for Meetings							49	11	6
Cost of Publications:				£.	s.	d.			
Transactions				229	9	2			
Proceedings				53	4	3			
							282	13	5
Contribution overpaid							3	3	0
Award of Wollaston Medal, and proceeds to Mr. Mantell							32	10	0
Balance in hand Jan. 1, 1836:				£.	s.	d.			
Banker (including 41*l.* 8*s.* 4*d.* Wollaston Fund)				399	10	10			
Accountant				40	0	0			
							439	10	10
							£2177	7	4

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, A. MARTIN, FRANCIS BAILY, } AUDITORS.

Feb. 1, 1836.

VALUATION *of the Society's Property; 31st December* 1835.

PROPERTY.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 41*l.* 8*s.* 4*d.* Wollaston Fund				439	10	10
Arrears due to the Society:						
Admission Fees	136	10	0			
Annual Contributions	453	1	6			
Subscriptions	33	2	0			
Transactions	5	7	0			
Proceedings	1	8	0			
				629	8	6
Estimated value of unsold Transactions	590	7	0			
——— Proceedings	10	0	0			
				600	7	0
500*l.* Stock, 3 per cent. Consols (90)	450	0	0			
300*l.* Stock, 3 per cent. Red. (90)	270	0	0			
				720	0	0
				£2389	6	4

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.*]

JOHN TAYLOR, TREASURER.

DEBTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes (estimated)	10	0	0			
Sewer's Rates (estimated)	5	0	0			
				15	0	0
Cash belonging to the "Wollaston Fund"				41	8	4
Arrears not likely to be received				230	0	0
Balance in favour of the Society				2102	18	0
				£2389	6	4

Estimates *for the ensuing Year*, 1836.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31, 1835. (See valuation sheet)				629	8	6
Ordinary Income of 1836 (estimated):						
Annual contributions of 165 Fellows				529	15	0
Admission Fees:						
Residents (20)	126	0	0			
Non-Residents (15)	157	10	0			
				283	10	0
Sale of Transactions				275	0	0
—— Proceedings				10	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends, 500*l.* 3 per cent. Consols	15	0	0			
Ditto 300*l.* —— Red.	9	0	0			
				24	0	0
Subscriptions to Alteration Fund				10	0	0
				1794	3	10
Balance against the Society				25	11	6
				£1819	15	4

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31, 1835. (See valuation sheet)				15	0	0
General Expenditure:						
Repairs of House	20	0	0			
Taxes	50	0	0			
Insurance	6	0	0			
House Expenses	175	0	0			
Household Furniture	50	0	0			
				301	0	0
Salaries and Wages:						
Curator and Assistant	181	5	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant	125	0	0			
Collector's Poundage	40	0	0			
				421	5	0
Scientific Expenditure				75	0	0
Stationery and Miscellaneous Printing				65	0	0
Tea for Meetings				55	0	0
Cost of Publications:						
Transactions	550	0	0			
Proceedings	75	0	0			
				625	0	0
Arrears not likely to be received				230	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				£1819	15	4

The Reports having been read, it was resolved :—

That these Reports be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows of the Society.

The President then announced the award of the Wollaston Medal and Proceeds for the past year; and, in doing so, said,

Gentlemen,

You have learnt from the Report of the Council that the Wollaston Medal has been awarded to Mr. Agassiz of Neuchatel for his work on Fossil Ichthyology, and that the sum of *25l.* from the Donation Fund has been awarded by the Council to Mr. Deshayes in promotion of his labours in fossil conchology. I shall now proceed to request Mr. Broderip to communicate this adjudication to his friend Mr. Agassiz, and I shall deliver in charge to our Foreign Secretary, Mr. De la Beche, the sum which has been voted to Mr. Deshayes.

The President then addressed Mr. Broderip in these words :—

Mr. Broderip,

I have great pleasure in requesting you to inform Mr. Agassiz, of Neuchatel, that the Council of the Geological Society have awarded the Wollaston Medal to him for his work of last year on Fossil Ichthyology. On a former occasion we presented the proceeds of the Donation Fund for one year to the same distinguished naturalist, to assist him in the publication of the early part of his great work, the importance of which was then only beginning to be known to the scientific world.

It will ever be a subject of gratification to us to have learnt that this small pecuniary aid was not without its influence in accelerating the publication of his "Researches on Fossil Fish," arriving as it did opportunely at a moment when the funds which could be appropriated for the undertaking were nearly exhausted. Mr. Agassiz acknowledged at the time his obligation to us for a mark of sympathy and regard which he received so unexpectedly from a foreign country, and which cheered and animated him to fresh exertions. You will have the kindness to acquaint him that the Council in now awarding the Medal to him, are desirous that he should possess a lasting testimony of their esteem and of the high sense which they entertain of the merit of his scientific labours.

Mr. Broderip replied,—

Sir.—I accept the trust: and permit me, on the behalf of Professor Agassiz, to offer his best thanks to the Society for the seal which it has this day set on the powerful zoological lever which he has placed in the hands of Geologists.

This crowning gift will be doubly precious to him when he reflects on the high character of those who have awarded it, and hears of the expressions with which you, Sir, have been pleased to accompany it.

These, he will feel, are the incentives

> "that the clear spirit do raise
> To spurn delights and live laborious days."

He will look upon the illustrious head that gives dignity to the gold—upon the representation of "that dark eye" before whose glance as it has been eloquently said by one of your predecessors, all false pretensions withered—and the sight will inspire him with new energies.

The President then addressed Mr. De la Beche in these words :—

Mr. De la Beche,

It is now my duty to deliver into your hands as Foreign Secretary of this Society the sum of *25l.*, and it is with great satisfaction that I request you to inform Mr. Deshayes of Paris that this portion of the proceeds of the Wollaston Donation Fund has been awarded to him by the Council for the promotion of his labours in Fossil Conchology. I beg that you will express to Mr. Deshayes at the same time how highly we appreciate the services which he has already rendered to Geology by his description of the fossil shells of the strata above the chalk, to which he has chiefly, although not exclusively, devoted his attention ; and we rejoice to hear that he is now engaged in the investigation of the fossil shells of the older formations.

We are not ignorant that he has prosecuted his scientific studies with zeal and enthusiasm under circumstances of considerable difficulty ; and we trust that the notice thus taken of his labours may encourage him to persevere in devoting the powers of his mind and his great acquirements to a department of science so eminently subservient to the advancement of Geology.

Mr. De la Beche on receiving the donation expressed the pleasure which it gave him to be requested to communicate the intelligence to Mr. Deshayes, and the satisfaction which he felt in publicly avowing his approbation of the award of the Council.

It was afterwards resolved :—

1. That the thanks of this Society be given to Roderick Impey Murchison, Esq. and Henry Warburton, Esq. retiring from the office of Vice-President.

2. That the thanks of this Society be given to George William Aylmer, Esq. ; Arthur Kett Barclay, Esq. ; John Henry Vivian, Esq. ; Sir Richard Vyvyan, Bart. ; and the Rev. James Yates, retiring from the Council.

On the balloting glasses having been duly closed, the scrutineers announced that the following gentlemen had been elected the Officers and Council for the ensuing year.

OFFICERS.

PRESIDENT.

Charles Lyell, jun. Esq. F.R.S & L.S.

VICE-PRESIDENTS.

Rev. William Buckland, D.D. F.R.S. Professor of Geology and Mineralogy in the University of Oxford.
Sir Philip de Malpas Grey Egerton, Bart. M.P. F.R.S.
George Bellas Greenough, Esq. F.R.S. & L.S.
Edward Turner, M.D. F.R.S. L. & E. Professor of Chemistry in the University of London.

SECRETARIES.

William John Hamilton, Esq.
Woodbine Parish, jun. Esq. F.R.S.

FOREIGN SECRETARY.

Henry Thomas De la Beche, Esq. F.R.S. & L.S.

TREASURER.

Tohn Taylor, Esq. F.R.S.

COUNCIL.

Francis Baily, Esq. F.R.S. & L.S.
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William Clift, Esq. F.R.S.
Sir A. Crichton, M.D. F.R.S.
William Henry Fitton, M.D. F.R.S. & L.S.
Henry Hallam, Esq. F.R.S.
Robert Hutton, Esq.
Roderick Impey Murchison, Esq. V.P.R.S. F.L.S.
Viscount Oxmantown, F.R.S.
John Forbes Royle, Esq. F.L.S.
Rev. Adam Sedgwick, Woodwardian Professor in the University of Cambridge, F.R.S. & L.S.
Lieut.-Col. W. H. Sykes, F.R.S. & L.S.
Henry Warburton, Esq. M.P. F.R.S.
Rev. William Whewell, F.R.S. & L.S.

Address to the Geological Society, delivered at the Anniversary, on the 19th of February, 1836, by Charles Lyell, Jun., Esq., *President.*

Gentlemen,

You have learnt this morning, from the annual report of the Council, that the financial affairs of the Society continue to flourish; and that since our last anniversary we have published the concluding part of the third volume of our Transactions, and the first part of a fourth volume. Another part of the same volume is nearly ready, and the Council have directed their thoughts seriously to the means of preventing, in future, the accumulation of such heavy arrears of unpublished memoirs. The delays have hitherto arisen from a desire to print all papers containing original and valuable matter in the order in which they were presented; but many have been sent to us in so unfinished a state as to retard the printing of the rest, and, as the science advances rapidly, and new facts pour in daily, the authors even of the most finished memoirs soon require to make additions and corrections, and thus the evil is continually augmenting. The Council have therefore resolved, for the future, to print at once those memoirs which are in the most complete state, without waiting for others which are imperfect.

During the last year there have been elected into the Society 45 new members, and we have lost 4 by resignations and 12 by deaths. Among the names of the deceased Fellows I may mention those of Mr. Goodhall and Mr. Mammatt as having zealously contributed to the progress of our science. Mr. Goodhall was an active collector of British fossils, and to his labours we owe many valuable contributions to our museum, and the discovery of shells of new species figured in Sowerby's Mineral Conchology. The work of Mr. Mammatt, on the Coal-field of Ashby-de-la-Zouch, has been honourably mentioned by my predecessor Mr. Greenough, in his last anniversary speech. Mr. Mammatt had superintended, for more than thirty years, the working of extensive coal mines, and kept a record of the details of various sections with which he was practically acquainted. To these documents he has added several plans of remarkable faults which intersect the carboniferous strata of Leicestershire. He has shown that on one side of one of these faults the beds rise to the height of 500 feet above the corresponding beds on the other side, yet the mass of uplifted strata does not project above the general level of the country. He infers, therefore, that it has been removed by denudation, and that the wreck of it alone now remains on the surface in the shape of sand and boulders. Mr. Conybeare has drawn similar conclusions respecting analogous phænomena observed on a still greater scale in the Newcastle coal district.* Whether the denudation was sudden or gradual, or whether the faults were produced at once or were the result of a series of

* Report on Geology to the British Association, 1832.

movements, are points which the limits of this discourse will not allow me to discuss at present. Mr. Mammatt contends that these enormous shifts were not effected by volcanic convulsions, but simply by a quiet and uniform operation accompanying the desiccation, shrinking, and induration of dense masses of argillaceous and other rocks, an opinion which, however ingenious, seems irreconcileable with the evidence of violent disruption with which this and other coal-fields abound. Mr. Mammatt's volume is illustrated by more than one hundred plates of fossil plants, but it is much to be regretted that before executing such costly illustrations the author did not obtain the assistance of a skilful botanist, who might have selected the most important and might have added descriptions, without which mere figures can scarcely ever convey accurate information.

Early in the spring of last year an application was made by the Master General and Board of Ordnance to Dr. Buckland and Mr. Sedgwick, as Professors of Geology in the Universities of Oxford and Cambridge, and to myself, as President of this Society, to offer our opinion as to the expediency of combining a geological examination of the English counties with the geographical survey now in progress. In compliance with this requisition we drew up a joint report, in which we endeavoured to state fully our opinion as to the great advantages which must accrue from such an undertaking, not only as calculated to promote geological science, which would alone be a sufficient object, but also as a work of great practical utility, bearing on agriculture, mining, road-making, the formation of canals and rail-roads, and other branches of national industry. The enlightened views of the Board of Ordnance were warmly seconded by the present Chancellor of the Exchequer, and a grant was obtained from the Treasury to defray the additional expenses which will be incurred in colouring geologically the Ordnance county maps. This arrangement may justly be regarded as an economical one, as those surveyors who have cultivated geology can with small increase of labour, when exploring the minute topography of the ground, trace out the boundaries of the principal mineral groups. This end, however, could only be fully accomplished by securing the cooperation of an experienced and able geologist, who might organize and direct the operations: and I congratulate the Society that our Foreign Secretary, Mr. De la Beche, has been chosen to discharge an office for which he is so eminently qualified.

At the same time that measures are thus in train for completing a Geological Map of England on a magnificent scale, the Map of Scotland, by Dr. MacCulloch, which has been so long and impatiently expected, is at length on the eve of publication. But at the moment when I can announce this welcome intelligence we have to deplore the sudden loss of this distinguished philosopher. The first paper in the first volume of our Transactions was from the pen of Dr. MacCulloch, and subsequent volumes contain no less than eighteen of his memoirs. It would lead me far beyond my present limits were I to attempt to give a general analysis of these, and of his numerous other works on geology, such as his Western Islands and his Classification of Rocks. The influence exerted by them on the progress of our science has been powerful and lasting, yet they have been less generally admired and studied than they deserve. Their popularity has been impaired by a want of condensation and clearness in the style, a defect which no one could more easily have remedied than the author, had he been willing to submit to the necessary labour. Another blemish has also contributed to give a repulsive character to some of his later productions, especially his System of Geology, the absence, or apparent absence, of all enthusiasm and love for his subject, and a disposition to neglect or speak slightingly of the labours of others, and even to treat in a tone bordering on ridicule some entire departments of science connected with geology, such as the study of fossil conchology. I attribute these imperfections principally to habitual ill health acting upon a sensitive mind, for certainly, Dr. MacCulloch's spirits were much depressed by bodily sufferings when I had first the pleasure of knowing him, about the year 1825. His imagination was then haunted with the idea that his services in the cause of geology were undervalued, and it was in vain to combat this erroneous impression. After that period he almost entirely withdrew himself, even when residing in London, from all personal intercourse with the most active geologists; and to those who knew him this seclusion from scientific society was a subject of frequent regret. Having expressed myself thus unreservedly on some of the peculiarities and defects of his style, I may affirm that as an original observer Dr. MacCulloch yields to no other geologist of our times, and he is perhaps unrivalled in the wide range of subjects on which he displayed great talent and profound knowledge. For myself I may acknowledge with gratitude that I have received more instruction from his labours in geology than from those of any living writer.

One of the most important communications which we have received for many years is an essay by Professor Sedgwick on the changes of structure produced in stratified rocks after their deposition. Respecting the magnesian limestone, he has confirmed by new arguments the conclusions which he formerly drew, in proof that the complicated concretions of this rock have been produced since the original deposition of the beds. But the principal part of his memoir is devoted to the description of the cleavage or slaty structure of rocks, and those partings which have been called joints. The author first shows the analogy of the Cumbrian zone of green slate and porphyry with the structure of the principal chain of North Wales. In these regions, as in part of the slaty series of Westmoreland and Lancashire, occur many beds exhibiting a slaty cleavage, which the Professor distinguishes from a jointed structure. Joints, he says, are fissures placed at definite distances from each other, the masses of intervening rock having no tendency to cleave in a direction parallel to such fissures: whereas in the planes of cleavage, the rock is capable of indefinite subdivision in a direction parallel to such planes. The planes of stratification, on the other hand, are perfectly distinct from both, and throughout the district alluded to have never been found to coincide with the lines of cleavage, dipping sometimes to the same point and sometimes to opposite points of the compass, but being always inclined to them at an angle of from 10° to 30° or 40°, and in no instance at 90°. There are regions in North and South Wales thirty miles in extent, and many miles in breadth, where the cleavage planes preserve an undeviating dip and direction notwithstanding that they traverse strata which are greatly contorted.

In that variety of slate-rock which is used for roofing, all traces of original deposition or stratification are often obliterated; yet in many quarries, a number of parallel stripes are discovered, sometimes of a lighter and sometimes of a darker colour than the general mass. These stripes, says the Professor, are universally parallel to the true beds, whenever such beds can be discovered, whether by organic remains, by the alternations of similar deposits, or other ordinary means. Many of these beds are of a coarse mechanical structure, others are fine chloritic slate; but the coarser beds and the finer, the twisted and the straight, have all been subjected to one change, a crystalline cleavage passing alike through all. Some of the sections given show the cleavage planes preserving an almost geometrical parallelism while they pass through curved strata, of which the sedimentary origin is obvious. In another place it is said that where the slaty cleavage is very perfectly brought out the rocks always make an approach to homogeneity, but where the coarse beds predominate the slaty structure almost entirely disappears. Dr. Boase in his comments on these passages has remarked that they seem inconsistent with each other, and I confess that at first they struck me in the same light; but the Professor has explained to me that although the coarse beds are not slaty, they have a grain parallel to the cleavage planes of the finer beds, this grain being exhibited when they are struck with the hammer; and it is only when the materials of the beds are very coarse that the cleavage planes entirely vanish.

In regard to the origin of these phænomena, the author supposes that crystalline or polar forces must have acted on the whole mass simultaneously in given directions, and that the action being carried on at once through a very large mass of matter may have acquired an accumulated intensity of crystalline action in each part, so that the whole intensity of crystalline force, modifying the mass, may not have been equal to the sum of the forces necessary to crystallize each part independently, but may have been some function of that sum whereby it may have been increased almost indefinitely.

I regret that I have not space to do justice to this ingenious speculation, nor have I yet had sufficient opportunities of observation to know whether we shall be able to distinguish generally, with precision, those slates which are diagonal to the strata, from those flagstone-slates, as it is proposed to term them, which are parallel to the layers of deposition. During the last summer I observed in the Swiss Alps that the fissile roofing-slate and drawing-slate of the Niesen, in the Canton of Berne, divides into extremely thin laminæ, which are *parallel* to the true planes of stratification. The direction of the beds is shown by alternations of coarse and clearly mechanical strata of a kind of greywacke, the whole series belonging to the Green Sand or fucoid grit formation. If it be said that these slates may owe their laminated texture to extremely minute flakes of talc, mica, or some other foliated mineral which may have fallen as sediment and have been all deposited on their flat surfaces, I reply, that in that case they would exemplify the exact similarity of certain acknowledged slates of deposition to others which have originated in crystalline forces independent of sedimentary action. Mr. Murchison, after confirming the truth of the Professor's observations as applied to all those regions of Wales which have come within his survey, has pointed out what might by some be considered an exception to the rule in a part of the slate-rocks of Pembrokeshire, where the planes of slaty cleavage are coincident with the true laminæ, as proved by colour and the alternation of various layers of deposit. Mr. Murchison states, however, that although these rocks are quarried as roofing-slates, and are a part of the older system, they may be classed by Mr. Sedgwick as fine flagstones.

Some confusion will, I fear, arise from attempting to restrict the term slate to those cases alone where the cleavage is oblique to the stratification; but whatever nomenclature we adopt, it is clear from the excellent paper of the Professor, that three distinct forms of structure are exhibited in certain rocks throughout large districts: namely, first, stratification; secondly, joints; and thirdly, slaty cleavage; the last having no connexion with true bedding, and being superinduced by a cause absolutely independent of gravitation. These different structures must have different names, even though there may be cases, and I believe there will be many, where it is impossible, after carefully studying the phænomena, to decide upon the class to which they belong.

One curious consequence, but slightly alluded to by the author, appears to follow from the facts described, namely, that the slaty structure must have commenced at a period posterior to the last series of violent movements which dislocated the strata and threw them into anticlinal and synclinal lines. Such disturbances would have deranged the parallelism of the cleavage planes. If, therefore, there are proofs, as I believe there are, of the elevation or subsidence of these rocks since they assumed the slaty structure, the whole country must have been moved bodily, or the separate masses, if they changed their relative position, must have moved in such directions as to allow the dip of the cleavage planes to remain unaltered.

It is with pleasure that I next call your attention to the investigations which Mr. Murchison has been steadily pursuing in the older fossiliferous rocks of Wales and the bordering counties of England. He has at length brought his survey of five years to a successful termination; and his work will form a most important step in the progress of geological science, not merely as elucidating the history of a portion of the sedimentary formations of our island, but as fixing the characters of a succession of normal groups to which the strata of other parts of Europe, and perhaps of America, may be referred. A large and beautifully illustrated treatise, in which he intends to give a detailed description of his original observations and views, will soon be published. In the mean time we have tasted, as it were by anticipation, the fruits of his labours, having, year after year, received at our meetings the earliest intelligence of his discoveries, and having freely discussed and criticized them long before it has been possible for him to lay the whole in a matured and digested form before the public. You are aware that the system of rocks, which have been the chief object of his research, constitutes the upper part of what was formerly called the transition or greywacke series. In these strata, which had previously remained in a state of obscurity and confusion, he has distinguished several formations. The old red sandstone rests conformably on the uppermost of these, while the lowest of them repose both conformably and unconformably on the ancient slate-rocks of Wales. Mr. Murchison proposes the general name of "Silurian" for this whole system, as the strata may best be studied in those parts of England and Wales once occupied by the ancient British nation the Silures.

The necessity of a new term has arisen from the uncertain latitude with which the word "transition" had been applied, some authors including in it the carboniferous rocks, and also from the still greater confusion introduced by the word "greywacke," a term which can only be employed conveniently, in a mineralogical sense, to designate a peculiar kind of rock which has been formed at many successive epochs. Thus, for example, in the memoir now under review, it is shown that in Pembrokeshire grits, which have passed for greywacke, occur in the true coal-measures, in the old red sandstone, in the Silurian, and in the still older systems of rock.

Below the Silurian strata are slate-rocks of older date, in which traces of organic remains have been again detected; and Professor Sedgwick has suggested the name of Cambrian for this more ancient system, which is conterminous over a wide territory with the Silurian formations, the relative position of both being clearly seen.

Mr. Murchison has recently traced the Silurian system running in zones through Pembrokeshire, and there rising out in the coast cliffs from beneath the old red sandstone as conformably as in the interior of the country,—an important verification of the accuracy of his previous determinations. Great lithological changes are, however, observed to take place in these localities, so distant from the best types of the system; thus, the "Ludlow and Wenlock" formations are no longer distinctly separated by subordinate limestones, and are therefore simply termed the "upper Silurian rocks," and these, changing their soft argillaceous characters of "mudstone," become hard sandstones, yet contain some well-known organic remains; whilst the lower Silurian rocks, or Caradoc and Llandeilo formations, not only maintain their usual fossil distinctions, but exhibit limestones of much greater thickness than in any other part of their course. Mr. Murchison has also shown that rocks occupying a large coast tract in Pembrokeshire, which from their mineral aspect had been laid down as "greywacke", consist of true coal-measures. After noticing a ridge of intrusive rocks in Caermarthenshire, between the Towey and the Taf, as connected with certain great lines of dislocation, he points out, in the Cambrian System of Pembrokeshire, examples of the existence of two classes of trap rock, one bedded or contemporaneous, the other amorphous and of posterior intrusion. He further shows that the main directions of the stratified deposits of this county are parallel to divergent zones of trap.

In another paper the same author states that he has lately discovered to the north-west of Shrewsbury, proofs of an eruption of trap posterior to the new red sandstone, and probably to the lias. This line of fissure along which he has observed the new red sandstone affected for a distance of thirty miles is on the precise prolongation of a linear eruption in the Breiddin Hills, which he had previously pointed out as having been in progress during and after the epoch of the deposition of the Silurian strata. The more modern trap is made up of a peculiar felspathic rock identical with some of those at the great vent of eruption fifteen miles distant, where they both alternate with and are intruded into the more ancient deposits.

It appears from these observations that volcanic operations were renewed along the same line after a wide interval of time, showing that we must be on our guard against inferring the synchronism of coincident lines of derangement. The repetition also in the same spot and at two distant periods of a trap identical in mineral character is curious, and reminds me of an opinion lately mentioned to me by Mr. Von Buch, that the composition of lava is often determined by that of preexisting volcanic rocks near the point of eruption. Thus on two opposite sides of the same volcano, as on Teneriffe for example, a trachytic flow of lava will issue from a mass of trachyte, and a basaltic flow from rocks of basalt.

Mr. De la Beche has shown that the trappean rocks are associated in such a manner with the new red sandstone of part of Devonshire,—among other places, near Tiverton and Exeter,—as to indicate that the trap and the sandstone were each in the course of formation at the same period. Some beds of sand present every appearance of having been of volcanic origin, and ejected from a crater, but the sand became mixed with common detrital matter then in process of deposition at the bottom of the sea. Numerous angular fragments, some of them even one or two tons in weight, of quartziferous porphyry with a felspathic base, are intermingled with the conglomerates of the old red sandstone, and do not resemble any trappean rocks discovered in place in this district. Mr. De la Beche conjectures with much probability that these fragments were ejected from volcanic vents, and that they fell upon the sand and pebbles then in the course of deposition around such vents, and were thus included. The author has not failed to show that the original features of the bed of the sea, of the period of eruption alluded to, have been obliterated by subsequent denudation; and I may suggest that this cause has often prevented geologists from recognizing the analogy of trappean phænomena to those of submarine and insular volcanos now active.

In another communication Mr. De la Beche informs us that the "Cornish grauwacké," in which term he here comprises the slates of that country and their associated sandstones and conglomerates, contains in some places organic remains. Specimens of these fossils have been presented by him to our museum. He also states that this greywacke formation, which extends into Somerset and Devon, is older than Mr. Murchison's Silurian system, and may be subdivided into natural sections, coinciding perhaps with some observed by Professor Sedgwick in the Cambrian group. The slates of Tintagel, long since known to be fossiliferous, belong to the same age as this greywacke of Cornwall.

A joint paper by Professor Sedgwick and Mr. Williamson Peile has made us acquainted with the carboniferous limestone flanking the primary Cumbrian mountains, and with the coal-fields of the north-west coast of Cumberland. These carboniferous strata rest unconformably on the primary Cumbrian slates. The carboniferous series is divided into four groups: 1st, The great scar limestone; 2nd, Alternations of limestone, shale, and coal; 3rd, Millstone grit; 4th, Great upper coal formation. It appears that the structure of the carboniferous limestone is nearly the same as that of the Yorkshire chain so admirably described by Professor Sedgwick in the first part of our fourth volume just published.

Mr. Griffith, who has for so many years been preparing a geological map of Ireland, has described to us the position of some veins of syenite which traverse the mica-slate and chalk near Fair Head in the county of Antrim. The syenite is composed of dark green crystallized hornblende and brownish red felspar, with occasional grains of quartz; and the chief point of interest consists in the circumstance that the syenitic veins have the appearance in general of being regular beds in the mica-slate, being for the most part conformable both in strike and dip. They are found, however, when more closely examined and traced for some distance, to deviate from the stratification of the mica-slate, and to have an indented and saw-like edge at their junction. Similar syenitic veins also penetrate through the chalk in the neighbouring part of the coast, and near their contact with the chalk nodules or spheroidal masses of syenite are occasionally observed so isolated and surrounded by chalk that had not the intruding veins clearly proved its posteriority, the syenite might be mistaken for the older rock, rounded fragments of which had been imbedded in the calcareous stratum. These phænomena remind us of the isolated nodules of granite which in Cornwall, the Valorsine, and other countries, occur in the immediate vicinity of granite veins.

I have next to call your attention to an able sketch of the geology of Denmark, which you will find at some length in our Proceedings, from the pen of an eminent Danish naturalist, Dr. Beck, of Copenhagen. He describes in Bornholm, besides the granitic and Silurian rocks, certain strata which appear to agree with our Wealden group in mineral character and fossil plants, some of these being the same as those found in the Hastings sands, although the shells are marine. In Bornholm this formation is characterized by containing coal. The most remarkable feature in the geology of Denmark Proper is the great development of the cretaceous system above the white chalk with nodular flints. In the island of Seeland the ordinary white chalk is covered with a hard yellowish limestone containing some fossils of the white chalk and others peculiar to itself, especially univalves of the genera Trochus, Fusus, Voluta, Oliva, Cypræa, and Nautilus. At Faxoe this rock consists of an aggregate of corals of unknown depth, but certainly more than forty feet thick. When I myself visited the Faxoe quarries in 1834 in company with Dr. Forchhammer, the rock struck me as agreeing with the description usually given of the limestone in recent coral reefs. The fossil zoophytes of Faxoe are often cemented together by white chalk, which may recall to your recollection the recent chalk which Lieut. Nelson has presented to our museum from the coral reefs of the Bermudas. This recent substance is not distinguishable from some of the white marking chalk of England, and like it is composed of pure carbonate of lime. It is in fact a white earthy mud, known to be derived from the decomposition of the softer corallines, such as Eschara, Flustra, and Cellepora. These observations support an opinion which has long been entertained by some geologists that all chalk may be derived from the decomposition of shells and zoophytes.

While on this subject I may mention a discovery made by Mr. Lonsdale during the last summer, and which he has permitted me to announce. In arranging our collection he has found that our common white chalk, especially the upper portion of it, taken from different parts of England, (Portsmouth and Brighton among others,) is full of minute corals, foraminifera, and valves of a small entomostracous animal resembling the Cytherina of Lamarck. From a pound of chalk he has procured, in some cases, at least a thousand of these fossil bodies. They appear to the eye like white grains of chalk, but when examined by the lens are seen to be fossils in a beautiful state of preservation.

According to Dr. Beck there is a whitish and hard chalk above the Faxoe beds almost entirely made up of pulverized zoophytes including bivalves and Echini, chiefly of the same species as those of the white chalk with flints, and with corals like those of Faxoe. There are layers of flint or chert in this upper division. These conclusions, drawn from a careful examination of an extensive series of the Danish fossils, are very important, for it was formerly imagined by Dr. Forchhammer that the Faxoe beds and the overlying chalk belonged to the calcaire grossier, an idea suggested by the generic resemblance of the shells to those of the tertiary deposits. But none of the species, according to Dr. Beck, agree with any known tertiary fossils, and the secondary genera Ammonite and Baculite occur among the Faxoe shells. Some of the Faxoe corals agree with those of Maestricht, and the newest of the cretaceous formations of Seeland and Jutland agree more nearly with those commonly called the Maestricht beds than with any previously known. Dr. Beck, however, says that the organic remains differ on the whole from those of Maestricht, and are more analogous to those found at Künruth near Liege.

The cliffs of Möen, one of the Danish islands, are composed of white chalk with nodular flints. The fossils agree with those of the chalk of England and France, as was shown in the year 1827 by the list of more than one hundred species of them given by Dr. Beck in Leonhard's Taschenbuch der Mineralogie. Two years before, Dr. Forchhammer had published in the Transactions of the Royal Danish Academy his opinion respecting Möen, and extracts from his paper afterwards appeared in the Edinburgh Journal of Science for July 1828. He then considered the Möen chalk to be an integral part of the same tertiary deposit of sand and clay which contains erratic blocks in Denmark; and in confirmation of this opinion he gave sections representing an alternation of chalk with beds of tertiary sand, clay, and loam. Being desirous of inquiring into this singular phænomenon I visited the Möen cliffs in company with Dr. Forchhammer in 1834, and came to a different conclusion. I have explained to the Society my reasons for inferring that the association of the cretaceous and tertiary deposits may be referred to the violent disturbances which the chalk strata have undergone. The cretaceous beds are curved, vertical, or shifted, and, upon the whole, more deranged than the chalk in Purbeck or the Isle of Wight. In fact the movements have been on so great a scale that masses of the overlying clay and sand have subsided bodily into large fissures and chasms, intersecting the chalk to the depth of several hundred feet. Some of the intercalations of clay and sand in the midst of great masses of unconformable chalk can only, I think, be explained by supposing engulfments of superincumbent matter, such as are described to occur during earthquakes. These appearances are analogous to those exhibited by masses of chalk nearly enveloped in crag near Trimmingham in Norfolk, although the Danish phænomena are on a much grander scale. Dr. Forchhammer did not fully concur in these opinions in 1834, but he appears to have since adopted them for the most part, in an excellent memoir on the geology of Denmark, a copy of which has been lately sent by him to the Society, accompanied by a small coloured map of the whole of Denmark and Bornholm.

As the fossils of the upper cretaceous series of Denmark are very peculiar, and of so much interest from their position, I have pleasure in stating that figures and descriptions of them are in the course of publication by Dr. Beck, and I may add that we owe this work to the liberality and the zealous interest taken in our science by an illustrious member of our Society, the Crown Prince of Denmark. The collection of recent shells formed by His Royal Highness and now in his private cabinet,—more extensive perhaps than any other in Europe,—has afforded Dr. Beck the most ample facilities of comparing fossil and recent shells, and from the opportunities thus enjoyed we may look, at no distant period, for results which will materially advance the general progress of fossil conchology.*

Few communications have excited more interest in the Society than the letters on South America addressed by Mr. Charles Darwin to Professor Henslow. Mr. Darwin has devoted four years, from 1832 to 1835 inclusive, to the investigation of the natural history and geology of South America. From the position of the tertiary deposits which exist on both sides of the southern Andes, he concludes that the primary chain must have had a great elevation anterior to the tertiary period. A transverse section from Rio Santa Cruz to the base of the Cordilleras, and another on the Rio Negro exhibit the structure of what Mr. Darwin calls the great southern tertiary formations of Patagonia, which may be separated into groups of distinct periods analogous to those already established in Europe. The lowest group is of great extent and thickness, and in one instance was observed to alternate with a bed of ancient lava, which seemed to mark the commencement of the eruptions from the craters of the principal chain of the Andes. Among the shells and corals, even of this lowest deposit, are some which are supposed to belong to species now living in the neighbouring Pacific. Overlying this is a stratum of rolled porphyry pebbles, which the author traced for 700 miles. Scattered over the whole, and at various heights above the sea, from 1300 feet downwards, are recent shells of *littoral* species of the neighbouring coast, so that every part of the surface seems once to have been a shore, and Mr. Darwin supposes that an upheaval to the amount of 1300 feet has been owing to a succession of small elevations, like those experienced in modern times in Chili.

The principal section described is one transverse to the Andes, extending from Valparaiso to Mendoza. The Cordillera consists here of two separate and parallel chains, the western being composed of stratified sedimentary rocks resting on granite. The strata are violently dislocated and contorted along parallel north and south lines, and become crystalline as they approach the gra-

* Having been led to speak of cretaceous fossils, I may state that it has been a question whether certain fossils found in the English chalk, and called by Mr. Mantell *Hippurites Mortoni*, are truly referrible to the genus Hippurite. When I first saw one of these fossils in the collection of Mr. Robert Hudson, I conjectured that it might belong to the family of Conia and Balanus; but I regret that this opinion has been published as mine in Loudon's Magazine, as it was abandoned by me as soon as I had opportunities of minutely examining the specimens. (See Loudon's Mag., No. 58.) Without being able to decide whether they are truly Hippurites, I may state that I believe them to belong to the family of Rudistes of Lamarck, and that they are not allied to Conia.

nite. Some of the slates and limestones, probably referable to the transition period, contain organic remains at an elevation of 13,000 feet above the sea. In the eastern chain are sandstones and conglomerates, and associated felspathic rocks regularly bedded, and more recent than the rocks of the western chain, being partly made up of their debris. After much investigation Mr. Darwin convinced himself that these were of the same age with certain tertiary deposits of Patagonia, Chiloe, and Conception, resembling them in mineral character and in the lignite and fossil wood which they contain. In one escarpment is seen a sandstone of this system in which there is a wood of petrified trees in a vertical position, some of the trees being perfectly silicified and of dicotyledonous wood, others consisting of snow-white columns of coarsely crystallized carbonate of lime. They appear to have formed a clump of trees which had grown on lava and was then submerged, so that layers of fine sandstone were quietly deposited between the trunks. The enveloping sandstone rests on lava, and is again covered by a bed of black augitic lava about 1000 feet thick. Over this there are at least five other grand alternations of similar rocks and aqueous deposits, amounting in thickness to several thousand feet. The same sedimentary strata, or the continuation of them, are not only altered by granite, but are traversed by dikes of granite proceeding from the mass, and also by numerous metallic veins of iron, copper, arsenic, silver, and gold, all of which can be traced to the underlying granite. A gold mine has been worked close to the clump of silicified trees.

From these observations I am led to suspect that, as in some parts of the Alps, the metamorphic structure has been assumed by strata high up in the secondary series, so in the Andes the same structure has been superinduced on certain tertiary deposits which have been also penetrated by granitic and by metalliferous veins.

Dr. Daubeny has analysed a new thermal spring discovered near the town of Torre del Annunziata in the Bay of Naples, and he refers the origin of nitrogen gas in this and other springs in the volcanic region of Naples and Mount Vultur to a process of subterranean oxygenation analogous to combustion. In the excavations made in volcanic tuff and lava near Torre del Annunziata for gaining access to the spring, vestiges of walls and buildings with fresco paintings, and other traces of human art were discovered, and vegetable mould containing the stems of reeds, similar to those now growing in the neighbourhood, and a fir and cypress tree in an upright position. The buildings must have been overwhelmed before the soil existed on which the fir and the cypress grew, as this soil was formed upon the materials which enveloped the town.

Mr. H. E. Strickland and Mr. Hamilton have examined a cavity below the level of the sea in Cephalonia adjoining the coast, into which a constant stream of sea water is flowing, and has been flowing for years. This singular phænomenon had previously attracted the attention of Mr. Martin and of Lord Nugent and others, some of whom had speculated, like Mr. Strickland, on the probability of the water thus descending through crevices being converted into vapour in subterranean hollows, and then carried off in other directions in the form of *stufas* or hot springs. I forbear to enlarge on this subject at present, as a description of the facts drawn up by Mr. Martin before Mr. Strickland's visit, will shortly be read to the Society.

We have received from Capt. Belcher a suite of geological specimens from various parts of the west coast of Africa, with remarks on the reefs and sand-banks of that coast; and a collection from the Rev. W. Hennah of recent calcareous limestone and volcanic products from the island of Ascension.

I shall next consider some papers relating more or less exclusively to fossil zoology, which have been read at our meetings during the last session. We are indebted to Mr. Broderip for a description of some new species of fossil Crustacea and Echinodermata, which were discovered by Lord Cole and Sir P. Egerton in the lias of Lyme Regis. One of these crustaceans belongs to a genus intermediate between the Palinurus and the Shrimp. It is of a gigantic size compared to any recent species, and belongs to a division of which the living types have been only met with in the arctic regions.

Sir P. Egerton has described some peculiarities of structure in the occipital bone of an Ichthyosaurus, observed in the skeleton of a new and gigantic species recently discovered by Miss Anning at Lyme Regis. He also states that the axis and atlas in this genus are usually found adhering firmly together, and they are connected by an auxiliary bone, showing that strength rather than freedom of lateral motion was required in the neck of these animals. These observations have been confirmed by Mr. Owen and Mr. Clift.

It has often been a question whether the bones of birds had ever occurred in strata below the chalk, some of the thin fragile bones found at Stonesfield, and formerly considered to be those of birds, having been ascertained to belong to Pterodactyls. In order to elucidate this point, Mr. Mantell lately placed all his specimens from the Wealden, supposed to be those of certain Grallæ, or waders, in the hands of Mr. Owen, and the result of his examination has confirmed Cuvier's opinion that they are true ornitholites. They seem, therefore, to be the oldest authenticated fossils of this class hitherto found in Great Britain. The rarity of such remains in geological formations, especially in the marine, cannot surprise us; for in the recent shell marl of Scotland, formed in lakes much frequented by water-fowl up to the moment of their drainage, no bones of birds have as yet been detected amongst the numerous relics of deer, ox, pig, and other quadrupeds occurring in the marl.

Mr. Darwin, in his travels in South America before alluded to, found, in crossing the continent from the Rio Negro to Buenos Ayres, many large bones of Mastodons, and other remains of the Mastodon at Port St. Julian, 50° S. lat., at a distance of more than six hundred miles from the former. He also saw, in the gravel of Patagonia, many bones of the Megatherium, and among the remains of five or six species of quadrupeds associated with them, he detected those of a species of Agouti.

Our museum has just been enriched by a truly magnificent present of fossil bones from India, more valuable than any which have reached England since those obtained by Mr. Crawfurd and Dr. Wallich from Ava. They were collected and presented to us by a gentleman whom we last year elected a Fellow of this Society, Capt. Cautley of the Bengal Artillery, and their existence seems to have been first distinctly recognized by Dr. Falconer, superintendent of the Botanic Garden at Saharunpore. These organic remains come from the range of hills formerly called Sewalik, which skirt the base of the Himalayan Mountains from the Ganges to the Sutluj rivers, or from north lat. 30° to 31°. They abound in part of the range to the westward of the Jumna river, and belong to the genera Mastodon, Elephant, Hippopotamus, Rhinoceros, Hog, Anthracotherium, Horse, Ox, Deer, Antelope, Canis, Felis, Gavial, Crocodile, Emys, Trionyx, besides fish and shells. Among the fossils there are some considered to be new genera, and one which Messrs. Cautley and Falconer have called Sevatherium.

We have also received a splendid collection of specimens of rocks from the Himalayas, illustrating the two sections published by Mr. Royle in his work on these mountains, from the plains to the snowy passes, and his section across the central range of India.

Several new facts have been brought to light in fossil ichthyology during the last year. Sir P. Egerton has found in the coal-field of North Staffordshire, among other remains of fish, some scales of the Megalichthys, that large sauroidal fish first described by Dr. Hibbert as occurring at Burdiehouse, near Edinburgh. I have lately seen a large tooth of this fish in a mass of Cannel coal found in Fifeshire by Mr. Horner and described by him in a paper read before the Royal Society of Edinburgh. It will be remembered that these teeth were formerly referred to saurians, to which, in fact, the Megalichthys had a much nearer affinity, according to Mr. Agassiz, than has any fish now living. Sir P. Egerton has also published a catalogue of the fossil fish in his cabinet at Oulton Park, and in that of Lord Cole, at Florence Court; two collections which are described by Mr. Agassiz as unrivalled in England in this department of organic remains, and only equalled by two others in the rest of Europe, that of Count Munster, at Baireuth in Bavaria, and that of the Royal Museum of Paris *. In this catalogue Sir Philip has given the names and localities of about 200 ichthyolites, British and foreign, and has indicated the geological position of each.

Remains of fishes have been found by Mr. Prestwich in a formation of sandstone and red conglomerate which overlies the old red sandstone in Banffshire. He supposes the deposit to be of the age of the coal-measures, an opinion which is in accordance with the characters of the ichthyolites as determined by Mr. Agassiz.

* Agassiz, *Poiss. foss*, 4me livr. p. 45.

One of the most perplexing enigmas in palæontology has lately been solved by Dr. Buckland, who has discovered that some curious fossils of the oolitic and cretaceous strata, which had long baffled the skill of comparative anatomists, are in fact the upper and lower jaws of extinct species of Chimæra, a rare genus of living fish. These fossils had been found by Sir P. Egerton in the Kimmeridge clay, by Mr. Townsend in the Portland stone, and by Mr. Mantell in the chalk. They belong to four distinct species, of which the characters are given by Mr. Agassiz. The scientific world is indebted to the splendid museum of comparative anatomy at Leyden for the opportunities enjoyed by Dr. Buckland of comparing the skeleton of the recent Chimæra with the fossils alluded to.

Mr. Agassiz has described two very singular genera of fossil fish from the lias, one of which has been known under the name of Squalo-raia from Lyme Regis; the other from Whitby, called *Gyrostris mirabilis,* probably the largest known fish.

Hitherto the new red sandstone in Great Britain had been destitute of all organic remains, but some distinct impressions of fish of the genus Palæoniscus, *Ag.*, have now been observed in this formation near Dungannon in Ireland. The geological position of these has been pointed out by Mr. Murchison, and a slab of sandstone presented to the Society by Mr. Greer exhibits on a single surface only two feet square, impressions of about 250 fishes.

I have already had occasion to allude more than once to the name of Agassiz, on whom the Council have this day conferred the Wollaston Medal. I may say with pleasure, that in his second visit to England, as in that of the preceding year, he has given an impulse to the study of fossil remains in various departments which will long be felt in this country. It is not merely sound knowledge which he has freely communicated to all who have enjoyed his society, but what is even of more lasting profit, a generous enthusiasm for the study of every department of natural history and particularly of fossils. The great work on which he is now engaged yields not in importance to any that has ever been undertaken for the illustration of organic remains, and the progress which he has already made at so early an age, holds out the most encouraging prospects of his future success.

When we consider the strong ties of affinity which unite together all animals of the vertebrate classes, and reflect that man himself, viewed in reference to his organization, belongs to this great division of the animal kingdom, we cannot but feel the highest interest in tracing the remains of the vertebrate animals through geological formations of every age, from the newest to the most ancient. In a small part of Europe alone more than 800 species of ichthyolites have already been determined. They are distributed through strata of all epochs; no less than 54 species have already been discovered in the carboniferous rocks, and five or six have been met with in the still older Silurian formations.

The museums of Great Britain alone have afforded to Mr. Agassiz no less than 300 new species of ichthyolites, 50 of which have been added since our last anniversary. He had previously pointed out as a general law that particular generic types are strictly confined to certain groups of strata, and it is remarkable that so vast an accession of new species offers but few exceptions to the rule. In the chalk two species have come to light belonging to genera before observed in the oolitic series only, and a distinct species of one of these genera extends even into the lower or Eocene tertiary deposits.

The labours of Mr. Charlesworth have thrown much light on the structure of the crag of Suffolk and Essex, and on the fossils of that deposit. He proposes to divide the crag into the upper or red crag, and the lower or coralline crag, the last of which consists for the most part of calcareous sand, derived chiefly from the decomposition of zoophytes and shells, and in which many very perfect corals and testacea are preserved. Among other places this coralline crag may be well examined at Tattingstone, Ramsholt, Orford, and Aldborough. It is now many years since Mr. Wood, of Heskerton in Suffolk, formed a large collection of crag fossils, amounting in number to no less than 450 species of the classes Annulata, Cirrhipeda, Conchifera, and Mollusca. Out of 370 species of shells found in the lower crag, Mr. Wood identifies 150 with those found in the red crag. Of these 150 species, common to the two deposits, Mr. Charlesworth suggests that many may have belonged to the lower bed and have been washed into the newer one, in the same manner as some fossil shells of the chalk have been evidently imbedded in the crag.

Such accidental mixtures have doubtless occurred, and they have been occasionally remarked by geologists in other places under analogous circumstances. But I continue to believe that these upper and lower divisions of the crag should be referred to the same geological period. The determination of that period or the exact place which the crag should occupy in the chronological series of European strata is a more difficult question. When I first submitted 111 species of crag shells to the examination of M. Deshayes, he was of opinion that 66 of them were extinct, and that the others belonged to recent species now inhabitants of the German ocean. I lately laid before him 60 species from the coralline crag with which Mr. Charlesworth had favoured me, and he was still of opinion that the proportion of recent species was equally great.

But I should add that the suites of individuals of each species were not so full and complete as might have been desired, to enable these identifications to be placed beyond all doubt. Dr. Beck has lately seen 260 species of crag shells in Mr. Charlesworth's cabinet in London, and informs me, that although a large proportion of the species approach very near to others which now live in our northern seas, he regards them as almost all of distinct species, and unknown as living. Both he and M. Deshayes have declared the shells to be those of a northern climate, and according to Dr. Beck the climate may even have resembled that of our arctic regions.

In regard to the discordance in the results at which these eminent conchologists have arrived, it may arise not only from the unequal opportunities which they have enjoyed of examining the necessary data, but also, in part, to the different estimate which they have formed of the amount of variation necessary to constitute a distinct species. One example will sufficiently illustrate my meaning. Those naturalists who agree with M. Deshayes in referring all the living varieties of *Lucina divaricata* brought from different countries to one and the same species, will identify many more fossils with recent shells than those who agree with Dr. Beck in dividing the same recent individuals of *Lucina divaricata* into six or eight distinct species. Provided, however, each zoologist is consistent with himself, and provided the distinctive characters relied on as specific by each are commensurate one with another, no confusion will arise.

In reviewing the proceedings of the Society during the last year, I find that the remaining memoirs, numerous as they are, may be all referred to one great class of subjects, for they either relate to changes now going on upon the surface of the earth as attested by man, or to geological proofs of similar changes since the rivers, lakes, and seas were inhabited by the existing species of testacea. Under these heads I shall be led to consider the effects of modern earthquakes in upheaving and depressing the land; the gradual rising of land in one region and the lowering of its level in another; the rolling in of great waves of the sea upon the coast during earthquakes; the transportation of rocks by floating ice; the signs of upraised beaches containing marine shells; erratic blocks; alluvial deposits of different ages; and other kindred topics on which a variety of new facts have been collected.

The last year has been signalized in South America by one of those terrific convulsions which have so often desolated the western coast since the discovery of the new world. A brief notice of this catastrophe was sent me by Mr. Alison, written immediately after the event. He mentions that on the 20th of February, 1835, when Conception, Chillan, and other towns were thrown down in ruins, the sea first retired from the shores of the Bay of Conception, and then returning in a wave about twenty feet high, rolled over several of the towns, and completely destroyed whatever the earthquake had left uninjured. He also states that the coast of the bay was reported to have been heaved up, and that a rock off the landing-place at the port of Talcahuano, which before the shock was nearly level with high water, stood afterwards three feet above that mark. Large fissures were made in the earth, and water burst from some of them.

In these and other particulars Mr. Alison's letter agrees with the more circumstantial account sent to the Royal Society by Mr. Caldcleugh, who was resident at Valparaiso, but who drew his information in great part from eye-witnesses. He mentions that a great number of the volcanos of the Chilian Andes were in a state of unusual activity during the shocks, and for some time preceding and after the convulsion. Among others, Osorno, of which the cone rises 3900 feet above the sea, and which is situated on the mainland north-east of the island of Chiloe was in eruption, lava being seen to flow from its crater. Several others are also noticed, and the lava emitted from one of them is stated to have covered an area eight leagues in circumference and to the depth of $3\frac{1}{2}$ yards. The ashes reached to the distance of 300 leagues. I refer you to these statements because it is rare to meet with any recent descriptions of the emission of lava and ashes from the high cones of the Andes.

The same writer was informed that the strata of clay-slate, forming the shore of the Bay of Conception, were elevated from three to four feet, whereas the rise at San Vicente, south of Talcahuano, amounted to only $1\frac{1}{2}$ feet. Mr. Caldcleugh was also informed that the island of Santa Maria, in the Bay of Conception, was upheaved about eight feet.

At the same time the island of Juan Fernandez, distant 360 miles from Chili, was violently shaken and devastated by a great wave. A dense column of vapour issued from the sea about a mile from the coast, and flames were seen at the same spot in the night which illumined the whole island. At this point in the sea whence the flames were emitted the depth of water was afterwards ascertained to be no less than 69 fathoms.

At a court-martial, lately held at Portsmouth, in consequence of the wreck of the Challenger frigate on the coast of Chili, in May 1835, some notes of Capt. FitzRoy were read, and afterwards communicated by Capt. Beaufort to the Society, in which he describes some remarkable alterations produced by the earthquake of February in the direction of the currents on the Chilian coast. A more detailed account of the convulsion has just been received at the Admiralty from the same officer, with a sight of which I have been favoured, but no allusion is here made to the currents. There are, however, other facts perfectly new and of the highest importance attested in this memoir, and as they come from an observer of great experience in hydrographical surveying, who examined the Bay of Conception immediately after the shocks, they will remove all doubts from the minds of those who have questioned the power of earthquakes to cause the permanent upheaval of land.

Capt. FitzRoy states, that on the 20th of February, 1835, the earthquake was felt at all places between Copiapo and Chiloe from north to south, and from Mendoza to Juan Fernandez from east to west. Conception and other towns were thrown down. After the shock the sea retired; the vessels in the bay grounded, even those which had been lying in seven fathoms water; all the shoals in the bay were visible; and soon afterwards a wave rushed in and then retreated, and was followed by two other waves. The vertical height of these waves does not appear to have been greater than from 16 to 20 feet, although they rose to much greater heights when they rushed upon a sloping beach. During the shocks the earth opened and closed rapidly in numerous places. The direction of the cracks was not uniform, though generally from south-east to north-west. The earth was not quiet during three days after the great shock, and more than three hundred shocks were counted between 20th February and 4th of March. The loose earth of the valley of the Bio Bio was everywhere parted from the solid rocks which bound the plain, being separated by cracks from an inch to a foot in width.

In the Bay of Conception two explosions or eruptions were seen in the sea while the great waves were coming in. One beyond the island of Quiriquina appeared to be a dark column of smoke in shape like a tower; another rose in the Bay of San Vicente like the blowing of an immense imaginary whale. Its disappearance was followed by a whirlpool which lasted some minutes. It was hollow and tended to a point in the middle, as if the sea was pouring into a cavity of the earth. The water in the bay appeared to be everywhere boiling, bubbles of air or gas were rapidly escaping, and dead fish were thrown ashore in quantities.

For some days after the 20th February the sea at Talcahuano did not rise to the usual marks by four or five feet vertically. "Some thought that the land had been elevated, but the common and prevailing opinion was that the sea had retired. This difference gradually diminished till, in the middle of April, there was only a difference of two feet between the existing and former high-water marks. The proof *that the land had been raised* exists in the fact that the island of Santa Maria was upheaved nine feet; but of this presently. When walking on the shore, even at high-water, beds of dead mussels, numerous chitons and limpets, and withered sea-weed still adhering, though lifeless, to the rocks on which they had lived, everywhere met the eye—the effects of the upheaval of the land."

From the above extracts, then, it appears that in the opinion of Capt. FitzRoy some of the land was first raised in February four or five feet, and that it afterwards gradually returned towards its former level, so that in about two months the temporary increase of its height was diminished by more than one half.

The observations which follow respecting Santa Maria, an island seven miles long and two broad, in the Bay of Conception, deserve particular attention, and I shall give them in Capt. FitzRoy's own words; for although in so doing I anticipate a communication which I trust will hereafter be given in full to the Society*, I am only supplying the proofs of the elevation which was asserted as a fact in Capt. FitzRoy's notes read before you during the last year.

"It appeared that the southern extreme of the island had been raised eight feet, the middle nine, and the northern end upwards of ten feet. The Beagle visited this island twice, at the end of March and in the beginning of April. At her first visit it was concluded, from the visible evidence of dead shell-fish, water-marks, and soundings, and from the verbal testimony of the inhabitants,

* Since the above was written the whole memoir has appeared in the Nautical Magazine for March 1836.

that the land had been raised about eight feet. However, on returning to Conception, doubts were raised, and to settle the matter beyond dispute, or the possibility of mistake, the owner of the island, Mr. Salvador Palma, accompanied us. An intelligent Hanoverian, who had lived two years there and knew its shores thoroughly, was also a passenger in the Beagle. His occupation upon the island was sealing. When we landed, the Hanoverian, whose name was Antonio Vogelborg, showed me a spot from which he used formerly to gather Choros by diving for them at low water. At dead low water, standing upon that bed of choros, and holding his hands up above his head, he could not reach the surface of the water. His height is six feet; on that spot when I was there the choros were barely covered at high spring tide.

"Riding round the island afterwards with Mr. Palma and Vogelborg, many measures were taken in places where no mistake could be made. On large steep-sided rocks, where vertical measures could be correctly taken, beds of dead mussels were found ten feet above the present high-water mark. A few inches only above what was taken as spring-tide high-water mark were putrid shell-fish and sea-weed, which evidently had not been wetted since the upheaval of the land. One foot lower than the highest bed of mussels, a few limpets and chitons were adhering to the rock where they had grown. Two feet lower than the same, mussels, chitons, and limpets were abundant.

"An extensive rocky flat lies around the northern parts of Santa Maria. Before the earthquake this flat was covered by the sea, some projecting rocks only showing themselves. Now the whole flat is exposed. Square acres (or many *quadras*) of this rocky flat were covered with dead shell-fish, and the stench arising from them was abominable. By this elevation of the land the southern port of Santa Maria has been almost destroyed; there remains but little shelter, and very bad landing. The soundings have diminished a fathom and a half everywhere around the island."

The author then goes on to inform us that at Tubul, to the south-east of Santa Maria, the land has been raised six feet. At Mocha two feet. No elevation has been ascertained at Valdivia, northward of Conception; at Maule, according to the assertion of the governor, the chief pilot, and other residents, the land instead of being elevated had sunk two feet, for they said there were two feet more water on the bar after the shock, and the banks of the river were lowered. Capt. FitzRoy, however, suggests that a rush of water might have shifted the loose sands of the bar; so that he doubts the subsidence at Maule, and only feels certain that the land had not risen there.

It is scarcely necessary for me to advert to the striking analogy of the phænomena observed by Capt. FitzRoy and those which were formerly described by Mrs. Maria Graham (now Calcott), and published in our Transactions, respecting the Chilian earthquake of 1822. The coast of Valparaiso, Quintero, and other places was then stated to have undergone unequal elevations, the greatest amounting only to a few feet, and banks of sea-shells were laid dry above high-water mark. But these statements, given on the authority of Mrs. Graham's personal observation, and confirmed by others to which I shall presently allude, have been met by a direct counter-statement so circumstantial and explicit as to deserve the fullest consideration. Mr. Cuming, well known to you by his numerous researches in conchology, declares that being at Valparaiso before and during the earthquake of 1822, and residing there constantly until 1827, he could never detect any proofs of the rise of the land, although his pursuit of conchology and natural history in general caused him to visit frequently the rocks and inlets with which the northern and southern parts of the bay abound. These rocks were covered with Fuci, Patellæ, Chitons, Balani, &c., yet he never perceived the least difference in their appearance from the date of his arrival to his finally quitting Valparaiso, nor observed any trace of them except in situations covered by the tide. He also remarked that the water at spring tides rose after the earthquake to the same point on a wall near his house which it had reached before the shocks. He imagines that the idea that a change had taken place in the relative level of land and sea originated in the gain of land opposite Valparaiso, occasioned by the accumulation of detritus at points where the tide had flowed previously to the earthquake. Mr. Cuming first heard of the notion of the land having been elevated at Valparaiso when Mrs. Graham's paper read to the Geological Society in 1824 was talked of at Valparaiso. Neither he nor his friends were then able to subscribe to the opinion expressed in that communication.

On the other hand, Lieut. Freyer, R.N., in a letter read to you during the last session, observes, that being at Valparaiso after the earthquake of 1822, he saw a shelly beach to the east of the town, above the reach of the tides; and rocks, which was pointed out to him as being less under water than it had been before the convulsion. Dr. Meyen also, a Prussian traveller, who visited Valparaiso in 1831, says he examined the coast there and found appearances in corroboration of Mrs. Graham's statements. I may also repeat what I have elsewhere recorded, that some years after the event I applied to Mr. Cruckshanks, an English botanist, who resided in Chili at the time of the earthquake, whether he had seen any signs of the alleged change of level. He said that he examined the coast at Quintero after the shocks, and satisfied himself that it had been uplifted several feet, and that the fishermen told him that the ocean had gone down and was lower than before, in confirmation of which they pointed to some rocks of greenstone at Quintero, a few hundred yards from the beach, which were always under water previously to the great shock of 1822, but were afterwards uncovered when the tide was at half ebb.

Without pretending that I can reconcile this contradictory evidence, I may suggest that some discordance in the accounts may have arisen from a want of uniformity in the movement at different places, and still more from a subsequent sinking down of some of the land which was first raised, in the manner described by Capt. FitzRoy as having taken place near Talcahuano in the spring of last year. In perusing Mr. Cuming's account we must all feel that the author has had no object in view but that of establishing the truth; and the doubts which he has raised will call for a reinvestigation of the phænomena; but after hearing all objections, even before the late convulsion of 1835, I expressed myself satisfied with the proofs in favour of the elevation of 1822*. If I had still cherished any scepticism, it would now be removed by the coincidence of the facts related by Capt. FitzRoy. To suppose that a set of imaginary phænomena, which appeared at first sight very improbable, and which no geologist could explain, should have been invented, in Chili, in 1822, by several intelligent observers, and that thirteen years afterwards nature should realize, in the same country, the same phænomena, or others strictly analogous, so as to lend countenance to all the previous misconceptions, is to imagine a combination of circumstances almost as marvellous as the upheaval of a continent itself.

We are indebted to Mr. Woodbine Parish for a collection of historical notices respecting the effects of the earthquake waves of the Pacific, which have repeatedly caused great inundations on the coast of Chili and Peru. The earliest date to which he has traced back these memorials is the year 1582. The sea usually retired in the first instance, and then rolled in upon the land, carrying ships far inland and levelling towns to the ground. Such floods must have left great banks of sand and gravel, mingled occasionally with broken and entire shells, upon dry land, considerably above the level of the highest tides, but they will by no means account for the very elevated position of recent marine shells on various parts of the maritime country of Patagonia, Chili, and Peru.

Mr. Freyer, to whom I have before alluded, states that he observed in many parts of Peru, especially near Arica and in the Isle of San Lorenzo, in the Bay of Callao, lines of shingle and sand, with shells of existing species, at various elevations above the level of the sea. The rocks of sandstone and gypsum south of the bold promontory called the Morro of Arica are shaped into distinct terraces towards the shore, and on these terraces the rock, wherever it is exposed, is seen to be incrusted with balani and millepores. At the height of about twenty or thirty feet above the sea, these shells and zoophytes are as abundant and almost as perfect as on the shore; at upwards of fifty feet they still occur, but in an injured state, for although there is no rain in this district to hasten their decay, by alternate moisture and desiccation, still they are abraded by the sand which is constantly blown over them. Some of the recent shells occurring at considerable heights in the island of San Lorenzo retain their colour almost as freshly as those living in the adjacent sea. Mr. Darwin has also observed in different parts of Patagonia and Chili beds of recent shells at various heights above

* Principles of Geology, 4th edit. vol. ii. p. 331.

the sea, and among them mussels which retained their blue colour, and emit a strong animal odour when thrown into the fire.

I shall now turn from the modern changes observed in South America to the evidences of recent alterations in the level of the land in high latitudes in the northern hemisphere. Dr. Pingel, a Danish mineralogist and naturalist, has communicated some facts showing the gradual sinking of part of the west coast of Greenland. It is now more than fifty years since Arctander inferred that this coast had subsided, having noticed some buildings in the Firth called Igalliko, on a low rocky island near the shore, almost entirely submerged at spring tides. From this point, which is in lat. 60° 43′ north, to Disco bay, extending to nearly the 69th degree of north latitude, Dr. Pingel has traced various signs of the depression of the land, ancient settlements of the Greenlanders and Moravians being now overflowed by the sea. In one case the Moravians were obliged to move inland the poles upon which their large boats were set, and the old poles still remain beneath the water as silent witnesses of the change. It is also mentioned that no aboriginal Greenlander builds his hut near the water's edge. Having conversed with Dr. Pingel, at Copenhagen, on this subject, I am convinced that the phænomena cannot be explained away by reference to a rise of the tides at particular points, the advance of the sea being general for more than 600 miles from north to south, and caused not by the undermining of cliffs and the denudation of land, but by submergence of what was before above water.

I am the less inclined to question the probability of a general subsidence of the land in Greenland, because I now believe that an equally slow and gradual movement is taking place, but in an opposite direction, throughout a large part of Sweden and Finland. I ventured formerly to controvert the proofs adduced in favour of such an upheaval of land in those countries, although the fact had been advocated by Celsius, the Swede, and in later times by Playfair and Von Buch. But after visiting, in 1834, several parts both of the eastern and western coasts of Sweden, I became satisfied that an elevation is in progress, more rapid at Stockholm than further to the south, and greater at Gefle than at Stockholm. The rate of rise appears in some places to have amounted only to a few inches in a century, in other places to several feet, but as far as I could learn from the report of pilots, travellers, fishermen, and traders, the alteration extends to the North Cape, and is probably felt over a space more than 1000 miles in length from north to south, and several hundred miles in breadth. The evidence is derived from many sources, partly from tradition and from the recollection of the oldest inhabitants and seafaring men, partly from the position of ancient buildings on the coast, and partly from marks chiselled at different periods on rocks bordering the sea, for the express purpose of indicating the ancient standard level of the waters. As the details of my own observations have been published in the Philosophical Transactions of last year, I need only add that at one spot to the south of Stockholm I saw what appeared to me a conclusive proof of an alternate rising and sinking of the same land since this region was inhabited by man, first a depression of the ground of at least 50 feet below its former level, and then a re-elevation of the same amounting to at least 50 feet.

The probable cause of the prolonged and insensible movements of large masses of land opens a wide and inviting field for speculation. As we know that volcanic action is never dormant in some parts of the interior of the globe, it seems most natural to imagine that an alternate expansion and contraction of the earth's crust may arise from a gradual increase or diminution of its temperature. Mr. Babbage has suggested that as many common kinds of stone have been shown by experiment to augment in volume when heated, and decrease in bulk when slowly cooled, a great thickness of subjacent rock may cause the surface to rise or sink according to the variations experienced in the subterranean temperature. We have also to consider the effects which might result from the slow cooling and crystallization of large reservoirs of melted matter, on which subject we have unfortunately as yet few experiments to guide our conjectures. We know not, for example, whether the passage from a fluid to a solid state would uplift or let down an incumbent mass of rock. A dense fluid, subjected to immense pressure, may, perhaps, on crystallizing into a rock like granite, occupy more space in its state of solidity. I need not remind you that as ice floats in water, so a bar of cast iron floats on the surface of melted iron.

But however obscure the origin of the movements in question, their reality if admitted affords a key to the interpretation of a variety of geological appearances, some of which I shall now proceed to consider.

Dr. Beck has mentioned that the oldest strata in Denmark are often covered by deposits of gravel, sand, and loam, several hundred feet thick, in which, but more commonly upon them, lie erratic blocks. The sand and gravel beds rarely contain any fossils, but when shells do occur they are absolutely identical with living species. He has also found, in the lower valleys of Jutland, more than seventy species of shells now living in the German Ocean. These facts agree precisely with others which I observed in different parts of Sweden, and which I have described in the memoir before alluded to. On the west coast, between Uddevalla and Gothenborg, the beds of sand, gravel, and clay, containing recent oceanic shells, are seen at various heights from 100 to 300 feet above the sea. M. Alex. Brongniart formerly pointed out those which rest on the gneiss, near Uddevalla, and like him I saw Balani still attached to the rocks at the height of more than 150 feet above the sea-level. I ought, however, to state that at the points where I discovered them they had not been exposed to decomposition in the atmosphere ever since their emergence. On the contrary, the adhering shells had been protected by a covering of shelly sand only removed of late years for road-making. I need scarcely insist upon the obvious inference that the Balani and corallines which also cover the rocks, and which are of the same species as those found on the shells of the recent strata in contact with the rocks, prove that the gneiss was long submerged beneath the waters, and that the shells were not washed up by an inroad of the sea upon the land. In the island of Orust, opposite Uddevalla, I found similar appearances, and on other parts of the western coast; but on the eastern shores of Sweden or those bordering the Baltic, both to the north and south of Stockholm, a marked distinction is recognized. In the assemblage of fossil shells which there occur in beds of upraised gravel, sand, and clay, the testacea belong to recent species, yet not to that assemblage which inhabits the ocean, but to a confined number of mixed freshwater and marine species characteristic of the brackish waters of the Baltic. Such deposits rise near Stockholm to the height of 200 feet above the sea, and show that the relative level of land and sea has greatly changed, not only since the existing testacea were in being, but also since the Baltic was divided off from the ocean as an inland sea freshened by a superabundance of river water.

It is well known that these parts of Sweden are densely strewed over with huge erratic blocks, many of the largest of which occur in the highest part of ridges of sand and gravel, finely stratified or made up of a continued series of thin layers of sand, loam, and gravel. In one of these ridges, at Upsala, I found layers of marl, containing perfect shells of recent species, such as live in the Baltic. The ridge was about 100 feet high, and on the summit of it were blocks of gneiss and granite, measuring from eight to ten feet in length. I saw similar boulders but inferior in size overlying some deposits of recent shells in Orust and near Uddevalla *. Hence it is evident that the transportation of these rocky fragments into their present position continued after the period when the modern shelly formations of both the coasts of Sweden were accumulated.

In addition to the facts enumerated in my paper on Sweden in the Philosophical Transactions for 1835, in regard to the agency of ice-islands, I may mention a fact observed by Dr. Beck on the coast of Jutland. He has ascertained that on the breaking up of the fringe of ice which encircles the coast there during winter, small islands of ice float off and carry with them not only small gravel from the beach but stones four feet in diameter firmly frozen into the solid mass. These ice-floes are sometimes driven eastward into the Cattegat, and have been known to stop up the narrow part of the passage of the Great Belt, and to cause new reefs of rocks thus transported on which vessels, and a few years ago a Danish man-of-war, have been stranded. If such power can be exerted by ice-islands, only a few hundred feet in diameter, in latitudes corresponding to those of England, we may be well prepared to find that islands several leagues in circumference may remove blocks of the magnitude of small houses.

Capt. Bayfield, in commenting on the inferences which I had drawn as to the transporting power of ice in the Baltic, communi-

* Phil. Trans., 1835, p. 33.

cated to me several interesting facts observed by him both on the lakes of Canada and in the St. Lawrence. In the river last mentioned the loose ice, when the water is low in winter, accumulates on the shoals, the separate fragments being readily frozen together into solid masses in a climate were the temperature is sometimes 30° below zero. In this ice boulders become entangled, and in the spring, when the river rises after the melting of the snow, the packs are floated off, frequently conveying away the boulders to great distances. Heavy anchors of ships lying on the shore have in like manner been closed in and removed. He also states that immense ice-islands, detached far to the north, perhaps in Baffin's Bay, are brought by the current in great numbers down the coast of Labrador every year, and are frequently carried through the Straits of Belle-isle between Newfoundland and the continent of America, which, after passing through the Straits, sometimes float for several hundred miles to the south-west up the Gulf of St. Lawrence. In one of these icebergs which Capt. Bayfield examined, he found heaps of boulders, gravel, and stones, and he saw other ice-floes discoloured by mud. Capt. Belcher also informs us that in 1815, when in His Majesty's ship Bellerophon he fell in with field-ice off Newfoundland, near St. John's Harbour, in which there were muddy streaks, gravel, and even stones: it was in the heat of summer and torrents of water were shooting off the ice. The importance of these phænomena will be duly appreciated by the geologist who reflects that they relate to the annual transportation of rocks from high latitudes probably corresponding to those of the northern parts of Norway and Sweden, and that the points sometimes reached by the ice are further south than any part of Great Britain. It is therefore by no means necessary to speculate on the former existence of a climate more severe than that now prevailing in the Western Hemisphere in order to explain how the travelled masses in Northern Europe may have been borne along by ice. We know from independent evidence that large parts of the lands bordering the Baltic, and now strewed over with erratics, have constituted the bed of the sea at a comparatively modern period.

It may be asked whether I refer all erratics, even those of Switzerland and the Jura, to the carrying power of ice. In regard to those of Switzerland I have elsewhere endeavoured to show that a combination of local causes might have contributed to their transfer; for repeated shocks of earthquakes may have thrown down rocky fragments upon glaciers, causing at the same time avalanches of snow and ice, by which narrow gorges would be choked up and deep Alpine valleys, such as Chamouni, converted into lakes. In these lakes, portions of the fissured glaciers, with huge incumbent or included rocks might float off, and on the escape of the lake, after the melting of the temporary barrier of snow, they might be swept down into the lower country*.

M. Charpentier has lately proposed another theory which he in-

* Principles of Geology, vol. iii. p. 149, 1833, enlarged in later editions.

forms us is merely a development of one first advanced by M. Venetz. The Alpine blocks, according to these writers, were not carried by water, for had that been the case the largest would be either in the Alpine valleys or near the base of the great chain, and we should find their size and number diminish as we receded from their original point of departure. But the fact is otherwise, many of the blocks on the Jura, or those farthest removed from the starting-place, being of the largest dimensions. They suppose, therefore, in accordance with the opinion of M. de Beaumont and others, that the elevation of the Alps occurred at a comparatively modern epoch, and that when these mountains were first upheaved they were more lofty than now, and more deeply covered with snow and glaciers. After the principal movement had ceased, a lowering of the Alps took place, the dislocated and shattered beds requiring time to settle down into their present more solid and stable form. According to this hypothesis, therefore, the erratic blocks are monuments of the greater magnitude and extent of the ancient glaciers under a different configuration of the surface. I have not space for all the ingenious arguments adduced, after a minute examination of the ground by M. Charpentier in support of this theory, but must refer you to the original memoir *.

Before leaving this subject I may observe, that although it is rare, in modern times, to meet with icebergs in the northern hemisphere so far south as the Azores, in north latitude 42°, yet they have been seen there, and not unfrequently in north lat. 44°, within the present century, thus reaching the parallel of Southern Italy and Central Spain. In the southern hemisphere we learn from Capt. Horsburgh that some large ones were carried, in 1828, still nearer to the equator as far as lat. 35° south, or within about forty miles of the Cape of Good Hope. I do not remember, when examining alluvial deposits, to have seen any blocks in Sicily nor in Italy till I approached the foot of the Alps; and in Sweden I found them increasing in number and size as I advanced northwards, where I saw some between thirty and forty feet in diameter. The erratics, therefore, as far as my experience extends, are a northern phænomenon; and M. Charpentier states, on the authority of Humboldt, that there are no such fragments at the eastern foot of the equatorial Andes, where, notwithstanding the altitude of the mountains, there are no glaciers.

But assuming that ice could have transported into their present position those myriads of angular blocks which cover the low countries bordering the Baltic, in what manner and by what force could these masses have been detached from the mountains of which they once formed a part? Now the granitic rocks in Sweden sometimes consist of large tabular masses, traversed by numerous horizontal and vertical joints; and entire hills may be said to be broken up, *in*

* *Sur les Blocs errat. de la Suisse,* Ann. des Sci., tom. viii. p. 219. Mr. Bakewell has also in some one of his works alluded to the carrying of Alpine blocks by ice.

situ, into blocks of the same forms and dimensions as the erratics of the Baltic. I remarked this particularly in Ostrogothland, near Lake Roxen. Whether this fissuring of the rocks has been due to earthquakes, or the expansive power of ice in northern regions, or to what other causes I cannot pretend to decide; but reefs of such jointed rocks before they emerged from the sea might have afforded an inexhaustible supply of detached fragments, over and around which the ice would freeze in winter. One block after another might be buoyed up and floated off on the rise of the Baltic when the snows melted, or of the ocean during high tides.

It has been suggested that large blocks may have been pushed far over the bed of the sea and over the land by a succession of waves raised by earthquakes or by hurricanes. Without denying that such agency may explain some facts in geology, I may remark that we cannot be too much on our guard against assuming violent catastrophes where the effects may have been brought about tranquilly, and even with extreme slowness. Let us imagine, for example, a sunken reef of granite in Baffin's Bay, in about 75° north lat., divided into fragmentary masses as above described, and these masses becoming year after year involved in packed ice. In a few months they may be drifted more than 1800 miles to the southward, through the Straits of Belleisle, to the 48° north lat., the ice moving perhaps at a slow rate—no more than a mile an hour. We might even land upon such ice-fields and be unable to determine whether they were in motion or not. After a repetition of these operations for thousands of years, the uneven bed of the ocean far to the south may be strewed over with drift fragments which have either stranded on shoals or have dropped down from melting bergs. Suppose the floor of the ocean where they alight to be on the rise as gradually as the bottom of the Baltic in our own times. The change may be so insensible that pilots may suspect, and yet scarcely dare to insist upon the fact till its reality is confirmed by the experience of centuries. At length a submarine ridge, covered with the travelled fragments, emerges, and first constitutes an island, which at length becomes connected with the main land,—in time, perhaps, the site of a university like Upsala. Here the question is agitated whether the land is stationary, or continually rising beneath their feet. Perchance they decide that it is motionless, and yet it continues to move upwards, "E pur si muove," till by a growth as imperceptible as that of the forest tree, what was once a submarine reef becomes the summit of an inland mountain. Here the geologist admires the position, number, and bulk of the transported fragments; identifies them with the parent mountains, a thousand miles distant to the north; and in speculating on the causes of the phænomena, imagines mighty deluges and tremendous waves raised by the shock of a comet, or the sudden starting up of a chain like the Andes out of the sea, by which huge rocks were scattered over hill and dale as readily as shingle is cast up by the breakers on a sea beach.

But it is time to return from these digressions and to consider the other memoirs treating of these and similar subjects which have been lately read to the Society. There is perhaps no class of geological phænomena in Great Britain which has hitherto remained in more obscurity than that relating to the distribution and origin of superficial gravel, sand, and mud, especially that which has been called diluvium. Mr. Murchison, in his examination of the older rocks of part of Wales and England, has made a great step towards reducing these phænomena to order, and has thrown so much light upon them that his treatise may be considered not only as one of much local interest, but as likely to contribute powerfully towards the establishment of a general theory of these deposits. He has distinguished between the local drift, or the gravel and alluvium of South Wales and Siluria, and that which he terms the northern drift of Lancashire, Cheshire, North Salop, and parts of Worcester and Gloucester. The surface of the Welsh and Silurian territories is exempt from the debris of far-transported rocks, the alluvium there being derived from the adjacent mountains, while Herefordshire is chiefly covered with debris of the old red sandstone. The author, after giving a detailed description of the drainage of the Teme, Onny, Lug, and Wye, shows that in the valleys of these rivers the loose materials change with each successive range which they traverse, the fragments becoming smaller in proportion as they have been carried to greater distances towards the valley of the Severn. It is also demonstrated that there is an evident connexion between the distribution of this ancient gravel or drift and the strike and dip of the strata in the Welsh and Silurian mountains; and hence it is inferred that the scattering of certain fragments took place during the original upheaving of the mountains. But there are other wide-spread accumulations of sand and gravel in the valleys of the same region, which have partly been due to the existing rivers, and partly to lakes which were drained long after the first emersion of the country from the sea.

The above-mentioned alluvia differ entirely from another kind of detritus, which is spread over parts of Lancashire, Cheshire, and North Shropshire, and which consists of granites, porphyries, and other hard rocks, similar to those of Cumberland and some of the Scotch mountains. To these, with their associated clay and sand, the author gives the name of the northern drift. It has two distinguishing features: first, the occasional occurrence in and upon it of large blocks or boulders of northern origin, sometimes of great size, like the erratics of the Baltic, and none of which ever enter into the region of the Welsh drift; secondly, the association with it of marine shells of existing species. This last fact was formerly noticed by the author and Mr. Gilbertson, at Preston in Lancashire, at heights of 350 feet above the sea. Sir Philip Egerton has since observed the same shells in sand and gravel, north of Tarporley, in Cheshire, at the height of 70 feet, where they occur at the western base of the Forest Hills, about nine miles from the nearest point of the estuary of the Mersey. But what is still more remarkable, Mr. Trimmer found similar recent marine shells on Moel Tryfane, near the Menai Straits, at the height of 1392 feet above the level of the sea. The same author also reported to us that he had discovered similar gravel with recent marine shells overlying a peat bog near Shrewsbury, in which were the remains of a submerged forest. Mr. Murchison, however, having examined this spot, has shown us that the supposed trees were stakes with sharpened points driven into the ground, forming a woodwork which supported an old road, and over these piles the shelly gravel or northern drift had been afterwards spread artificially. I understand that Mr. Trimmer is now fully aware of the mistake into which he had fallen.

From the evidence afforded by the shells, as well as by the indication of several newly discovered localities where they occur sixty miles from the nearest sea-coast, Mr. Murchison infers that the tracts covered by them must have formed the bed of the sea during the modern period, and as the granitic drift occupying the high grounds east of Bridgnorth rises to the height of 500 or 600 feet, and thence descends in a deltoid form into the Vale of Worcester, he conceives that the sea also extended over the valley of the Severn from Bridgnorth to the Bristol Channel, so that there was then a strait separating Wales and Siluria on the one side from England on the other. The deposits observed by Mr. Strickland at Cropthorne and at other points in the valley of the Avon, an eastern tributary of the Severn, and which contain fluviatile and land shells, with the bones of extinct quadrupeds, must, according to Mr. Murchison, have been accumulated at the mouth of a river which flowed from the east, or from the Cotteswold Hills, into the ancient straits above alluded to, and into which the northern drift was prolonged.

There are sections near Shrewsbury from which Mr. Murchison has been enabled to deduce the relative age of the two alluvial formations, the local or Welsh drift having in those places been found covered by the clay and boulders of the northern drift. The latter is, therefore, evidently of newer origin. As to the mode in which the erratic blocks were transported, Mr. Murchison adverts to the possible agency of ice-floes, and to the difficulty of imagining that currents of water alone, whether of rivers or the ocean, could have exerted a force adequate to their removal to such great distances; many boulders of several tons in weight having been transported to more than 100 miles from the nearest possible source of their origin. He also infers from the position of the shells, gravel, and boulders, that they were not washed, as has sometimes been imagined, by one or more diluvial waves over preexisting lands, but were all deposited during the same period in the bed of the sea, which bed was afterwards uplifted to unequal heights by movements of elevation of unequal intensity—movements which, though so largely affecting the physical geography of our island, must have taken place within the modern æra.

Mr. Edward Spencer has communicated to us the result of his examination of the "diluvium" near Finchley, and the summits of the neighbouring hills of Highgate and Hampstead. The gravel there contains water-worn boulders of granite and porphyry, together with fragments of secondary rocks with their characteristic fossils from the mountain limestone to the chalk inclusive. Mr. Spencer supposes that the current which brought these materials into their present situation must have flowed from the north. The diluvium here alluded to seems to correspond to that which covers the crag of Norfolk, and which is in some places intimately connected with that deposit. I may add that I have seen a similar formation on the banks of the Elbe, below Hamburgh, and in other parts of Denmark, with erratic blocks included in it in some places.

Our Secretary, Mr. Hamilton, has described a bed of marine shells, of recent species, on the southern coast of Fifeshire, near Elie, part of the deposit being twelve or fourteen feet above the level of high tide. Similar marine shells have been observed above the sea-level in many of the low lands bordering the estuaries of the Forth and Tay; and in the memoirs before mentioned Mr. Murchison has described a raised beach at the mouth of Carlingford Bay, Ireland, which he lately examined in company with Professor Sedgwick. Mr. De la Beche also informs us that he has lately discovered proofs of two movements of the land of Somerset, Devon, and Cornwall, one to a height of about thirty to forty feet above the present sea-level, and another to an uncertain depth beneath it, both subsequent to the period when the vegetation of the land and the molluscous inhabitants of the neighbouring sea were the same as they now are.

The evidence, therefore, is annually augmenting in favour of considerable alterations in the relative level of land and sea having been brought about in northern Europe at a comparatively modern epoch. For this reason I am more than ever disposed to refer to great movements of elevation and depression, the origin and present position of the loess of the valley of the Rhine, of which I gave some account in a former year. I have lately had occasion to recall your attention to this ancient silt in which terrestrial and aquatic shells are preserved of species still living in Europe. It is found from below Cologne to the neighbourhood of the Falls of Schaffhausen, exhibiting almost everywhere the same mineralogical character and fossils, forming sometimes low hills which cover the gravel of the great alluvial plain of the Rhine, sometimes rising up on the flanks of the mountains which border the great valley to an elevation of 300 or 400 feet above the river, or more than 1200 feet above the sea. I discovered lately, in the neighbourhood of Basle, the first remains of fossil fish which have been detected in this silt; and Mr. Agassiz recognized them as the vertebræ of a small species of the Shark family, perhaps of the genus Lamna. They were associated with the usual fresh-water and terrestrial shells, and the fact appeared anomalous, but the celebrated ichthyologist informs me that species of this family and of the Skate tribe have been known to ascend from the sea up the mouths of the rivers Senegal and Amazon to the distance of several hundred miles.

Some have imagined that a great lake once extended throughout the valley of the Rhine, which sent off large branches up the courses of the Mayne, Neckar, and other tributary valleys, in all of which large patches of loess are occasionally met with. The barrier of such a lake has been placed in the narrow gorge of the Rhine between Bingen and Bonn; but this theory is untenable, as there are proofs of the loess having once filled that gorge, and of its having overspread the adjoining hills of the Lower Eifel; also that it reached to the flanks of the hills bounding the valley of the Rhine as far down as Cologne and still further.

Instead of supposing one continuous lake of sufficient extent and depth to allow of the simultaneous accumulation of loess at all heights and throughout the whole area where it now occurs, I conceive that subsequently to the period when the countries now drained by the Rhine and its tributaries, acquired nearly their actual form and geographical features, they were again depressed gradually by a movement like that now in progress on the west coast of Greenland. In proportion as the whole district was lowered, the general fall of the waters between the Alps and the ocean was lessened, and both the main and lateral valleys, becoming more subject to river inundations, were partially filled up with fluviatile silt containing land and freshwater shells. After this operation, when a thickness of many hundred feet of loess had been thrown down slowly, and in the course of many centuries, the whole region was once more upheaved gradually, but perhaps not equally, throughout the whole region. During this upward movement most of the fine loam was carried off by denudation to such an extent that the original valleys were nearly re-excavated. The country was thus restored to its pristine state, with the exception of those patches of loess still remaining, and which, from their frequency and their remarkable homogeneousness of composition and fossils, attest the original continuity and common origin of the whole. By introducing such general fluctuations of relative level, we may dispense with the necessity of erecting and afterwards removing a great barrier more than 1200 feet high, sufficient to exclude the ocean from the valley of the Rhine during the accumulation of the loess.

Dr. Fitton has again brought before us those curious phænomena in the Island of Portland from which the former alternate existence of sea, of dry land, and lastly, of a body of fresh water in the same place, all anterior to the formation of the chalk, has been clearly inferred. In the ancient soil, called in Portland, the "Dirt bed," the silicified trunks of trees and their roots are still preserved. Some curious facts are just published on this subject in the new Part of our Transactions, in a memoir by Dr. Buckland and Mr. De la Beche. After Mr. Webster had first made known the nature and existence of the dirt bed, Professor Henslow ascertained that between this and the marine oolite of Portland there were two other beds of carbonaceous clay, and in one of these Dr. Fitton has now found the remains of Cycadeæ, from which it appears that the forest of the dirt bed was not the first vegetation which grew on this tract. First there must have been the sea of the oolite, then land which supported Cycadeæ, then a lake or estuary in which freshwater strata were deposited, then again land on which other Cycadeæ and a forest of dicotyledonous trees flourished; then a second submergence under fresh water, in which new strata were formed; and finally, a return of the ocean in the South-east of England, when the greensand and chalk were superimposed upon the Wealden. The appearances in Portland alluded to by Dr. Fitton may be explained either by the alternate rising or sinking of the same ground, or by simply supposing one gradual and continuous subsidence in a region where a large and turbid river entered the sea. The conversion of certain tracts into land several feet high might be caused in a single year by river-inundations, and there might be sufficient time for a forest to grow upon these before the continued sinking down of the land (assuming it to have been constant) had time to cause the tract to be again submerged. I have before adverted to the petrified forest described by Mr. Darwin, in Chili, where the trees have grown on a bed of lava, and have then been covered by sand and sedimentary and volcanic matter 2000 feet thick. These facts seem to prove that the region of the Andes, instead of having been raised up suddenly and at once, a few thousand years before our time, as some have conjectured, has undergone, even since the commencement of the tertiary period, vast movements of depression as well as of elevation.

Among the modern changes of the surface of the globe which have been attributed to a depression of the earth's crust, I may mention the great cavity in Western Asia spoken of by Humboldt in his Asiatic Fragments. The supposed existence of a region of dry land 18,000 square leagues in area, surrounding the Caspian Sea, and below the mean level of the ocean, naturally excited the most lively curiosity. The fact was regarded for twenty years as established by a series of barometrical measurements made in 1811 by Professors Engelhardt and Parrot. The difference of level which these travellers assigned to the Caspian and Black Seas amounted to about 350 feet. But Professor Parrot, having revisited the tract in 1829 and 1830, soon found reason to doubt the accuracy of his former conclusions. He learnt that some Russian engineers had ascertained by careful measurements that the Don, at the place called Katschalinsk, where it is only sixty wersts distant from the Wolga, is 130 Paris feet *higher* than the latter river, and as the Don flows with much greater rapidity to the Black Sea than the Wolga does to the Caspian, the difference of level between the two seas, if any, must be considerably less than 130 feet. Parrot accordingly made a series of levellings from the mouth of the Wolga to Zarytzin, 400 wersts up its course, and from the mouth of the Don to the like distance; and these observations gave as a result that the mouth of the Don was between three and four feet *lower* than that of the Wolga! So that, according to this measurement, if there is any difference between the levels of the two seas, the Caspian is the highest! Baron Humboldt, who with other geographers had given full credit to the former statement of Parrot, very naturally refused to admit the validity of these new observations, unless the Professor was prepared to show that his former ones were less worthy of confidence. In reply to this, Professor Parrot, in his Appendix, admits that the barometrical instruments used in 1811 were imperfect, and that his former calculations also were in some respects inaccurate.

It appears to me perfectly natural that Baron Humboldt, M. Arago, and others, should have willingly admitted the supposed fact of a considerable variation between the levels of the Caspian and Black Seas. It is well known that the Mediterranean sustains its level at nearly the same height as the ocean by drawing largely from the Atlantic on one side and from the Black Sea on the other. But if these constant supplies of water were cut off, if the Straits of Gibraltar and Constantinople were closed, and the Mediterranean became an inland lake isolated like the Caspian, its level must immediately fall. Its loss, by evaporation, would not be counterbalanced by the influx of river water, and there would then exist around its borders a tract of dry land lower than the ocean. It is true that we have no data for deciding to what extent this depression of level would reach; but it would present, at least on a small scale, a phænomenon analogous to that supposed to have been established in the case of the Caspian.

With every inclination to acknowledge and duly to appreciate the honest zeal with which Professor Parrot has laboured to correct his first error, I may remark that it does not yet appear why three or four years were lost after 1829 in putting the scientific world on their guard, and above all why the author of the Asiatic Fragments, published in 1831, was allowed to remain in ignorance of results previously obtained.

Gentlemen, I have now endeavoured to lay before you a brief sketch of the principal subjects referred to in the papers and in the discussions which have engaged the attention of the Society during the last year. I have confined myself exclusively to our own Proceedings; for the limits of this address would not allow me to give an analysis even of all the English works on Geology which have appeared since our last Anniversary, still less of all those which have been published on the Continent. A brief notice of these last would indeed require a volume, and this fact alone should inspire us with a feeling of strength and confidence in the future progress of Geology, which although it had scarcely obtained a recognized place among the sciences towards the close of the last century, has already risen into such importance as to excite a general interest in every nation throughout the world where the works of nature are studied.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1836. No. 45.

Feb. 24.—William John Prescott, Esq., of Threadneedle-street, and Thomas Collett, Esq., of the Inner Temple, were elected Fellows of this Society.

A paper was first read, entitled "Observations on a Patch of red and variegated Marls, containing Fossil Shells, at Collyhurst, near Manchester," by J. Leigh, Esq., and E. W. Binney, Esq., and communicated by Roderick Impey Murchison, Esq., F.G.S.

Manchester stands on a slightly elevated platform of upper new red sandstone; but the country to the north-west, north, and east of the town rises to a considerable height, and is traversed by the valleys of the Irwell, the Irk, and the Medlock, which furnish the only natural sections of the district. The formations exhibited in these valleys, and supposed to extend under Manchester, are, first and lowest, the carboniferous group; secondly, the lower red sandstone and marls; thirdly, the magnesian limestone; fourthly, the lower red marl; fifthly, the upper red sandstone; sixthly, the upper red marl; and seventhly, the superficial detritus.

The principal object of the authors being to describe the upper red marl, they notice briefly the characters of the other deposits.

The accumulations of superficial detritus are sometimes thirty feet thick, capping nearly all the high ground, and extending over the valleys. In the lower part they consist of water-worn fragments of granite, greenstone, porphyry, claystone, mountain limestone, and coal measures, imbedded in sand; and in the upper, of stiff blue clay, containing partially rounded fragments of the same rocks but of greater size. Portions of the lower red sandstone and marl are sometimes found, but none of the magnesian limestone. Blocks of granite, weighing two or three tons, occur on the summit of some of the hills which surround the Irwell and the Irk.

The lower red sandstone, the magnesian limestone, and lower red marl are exposed at Worsley Mills and at Stockport, dipping conformably with the coal measures; but at the latter locality they are stated to be overlaid unconformably by the upper new red sandstone.

The immediate vicinity of Manchester consists of upper new red sandstone, occupying the cavity formed by a flexure in the underlying deposits, and is generally supposed to be unconformable to them. It is very soft when first exposed, but hardens by exposure to the atmosphere; and is occasionally marked by belts and nodules of white sand, and in the lower part contains rounded fragments of granite, quartz, and other older rocks. No organic remains have been noticed in it.

The upper red marl is exposed only at Collyhurst, about a mile to the north-east of the Manchester Exchange, in the old road to Blakeley; but it has there yielded a greater number of fossils than has been found in any other bed of the superior divisions of the new red sandstone group in England.

The deposit extends about a hundred yards, and at one of the points examined presented the following details:

Top *a.*	Variegated marls, no organic remains	6 inches.
b.	Strong, red marl, traversed near its centre by a thin layer of fragile bivalve shells ..	5 ——
c.	Light-coloured, calcareous marl, marked with lines and spots of a beautiful red ..	3 ——
d.	Light-coloured, calcareous, strong marl, containing an immense number of imperfect casts of bivalves and perfect univalves	5 ——
	When the marl is first excavated it crumbles under the touch, but after exposure for a short time, it is fractured with difficulty.	
e.	Clay, striped red and white, and containing casts of bivalves	4 ——
f.	Light-coloured marl, similar to No. 4, and inclosing numerous casts of bivalves and univalves	3 ——
g.	Variegated marl, with an immense number of univalves and bivalves, 2 inches	2 ——
h.	Indurated red marl, mottled with streaks of a greenish colour. The upper part contains numerous casts of large bivalves, and the light-coloured streaks also inclose casts of bivalves and univalves. Few shells are found below the depth of one foot, though the author had the bed penetrated to the depth of 29 feet, when an influx of water prevented them from boring any further. The rhomboidal fracture, so characteristic of the red marl, was very observable in this bed	29 feet.

With respect to the geological position of these fossiliferous marls, the authors are fully satisfied that the deposit reposes on the upper new red sandstone by which the marls are surrounded, though, from the covered nature of the ground, the connexion of the two formations cannot be ascertained. In mineral aspect the lowest beds at Collyhurst are said to agree with the upper red marl of Lincolnshire and Cheshire, and to be distinguished from it only by the presence of fossils and the absence of salt; while the Collyhurst strata differ from the lower red marl, in colour, fracture, and the organic remains.

In accounting for the presence of these fossiliferous marls in the situation described, and their absence from the top of the new red sandstone in the immediate neighbourhood, the authors suppose that the marls were deposited in a hollow of the new red sandstone, and to have been, therefore, protected from denudation.

A notice, by Francis Offley Martin, Esq., inclosing communications from Col. Brown and Lieut. Laurence, of the Rifle Brigade, and Mr. Stevens, on the streams of sea water which flow into the land in the island of Cephalonia, was next read.

These communications were procured by Mr. Martin at the request of Mr. Lyell.

Lieut. Laurence's letter is dated 31st of May, 1835, and contains an extract from an account sent to him by Mr. Stevens of the nature, excavation, and the operation of the stream. The length of the channel made for conducting the water was 20 yards and its width 3 feet; and at the end of the channel a pit was made nearly 100 square yards in extent, and to the depth of about 4 feet below the level of the sea. On opening the sluice a stream of 150 square inches rushes into the pit with a velocity of 20 feet a second, and down a channel in the form of a segment of $\frac{1}{3}$th of a circle of 18 feet diameter. A constant discharge of this stream raises the water in the pit to within 2 feet of the top of the arched channel. The stream escapes through the fissures in the pit, but the direction which it afterwards takes has not been well ascertained, though shafts have been sunk for that purpose. In these shafts water of the same description with that in the pit is found, rising and falling in the same manner. Mr. Laurence also states that when the sluice-gate is shut down after a very considerable discharge of sea water into the pit, the water in the pit falls a few inches lower than it was previously to the discharge; but is afterwards raised to the usual level by the freshwater springs.

Mr. Stevens's letter, dated the 28th August, 1835, gave an account of the making of the excavation, and states that the experience of a year and a half had proved that the stream is not liable to any periodical change.

Col. Brown's communication bears date the 27th of August, 1835, and gives an account of the physical features of the island, the nature of the excavation, and the probable manner by which the subterranean current is disposed of.

On the eastern side of the harbour of Argostoli the country rises abruptly from the shore to a considerable elevation, and then more gradually until it is lost in one of the great ridges which intersect the island; but on the western side the narrow peninsular ridge at the foot of which Argostoli is built, nowhere exceeds 400 feet in height, sloping gradually towards the sea, and is surrounded by comparatively shallow water. The whole of the ridge consists apparently of coarse limestone, presenting on the surface large, detached blocks. Col. Brown's account of the excavation agrees with those already given. He notices the springs of fresh water, and the fact, that when the sluice is first shut the pool is drained to a much lower level than that at which it afterwards stands, and this phænomenon he conceives may be explained on the principle of natural siphons.

He says that there are three other openings on opposite sides of the promontory, through which sea-water flows into the land, and he is of opinion that there may be many more.

With respect to the question what becomes of the water, Col. Brown has always believed that the streams are conducted to subterranean fires, and that the earthquakes so common in the island are caused by the expansion of the gases generated by the action of those fires on the sea water.

A notice accompanying rock specimens from the caves of Ballybunion, on the coast of Kerry, by Lieut. Col. W. H. Sykes, F.G.S., was then read.

The author states that his principal object in bringing this communication before the Society is to induce geologists to examine a part of Ireland seldom visited, but which he conceives to be highly deserving of attention.

The coast of Kerry, in the neighbourhood of Ballybunion, presents a series of cliffs varying from 100 to 150 feet in height, and is indented by numerous bays. The stratification consists of several feet of debris, composed of angular fragments of silicious rocks and earth; a bed of alum shale follows, breaking into rhombs; then a stratum of lignite or carbonaceous schist, and another of iron shale. These strata are occasionally repeated, and said, on the authority of Mr. Ainsworth, to rest on limestone.

A principal feature in these beds is a disposition to separate into rhombs; and the cliffs in several places present the solid angles projecting beyond the vertical line of the cliffs, while the roof of some of the caves is groined like the intersection of Gothic arches. The general inclination of the strata is about 13° to the east, but it is frequently altered by faults, and sometimes presents anticlinal dips.

Of the exact age of the beds the author offers no opinion, but he thinks that it is not posterior to the carboniferous series.

Among the specimens which accompanied the memoir were some from the west end of the Isle of Innisfallen, in the Lake of Killarny. The strata at that point consist of narrow vertical and alternating ridges of a silicious rock and limestone: the former projecting beyond the surface of the latter.

A paper was last read, entitled, "An Account of some fossil vegetable Remains found in the sandstone which underlies the lowest bed of the carboniferous Limestone, near Ballisadiere, in the County of Sligo, Ireland," by Sir Alexander Crichton, M.D., F.G.S., &c.

In the county of Sligo there are no coal deposits, the nearest being the Arigna coal-field, in the county of Leitrim. The bed of sandstone containing the plants is well exhibited, resting upon gneiss, with which it is stated to dip conformably, and is covered by the mountain limestone. The state of the plants prevented the author from ascertaining their generic characters, but the specimens consist principally of flattened stems covered occasionally with a thin coating of carbonaceous matter. The lowest beds of limestone in this part of Ireland abound with corals, and contain nodules of chert; while the upper contain many shells, and are purer and better adapted for forming quicklime. The author then remarks on the great interval which must have taken place between the growth of the plants contained in the sandstone, which underlies the limestone, and of those which occur in the coal-measures resting upon it.

March 9th.—The Rev. George Brett, A.M., of Jesus College, Cambridge, and of Ranelagh House, Chelsea; and John Brown, Esq., of Stanway, near Colchester, were elected Fellows of this Society.

A paper was read, "On the Remains of Mammalia found in the Sewalik Mountains, at the southern foot of the Himalayas between the Sutluj and the Ganges," by Capt. Cautley, F.G.S., and communicated by J. F. Royle, Esq., F.G.S.

The range of mountains from which the remains described in this paper were obtained, extends from the Sutlej to the Burhampooter and the district of Cooch Behar. Its general direction near the Sutluj is N.W. and S.E., but on approaching the Burhampooter it is many points nearer direct E. and W. It is either connected with the Himalayas by a succession of low mountains, or is separated from them by valleys varying in breadth from three to ten miles, the principal being the Deyra valley, between the Ganges and the Jumna, and the Kearda and the Pinjore, between the Jumna and the Sutluj. The breadth of the range is from six to eight miles; and the loftiest peaks do not exceed 3000 feet, the average height being from 2000 to 2500 above the level of the sea, or from 500 to 1000 above that of the adjacent plains. The only roads by which the range can be passed follow the line of the rivers which flow through gorges flanked by precipitous cliffs, sometimes crowned by inaccessible pinnacles, on the top of which is usually a solitary fir-tree. As the range is not known to the present inhabitants or to geographers by a distinct name, Capt. Cautley has been induced to call it the Sewalik, a term by which the portion between the Jumna and the Ganges was formerly known*; and he states that he is anxious to give to it a distinct appellation to avoid the use of the indefinite terms Lower Hills and Sub-Himalayas.

The formation of which the range is composed between the Sutluj and the Ganges, the portion personally examined by the author, con-

* Smith's Exotic Botany, vol. i. p. 9. Dow's History of India. The name is also used in some writings in the possession of the high priest residing at Deyra. The word is a corruption of Shibwalla, from the district between the Ganges and the Jumna having been the residence of Shib.

sists of alternating beds of conglomerate, sandstone, marl, and clay, inclined at angles varying from 15° to 35°. The succession of the beds is irregular, the marl prevailing to the west and the conglomerate to the east of the Jumna.

The beds of conglomerate, or in the language of the author, of shingle, are of enormous thickness, and are composed of pebbles of granite, gneiss, mica-slate, hornblende-slate, and trap, derived apparently from the Himalayas, and are either loosely aggregated or cemented by clay and carbonate of lime.

The sandstone consists of grains of quartz and scales of mica, cemented by oxide of iron or carbonate of lime. The colour presents various shades of red and grey; and the state of induration differs in proportion to the quantity of the cementing matter, which sometimes gives the stone a crystalline appearance. It is occasionally used as a building material and in some instances has resisted for a long time the action of the atmosphere. Carbonaceous matter is of common occurrence in the sandstone, either in fragments exhibiting the structure of dicotyledonous plants, or as grains disseminated throughout the stone in nearly equal proportions with the sand. Carbonaceous matter exists also in the marl, and in one instance Capt. Cautley noticed it in the conglomerate. It has never yet been found in sufficient quantity to be of œconomical importance. At the Kalowala Pass, one of the entrances into the Deyra valley, the author discovered in a bed of yellow and red sand elliptical masses of sandstone coated by a thin layer of carbonaceous matter.

The marl or clay conglomerate is described as consisting of fragments of indurated clay cemented by clay, sand, and carbonate of lime. It is exceedingly tough, and is less easily acted upon by running water than the other strata.

The only point at which trap has been observed is in the neighbourhood of Nahun, where it has been noticed by Dr. Falconer.

Soda effloresces on the surface of the shingle and sandstone, and selenite occurs occasionally in the clay.

The distribution of the organic remains in the district between the Jumna and the Ganges, Capt. Cautley states to be as follows, the greater part of the fossils having been obtained at the Kalowala Pass.

Conglomerate or Shingle Beds.—Lignite, scarce.

Sandstone.—Trunks of dicotyledonous trees in great abundance, lignite, and remains of reptiles.

Marl.—*Pachydermata*: teeth, and remains of a species of Anthracotherium.

Carnivora: genera doubtful, but some of the teeth correspond with those of the Bear.

Rodentia: Rat, and a small variety of Castor.

Ruminantia: Deer, more species than one.

Solipede, teeth of a Horse

Gavial and *Crocodile,* teeth and bones in abundance.

Emys and *Trionyx,* fragments of.

Pisces, vertebræ and perhaps scales.

Shells, freshwater genera.

The district between the Jumna and the Sutluj consists of the same series of shingle or conglomerate, sand, clay, and marl; but the shingle is less abundant, and differs in being composed of pebbles of various kinds of clayslate and quartz, and the marl is exposed only at Nahun, where it contains the same organic remains as in the Kalowala Pass. From Nahun to the plains there is a succession of sandstones and clays, dipping on an average about 20° to the north. In the neighbourhood of that town the sandstone is hard and used for building; but it becomes soft on approaching the plains. The clays are stated to be more or less rich in Testacea, and the sandstone in remains of Mammalia.

The large collections of bones obtained by Capt. Cautley were found partly lying on the slopes among the ruins of fallen cliffs, and partly in situ in the sandstone; and he is of opinion that the former have been, in a great measure, preserved by the sandstones in immediate contact with the bones, being much harder and more ferruginous than in the general mass.

The following is a list of the remains which had been determined at the time the memoir was written.

Mastodon, elephant, rhinoceros, hippopotamus, hog, horse, ox, elk, deer, several varieties; carnivora, canine and feline; crocodile, gavial, emys, trionyx, and fishes; and portions of undescribed mammalia.

The remains of all these animals are in great abundance, with the exception of the Horse and Carnivora; but the bones of the head are better preserved than those of the trunk or the extremities. Sometimes the fractured bones have admitted of being joined, though the surfaces were coated with calcareous spar.

In assigning an age to the formation composing the Sewalik mountains, Capt. Cautley adopts the views of his friend Dr. Falconer, who in a notice read before the Asiatic Society of Calcutta, considered the deposit to be synchronous with that from which Mr. Crawfurd obtained the remains near Prome, on the banks of the Irawadi, there being an agreement in the organic remains. The author then offers some remarks on the *Mastodon elephantoides* and *M. latidens*, and in consequence of his having found jaws in which the front teeth are not to be distinguished from the teeth of *M. latidens*, and the rear from the teeth of *M. elephantoides*, he conceives that the distinction established on detached teeth will be found to be erroneous.

March 23.—Henry G. Atkinson, Esq., of Grove End; Henry Harpur Spry, Esq., of the Bengal Medical Service, Member of the Physical Class of the Asiatic Society of Calcutta, &c., and Frederick Edwards, Esq., of Southampton Place, Euston Square, were elected Fellows of this Society.

A paper was first read, entitled, "A Description of various Fossil Remains of three distinct Saurian animals discovered in the autumn of 1834, in the Magnesian Conglomerate on Durdham Down, near Bristol." By Henry Riley, M.D. and Mr. Samuel Stutchbury; and communicated by Charles Lyell, Esq., P.G.S.

The conglomerate in which these Saurian remains were discovered rests upon the edge of inclined strata of mountain limestone, filling up the irregularities of their surface, and consists of angular fragments of the limestone cemented by a dolomitic paste. The thickness of the deposit at the point where the remains were discovered does not exceed twenty feet.

Of the three animals described in the paper, two belong to a genus for which the author proposes the name of Palæosaurus, and the third to one which they have called Thecodontosaurus.

The characters of the genus Palæosaurus are derived from the teeth, which are described as being carinated laterally, and finely serrated at right angles to the axis. They are stated to differ from those of all the Saurians known to the authors: and as the teeth in their possession exhibit minor marked characters, they are induced to consider that they belonged to two species, which they have named *P. cylindricum* and *P. Platyodon.*

The genus Thecodontosaurus is likewise founded on the structure of the teeth, and their having been deposited in distinct alveoli. Among other remains in the Museum of the Bristol Institution is the right ramus of a lower jaw, $3\frac{1}{4}$ inches long and $1\frac{1}{4}$ in the greatest depth, from the summits of the teeth to the under rise, consisting of the dental bone, containing 21 teeth, with portions of the sub-angular and complementary bones, and perhaps traces of the opercula. The alveolar groove for the reception of the teeth is formed by two ridges of nearly equal height, the teeth being deposited in it, in distinct alveoli, to nearly half their length. The teeth somewhat resemble in shape a surgeon's abscess-lancet, being acutely pointed and flattened; while the anterior edge is also curved, but concave and strongly serrated, the serrature being directed towards the apex of the tooth. The middle teeth are the largest, rising not less than a quarter of an inch above the socket. They all possess a conical hollow, and in a specimen belonging to the Rev. D. Williams a young tooth is well exhibited in one of the alveolar cavities. From these characters the authors infer that the jaw belonged to a Saurian, but not to the great genus Lacerta of Linnæus as reformed by Cuvier by rejecting the Crocodiles and Salamanders. They further infer from the shape and serrated edge of the teeth that it did not belong to the Crocodiles; nor to the Lizards, whose alveolar inner edge is either wanting or much less elevated than the outer. They also show that it was not allied to the Monitors, because of the elevated inner alveolar edge, the distinct alveoli, the teeth remaining hollow and the formation of the new tooth in the same cell with the old one, as well as from the great number of the teeth. With respect to the Iguanas and Scinks they show that the fossil could not have belonged to them, in consequence of the distinct alveoli, the inner alveolar edge, and the form of the summit and serratures of the teeth: and that it differed from the Saurodon in having a ridge on the outside of the tooth with the edge crenated and of unequal length.

Numerous other bones have been discovered, but as none of them were found in connexion with teeth, the authors hesitate to assign them to either of the genera which they have established. Among these remains the following are described:

Vertebræ possessing the peculiar characters, of having the centre of the body diminished one half in its transverse and vertical diameters so as to resemble an hour-glass; of a suture connecting the annular part or body with the processes; and in the extremities of the vertebræ being deeply concave. These characters the author conceives distinguish the fossil vertebræ from those of all recent Saurians.

A nearly perfect chevron bone; ribs, one flat and imperfect, the other round with a double head and a deep intercostal groove; a clavicle; portions of coracoids; a humerus, the articulatory extremities of which expand to nearly three times the diameter of the centre of the bone; a humerus 7 inches long, 2 inches broad at the superior extremity, and $1\frac{1}{4}$ at its inferior; two femurs, one nearly perfect, being 10 inches in length; part of an ischium; a tibia; a fibula; metacarpal or metatarsal bones, with penultimate and ungueal phalanges.

In conclusion the authors state that these remains afford further proof of the truth that the more ancient the strata the more the animal remains differ from existing types.

A memoir was afterwards read, "On the Ossiferous Cavern of Yealm B idge, 6 miles south-east from Plymouth." By Capt. Mudge, Royal Engineers, F.G.S., F.R.S., &c.

This cavern is situated in a mass of limestone adjoining the village of Yealmpton, near Yealm Bridge, and on the south side of the river. It has been long known, and though large quantities of the bones have been burnt in the limekiln, yet it was not till lately that its contents attracted the attention of the scientific observer. Mr. Bellamy, of Yealmpton, first detected their value, and Capt. Mudge in a visit to Devonshire in the autumn of last year collected the information detailed in the memoir. "There were originally three openings into the cave, each about 12 feet above the river Yealm, and a few yards distant from each other. Large portions of the rock being removed for economical purposes, a considerable part of the cavern has been destroyed, and at the time of Capt. Mudge's visit portions of only the eastern and western chambers remained. The former consisted of a descending shaft to the depth of 10 feet, which turned at right angles and again ascended to the surface, both the descent and the ascent being at an angle of 45°. Of the western cavern, a portion remained uninjured. Prom the present opening it takes a northerly direction for 43 feet, the height varying from 5 to 6 feet, and the breadth from 4 to 5. It then turns westerly for 25 feet, the height varying from 5 to 12 feet, and the breadth from $3\frac{1}{2}$ to 5. The cave contained five, distinct, sedimentary deposits, and where they did not fill it to the roof the uppermost bed was covered by a layer of stalagmite. The order of the deposits was as follows:

Top.	Loam, containing bones and stones	$3\frac{1}{2}$ feet.
	Stiff whitish clay	$2\frac{1}{2}$
	Sand	6
	Red clay................................	$3\frac{1}{2}$
	Argillaceous sand	6 to 18.

Animal remains have been found only in the uppermost bed, and the author, on the authority of Mr. Clift and Mr. Owen, states that they belong to the elephant, rhinoceros, horse, ox, sheep, hyæna, dog, wolf, fox, bear, hare, water-rat, and a bird of considerable size. Coprolites also occur in the same bed. Many of the bones are splintered, chipped, and gnawed. Of the elephant only two teeth of a young animal have been preserved, and the remains of the rhinoceros are also rare, being confined to teeth and a doubtful bone, but those of the hyæna, particularly teeth, exceed in quantity all the bones of the other animals. Teeth and bones of the horse and ox are very abundant, but the remains of the bear are confined to teeth. It is however stated by the author that it is impossible now to determine what proportions the animals originally bore to each other. The pebbles found in the same bed with the bones are apparently derived from the confines of Dartmoor, and differ from those contained in the bed of the Yealm. In one part, where the roof is a little lower than usual, the limestone is beautifully polished, as if by the friction of the animals which inhabited the cave.

There are many other caverns in the neighbourhood, but the one next in importance to that at Yealm Bridge is in the grounds at Ketley. The floor of this cavern rises but little above the present level of the river, and consists of gravel and pebbles corresponding with those in the bed of the Yealm. It has been ascertained that it does not contain bones, and Capt. Mudge therefore concludes that the caverns of Yealm Bridge and Ketley were exposed to very different conditions when the elephant and the hyæna inhabited the southern part of Devonshire. As far as regards space the accommodation in Ketley Cavern was much superior to that of Yealm Bridge Cave, and consequently it may be inferred that at the time when the hyænas inhabited the latter, they were prevented from entering the former either from its having been frequently flooded or permanently under water.

PROCEEDINGS

OF

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April 13.—A memoir on the Geology of Coalbrook Dale, by Joseph Prestwich, Jun., Esq., was commenced.

April 27.—The memoir on the Geology of Coalbrook Dale, by Joseph Prestwich, Jun., Esq., began on the 13th of April, was concluded.

In a paper read before the Society in February 1834, Mr. Prestwich gave an account of some of the principal faults of this coal-field, and in the present memoir describes fully the extent and physical features of the district, the formations of which it consists, the dislocations not previously noticed, the superficial detritus or drift, the organic remains, and the inferences which the author conceives may be drawn from the facts enumerated. In the first place, however, he acknowledges the assistance which he has received from Mr. Murchison, Mr. Anstice of Madeley, and the gentlemen connected with the coal-works; he also acknowledges the aid which he has derived from Mr. Arthur Aikin's labours in the same district.

The coal-field is bounded on the east by a slightly undulating line ranging from Lilleshall to Bridgenorth; on the north-west by a line nearly coincident with the main road from Lilleshall to Watling-street, near Wellington, and thence by the Wrekin; on the west the boundary is broken by the gorge of the Severn, but is formed, in part, by the elevated ridges of Benthall and Wenlock; and on the south-east it is defined by the road from Much Wenlock to Bridgenorth.

The area thus circumscribed consists of a platform raised about 400 feet above the Severn at Madeley, or 500 above the level of the sea; the surrounding country seldom rising to a height exceeding 350 feet. It is intersected by numerous picturesque glens, including the celebrated defile through which the Severn flows at the Iron Bridge, and is traversed by several low hills, the most elevated of which is about 746 feet above the level of the sea; but the Wrekin, which forms part of the north-western boundary, rises to the height of 1320 feet.

The formations of which the district consists are, commencing with the oldest, 1st, some members of the Lower Silurian rocks; 2ndly, the Wenlock and Ludlow rocks, belonging to the Upper Silurian system; 3rdly, the old red sandstone; 4thly, carboniferous limestone; 5thly, coal measures; 6thly, new red sandstone; and, 7thly, trap.

In describing the formations subjacent to the old red sandstone, Mr. Prestwich states that he owes his knowledge of their order of superposition entirely to the previous labours of Mr. Murchison, and that unassisted by them it would have been impossible for him to have determined correctly their relative antiquity.

1st. The lower Silurian rocks consist of quartzose grit succeeded by micaceous flags, which are overlaid by a coarse-grained sandstone alternating with beds of light grey clay. They occur on the flanks of the Wrekin and Arcol Hills.

2ndly. The Wenlock rocks are composed, in the lower part, of beds of shale, and in the upper of limestone abounding with organic remains. They form the escarpment of Wenlock and Benthall Edges, Lincoln Hill, &c. The Ludlow rocks consist of three divisions: the lowest being formed of grey-coloured, soft, calcareous sandstones and shales; the middle of very thin beds of light grey and brown limestone; and uppermost of sandstones. They are stated to occur at Much Wenlock and Wyke, also near Apley, in the Meadow-pits and in several other pits in Broseley parish; likewise between Dean and Willey, &c.

3rdly. The old red sandstone skirts the southern parts of the coal-field, and consists of beds of dark red marl alternating with dark, micaceous sandstones.

4thly. The carboniferous limestone appears on the south of Little Wenlock, at Steeraways and Lilleshall Hills, and presents thin beds of argillaceous limestone and shale.

5thly. The *coal measures* consist of the usual alternations of shale, sandstone, and coal, amounting at the Madeley Meadow pits to 135 beds, having an aggregate thickness of about 250 yards. The first 70 or 80 beds are light grey, yellow, or red; the succeeding 20 are nearly black, and the underlying are mostly light-coloured. These distinctions are general, but not universal. In the uppermost part of the series clays and soft calcareous sandstones predominate; in the middle argillaceous sandstones and indurated clay; while in the lowest part fine hard sandstones. The upper coal seams are thin, generally sulphurous, widely separated, and extremely irregular, but the lower are nearer together, and are persistent throughout the field. The average thickness of the seams is about 3 feet, and the number in different pits varies from 1 to 16. The following table contains the aggregate thickness of the seams and the number at each of the localities mentioned:

	Yards.	ft.	in.	Number of beds.
Hadley	15	0	0	16
Sned's Hill	14	2	2	12
Malmslee	11	0	10	13
Langley	11	2	6	11
Dawley	14	0	0	16
Lightmoor	13	2	0	17
Madeley	10	2	10	24
Broseley	7	0	9	13

In these pits the measures are fully developed, and consequently the variations may be explained by the thinner beds not having been equally included. In the Madeley list every thin seam is given.

The shales and sandstones vary greatly in their characters, though the former are said to be more uniform than the latter, and to contain layers of argillaceous carbonate of iron. A bed of freshwater limestone occurs in the upper part of the measures, at Inet, the Frog's Mill near Nordley, and at Tasley. It is very hard, has a fine conchoidal fracture, and varies in thickness from one to two yards. A minute account is then given of the changes presented at different pits, and it is shown that the thinning out of the strata of sandstone and shale is frequently of great advantage to the miner by bringing into contact, beds of coal, which would otherwise be separated many feet.

Carburetted hydrogen is disengaged in greater abundance from the lower than from the upper measures, and in greatest quantity on commencing a new work, especially on approaching a fault, when large masses of coal are constantly blown off the main beds with loud reports. Carbonic acid gas is rarely found in a pit at work, and Mr. Prestwich suggests that the quantity sometimes noticed may have been accumulated in adjacent old pits.

The mineral contents of the coal measures are confined to the argillaceous carbonate of iron, sulphuret of iron, sulphuret of zinc, and petroleum. The celebrated spring, which once yielded more than a hogshead a day, produces now only a few gallons a week; but another abundant spring has been discovered, and considerable quantities of petroleum have been obtained in working the Dingle pit. Titanium is found in considerable quantities in the hearthstones of the old furnaces, often beautifully crystallized, but in greatest abundance in a massive state. In analysing some crystals of zinc found in the coal measures the author detected titanic acid.

6thly. New red sandstone.—Only the lower divisions of this formation occur in the immediate neighbourhood of Coalbrook Dale, flanking the eastern and north-western sides of the field, and in some places abutting against the dislocated edge of the coal measures. They consist of clay, marl, and sandstones, overlaid by calcareous conglomerates, to which succeed coarse sandstone, marls, and other conglomerates. The lowest beds pass conformably into the coal measures, the line of distinction being chiefly distinguishable by the change in the colour; but some of the vegetable remains of the coal may be, though rarely, detected in the sandstone series. Mr. Prestwich is of opinion that there is a want of conformity between the lower and upper systems of the new red sandstone series.

7thly. Trap rocks.—The greater portion of the Wrekin, Arcol, Maddox, and Lilleshall Hills, &c. are composed of greenstone, felspar rocks, and amygdaloid. Smaller bosses also rise to the surface at various points within the coal-field, and others have been discovered in the deep workings; but it is worthy of remark that no trap has been noticed in any of the crevices or fissures connected with the faults. The trap does not appear to have charred the coal; but at New Hadley, at a point where a boss appears at the surface, the coal in its vicinity loses its cohesion and becomes sooty, and the same change was noticed elsewhere near dislocations, though no trap was visible.

Dislocations.—The author says that there is probably no coal-field of equal size in the kingdom so greatly shattered as that of Coalbrook Dale. The faults are most numerous and complicated where the measures are thinnest, the miner in those parts rarely proceeding 20 yards without interruption, and frequently not more than two or three; but when so close together the dislocations are small in effect and extent, and are connected with others of greater magnitude.

The larger faults tilt the strata in various directions, but have generally a parallelism of strike, and deviate but very slightly from a straight line. Sometimes the sides of the disjointed strata are in contact, when the edges of the beds of coal and shale have a shining striated surface, but at others the sides are separated several yards, the interval being filled with the debris of the strata. The inclination of the principal faults as well as of the minor, obeys no general law, and even in the same fault it occasionally varies from 45° to 90°. The difference of level on the opposite sides of the principal dislocations also varies considerably; thus the Lightmoor fault, at Malmslee and Old Park produces a difference of level of 600 or 700 feet, but at Sned's Hill of only 300, and a branch of it does not affect the strata more than 50 or 60 feet. In some instances the change of level is by steps or hitches, owing probably to unequal resistance, or a series of small dislocations. Another character of the large faults is their subdividing, more especially at the extremities—the subdivisions occasionally taking a direction at right angles to the main fault, but when they are numerous they diverge from it only a few degrees and extend but a short distance.

The author then describes minutely the chief faults; the two principal of which, bounding the field on the east and partly on the west, bring the disjointed edges of the coal measures in a level with those of the new red sandstone; and he afterwards gives a table of the minor faults, containing the name of each fault with its direction, extent, average angle of inclination, breadth, fall, the greatest difference of level produced by it, and the localities at which the difference of level varies; and from the phenomena presented by the faults, and the fact that the field is a platform raised above the level of the surrounding country, the author infers that the coal-field has been elevated above its original position; he also adds that the contortions of the beds are not of any great magnitude.

Superficial detritus or drift.—Thick beds of gravel and sand cover a large portion of the surface, and are considered by the author as consisting of two distinct deposits. The lower, which is of local occurrence, though from 20 to 50 feet thick, consists of fine-grained red sand, containing beds of small angular pebbles of the adjacent rocks, and thin, distinct seams of marl or clay. Imbedded in the sand are frequently found masses of coal, some of them six feet in diameter. The upper deposit is composed of rolled pebbles of rocks, composing the coal-field and its boundaries, imbedded in coarse reddish sand. Its distribution is more regular than that of the lower division; and it is distinguished by the abundance of fossils derived from the Dudley limestone and the coal measures, as well as the presence of marine shells of existing species.

Organic remains.—The fossils of the coal measures are described with great detail, as well as the phenomena of beds containing marine remains, alternating with others in which freshwater shells and land plants occur; and a comparison is made with the Ganister coal-field, in which similar alternations have been noticed. The following are the principal points detailed in the paper respecting these alternations at Coalbrook Dale. The lowest part of the coal measures presents numerous beds of sandstone and shale, with seams of good coal; some of the beds containing in abundance vegetable remains, occasionally associated with Unios. To these succeed the bed called the penny ironstone, in which has been found a few vegetable remains and casts of Unios and Cyclades, but great abundance of marine remains belonging to the genera Producta, Spirifer, Ammonites, Nautilus, Bellerophon, Conularia, Euomphalus, Pecten, Orbicula, Terebratula, Venus, Asaphus, and Pentacrinites; remains also of fishes, namely, the *Megalichthys Hibbertii* and *Gyracanthus formosus.* The next series of beds, consisting of the usual alternation of sandstone, shale, and coal, inclose vegetable remains and Unios. Upon these repose a stratum of micaceous shale, containing ironstone nodules in which have been found land plants, Unios in considerable quantities, remains of the Megalichthys and Gyracanthus, and Trilobites of a distinct genus. This singular stratum is surmounted by a series, of great thickness, of the usual coal measures, in which organic remains and land plants have been observed, and is succeeded, in two localities, by the Chance penny-stone, in which *Productus scabriculus* occurs in vast abundance. The uppermost beds of the series, consisting of many thick beds of sandstone with layers of shale and one seam of coal, are almost destitute of organic remains. The distribution of the fossils is extremely irregular in different parts of the coal-field, being most persistent in the lower beds; and though they are most commonly found in the ironstone nodules, yet they sometimes occur in the sandstones and shales adjacent to the coal seams.

In the concluding part the author reviews the facts detailed in the memoir, and draws the inferences which he conceives they warrant.

1st. Mr. Prestwich is of opinion that the alternations of freshwater shells with marine remains, do not prove as many relative changes of land and sea; but that the coal measures were deposited in an estuary, into which flowed a considerable river, subject to occasional freshes; and he conceives that this position is supported by the fact of frequent alternations of coarse sandstones and conglomerates with beds of clay or shale; and for the same reason he is of opinion that the vegetable remains did not grow where they are found.

2ndly. After recapitulating the evidence in support of the protrusion of Coalbrook Dale through once continuous overlying formations, he calls attention to the important inquiry whether there may not be buried beneath the new red sandstone districts other considerable coal-fields, which are unknown, because they have not been subject to disturbing agents similar to those which exposed the district under review.

Lastly. With respect to the agents which have modified the surface of Coalbrook Dale, the author is of opinion that it was denuded, in part, while beneath the level of the ocean; that the lower bed of detritus, containing angular gravel and large masses of coal, proves a sudden and short cataclysm; while the upper beds of rounded gravel, containing recent shells, indicate the long-continued action of a body of water, since the existence of the present Testacea of our coasts.

A letter from R. W. Fox, Esq., addressed to Sir Charles Lemon, Bart., M.P., F.G.S., "On the Formation of Mineral Veins," was then read.

Mr. Fox is of opinion that mineral veins were originally fissures probably caused by changes in the earth's temperature; that they were small at first and gradually increased in their dimensions; and that the mineral contents progressively accumulated during the whole period of the development of the fissures; and as changes in the earth's temperature might produce changes in the direction and intensity of the terrestrial magnetic curves, he conceives that electricity may have powerfully influenced the existing arrangement of the contents of these fissures.

Copper, tin, iron, and zinc, in combination with sulphuric and muriatic acids, being very soluble in water, Mr. Fox says, they would in this state be capable of conducting voltaic electricity; and as the rocks forming the walls of the veins, contain different salts, they would be in opposite electrical conditions, and hence currents would be generated and readily transmitted through the fissures, and in time the metals would be separated from their solvents and deposited in the veins. But, on the known principles of electro-magnetism, Mr. Fox adds, it is evident that such currents would be more or less influenced by the magnetism of the earth; and therefore that they would not pass from north to south or from south to north as easily as from east to west, but more so than from west to east.

The author then offers some observations relative to the production of sulphurets from the decomposition of the metallic sulphates; and explains how fissures, gradually widening, would be successively filled, and would account for veins occurring within veins; he offers some remarks also on the greater productiveness exhibited at the points where veins pass from one formation to another, and is of opinion that the fact may be explained by supposing the rock in which the vein is productive to have been electro-negative.

In conclusion Mr. Fox states, that if in other parts of the world veins may be found to deviate from an east and west direction much more than they do in England, the apparent discrepancy may be explained by the rocks having yielded more easily in one direction than in another, and from a difference in the direction of the magnetic meridian in different countries, as well as from the probability that it has varied greatly at different epochs.

April 27.—After the ordinary business of the Society had been transacted, a Special General Meeting was held to take into consideration the By-Law respecting Defaulters.

The President having stated that, according to the existing Bylaws, a defaulter could not be removed from the Lists of the Society until his name should have been suspended two calendar months, and been subsequently read from the Chair at four successive ordinary General Meetings, and a Special General Meeting should have been held to take into consideration the removal of the name from the List of the Society:

It was unanimously resolved, by ballot,

"That the Council be authorized to remove from the List of the So-" ciety any Fellow being more than two years in arrear; the name of " that Fellow having been suspended during one month, and it having " been announced at two subsequent ordinary Meetings to be the in-" tention of the Council to remove the said defaulter's name from the " List of the Society unless his arrears be paid up."

May 11.—Thomas Bland, Esq., of Bedford-row; John Thomas Woodhouse, Esq., of Ashby-de-la-Zouch; William Holl, Esq. of Edgbaston, near Birmingham; George Owen Rees, Esq., of Holland-place, Clapham-road; George Cornwall Legh, Esq., of High Legh, Cheshire; and Michael Jones, Esq., of Mount-street, Grosvenor-square, were elected Fellows of this Society.

A paper was read "On the Silurian and other Rocks of the Dudley and Wolverhampton Coal-field, followed by a Sketch proving the Lickey Quartz Rock to be of the same age as the Caradoc Sandstone," by Roderick Impey Murchison, Esq., F.G.S., V.P.R.S.

In previous memoirs the author has shown that the coal-field extending from Dudley into the adjacent parts of Staffordshire is surrounded and overlaid by the lower member of the new red sandstone; and on this occasion, laying before the Society an Ordnance map, geologically coloured, he gave, 1st, A general sketch of the structure of the coal-field in descending order: 2ndly, Detailed accounts of the Silurian rocks which protrude through the coal measures or lie beneath them: 3rdly, A sketch of the quartz rocks of the Lickey: 4thly, A description of the trap rocks: 5thly, General remarks upon the dislocations of the stratified deposits; and the dependence of these phenomena upon the intrusion of trap rocks.

1. *Coal measures.*—In most parts of the productive coal-field the coal measures are covered by a considerable quantity of detritus, the greater part of which has been derived from the breaking up of the new red sandstone which once overspread this tract, with which are mixed, especially in the northern part of the field, a few boulders of northern origin and some from the surrounding region.

General and detailed sections are then given of the regular succession of the carboniferous strata; for the greater part of which in the neighbourhood of Dudley, and for much valuable information, Mr. Murchison expresses great obligation to Mr. Downing; the best sections of the Wolverhampton field having been afforded by Mr. J. Barker. The principal points of novelty consist in drawing a clear distinction between the upper or thicker measures, which contain the 10-yard coal, generally known as the Dudley coal, and the *underlying* carbonaceous strata, or ironstone measures. The latter, rising from beneath the 10-yard coal, range to the N.N.E. from Wednesbury and Bilston, in a long tract between the parallels of Walsall and Wolverhampton, extending to Cannock Chase. At the southern end of the field, emerging from beneath the 10-yard coal, they occupy the district between Stourbridge and Hales Owen, containing the well-known "fire clay;" though some of the most valuable of the Wolverhampton iron-stones, beneath those called the "New Mine," are here wanting, viz. the "Gubbins," and "Blue Flats." This poverty in the lower coal measures extends over all the district south of Dudley. In the northern and southern ends of the district these lower measures represent the whole carboniferous system; and in various natural sections near the Hagley and Clent hills, the author has detected them, in very feeble bands, passing upwards and conformably into the lower new red sandstone. Besides the open works formerly alluded to by him in previous memoirs, Mr. M. now states, that his former conjectures respecting the passage of the 10-yard coal beneath the new red sandstone which flanks it on the east and west have been verified by the efforts of the Earl of Dartmouth, who, after sinking to a depth of 151 yards through strata of the lower new red sandstone, has very recently succeeded by further borings, carried down to the depth of 290 yards, in discovering the 1-foot, 2-foot, and "Brooch" coal seams, which *overlie* the 10-yard coal throughout the Dudley field. These operations have taken place at Christchurch, one mile beyond the superficial boundary of the coal-field.

Besides the plants so common in all carboniferous tracts, the author has observed the presence of animal organic remains. Unios of several species are abundant; and in the northern or lower part of the field he has extracted fragments of fishes, which have been named by Professor Agassiz,

Megalichthys Hibbertii,
M. Sauroides,
Diptodus gibbus;

together with scales, coprolites, &c., proving an identity between the animals deposited in these coal measures and those of Edinburgh, described by Dr. Hibbert. The same species, it will be recollected, have been pointed out by Sir Philip Egerton as occurring in the N. Staffordshire coal-field, and one of them has been observed by Mr. Prestwich in the coal-field of Coalbrook Dale. Mr. Murchison, however, remarks that he has not yet observed any marine remains in these coal measures similar to those of Coalbrook Dale; and nothing *yet* found can invalidate the inference that the coal of Dudley and Wolverhampton may have been accumulated exclusively in fresh water.

b. Silurian rocks.—The mountain or carboniferous limestone and the old red sandstone, which in so many other parts of England form the support of coal tracts, being wanting, this field reposes directly on rocks which Mr. Murchison proves to consist of the two *upper members of the Silurian system*, viz. "the Ludlow rocks" and "Wenlock limestone."* As, however, these rocks rise up irregularly, like separate islands, through the surrounding coal measures, and not in their regular order of superposition, so it was obviously impracticable to have determined their *relative* age by any local evidences; and hence no attempts could have been made to distinguish the younger from the loder deposits, until the structure and organic remains of the different members of the Silurian system, had been fairly worked out in other districts, where these types were fully and clearly displayed in their regular order.

2. *Ludlow rocks.*—These rocks appear at the surface in three detached points in this coal-field, viz. Sedgeley, Turner's Hill, and the Hayes. At Sedgeley they are thrown up in an elongated ellipse, very much resembling a large inverted ship, of which Sedgeley Beacon, 630 feet above the sea, may be considered as the keel. The upper Ludlow rock, though not thick, is plainly marked by containing the *Leptæna lata*, the *Serpula gigantea*, &c., and by overlying a limestone which is in every respect identical with that of *Aymestrey* or the middle member of the *Ludlow* rocks, presenting the same lithological structure, *i. e.* a dull argillaceous grey limestone, which among other well-known shells, such as the *Terebratula Wilsoni* and the Lingula, contains also the beautiful *Pentamerus Knightii* so entirely *peculiar* to this stratum. As at Ludlow and Aymestrey, this limestone of Sedgeley, known here as the "black limestone," forms an excellent cement under water.

Turner's Hill, a small elevation between Gornals and Himley, is composed of Ludlow rocks; and the Hayes is a narrow short tongue of the same, with a central band of limestone, which rises at a high angle from beneath the coal measures, on the main road from Stourbridge to Hales Owen, a portion of the lower Ludlow rock being also well exposed.

2*a*. "*Wenlock limestone.*"—This limestone formation is much more largely developed than that of the Ludlow rocks, constituting several ellipsoidal masses near the town of Dudley, which have been long worked and extensively known among collectors, from the number and beauty of their organic remains. Hence the rock has been usually termed the "Dudley limestone." As, however, it was impossible to have ascertained in this district the relative age of these rocks, their different members being independently in contact with the coal measures, the nomenclature of the Silurian system already selected is adhered to, because in Shropshire the Wenlock limestone, in its fullest standard, rises out regularly from beneath the Ludlow rocks, and the latter passing beneath the old red sandstone and carboniferous limestone (both of which are wanting at Dudley) complete the proofs required. The author therefore entreats geologists not to employ the term Dudley limestone except as the synonym of Wenlock, with which

* There is one spot, however, within the author's knowledge where the underground works reached a thick mass of red shale or marl *beneath* the coal-field; but the works having been long abandoned, no correct knowledge of these red rocks can be now obtained.

he proceeds to show its lithological and geological identity. This limestone is described in detail at the Castle Hill, Wren's Nest, and Hurst Hill, in all of which it forms ellipsoidal elevated masses, 500 to 650 feet high, protruding through the coal measures in lines parallel to similarly shaped masses of Ludlow rock at Sedgeley; &c., *i. e.* trending from 10° E. of N. to 10° W. of S. Two strong bands of limestone occur in these hills, overlaid and separated from each other by shale, charged with numerous small concretions of impure limestone, the "bavin" of the workmen. The limestone having been quarried out from these bands which have been raised up from a common centre, and disposed with a quâquâversal dip at high angles, it is evident that the hills themselves would ere now have been demolished, had they been composed throughout of calcareous masses of equal purity; but the "bavin" or refuse composes the framework of these perforated hills, and preserves their outline. The Wenlock shale, or underlying part of the formation, constitutes the nucleus of the Wren's Nest, the largest and most perfect of these ellipsoids, and of this the author gives a detailed plan. These ellipsoids usually feather off at one extremity with a broken-down margin, and thus complete their resemblance in physical features to ancient craters of eruption*. The greatest superficial extent of the Wenlock formation is in the neighbourhood of Walsall, where it rises both in dome-shaped masses and in rectilinear ridges, running from S.S.W. to N.N.E. parallel to the axis of the Wolverhampton coal-field, of which one of these ridges forms the eastern boundary, the limestone plunging beneath the coal-field at a rapid angle. The other ridge is continuous with the new red sandstone of the Bar-beacon, and is known as the Hay Head lime. In the Dudley or 10-yard coal tract few works have yet proceeded downwards beneath the lower coals, and hence the subjacent Silurian rocks are little known to the miners. A remarkable and accidental discovery of a mass of limestone took place recently near Dudley Port, on the rise side of a great fault, which bounds the downcasts of the coal, called "Dudley Trough." Having worked out the coal on the upcast side, a shaft was sunk in and upon the southern side of this fault, when at a depth of 208 yards, and about 100 yards below the exhausted coal strata, a mass of limestone was met with, which proved to be near 7 yards thick, and of very good crystalline quality. Being found to extend in a form more or less horizontal, extensive works were promptly opened in it for the extraction of a rock so precious in the heart of the coal-field. When the author visited it, a considerable cavity had been formed, in which no trace of moisture was discernible, whilst it was known that copious streams of water were flowing in the coal measures overhead. He accounts for this mass of limestone being hermetically excluded from the percolation of water, by the impervious nature of the Silurian shale which separates the coal measures from the limestone, and by the shafts being sunk in the fault itself, which, like other lines of fissure, is filled up with clay and other materials, so closely compacted as to form com-

* See account of Valley of Woolhope for similar phenomena on a larger scale, and with a greater number of concentric and enveloping formations. —Proceedings Geol. Soc., vol. ii. p. 15.

plete dams to water. At the north-western edge of the subterranean excavation the fault was stripped, and the materials of which it is composed having thinned out, the limestone was found in contact with a bed of coal, the edges of which appeared *bent*, both the *coal and the limestone* having a slickensides polish. By boring through the limestone a second calcareous stratum was found, thus completing the proofs of identity between this underground mass and that which rises to the surface in the hills of Dudley Castle and the Wren's Nest.

In the northern or Wolverhampton field, where the whole of the coal measures, even to beneath the lowest beds of ironstone, (the *blue flats,*) are traversed by shafts not exceeding 120 yards in depth, the field has been proved at several points to rest on shale and impure limestone, the equivalents of the Ludlow and Wenlock formations. For lists of the fossils in this group of Upper Silurian rocks the author refers to previous memoirs, announcing that more perfect lists will shortly be laid before the public in his large work upon the Silurian system.

3. *Lickey Quartz rock, Caradoc sandstone,* (*Lower Silurian rocks.*) Dr. Buckland first called the attention of geologists to the Lickey quartz rock* ; and, showing that it had been one of the principal magazines of the quartz pebbles in the new red sandstone and diluvium of the southern counties, he further compared it with certain rocks *in situ* in the neighbourhood of the Wrekin. The Rev. J. Yates has also clearly described the lithological structure of this rock, and has briefly touched upon some of its fossils †. Mr. Murchison undertakes to prove the true geological position of these rocks. He shows that they lie in the direct prolongation of the Silurian rocks of Dudley, and that, being partially flanked and covered by thin patches of coal, they emerge through a surrounding area of the lower new red sandstone and calcareous red conglomerate (described in previous memoirs). Unlike, however, the succession in the Dudley field, there are here no traces of the Ludlow rock and Aymestrey limestone. Nor are there masses of any size of the Wenlock limestone, but shreds only of the shale or lower part of this formation with some of its well-recognised fossils, (*Colmers.*)

The lower Silurian rocks rise from beneath the Wenlock shale in thin courses of bastard limestone, alternating with red and green courses of sandstone and shale, the equivalents of those bands, which at various places in Shropshire, and at Woolhope in Herefordshire, constitute the top of the formation of Caradoc sandstones. Like these, they are here underlaid by flaglike sandstones, sometimes rather more argillaceous and approaching to clay slate, the whole passing down into silicious sandstones, both thick and thin bedded. In the latter are casts of several fossils of the Caradoc formation, such as Pentameri of two species, and corals peculiar to it. These fossilliferous strata are well exposed on the eastern side of the hills by recent cuttings, where the new road from Bromsgrove to Birmingham traverses the ridge. The ridge itself, however, consists essentially of quartz rock, which

* Transactions Geol. Soc., 1st Series, vol. v. p. 507.
† Transactions Geol. Soc., 2nd Series, vol. ii. p. 137.

the author shows is nothing more than altered Caradoc sandstone, precisely analogous to that which he has on former occasions pointed out on the flanks of Caer Caradoc, the Wrekin, Stiper stones, &c. In those districts the passage from a fossiliferous sandstone to a pure quartz rock has been accounted for by the latter being in absolute contact with eruptive masses of igneous origin; and here it is suggested that the same cause may have operated, though the contact is not visible, because the line of quartz rock is precisely upon the prolongation of the trappean axis of the Rowley Hills, whilst the southern end of the parallel outburst of the Clent Hills, is but little distant. Notwithstanding their highly altered condition, it is shown that all the quartz rocks throughout this ridge of low hills are uniformly *stratified*, the dip being either to the E.N.E. or W.S.W., *i. e.* at right angles to the direction; and the parallelopipedal fragments into which the rock breaks are shown to be produced by fissures more or less at right angles to the planes of stratification; these fissures being so numerous where the mass is much altered, as almost to obscure the true laminæ of deposit.

4. *Trap.*—The composition and characters of the trap rocks and basaltic masses of the Rowley Hills are first described, together with the manner in which they are supposed to rise through and cut off the coal upon their flanks. Rocks of similar origin occur at various detached points to the west of Dudley, of which Barrow Hill is the principal, affording the most convincing proofs of the volcanic mass having burst through the carboniferous strata, since the latter are not only highly disturbed and broken, but fragments of coal and coal measures, in highly-altered conditions, are found twisted up upon the sides, and even mixed with the trap itself. In the Wolverhampton or northern coal-field, the chief vent of eruption is at Pouk Hill, two miles west of Walsall, where the greenstone is arranged in fan-shaped columns. After pointing out distinct evidences of the intrusion of similar rocks at Bentley Forge and the Birch Hills, in some of the old open works near which the trap is seen to overlie the coal, the author gives various sections of subterranean works, which prove the existence of greenstone, in bands more or less horizontal. As these bands of trap have jagged edges, are of limited extent, of exceeding irregularity in thickness, and often produce great alteration upon the inclosing carbonaceous masses, the author has no hesitation in expressing his belief that they are not true beds, but simply wedges of injected matter which have issued from central foci, and have been intruded laterally amid the coal strata; an opinion formerly expressed by Mr. A. Aikin in an able memoir*.

Although these lateral masses of greenstone in the Wolverhampton field are of origin posterior to the accumulation of coal strata, the author does not deny that the tufaceous conglomerates of Hales Owen, which have a strong analogy in composition to a certain class of volcanic grits described in former memoirs, may have been formed contemporaneously with the carboniferous deposits.

The trap of the Clent Hills is then briefly described, and is shown

* Transactions Geol. Soc., 1st Series, vol. iii. p. 251.

to be identical with that of the Abberley Hills, also mentioned in previous memoirs.

5. *Principal lines of dislocation.*—The whole of this carboniferous tract has been upcast through a cover of new red sandstone, the lower members of which are frequently found to have been dislocated conformably with the inferior carbonaceous masses, proving (as formerly expressed by Mr. Murchison) that some of the greatest of these movements took place *subsequently* to the deposits of the red sandstone. In describing the faults along the boundary of the new red sandstone, he directs particular attention to that of Wolverhampton, where the coal measures dip slightly inwards from the line of fissure, along which they are conterminous with the *overlying* strata, a fact perhaps without parallel in this or the adjacent coal-fields (including Coalbrook Dale), the usual phenomena being that, however disrupted, the carbonaceous or upcast strata always incline outwards, as if they would pass eventually beneath the lower new red sandstone on their flanks. This exception is supposed to have been caused by the upheaving of a subjacent mass of Silurian or trap rocks close to the edge of the line of fault.

Having next described the effect of the great longitudinal faults produced by the upcast of the Wenlock limestone of Walsall, he shows that the subterranean mass at Dudley Port (p. 410), is upon the same parallel, *i. e.* from N.E. to S.W., if not directly on the same line of fissure. This line of eruption is strongly marked on both edges of the northern half of the coal-field extending to Cannock Chase.

Another great axis of elevation which affects the Dudley field, diverges at a considerable angle from the former. It is prominently marked by the line of the Rowley Hills, and after concealment for a certain distance beneath the red sandstone to the S. of Hales Owen, reappears in the ridge of the Lickey quartz rock. The lofty trappean ridge of the Clent Hills is parallel to this last-mentioned axis. It is further pointed out as remarkable that at the angle formed by the confluence of these divergent lines of elevation, the Silurian or fundamental rocks of the tract are raised in inflated ellipsoidal forms from common centres, the strata having a quâquâversal dip, in one case completing the outlines of a very perfect valley of elevation. The author infers that such curvatures are exactly what might be expected at the point of greatest flexure in the axis of the coal-field, where the volcanic matter, unable to find issue, has produced these inflated masses. There are numberless faults in this coal-field to which no reference is made, it being stated that much additional labour is required to give a complete history of them ; but attention is called to the Birch Hill, Lanesfield, and Barrow Hill faults, which are the principal *transverse* faults, and which the author conceives may be explained upon the principles of the theory of Mr. Hopkins, or as cross fractures which have resulted from elevation of the coal-field *en masse*.

The memoir concludes with referring to the importance of one of the problems to which the author has been directing public attention during the last few years, viz. the probable extension of carboniferous tracts of the central counties beneath the *surrounding* new red sandstone; and he rejoices that the deductions which necessarily follow from his observations in this and the adjacent coal-fields, have recently been so ably supported by the masterly observations of Mr. Prestwich upon Coalbrook Dale, with whose opinions he entirely coincides.

The quantity therefore of unwrought coal beneath the new red sandstone of Shropshire, Worcestershire, Staffordshire, &c. though previously omitted in statistical data, must form an element in all calculations concerning the probable duration of the carboniferous wealth of the empire.

May 25.—Golding Bird, Esq., F.L.S., of Seymour-street, Euston-square; James Smith, Esq., F.R.S., of Jordan's Hill, near Glasgow; and Octavian Blewitt, Esq., of Charlotte-street, Bloomsbury-square, were elected Fellows of this Society.

A paper was first read "On the part of Devonshire between the Ex and Berry Head and the Coast and Dartmoor;" by Robert Alfred Cloyne Austen, Esq., F.G.S.

The formations of which the district consists are transition rocks, new red sandstone, greensand, and trap.

The transition rocks are sometimes arenaceous, more often slaty, and contain beds of limestone rich in organic remains. The only portion of the system considered by the author as undescribed is a conglomerate, 100 feet thick, which occurs at the Park at Ugbrook. It is composed of rounded quartz pebbles and fragments of clay slate, united by a siliceous cement. It alternates in the upper part with beds of clay slate, and is older than any of the limestone of the country. These transition formations are traversed by numerous faults, the strata being thrown into the wildest confusion. In some places beds of trap are regularly interposed without producing any effect upon the adjacent strata; but in other localities dykes intersect the sedimentary deposits, and have produced great alterations both in their structure and dip.

The new red sandstone consists in the lower part of fine-grained fissile sandstone, and a coarse conglomerate, formed out of the surrounding older formations, including partially rounded fragments of slate, limestone, porphyry, greenstone, &c. This formation is also much disturbed by faults, some of which, the author thinks, are contemporaneous with the deposition of the sandstone, as they appear to affect the lower and not the upper beds in the same section.

The elevation of the greensand of the Haldons, Mr. Austen thinks, was due to the action of a subjacent mass of trap, portions of which are visible at the extremities of the hills: and he is of opinion that the preservation of these insulated patches of greenstone has been owing to their having been raised above the level of the waters which denudated the surrounding districts.

In conclusion the author briefly reviews the geological phenomena which this part of Devonshire presents, and infers from them, that during the transition epoch there were submarine volcanic irruptions, as shown by the interstratified trap; that the number of organic remains in the limestone prove the ocean teemed, in parts, with life: that the new red conglomerate was due to the breaking up of the transition formations: that there were irruptions of trap at later periods, as proved by the dykes in the new red sandstone; and that Dartmoor was elevated after the deposition of the greensand, as the first traces of granitic debris are found in the Bovey deposit.

A notice was next read on the supposed existence of the Lias formation in Africa, by Roderick Impey Murchison, Esq., F.G.S.

Mr. Leach, of Milford Haven, a short time since presented to the Society some organic remains, stated to have been obtained by Commodore Sir Charles Bullen on the west coast of Africa. As these organic remains agree exactly with fossils of common occurrence at Lyme Regis, it was conjectured that some mistake might have occurred respecting them; but Mr. Leach has been subsequently informed by Sir Charles Bullen that they were collected by himself and officers at West Bay, Fernando Po, Accra, andSierra Leone, and that they occur in abundance.

Mr. Murchison also announced in this notice, that Sir John Herschel has discovered Trilobites in a rock which occurs to the north of the Cape of Good Hope.

A paper was then read, entitled " A Notice on Maria Island, on the east coast of Van Diemen's Land, (S. lat. 42° 44′ E., long. 148° 8′,) by George Frankland, Esq., Surveyor-General of the Colony; and communicated to the Society by Robert W. Hay Esq., Under Secretary of State for the Colonies.

Maria Island is composed, for the greater part, of trap; but strata of freestone well calculated for building purposes frequently occur, and at the northern point of the island is a perpendicular cliff, from 200 to 500 feet high, composed of dark grey limestone, formed of oysters, muscles, and other shells, in a state of great preservation. On the eastern coast, near Cape Mistaken, are numerous caverns, some at the height of 600 feet above the level of the sea, the roofs of which are studded with stalactites. Mr. Frankland states that Van Diemen's Land in every part furnishes strong evidence of the ocean having once occupied a much higher level than at present. The paper also contains much valuable information respecting the natural productions of the island.

A letter was next read on the geology of the country included in the S.W. quarter of the Daventry, or 55th sheet of the Ordnance Survey, by J. Robison Wright, Esq., F.G.S., and addressed to Capt. Mudge, R.E., F.G.S.

The surface contained in this quarter sheet is about 168 square miles, including the towns of Southam and Kineton, and the field of the battle of Edge Hill. The formations of which the district consists are the new red sandstone, the lias, and the inferior oolite.

A notice on the occurrence of marine shells in a bed of gravel at Narley Bank, Cheshire, by Sir Philip Grey Egerton, Bart., M.P., F.G.S., was then read.

In proceeding from the valley of the Weaver, at the point where it is crossed by the Liverpool and Birmingham Railway, towards Delamere Forest, are two acclivities, each about 60 feet high, and distant about a mile and a half from each other. Narley Bank is situated on the summit of the second ridge, and the gravel-pit is in the face of the northern declivity, about 157 feet above low-water mark at Weston Point, and six miles from it. The gravel differs from the common gravel of the country by the prevalence of calcareous matter and the small proportion of fine sand; but agrees with the gravel at the Willington, described in a former paper*. This resemblance induced the author to search for shells, and he found, at a second visit to the pit, several imperfect fragments of apparently recent marine shells.

In conclusion, Sir Philip Egerton states that he has always found a marked distinction, in Cheshire, between the gravel containing recent shells and that which does not; and he infers, from the former being occasionally covered, as at the Willington, by a thick deposit of sand and gravel, that it was accumulated before the occurrence of the last drift, to which he ascribes the origin of the common detritus of the county.

A paper was afterwards read, entitled "Accompanying remarks to a section of the Upper Lias and Marlstone of Yorkshire, showing the limited vertical range of the species of Ammonites and other Testacea, with their value as geological tests," by Louis Hunter, Esq., and communicated by John Forbes Royle, Esq., F.G.S.

The portion of the coast to which this paper immediately refers is called the Easington Height, situated between Whitby and Redcar, and presents the following details:

INFERIOR OOLITE.		
Upper Lias Shale.		
Shale	35 feet	
Hard or cement stone bed	25	
Shale, containing nodules of ironstone	90	
Jet rock	20 to 30	
Hard compact sandy shale	30	
	about ——	200
Marlstone.		
Thin seams of shale, alternating with hard ironstone bands, a foot thick	25	
Sandy shale, with beds of dogger	63 ?	
Alternating beds of calcareous sandstone and sandy shale	40	
Shaly sandstone, passing gradually into the lower lias shale	30 ?	
	——	160
Lower Lias Shale		150

The beds of shale superior to the jet rock are characterized by the presence of *Nucula ovum*, *Orbicula reflexa*, *Plagiostoma pectinoide*, *Ammonites communis*, *A. heterophyllus*, *A. fimbriatus*, *A. Walcottii*,

* Proceedings Geol. Soc., vol. ii. p. 189.

A. subcarinatus, A. angulatus, A. crassus, A. fibulatus, A. subarmatus, A. Lythensis, A. Boulbiensis, A. annulatus, Nautilus astacoides, and *Belemnites elongatus.* The species gradually decrease in abundance on approaching the jet rock, and the specimens which do occur in that stratum are stated to be smaller than in the higher beds. The jet rock contains a peculiar suite of Ammonites, viz. *A. elegans, A. signifer, A. elegantulus, A. exaratus, A. Mulgravius, A. concavus,* and *A. ovatus.* It is also distinguished by containing the remains of the gavial-snouted crocodile. With respect to the relative abundance of the fossils, Mr. Hunter observes that where they occur in the greatest number they are smallest in size.

The beds situated between the jet rock and the marlstone are very poor in fossils.

The marlstone series is distinguished not only by a change in the species, but in the preponderance of bivalves and the comparative rarity of Ammonites; the characteristic fossils being *Avicula cygnipes, A. inæquivalvis, Pecten sublævis, P. æquivalvis, Pullastra antiqua,* several species of Terebratula, *Cardium truncatum, Modiola scalprum.* The species of Ammonites are few, *A. vittatus* occurring about the centre of the series, and *A. maculatus* at the junction with the lower lias shale.

In conclusion, Mr. Hunter states that the difference between the distribution assigned to the fossils by himself and other authors may be owing to the prevalent practice of collecting fossils from subsided masses, and not from undisturbed portions of the cliffs.

A letter was, lastly, read from Robert Fitch, Esq., of Norwich, to Edward Charlesworth, Esq., F.G.S., on the discovery of the Tooth of a Mastodon in the crag at Thorpe, near Norwich.

The pit in which the tooth was found is stated to present the following section:

Top.	Alluvium	5 feet
	Gravel	6
	Brick-earth, sand, and gravel	14
	Crag	5
	Large chalk flints, mixed with crag shells, principally Pectens	
	Chalk	

It was in the bed of large chalk flints that Mr. Fitch found the tooth; and he adds that Thorpe adjoins the parish of Whitlingham, in which Mr. William Smith discovered the tooth figured in his "Strata Identified."

June 8.—Henry Hubert, Esq., F.R.A.S. of New Bridge-street, Blackfriars; the Hon. William Lascelles, of Wilton-crescent; the Hon. W. Bingham Baring, M.P., of Great Stanhope-street; the Hon. John Stewart Wortley, of Curzon-street, May Fair; and the Right Hon. Baron James Parke, of Park-street, were elected Fellows of this Society.

A paper was first read, entitled, "Notice respecting a piece of Wood partly petrified by Carbonate of Lime; with some remarks on Fossil Woods, which it has suggested." By Charles Stokes, Esq., F.G.S.

Mr. Stokes lately received from Germany, with a collection of fossil woods, a piece of recent wood, stated to have been found in an ancient Roman aqueduct, in the principality of Lippe, in the Buckeberg, in which some parts are petrified by carbonate of lime, while the remainder of the wood, though in some degree decayed, is not at all mineralized. This fact has afforded an explanation of the peculiarities of some other instances of fossil wood, in which different parts of the specimen present different appearances. Two other instances are particularly described: one of silicified wood from Antigua, and one of a calcareous petrifaction from Allen Bank in Berwickshire. In both these cases it is inferred by the author, that the process of petrifaction commenced simultaneously at a number of separate points, and that it was suspended when only parts of the wood had been petrified. The unchanged parts would then be liable to decay; and in the specimen from Antigua the process has been renewed after this remaining part had decayed in a considerable degree, when that also became silicified. In the calcareous petrifaction from Allen Bank (which is described and figured by Mr. Witham, in his work on the structure of fossil vegetables), the parts which had not been petrified at the time the process was interrupted, have been entirely destroyed by the decay which then ensued, and the intermediate spaces have been filled up by the crystallization of carbonate of lime, without the removal of the petrified portions from the positions in which they grew and in which they had become mineralized.

In the specimen from the Roman aqueduct the petrified portions run in separate columns through the wood, as if conducted downwards by the vessels or woody fibres. In that from Allen Bank the separate portions are spherical in form and independent of each other; and in that from Antigua they are independent, and though nearly spherical not regularly so. Hence the author infers that a different explanation must be sought for the manner in which the solution of mineral matter was supplied in the first instance from that of the two last.

The paper notices also the fossil wood from Lough Neagh and Bonn, in which some small parts preserve their texture, although remaining still unchanged in the midst of the petrified mass.

The author concludes with a short notice of the different conditions in which the structure of wood is preserved in different specimens, and considers that the condition of the wood has not any influence on the process of petrifaction.

A paper was next read, entitled, "Further notice on certain peculiarities of Structure in the Cervical Region of the Ichthyosaurus," by Sir Philip Grey Egerton, Bart., M.P., V.P.G.S.

In a former communication* Sir Philip Egerton gave an account

* Proceedings Geol. Soc., vol. ii. p. 192.

of the cervical vertebræ of the Ichthyosaurus, and announced the discovery that the atlas and axis are firmly united and strengthened below by an accessory articulating bone. In this paper he shows, that the union of the two vertebræ is perfect at all periods of the animal's growth, and apparently in all the species of the genus hitherto discovered, having observed it in vertebræ varying in size from half an inch to seven inches and a half in diameter. Externally there is a strong line of demarcation between the two bones, but internally the cancelli appear to pass from one to the other. The atlas, independently of the union of the two vertebræ, is distinguished by the form of the anterior cavity for the reception of the basilar process of the occipital bone; by the outer margin being rounded instead of sharp, and by the triangular facet on the inferior part of the circumference for the reception of the accessory bone: the axis, independently also of its union with the atlas, differs from the other vertebræ, by the facet on the under surface for the reception of the accessory bone: and the third vertebra is also distinguished from the remaining bones of the neck by a facet for the articulation of a very small accessory bone. The intervertebral cavities of the 4th and 5th cervical vertebræ, the author states, are less than in the vertebræ of the dorsal and caudal regions, and the anterior cavity is considerably smoother than the posterior one of the same vertebræ.

Sir Philip Egerton states that the spinal column does not, as described by other authors, decrease in diameter from the middle dorsal vertebra to the atlas, but that the minimum diameter is attained about the fifth cervical vertebra, from which point to the occipital bone the increase in size is very rapid, the atlas being fully one fifth more in diameter than in the above-mentioned bone.

In the former memoir Sir Philip Egerton described only one accessory bone in the cervical region of the Ichthyosaurus; but in this paper he proves that there are three, and proposes to designate them by the name of subvertebral wedge-bones. One of them is supplementary to the atlantal socket, another is common to the atlas and axis, and the third, which agrees in form with the second, but is much smaller, articulates on the under surface of the third vertebra.

The author, then, in conclusion, enlarges upon the admirable adaptation of the structure of the Ichthyosaurus to the habits of the animal.

A communication was afterwards made "On the coal-fields on the north-western coast of Cumberland, &c., &c.:" by the Rev. Professor Sedgwick, M.A., F.R.S., F.G.S., and Williamson Peile, Esq., of Whitehaven, F.G.S.

In a former paper* the authors described the range of the carboniferous limestone from the neighbourhood of Kirkby Stephen to Egremont; and showed that the formation admitted of two divisions: the lower representing the scar limestone of the Yorkshire sections, the upper (also like the Yorkshire sections) exhibiting

* Proceedings Geol. Soc., vol. ii. p. 198.

alternations of limestone, sandstone, and shale, with thin seams of coal. They commenced with a short notice of rocks and sections made through this upper division, which in its range towards the western coast of Cumberland, appears gradually to thin off, and lose its importance. They then proceeded to describe in more detail, and with many illustrative sections, a still higher coal-field; which is on the same parallel with the great Northumberland and Durham coal-fields, and in the quantity of carboniferous beds subordinate to it, is in no respect inferior to them.

This field is bounded by the red sandstone of St. Bees Head; by the carboniferous limestone, in a part of its range above described; by the sea coast between St. Bees Head and Maryport; and by the new red sandstone in its range from Maryport to Chalk Beck near Rosley. The whole system appears to thin off near Rosley, and is succeeded by some sterile, alternating, masses of red shale and sandstone, to which the miners, though improperly, have given the name of the "*great red metal dyke.*" To the east of this series of red beds the rich upper coal-field never appears to have extended. From many borings and workings near Whitehaven, it is inferred that the upper division of this carboniferous limestone, as well as the millstone grit, have almost disappeared; and that the coal measures are brought nearly into immediate contact with the lower division of the limestone. In some places the whole limestone has thinned off, and the coal measures seem to rest almost immediately on the Skiddaw slate

The authors commence their details, in the present paper, with an account of the Whitehaven coal-field, which they separate into three divisions: the southern, or How-Gill colliery; the middle, or Town field bounded by a great downcast dyke towards the north; and the northern, or Whin-Gill colliery, bounded by an anticlinal line which enters the sea near Parton. The strata found in these several parts of the field are described by the help of the sinkings and borings at Croft Pit, and by other sinkings in various parts of the field down to the limestone. A comparison is then made between this series of strata and those exhibited in corresponding sections of the Harrington and Workington fields; and it is shown that the whole series may be conveniently separated into two divisions: the upper, containing two principal bands of coal, called the "*Bannock Band,*" and Whitehaven "*Main Band*"; the lower, containing many thin seams of coal, but only one band which has been much worked near Whitehaven. They then proceed to describe the most remarkable workings in the several divisions of the Whitehaven field; the new field to be approached by the Parton tunnel; and the extension of the "Main and Bannock band" to the hills S.E. of Dissington; but these details, as well as an account of the works attempted in a small triangular field bordering the sea to the north of Parton, are necessarily passed over in this abstract.

They then describe the Harrington coal-field, bounded to the north and south by two enormous faults; between which the country is occupied by the lower division of the coal measures. It is impossible in an abstract to describe the complicated *faults* that everywhere intersect this field, and by which the limestone is in two instances brought up to the surface. The coal beds, worked within it, are five in number, and are described, in descending order, under the following names: (1.) Metal Band; (2.) Two-feet Band; (3.) Yard Band; (4.) Four-feet Band; (5.) Yendale Band. By help of a transverse section to Castlerigg, this field is connected with the upper division of the coal measures; in as much as pits have been sunk near that place, through the great beds of the upper division, down to the *two-feet band*; thus giving a consistency and unity to all the sections.

The authors next describe the Workington field, bounded to the south by the great *fault* which brings in the lower division of the Harrington field; and to the east and west by the sea and the turnpike road. The river Derwent was formerly regarded as its northern boundary; but the *main band* unfortunately thins out a little to the south of Workington, and thereby contracts the extension of the valuable part of this field. Nearly all the beds worked in this field belong to the upper division; and their general agreement with the Whitehaven bands of coal is proved by detailed sections; especially from the sinkings at Henry Pit near the mouth of the Derwent. The principal *faults* traversing this district, the outcrops of the principal bands of coal, and the extension of the works under the sea are described in some detail. Several other small divisions of the great field are then noticed: viz. the Starmire, Keekhill-Side, Brownrigg, Branthwaite-Edge, Gillgaron, and Graysouthern fields; after which the authors proceed to describe the phenomena on the north side of the Derwent.

To the north of the Derwent, there is near the sea-coast a sterile region, partly occupied by the *lower red sandstone*, and partly by the upper division of the coal measures, in which the main coal is wanting; a fact connected with the thinning off of the *main band* to the south of Workington. In a very extensive field, commencing a little to the N. of the village of Seaton, and extending over Broughton Moor, and from thence to Dearham, two beds of coal (known by the names of the "*ten-quarter band*" and the "*kernel and metal band*") have been very extensively worked, and are identified with the "*bannock-band*" and "*main-band*" of Whitehaven and Workington. The relations of the several parts of this extensive tract of country are exhibited in detailed sections, of which it is very difficult to convey a notion in a mere abstract; and the works carried on within the mare, with very limited exceptions, referred to the upper division of the Whitehaven field.

The coal bands exhibited in the works near Gillerux, Aspatria, Plumland, and Weary Hall are then described; and detailed sections are given of the works in the Bolton field,—generally regarded as the north-eastern limit. There is, however, an unexplored tract to the east of a great fault which forms the northern limit of the Bolton field; and, in the neighbourhood of Rosley, a seven-feet coal (undoubtedly a member of the upper division) was formerly worked;

though to a very small extent, in consequence of the complicated dislocations which intersect the district.

Having described, in the above order, the several portions of the great coal-field, and noticed some of its peculiarities of mineral structure, the authors endeavour to ascertain the limits of certain outlying masses of the *lower red sandstone*, of the *magnesian conglomerate*, and of the *new red sandstone*. From the facts stated, it appears that the coal measures pass, in some instances, in regular ascending order, into the lower red sandstone. In other instances, however, the coal measures appear to have undergone considerable movements of elevation before the existence of the lower red sandstone; in as much as the position of the two formations is discordant. Again, though the lower red sandstone forms the natural and immediate basis of the magnesian limestone and conglomerates, yet there are several places, within the south-western limits of the country described, where the conglomerates appear to have been deposited in hollows and inequalities presented by the waterworn beds on which they rest unconformably. From which facts it seems to follow, that the formations described in this paper have undergone, during their development, two considerable movements, affecting the position of the component strata: 1st, a partial movement of the coal measures, anterior to the deposition of the lower red sandstone; 2ndly, a partial movement, both of the coal measures and the lower red sandstone, anterior to the formation of the magnesian conglomerates.

This being the last evening of the Session, the Society adjourned, at its close, to Wednesday, November the 2nd.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1836—1837. No. 47.

November 2, 1836.—The Society assembled this evening for the Session.

J. Talbot, Esq., of Evercreech House, Shepton Mallet, Somersetshire, was elected a Fellow of this Society.

In conformity with Section VI. Article 8. of the By-laws, the names of the following Fellows proposed by the Council to be removed from the lists of the Society on account of arrears, were read from the Chair for the first time:

Lord Glenlyon, William Higgins, Esq.

A paper was read, entitled "A general sketch of the Geology of the western part of Asia Minor," by Hugh Edwin Strickland, Esq., F.G.S.

This memoir embodies the observations made by the author during a winter's residence at Smyrna, a tour into the valleys of the Meander and Cayster, and a journey from Constantinople up the river Rhyndacus into Phrygia, and thence down the valley of the Hermus to Smyrna. In the latter excursion he was accompanied by Mr. Hamilton, one of the Secretaries of this Society, to whom he acknowledges himself indebted for a zealous cooperation.

The country, thus visited, is thickly beset with mountains, some of which are arranged in five parallel chains having, on a great scale, nearly an east and west bearing, but the remainder are variously grouped and without any particular direction. Four of these parallel chains bound the valleys of the Hermus, the Cayster, and the Meander; and the fifth, commencing with Mount Ida, extends eastward to the Mysian Olympus, and probably is continued in the Bithynian Olympus. With respect to the theories which have been advanced relative to the direction of a range being a mark of its comparative antiquity, the author says that the whole of the mountains of this part of Asia Minor, whether parallel or not, appear to have been elevated at nearly the same geological epoch.

The formations of which the country is composed, Mr. Strickland arranges in the following chronological order, but he states that further researches may require it to be modified: 1. Granitic rocks; 2. Schistose and metamorphic rocks; 3. Greenstone; 4. Silurian rocks; 5. Hippurite limestone; 6. Tertiary lacustrine limestone;

7. Tertiary marine formations; 8. Trachytic and trap rocks; 9. Modern volcanic rocks; and 10. Modern aqueous deposits.

1. *Granitic rocks* were not observed *in situ*, but on the authority of M. Fontanier, M. Texier, and other travellers, the loftiest part of Ida, the Mysian Olympus, the range of the Bithynian Olympus, Mount Dindymus, the top of Mount Tmolus, and Mount Latmus are granitic.

2. *Schistose and metamorphic rocks.*—This class of formations, constituting nearly all the mountain chains, consists principally of mica-schist associated irregularly with beds of marble and quartz rock, and is supposed by the author to be altered clays, earthy limestones, and sandstones. The marble is very generally distributed, but the chief points mentioned in the paper are the quarries in the island of Proconnesus, from which the name of Marmora was given to the neighbouring sea, Broussa, Ephesus, the north and west sides of Mount Olympus, and the valley of the Cayster. The colour is white, gray, or striped, and thin seams of mica often traverse the blocks, giving them a tendency to split into slabs. The quartz rock is interstratified with the slate, into which it frequently passes. The strike of the beds commonly coincides with that of the mountain range, but the amount and direction of the dip is said to vary greatly.

3. *Greenstone.*—It is with some hesitation that the author gives a distinct place to this rock, as he conceives that it may be of the age of the trachytes. He observed it between Kesterlék and Adrianós, associated, though not clearly, with the mica slate; and near the village of Eshén he noticed a vein of greenstone traversing a tertiary rock, and therefore believes that the extensive greenstone formation around that village may be tertiary.

4. *Silurian rocks.*—A formation of schist and limestone containing many fossils resembling in general character those of the Silurian rocks, was observed on both shores of the Bosphorus north of Constantinople. Mr. Strickland stated that the formation would be described in a separate memoir.

5. *Hippurite limestone and schist.*—This term is employed by the author to designate the vast series of limestones, which covers a great area in the South of Europe, and represents in Asia Minor the whole of the secondary formations. On the south side of Lake Apollonia the deposit consists of compact, yellowish, lithographic stone, identical with that of Greece; at Mount Tartalí, on the east of Smyrna, of compact, gray limestone, abounding with large Hippurites, and of greenish schistose sandstone like some of the Italian macignos; on the eastern part of Mount Sipylus, above Magnesia, as well as in the peninsula of Carabornou, and in the island of Scio, it also consists of gray compact limestone; and at Mount Corax, west of Smyrna, of schistose marls and sandstone apparently devoid of fossils.

In addition to these localities, Mr. Strickland says, that on the south side of the Hermus, between Ghiédiz and Húshak, he and Mr. Hamilton observed a series of beds consisting chiefly of micaceous sandstone finely laminated, and containing occasionally beds of rolled pebbles and soft white limestone; and though the deposit is unlike any other in Asia Minor, yet he is inclined to class it with the Hippurite limestone.

6. *Tertiary lacustrine limestone.*—In the part of Asia Minor described in this paper, every large valley, with the exception of the Cayster, contains remains of extensive lacustrine deposits, forming occasionally rounded hills several hundred feet high; but they are totally wanting in the narrow ravines. They consist generally of horizontal beds of calcareous marl, sandstone, and white limestone, which is often identical in composition with English chalk, inclosing layers and nodules of flint; but sometimes approaches in character to the Italian scaglia. Near the skirts of the deposits the marls and limestones gradually become sandy and gravelly, resembling in some instances a shingle beach. The fossils noticed in these beds belong to shells of the genera Unio, Cyclas, Lymnæa, Planorbis, Paludina, and Helix, and to leaves of dicotyledonous plants.

As far as the author's observations extended, these testaceous remains resemble more the existing freshwater shells of the North of Europe than those now inhabiting Asia Minor. Thus the genus Cyclas, common in the North of Europe, was not noticed by him in Asia Minor, except in a fossil state; and the genus Melanopsis, abundant in every stream in the country, was not found in the tertiary strata.

The author then gives a detailed account of each lacustrine deposit, designating it by the name of the valley in which it occurs, or the principal town in its vicinity. He terms them the basins of Moudania, Doondár, Harmanjík, Taushanlí, Gozulják, Azani, Ghiédiz, Husbák, Sardis, Smyrna, and the lower vale of the Meander.

7. *Tertiary marine formations.*—Accumulations assigned to this class, are stated to occur on the coast of the Troad, both banks of the Dardanelles, and in the southern part of Tenedos, but they were not examined by the author.

8. *Trachytic and trap rocks.*—Patches of these rocks are scattered abundantly over Asia Minor, and are commonly associated with the lacustrine deposits, which in some cases appear to be older, in others younger, than the igneous rocks. The following are the points at which they were observed by Mr. Strickland and Mr. Hamilton in the journey from Constantinople to Smyrna: Both sides of the Bosphorus, a few miles north of Constantinople; the promontory of Bozbornou, north of the gulf of Moudania; Hammamlí near Kirmasteu on the Rhyndacus; between Debrént and Taushanlí, where volcanic matter is intermixed with a lacustrine sandstone; the vicinity of Ghiédiz, where a basaltic mass has sent forth a coulée of columnar amygdaloid, which is 10 feet thick, and rests upon beds of sand and gravel inclosing pebbles of trachyte; Gunáy; the hills west of Kobék; an isolated hill about 8 miles from Adala, on the road to Koola; the western side of Mount Sipylus; and the hills immediately above Smyrna.

9. *Modern volcanic rocks.*—These were observed by the author only in the Catacecaumene, and are termed by him modern, with reference to geological epochs and not to historical events. He refers them to two ages, marked by the different degree of preservation of the cones of

scoria and by the appearance of the streams of lava which have flowed from them. The older cones, 30 in number, are low and flat; their craters have either disappeared or are marked by a small depression, and they are covered almost invariably with vineyards producing the Catacecaumene wine. The streams of lava connected with them are also level on the surface and covered with turf. To the north of the Hermus the author observed many isolated hills of lacustrine limestone, capped by beds of lava or basalt, which he considers may have flowed from these older cones.

The newer volcanos, of which there are only three, must have been extinct for at least 3000 years; yet their craters are perfectly defined, and their streams of lava are black, rugged, and barren. One of these craters, visited by the author, is called Karadewit or the Black Inkstand, and is about $1\frac{1}{2}$ mile north of Koola. It is a vast mound of reddish scoriæ and ashes, has a small crater on the north side, and an immense sea of black lava containing olivine and augite has flowed from its base.

As an additional proof of the comparatively great antiquity of these modern volcanic eruptions, Mr. Strickland describes the effects produced by running water on a stream of lava at Adala, a town in the north-east extremity of the plain of Sardis. The Hermus enters this plain from the Catacecaumene through a narrow gorge between hills of mica schist. A coulée, probably derived from the most western of the three newest cones, has flowed through this gorge and expanded over the plain at Adala. The Hermus, thus impeded in its course, appears to have flown over the lava, the surface of which is smooth and bears a stratum of pebbles. In course of time the river has worn a channel between the mica slate and the lava to the depth of 80 feet, completely cutting through the coulée; yet so compact is the lava which has escaped the action of the stream of water, that it exhibits not the slightest tendency to decomposition.

The author then points out the strong resemblance between the structure of the Catacecaumene and the volcanic district of Central France. In each country are extensive lacustrine formations, cones of scoriæ of different ages, coulées, sometimes forming plateaus on the summits of isolated hills, at others continuous streams, and thick beds of lava worn through by the action of running water.

10. *Modern aqueous deposits.*—Under this head a description is given of the travertine deposited by hot springs between the foot of Mount Olympus and Broussa, forming an accumulation 2 miles in length, and at the latter locality half a mile in breadth and 100 feet thick. The water has a temperature of 184° of Fahrenheit, but at present there are no springs except those at the foot of Mount Olympus.

A description was next given of the changes which have been produced by sedimentary matter deposited near the mouths of the rivers. Thus the island of Lade, once the scene of a sea-fight between the Persians and the Ionians, is now a hill in the midst of a plain; the Latmic Gulf is changed into an inland lake; the once flourishing town of Miletus, losing its harbour, is become a heap of ruins; the port of Ephesus is converted into a stagnant pool; and the delta of the Hermus threatens in a few centuries to destroy the harbour of the prosperous city of Smyrna.

The memoir concluded with the description of a recent lacustrine deposit in the valley of the Rhyndacus above Kirmasteu, which appears to have been for the greater part removed by the action of that river, only detached platforms, 50 or 60 feet thick, being left on the sides of the valley.

Nov. 16.—James Philips, Esq., of the Royal Navy; Lieutenant Henry Drummond of the Bengal Army; Louis Hunter, Esq., of Lofthouse, Yorkshire; and Henry Glasford Potter, Esq., of Ridley Place, Newcastle-on-Tyne, were elected Fellows of this Society.

In conformity with Section VI. Article 8. of the By-laws, the names of the following Fellows proposed to be removed from the lists of the Society, on account of arrears, were read from the Chair for the second and last time:

Lord Glenlyon, William Higgins, Esq.

A paper was first read "On indications of changes in the relative level of Sea and Land in the West of Scotland," by James Smith, Esq., of Jordan Hill, F.G.S.

In the West of Scotland are two superficial deposits. The lowest, in some districts called "Till," consists of stiff unstratified clay, confusedly mixed with boulders. It rarely contains organic remains, but stags' horns, tusks, and bones of the elephant have been found in it in the bed of the Union Canal at Kilmarnock, and remains of the elephant associated with marine shells at Kilmaurs in Ayrshire.

The upper deposit is composed of finely laminated clay, overlaid by sand and gravel; and marine remains of existing species occur in every part of it, but most abundantly in the clay. It has been traced by Mr. Smith, on both sides of the Clyde from Glasgow to Rosemeath and Greenock, at points varying from 30 to 40 feet above the level of the sea. He has also observed sea-worn terraces on each side of the Clyde below Dumbarton and between Cloch Light-house and Largs.

The following are the principal localities, mentioned in the paper, at which the clay bed has been examined:

A brick-yard at Glasgow, 30 feet above high water-mark, where the author found the remains of six species of recent marine shells of common occurrence on the adjacent coasts of Scotland; also a branch of an elm and an oak-tree with its roots. The canal from Glasgow to Paisley and Johnstown was excavated in the clay at the height of 40 feet above the sea, and numerous remains of 26 species of existing marine testacea were found in it. In a pond lately dug at Paisley, a bed of clay was exposed, to which a violet colour had been given by decomposed muscles, in a manner similar to that described by Mr. Lyell in his memoir on change of level on the coast of Sweden*.

* Phil. Trans., 1835, pp. 5, 7.

In the brick and tile works around Paisley, and in the adjoining parishes, recent shells are abundant. Near Renfrew, cockles are so numerous, that a farm and hill, are called Cockle Farm and Cockle Hill. At Johnstown, which is about 8 miles from the sea and at a point about 40 feet above its level, in making a well, there were found bones of fishes and sea-fowls, fragments of sea-weeds, crabs' claws, and numerous layers of shells imbedded in sand and clay, which rested on a deposit of "till" more than 70 feet thick. Besides these localities, recent shells have been noticed at Helensburgh, also near Loch Lomond, at Dalmuir, and the shores of the Firth of Forth.

With respect to the origin of these deposits, Mr. Smith is of opinion, that the lower or "till" resulted from the violent though transitory action of a body of water; but that the upper was gradually deposited at the bottom of a sea of sufficient depth to protect it from the agitation of waves, and that it was raised to its present level by a process analogous to that described by Mr. Lyell as now taking place on the shores of the Baltic*.

Of the period when the change was effected, Mr. Smith offers no conjecture; but he states that it must have been anterior to the occupation of Britain by the Romans, because the terminations of their wall on the shores of the Forth and the Clyde were constructed with reference to the present level of the sea. He also adds, that on the banks of the Firth of Clyde there are vitrified forts and tumuli to which the same observation applies; and that no human remains or works of art have been found in the clay.

At his first examination, the author concluded, judging from the sea-worn terraces which skirt the coasts, that the change of level could not exceed 40 feet, but he has since observed the clay at the height of 50 feet; and Mr. Buchanan of Arden has found oyster-shells near Loch Lomond 70 feet above the sea. Mr. Smith, however, believes that at the period when the clay was accumulated and the terraces formed, the relative level of sea and land was stationary, and that, if we may judge from the comparative dimensions of the ancient terraces with those now forming, the period during which the level was thus stationary must have greatly exceeded 2000 years.

The important question, if the Fauna and Flora of the period when this deposit was accumulated were identical with those of the present epoch, Mr. Smith says it would be premature now to determine. A very great proportion of the species of shells, amounting in all to about 70, abound in the present seas; and it is worthy of remark that *Astarte Garensis*, which is common in the clay at Helensburgh, is found in great numbers in the Gare Loch; on the other hand, some of the species have become very rare, if not extinct with reference to the coast of Scotland.

In alluding to the geological position of the upper deposit, the author says, that it must be placed among the newer pliocene; and as it belongs to one of the first steps in the descending series, every circumstance connected with it should be carefully observed and re-

* Phil. Trans., 1835, p. 1.

corded, that researches into the more ancient formations may be conducted with greater success.

A paper was afterwards read "On the distribution of Organic Remains in the Oolitic formations on the coast of Yorkshire," by W. C. Williamson, Esq., Curator of the Natural History Society of Manchester, and communicated by the President.

In a former paper* Mr. Williamson gave detailed sections of the lias of the Yorkshire coast, with a view to determine how far its fossils might be useful in recognising the different beds of the formation at other localities. The paper read at this meeting was prepared with the same intent, and gave detailed accounts of the fossils of the (1) inferior oolite, (2) the lower shale and sandstone, and the (3) Great or Bath oolite.

1. The point selected by Mr. Williamson as affording the best section of the inferior oolite on the Yorkshire coast is Blue Wick; and the following is the succession of the strata which it presents in ascending order:

	Feet.
1. Thick beds of dark grey finely grained sandstone..	20
2. Irregular beds of yellow sandstone..............	20
3. Hard ironshot sandstone containing small pebbles..	$1\frac{1}{2}$
4. Irregular beds of yellow sandstone, in some parts ironshot, and inclosing layers of pebbles.........	30
5. Hard ironstone, many fossils....................	4
6. Hard ironstone, no fossils	8

The beds No. 1. contain, in their lower part, argillaceous nodules resembling those of the Alum shale, and inclose great numbers of *Ammonites striatulus, Lingula Beanii, Orbicula reflexa*, and, in less abundance, an Avicula resembling *A. echinata* and *Terebratula bidens.* Above this nodular bed no fossils have been noticed till within 10 feet of the top of No. 1, where another layer of similar concretions occurs, inclosing portions of an Astacus, resembling in some respects *Astacus rostratus,* and a species agreeing with one found in the Cornbrash. A little nearer the top of No. 1. is a thin seam containing great numbers of *Vermetus compressus,* which is found also in the coralline oolite of Yorkshire.

The division No. 2. presents throughout its whole thickness small fragments of dicotyledonous wood with an undescribed Belemnites; and towards the top are found, though rarely, *Mya litterata,* and still higher two species of Ammonites, apparently new.

The bed No. 3. contains the same Belemnites as No. 2, but is characterized by great abundance of *Terebratula trilineata.*

No. 4. is destitute of fossils, except near its junction with the overlying bed, where it contains the Belemnites and Avicula of Nos. 1. and 2.

The bed No. 5, though not more than 2 feet thick, incloses the greater part of the fossils of the inferior oolite of the Yorkshire coast,

* Geol. Proceedings, vol. ii. p. 82.

and the following is a list of the species given by Mr. Williamson, as occurring chiefly in the middle and lower portions of the bed:

Trochus granulatus, T. bisertus, T. pyramidalis, Solarium calix, Nerita costata, Turbo lævigatus, T. funiculatus, Rostellaria composita, Natica adducta, N. tumidula, Terebra vetusta, Acteon humeralis, Auricula Sedgvici, Ostrea Marshii, O. solitaria, Pecten virguliferus, P. abjectus, Trigonia angulata, T. costata, T. striata, T. gibbosa, Avicula Braamburiensis, Astarte elegans, A. minima, Modiola pulchra, M. cuneata, Mytilus sublævis, Cardita similis, Nucula axiniformis, Isocardia concentrica, Cardium incertum, Pholadomya ovalis, Unio abductus, Gastrochæna tortuosa.

The upper part of the stratum is characterized by *Turritella muricata, T. quadrivittata, T. humifusa, T. cingenda* (Phillips) in great abundance, *Melania Heddingtonensis, Terebratula obsoleta,* and *Caryophyllia convexa.*

In No. 6, the highest stratum of the inferior oolite, no fossils have been noticed by Mr. Williamson.

2. Immediately above the inferior oolite lies the lower sandstone and shale, an important formation on account of the absence of marine remains and the presence of terrestrial plants. With the exception of a similar series of beds above the great oolite, this formation is the most irregular in its subdivisions of any on the Yorkshire coast. The only point at which the upper and middle divisions of the series are fully developed are the cliffs between Cloughton Wyke and Blue Wick; the remainder of the coast exhibiting only the lower divisions. The following is the succession of the beds in ascending:

		Feet.
1.	Black carbonaceous shale, no vegetable remains ..	10
2.	Hard, pale, gritty sandstone, containing at its junction with No. 1. great abundance of a new species of Calamites, also fronds of *Zamia gigas*, and a remarkable fossil apparently connected with the fructification of a Cycas	20
3.	Shale	10
4.	Gritty sandstone	20
5.	Softish sandstone containing fine specimens of *Equisetum columnare*, all in a vertical position with their roots downwards	8
6.	Soft black shale	3
7.	Sandstones and shales......................	170
8.	Dark shaly sandstone	8
9.	Hard grey sandstone	6
10.	Black shale	2
11.	Laminated sandstone containing great abundance of various species of beautiful ferns, Cycadean plants, and Equiseti, also towards the lower part three seams of soft jet	6

The following are the species enumerated by Mr. Williamson:—*Equisetum laterale, Lycopodites Williamsonis, L. falcatus, Thuites expansus, Sphenopteris longifolia, S. hymenophylloides, Pecopteris ligata, P. curtata, P. Whitbiensis, P. Williamsonis, Pterophyllum pectinoides, P. minus, Otopteris acuminata, Cyclopteris digitata, Tæniopteris vittata, Solenites Murrayana.*

Feet.

12. Sandstones and shales containing no well-preserved plants, but about 90 feet from the top a bed of coal 1 foot thick 170

The plants of this system differ from those of the upper sandstone and shale by the abundance of *Pterophyllum minus, Otopteris acuminata, Sphenopteris hymenophylloides,* and the deeply lobed *Cyclopteris digitata,* and is characterized by *Pterophyllum pectinoides, Equisetum laterale, Lycopodytes falcatus,* and by a singular frond supposed to belong to a Cycadean plant. With respect to the vertical Equiseti in bed 5, Mr. Williamson is of opinion that they did not grow where they are found, but were transported, not, perhaps, from a great distance; and that their perpendicular position is owing to the roots of this description of plants being specifically heavier than the stem.

3. The Great or Bath oolite varies very little in its characters or fossils, except for 8 or 9 feet from the top, where, according to Mr. Williamson's observations, it presents two forms very different both in structure and organic remains. The localities referred to in the memoir for the general structure of the formation are Cloughton and White Nab, and for the upper beds Cayton and Gristhorpe Bays.

Section of the general structure of the Great Oolite.

Feet.

1. The lowest beds consist of a very hard blue limestone, sometimes oolitic and destitute of fossils, except in the upper part, where the stone is softer, and where the author has found *Ostrea edulina, Amphidesma decurtatum, Mya calceiformis,* a large undescribed Ammonites, and at the junction with the next bed *Belemnites compressus, B. Aalensis, Melania Heddingtonensis, Amphidesma decurtatum,* Serpulæ, and long tuberculated spines of a Cidaris, but no portion of the Cidaris itself.... 14 to 20
2. Hard blue fine-grained oolite, sometimes ironshot, and apparently devoid of organic remains 6
3. Soft or hard bluish clay, tinged, at some localities, with iron. It contains at least 11 species of fossil shells, which are most abundant at Cloughton Wyke, and some species which occur there have not been noticed at any other point. This bed also contains the remains of a Saurian, which the author is induced to consider a new species of Plesiosaurus.. 2

The shells given by Mr. Williamson are, *Rostellaria composita, Acteon glaber, Terebra vetusta, Phasianella cincta, Trochus, Avicula Braamburiensis, Gervillia acuta, Cucullea cancellata, Astarte minima, Cardita similis, Pholadomya acuticostata.*

4. Nodular ironstone, sometimes inclosing fragments of *Ammonites Blagdeni* .... 6 to 12 in.
5. Clay containing *Avicula Braamburiensis, Amphidesma decurtatum,* and a *Gervilia* .... 1 ft.
6. The top strata consisting of layers of nodular ironstone and argillaceous oolite 3

The lower part of this bed is characterized by the presence of *Perna quadrata*, and the upper by numerous remains of the following shells:

Melania Heddingtonensis, Ammonites Blagdeni, Terebratula spinosa, Gryphæa nana, Ostrea Marshii, Pecten lens, Plagiostoma interstinctum (c), *Avicula Braamburiensis* (c), *A. echinata* (c)? *Gervilia acuta* (c), *Trigonia costata, T. clavellata, Astarte minima* (c), *Corbula depressa, Pinna cuneata, Pentacrinites vulgaris, Cidaris vagans.*

The author then describes the upper beds of the Great Oolite at the two extremities of Cayton Bay, and at low water at the south side of Carnelian Bay.

Top. Irony nodules, without organic remains........ 1 ft.
Extremely hard ironshot rock, composed almost wholly of fragments of fossils, viz. *Millepora straminea*, papillæ of a Cidaris, innumerable small spines, probably of *Cidaris vagans*, muricated spines, and joints of a Pentacrinites .... 8 ft.

This bed Mr. Williamson appears to consider peculiar to the localities mentioned, not having observed it elsewhere.

He afterwards describes the upper beds of the Great Oolite at the south point of Cayton Bay. Immediately above the nodular ironstone bed is a very thick series of sandstones and shales surmounted by a seam of argillaceous oolite, containing *Avicula Braamburiensis*, and similar to that which forms the top of the Great oolite at White Nab (No. 6. of the section), with the exception that the nodular ironstone is wanting. This system of sandstone and shale, considered by Mr. Phillips to belong to the upper marl and sandstone, is, in Mr. Williamson's opinion, a distinct and merely local deposit included in the superior division of the Great oolite. It contains most of the fossil plants assigned by Mr. Phillips to the upper marl and sandstone, and several which are new and peculiar to it. An ascending sectional list is given of this deposit, commencing with the 1 foot bed of irony nodules, and passing through 35 feet of alternations of shale, with ferruginous and other sandstones, ends in the seam of argillaceous oolite, which is said to be overlaid by the upper sandstones and shales. One of the beds of shale contains a vast number of plants, amounting to above 40 species. The following list is given by Mr. Williamson:

Pecopteris lobifolia, P. insignis, P. undans, P. polypodioides, P. propingua, P. Williamsonis, P. acutifolia, P. obtusifolia, P. dentata, P. exilis, P. cæspitosa, Neuropteris recentior, N. ligata, N. arguta, Sphenopteris stipata, S. Williamsonis, Cyclopteris digitata, Glossopteris Phillipsii, Tæniopteris vittata, T. major, Solenites Murrayana, Lycopodites Williamsonis, Sphæridia paradoxa, Pterophyllum comptum, P. Pecten, P. minus, Otopteris cuneata, O. Beanii, Ctenis falcata, Dictyophyllum rugosum, Cycadites tenuicaulis.

Two shells are occasionally found in these beds, and are considered by the author to be allied to the genus *Anodon*.

In conclusion, Mr. Williamson says, that the characteristic shells of the Great oolite are few, as they bear a general resemblance to those of the cornbrash and inferior oolite.

(c) The species thus distinguished are found in the greatest abundance.

TRANSACTIONS

OF THE

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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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November 30.—Charles Darwin, Esq., A.B., Christ's College, Cambridge; Thomas White Collard, Esq., of Prospect House, near Herne, Kent; Rev. John Pye Smith, D.D., of Homerton College, near London; William Cubitt, Esq., of Gray's Inn Lane; and William Railton, Esq., of Carlton Chambers, were elected Fellows of this Society.

A paper "On certain elevated Hills of Gravel containing Marine Shells in the vicinity of Dublin," by John Scouler, M.D., F.L.S., Professor of Mineralogy in the Royal Dublin Society, and communicated by Robert Hutton Esq., F.G.S., was first read.

The object of this communication is to give a brief account of phenomena which, although frequently described in other countries, have been but recently observed in Ireland. Before entering on the immediate subject of the paper, Dr. Scouler gives a general description of the formations constituting the district under examination. They consist of granite, porphyry, quartz rock, micaceous, talcose, and argillaceous schists, greywacke, which near Lyons is succeeded by a very ferruginous conglomerate, and mountain limestone, called, near Dublin, calp.

The principal points at which the author examined the shelly deposits are, the promontory of Howth, Bray Head, and the valley of Glenismaule. On the south side of the promontory of Howth, where the limestone or calp approaches the quartz rock, is a deep depression occupied by an exceedingly tenacious and very ferruginous clay, which also extends across the peninsula, filling up fissures in the limestone. It is unstratified, and does not contain any transported fragments of rocks, but abounds with nodules of oxide of iron, iron pyrites, and oxide of manganese; the last being extracted for economical purposes. Resting upon this clay, the limestone and the quartz rock, is a thick accumulation of shelly coarse gravel and fine sand, extending about half a mile in length, but separated into two parts by the hollow in which is situated the village of Howth. The highest portion of the deposit is about eighty feet above the level of the sea. The gravel consists chiefly of limestone, differing in no respect from the limestone of the district; pebbles of argillaceous schist are not uncommon; and rounded fragments of granite, the hard chalk of Antrim, and flints occur, but rarely; and it is worthy of remark that though the gravel rests partly on quartz rock, fragments derived from it are scarce.

The beds of sand are sometimes very thin, at others of considerable thickness, and though, for limited distances, there appears to be a regular stratification, yet the beds cannot be traced to any extent, thinning out in the same manner as on existing sea-beaches. The shells which have been found were, for the greater part, very imperfect, but Dr. Scouler has been enabled to determine, from well-defined specimens, the following species: *Turritella ungulina*, *Turbo litoreus*, *Nerita litoralis*, *Buccinum undatum*, *Cardium edule*, *Cyprina Islandica*, and *Pecten varians*.

On the opposite side of the Bay of Dublin, and to the south of the promontory of Bray Head, is a similar accumulation extending for upwards of a mile. At its northern extremity it presents a perpendicular section about 200 feet high, but gradually declines towards the south till it sinks to a level with the present shore. It consists, in the upper part, of angular fragments of granite or syenite, and quartz rock; in the middle, of numerous beds of shelly sand and gravel, and in the lowest, of clay and marl. The central beds of gravel are chiefly composed of fragments of limestone of moderate size, and imperfectly rounded, but they also contain pebbles of chalcedony, flint, hard chalk, and a ferruginous conglomerate. With respect to the localities from which these materials were derived, Dr. Scouler says, that no limestone occurs *in situ* nearer than the opposite side of the Dublin granitic mountains; that the fragments of chalcedony, flint, and hard chalk, appear to have been transported from Antrim, and the pebbles of ferruginous conglomerate from Lambay Island, or Lyons Hill, to the west of the Dublin chain. The whole of the recent species of shells found at Howth, have been obtained at Bray Head, with the addition of *Dentalium entalis*.

Besides these shelly deposits which occur adjacent to the existing sea shores, Dr. Scouler describes others at a considerable distance inland. One of the most remarkable of these, is in the valley of Glenismaule, near the source of one of the branches of the Dodder, and about seven miles from the Bay of Dublin. On each side of the valley are perpendicular cliffs formed of irregular beds of sand and calcareous gravel, about 100 feet thick, and probably 200 feet above the level of the sea. These beds are also above the level of any of the calcareous strata of the immediate neighbourhood. Associated with the limestone fragments are pebbles of flint and chalcedony, as well as recent shells identical with those in the beds previously described at Howth and Bray Head. Dr. Scouler also mentions having found a specimen of limestone perforated by *Lymnoria terebrans*. Similar deposits are stated to exist in other valleys in the vicinity of Dublin; and accumulations of gravel, agreeing in the arrangement of the beds but differing locally in the nature of the materials, to extend over the whole of Ireland, forming low rounded hills, and filling previously existing depressions.

The only instance of remains of mammalia in this gravel, known to Dr. Scouler, is the discovery of bones of the Irish Elk, at Enniskerry, near Dublin.

The following inferences were then given, as deducible from the facts contained in the memoir:

1st, That the coast around the Bay of Dublin has been elevated, though unequally, at a comparatively recent geological epoch; 2ndly, That the valley of Glenismaule, and other valleys containing similar accumulations of drift, were at one time under water, and then filled with calcareous gravel; and that they were afterwards elevated, and subsequently re-excavated by the action of running water.

The memoir concluded with some theoretical observations respecting the sources from which the calcareous gravel was derived, and the agents by which it was brought into its present position.

A paper "On the Geology of the Thracian Bosphorus," by Hugh Edwin Strickland, Esq., F.G.S., and William John Hamilton, Sec. G.S., was then read*.

The formations which occur in the neighbourhood of the Bosphorus may be classed as follows: 1. A series of beds considered to be equivalents of part of the Silurian system; 2. Igneous rocks; 3. Tertiary limestone; 4. Ancient alluvium.

1. *The equivalents of the Silurian system* occupy both sides of the Bosphorus for about three quarters of its length, and extend in Europe and Asia towards the W.N.W. and E.S.E. to an unascertained distance. The prevailing rock is argillaceous schist, but associated with it are compact brown sandstone, and compact dark blue limestone, the whole passing insensibly into each other. Andreossy and an American traveller referred the deposits to the transition class, on mineralogical characters; and the authors of this memoir, to that portion of it lately named Silurian by Mr. Murchison, from the general agreement of the organic remains to those found in the formations beneath the old red sandstone in England. Fossils are, however, of so rare occurrence that Messrs. Strickland and Hamilton noticed them at only two localities, a ravine above Arnaout-keui, about four miles from Pera on the European side; and the Giant's Mountain on the Asiatic side of the Bosphorus, and about fifteen miles from Constantinople. At the former locality they were found in argillaceous schist, and in the latter in limestone. They belonged chiefly to the genera *Spirifer*, *Productus*, *Terebratula*, *Atrypa* and *Orthis*; but the eye of an *Asaphus*, remains of *Crinoidea*, and of three genera of *Corals* were also obtained.

2. *Igneous Rocks.*—The transition rocks are united on the north to a mass of igneous rocks, and on the south-west to tertiary deposits. The authors were unable to determine the relative age of these two formations; but as the igneous rocks are brought into more immediate connexion with the Silurian or transition group than the tertiary, they are described first. They consist of trachytes and trachytic conglomerates. The former are more or less compact, sometimes passing into phonolite and basalt, and occasionally assume a columnar struc-

* In a note, Mr. Strickland says, that Mr. Hamilton being still in Asia Minor, he has been deprived of any direct assistance in drawing up this paper; and that he is solely responsible for any theoretical views which it may contain.

ture. The conglomerates are composed of angular fragments of trachyte, imbedded in a tufaceous paste. The inclosed portions are sometimes softer than the cement, when the rock assumes a honeycomb appearance, but they are more often harder, and stand out in bold relief. The conglomerates rest upon and alternate with the trachyte, and in some places are intersected by basaltic dykes. Veins of carnelian and chalcedony are stated to be contained in the igneous rocks, and near Filbornou to pass through the conglomerate, traversing both the basis and the included fragments. These conglomerates are considered by Mr. Strickland to have been accumulated by water, and the contained fragments, though commonly angular, are sometimes rounded, and included in finely laminated volcanic sand. On the Asiatic side of the Bosphorus the igneous rocks commence *en masse* at Kavak, under the old Genoese Castle, and extend to Yoom-bornou on the Black sea, or perhaps further; and on the European side they commence on the north of Buyukderé, and also extend to the Black sea. Besides these great masses of igneous products, trachytic and trap dykes were observed by the authors traversing the Silurian rocks at Baltalimani, in the hills above Bebek, at Kiretch-bornou, and the base of the Giant's Mountain.

3. The *Tertiary deposit* commences immediately on the west of Constantinople, and extends inland about three miles, till it meets the transition formations, and ranges along the north coast of the Sea of Marmora for many miles, its western limit being at present undefined. It is best exhibited in the quarries at Baloukli and Makri-kuei, where it consists of horizontal beds of soft, white, shelly limestones and marls, resting on sand in which no fossils have been observed. Near Constantinople the deposit was apparently accumulated in an estuary, for it contains a species of Cardium, and considerable numbers of a fossil considered to be a Cytherea, the whole being associated with land and freshwater shells, some of which resemble recent species.

Along the banks of the Bosphorus the authors observed no traces of a tertiary formation; and consequently infer that this channel was opened at a comparatively very recent period.

The only ancient alluvium mentioned in the memoir is an extensive and thick deposit of ferruginous clay, sand, gravel and boulders, resting upon the Silurian or transition rocks. It commences a few miles north of Constantinople, forms the subsoil of the Forest of Belgrade, and apparently skirts the southern side of the Lesser Balcan range.

December 14.—William Percival Hunter, Esq., of the Albany; Francis Charles Parry, Esq., of the Court of Bankruptcy; Major William Harding, of Ilfracomb, Devonshire; John Hey, Esq., Curator of the Leeds Philosophical Society; William Stanger, Esq., of Wisbeach, Cambridgeshire; William Charles Henry, M.D., F.R.S., Manchester; William Gray, jun., Esq., of York; James Thompson, Esq., of Kirkhouse, near Brampton, Carlisle; the Hon. Henry Upton, of Whitehall Place; William Darley Hull, Esq., of the Wood House, Rosstrevor, Ireland; Thomas Cabbell, Esq., Barrister at Law, Essex Court, Temple; and William Mathews, Esq., of Greenhill, near Dudley, were elected Fellows of this Society.

A paper "On Impressions in Sandstone resembling those of horses' hoofs," by Charles Babbage, Esq., and communicated by the President, was first read.

During a recent visit to Dowlais, Mr. Guest mentioned to the author, that in the channel of a stream on the extensive moor called Pwll y Duon, and about seven miles from Merthyr Tydvil, there were many impressions considered by the country people to have been made by horses' hoofs. The stratum of sandstone in which they occur is called the Farewell Rock, being the lowest bed of the coal measures. At first sight they presented a strong resemblance to the marks which the hoof of a horse would leave on a soft surface, but on a closer examination Mr. Babbage found that the part which should have received an indentation from the frog was in relief, and resembled rather a cast of the frog itself. The first mark examined by him proved to be the letter G, which had been carved on the rock by some person whose initials were G. H. This discovery made him inspect the others more minutely, and he ascertained satisfactorily that they were not artificial. Similar impressions were noticed by him at several places on the moor.

The author then referred to analogous casts in the old red sandstone of Forfarshire, and there called Kelpies' feet.

In attempting to account for the marks, Mr. Babbage described some observations recently made by Mr. Lyell on impressions left by Medusæ on the rippled sand near Dundee. On removing the gelatinous body of the animal, a circular space was exposed, not rippled, but having around half the border a depression of a horse-shoe form. These marks, however, were not considered by Mr. Lyell as identical with those called Kelpies' feet, but merely so far analogous as to invite further observations, and to make it desirable to possess drawings of the impressions which different species of Medusæ leave, when thrown by the tide upon a beach of soft mud or sand.

A memoir "On the occurrence of silicified trunks of large trees in the new red sandstone formation or Poikilitic series, at Allesley, near Coventry," by the Rev. Wm. Buckland, D.D., Professor of Geology and Mineralogy in the University of Oxford, was then read.

In the great bed of gravel which overspreads the portion of Warwickshire referred to in this paper, specimens of silicified wood had been long found, and from being slightly rolled, it was conjectured that they could not have been drifted from a distance, though no indication of their original matrix had been observed. In the spring of last year, however, Dr. Buckland was informed by the Rev. W. T. Bree of Allesley, that part of the silicified trunk of a tree, several feet in length and a foot and a half in diameter, had been discovered in the garden of the Rev. Mr. Gibson, at the bottom of Allesley Hill. On visiting the spot in October last, the author ascertained that the tree was not imbedded in the gravel, but in that portion of the new red sandstone series, which consists of indurated sandstone, alternating with beds of conglomerate, chiefly made up of sand and of pebbles of quartzite and compact forms of trap.

In the churchyard of Allesley Dr. Buckland found an angular fragment of similar silicified wood which had been fresh cast up from the bottom of a grave, sunk to an unusual depth in the red sandstone; and in making a road from Allesley towards Coventry another large tree was discovered a short time ago, and the greater part of it used in forming the foundation of the road. On comparing the fragments found in the gravel with the tree in Mr. Gibson's garden, which is carefully preserved in its matrix, Dr. Buckland found so perfect an identity in mineral character as to leave no doubt that the fragments in the surface gravel had been derived from denuded beds of the new red sandstone.

A description was then given of the mineralized condition of the wood, and its organic structure. On the surface of many of the specimens from the gravel, is a multitude of small spherical cavities, each of which was once filled with a minute round concretion of oxide of iron or imperfect jasper; and innumerable specks formed by these concretions pervading the interior of the specimens, appear to have been formed in a manner analogous to that which produced the eye agates in the Antigua wood. The tree in Mr. Gibson's garden, and many of the larger fragments found in the gravel, abound with minute longitudinal apertures resembling those in shrunk and shaken timber; many of these are filled with red oxide of iron, or lined with beautiful crystals of dark-coloured quartz. In two specimens Dr. Buckland noticed longitudinal holes about $\frac{1}{4}$th of an inch in diameter, which had apparently been perforated by the larvæ of some insect. In the large collection formed by Mr. Bree, the author sought in vain for examples of the petrified palms, psarolites and helmintolites described by Cotta and Sprengel as found in Saxony, in beds considered to be the equivalents of the new red sandstone of England; all the Allesley specimens are either referrible to decided coniferæ, which have distinct concentric lines of growth, or exhibit a compact structure in which neither large vascular tubes nor concentric lines of growth are visible.

A paper entitled "Further notice on a partially petrified piece of wood from an ancient Roman aqueduct at Eilsen, in the Principality of Lippe-Buckeberg," by Charles Stokes, Esq., F.G.S., was next read.

Since his former communication on this subject, the author has been shown by Mr. Robert Brown a specimen from the same partially petrified piece of wood; and Mr. Brown has pointed out to him, in its longitudinal section, that the petrified portions are spindle-shaped bodies, about two inches in length, in some instances completely inclosed within and surrounded by the unchanged wood, and are not, therefore, as formerly conjectured by the author, connected by such an external supply of carbonate of lime to particular points as might have been derived from stalactites formed in the building.

The author also stated that Mr. Brown had called his attention to the remarkable circumstance exhibited in this specimen, that though the change in the longitudinal fibres appears to be complete, yet the medullary rays are still in their ligneous state; and on referring to the specimen formerly described, Mr. Stokes has found some instances in which a part of the medullary ray which passes through the petrified portion has not been so completely changed as the surrounding longitudinal fibres, or the part of the same ray which is more in the centre of the petrified portion.

Of the unpetrified part of the specimen, some portions are much decayed and worm-eaten, while others are hard and apparently in good preservation; the line of separation between the two conditions being occasionally remarkably well defined. On submitting portions of each to the action of muriatic acid, Mr. Stokes found that the decayed part exhibited only a slight effervescence, while that which appeared in good preservation gave off a much greater quantity of gas, and chiefly from the inside of the larger vessels, as if they were coated with an extremely thin layer of carbonate of lime. This fact, connected with the medullary rays remaining in some instances unchanged, or but partially changed, presents, as stated by the author, the first ocular demonstration of progressive steps in the process of petrifaction. The communication concluded with some observations on the fossil wood of Allesley described in Dr. Buckland's paper, in some of the specimens of which there are spindle-shaped portions similar to those in the partially petrified wood of Buckeberg.

"Description of a Raised Beach in Barnstaple Bay, on the north-west coast of Devonshire," by the Rev. Professor Sedgwick, F.G.S., and Roderick Impey Murchison, Esq., F.G.S., was afterwards read.

This raised beach is first seen at the northern extremity of the blown sand-hills called Braunton Burrows, and thence may be traced round the western end of Saunton Down, into Croyde Bay. After meeting with some interruptions it reappears, and may be followed to the face of the bold headland called Baggy Point, about three miles from the place of its commencement. In situations where it is best exposed, especially on the south side of Saunton Down, it puts on the form of a horizontal under terrace, resting upon an indented and irregular surface of the older formations, and abutting against their component beds. It forms regular sea-cliffs, the stratification of which is most distinct; and the several beds may be traced by small bands of shingles, by alternating courses of different degrees of fineness, and by horizontal lines of division. In distinctness of stratification it yields to no rock; and as several parts of the cliff are in a state of perfect induration, presenting regularly bedded masses of calcareous grit and sandstone, the authors at first sight mistook it for a secondary formation.

The bottom of this horizontal deposit is chiefly composed of indurated shingles resting on the ledges of the older rocks, and filling up their inequalities. These conglomerates or shingles are seldom of great thickness, but in some places alternate two or three times with beds of sand, so as to reach an elevation of eight or nine feet in the horizontal deposit. Over the shingles are horizontal beds of sand, occasionally indurated, sometimes putting on a concretionary structure, and weathering into grotesque forms by the action of the elements. Lastly, the preceding deposits are surmounted by regular beds of finely laminated sand in a state of imperfect induration, and sometimes hardly differing from the sand of the actual beach between the high and low water marks. The thickness of these beds of sand amounts in some places to more than twenty feet. These marine deposits are frequently covered by terrestrial overshot materials which have descended from the higher talus of Saunton Downs. In the whole of the stratified undercliff above described there are sea shells. In the upper part they are rare, and in a bad state of peservation; but in the lower and more indurated portions they are more abundant, are often well preserved, sometimes appearing in beds, and in their condition and arrangement exactly resembling the shells of a modern beach. In species, they are identical with the living shells of the coast. Among them the authors enumerate *Mactra stultorum, Tellina fabula, T. solidula, Cardium edule, Ostrea edulis, Mytilus edulis, Mya margaritacea, Pholas, Patella vulgaris, Natica canrena, Purpura lapillus*, &c., making in all twelve or fourteen species*.

At the north side of Croyde Bay the sea shells are very abundant in the deposit; the lower shingles expand to the thickness of nineteen feet, and are found on the face of Baggy Point at various heights and rising to sixty or seventy feet above high water level.

The horizontal beds, above described, cannot have been formed by accumulations of blown sand. They are stratified marine deposits, differing in no respect from the sand and coarsest shingles of the neighbouring beach, except in the level; and they perfectly demonstrate an elevation of the neighbouring coast during the *modern period.*

In confirmation of their views, the authors assert that the physical features of the neighbouring region, indicate that kind of depression in the sea level which is demonstrated by the raised beach. The ancient line of sea-cliffs may be traced inland by Saunton and Braunton towards the mouth of the Barnstaple river, passing to the east of the existing marshes and dunes of blown sand. In like manner the old line of cliffs, anterior to the elevation, may be traced from Appledore along the south side of Norton Burrows. The popple or pebble beach, a remarkable ridge of large rounded blocks of stone, rising to a height of seventeen feet above the sea level, and shutting out the ocean from the neighbouring marsh lands, &c., of Appledore, is, in connexion with the blown sands, regarded by the authors as the natural and necessary consequence of a considerable elevation of the coast, and as strongly confirming the views they have advanced. In

* This list has been much augmented by the subsequent labours of Major W. Harding, F.G.S. of Ilfracomb, who has in other respects confirmed the views of the authors, and added some important facts. In the craggy cliffs of the old transition rocks near Baggy Point, he has detected patches of the indurated shingle, or "dry beach" as he terms it, containing modern sea shells at *different heights,* far above the reach of the highest tides.

further support of these views, they state that the raised beach of Barnstaple Bay, forms only one of a connected series of phenomena, all tending to demonstrate the same conclusion, viz. the occasional changes of high-water level, both in the way of elevation and depression, within a comparatively recent period. They point out the conditions under which raised beaches (admitting their hypothesis) may or may not be expected; and they affirm that there is a connected series of phenomena both on the north and south coasts of Devonshire and Cornwall, in perfect accordance with what they have described. The raised beach of Hope's Nose is the most striking instance in South Devon; and they bear witness to the correctness of Mr. Austen's description of it, and to the justice of his conclusions. On the coasts of Cornwall phenomena of like kind are very numerous. Not only is there incontrovertible proof of raised beaches at various levels, but in some places long smooth waterworn surfaces, exactly like those formed by the existing breakers of a rocky shore, may be traced midway in the cliff, at an elevation quite out of the reach of the cause which formed them.

Lastly, the authors enter on some details as to the quantity of elevation, proved by the phenomena of recent marine deposits in different parts of England. They state that the raised beaches of South Devon and Cornwall indicate various changes of level, from ten to forty feet, the phenomena of depression, of which there are examples, not being considered. That the greatest elevation in North Devon seems to have been about 70 feet, while in Lancashire, Cheshire, and Shropshire, there are marine deposits, containing also shells of existing species, at various elevations of from 300 to 500 feet. The intensity of elevatory force seems therefore to have increased towards the north, and perhaps reached its maximum among the Cumbrian mountains, from which enormous masses of materials have drifted in various well-known directions.

The country of Siluria and South Wales, the detritus of which was described by Mr. Murchison on a former occasion, is of course specially exempted from the application of this inference; since that region has been shown to have been elevated at an antecedent period*.

On the same evening, after the ordinary business of the Society had terminated, a Special General Meeting was held for the purpose of electing two Secretaries in the place of William John Hamilton, Esq., and Woodbine Parish, jun. Esq., who had retired from the office; the former in consequence of his continued absence from England, and the latter from being unable to attend the meetings of the Society.

The President having read the By-Law (Sec. XI. art. 5.) respecting the resignation of any officer during the interval between two successive Annual General Meetings, and the election of another to sup-

* Geol. Proceedings, Vol. II. p. 77.

ply the place, appointed John Willimot, Esq., and William Clift, Esq., scrutineers of the ballot.

It was then resolved unanimously, That the thanks of the Society be given to William John Hamilton, Esq., and Woodbine Parish, jun. Esq., on retiring from the office of Secretary.

A ballot was next held, and the scrutineers reported that Robert Hutton, Esq., and John Forbes Royle, M.D. F.L.S., were duly elected.

January 4, 1837.—John Henry Philipps, Esq., of Williamston, Haverford-West: Colonel the Honourable Dawson Damer, Tilney Street; Henry Morley, Esq., of the Grove, Camberwell; and William Benford Nelson, Esq., Essex Street, Strand; were elected Fellows of this Society.

A paper entitled, "Some Observations on the Elevation of the Strata on the Coast of Chili," by Alexander Caldcleugh, Esq., F.G.S., &c., was first read.

The author commences by stating, that previously to his return to South America several circumstances induced him to suspend his opinion as to the correctness of the details which had been published of the effects of the earthquake of 1822. He thought that the wreck in the Bay of Valparaiso, which had become accessible after the earthquake, might have been thrown higher up by the heavy rollers, and that rocks covered with testacea, which after the event were laid dry, might likewise have been drifted. He also thought that the accuracy of the observations might be doubted, because certain genera of shells were stated to have been found adhering to the rocks in Valparaiso Bay, which it was well known did not exist there; and because there was a vagueness in some of the statements, as the raising of the whole country from the foot of the Andes to far out at sea. Since his return to South America, however, especially since the earthquake of 1835, Mr. Caldcleugh has investigated the evidences of change of level on the Chilian coast, and he states, in this communication, his full conviction, that there have been many distinct alterations in the relative level of land and sea.

In detailing the results of his researches, he gives extracts from all the historical and documentary evidence which he has been able to consult, separating those proofs of accession of land which may be ascribed to the deposition of sedimentary matter, from those which demonstrate a vertical movement.

1. *Accumulations of sedimentary matter.* The Abate Molina states, that the sea had long been gradually retiring, and even hazards the observation, that in some places it had receded two, in others, especially near the mouth of rivers, six inches annually. Near the village Talcahuano, Frezier says, that in 1712 the depth of water near the shore was from five to six fathoms; while Ulloa in 1744 gives five fathoms, and Capt. Fitzroy has found the soundings near the same spot to be only three and four fathoms. Frezier also states, that in

Valparaiso Bay vessels anchored close to the shore in eight or ten fathoms; and Ulloa, in fourteen fathoms at the distance of a cable and a half; though at present the soundings at the same distance are five to seven fathoms. In 1778, a Spanish seventy-four moored within a cable's length of the arsenal in fifty fathoms water, where there are now but six.

In the port of Coquimbo, according to Frezier, at half a cable's length from the Tortoise Rock, the soundings were from six to ten fathoms: they are now from three to four: it is also said that a whale once passed between the rock and the main land. In the port of Huasco, the same author gives the depth very near the shore to be eighteen and twenty fathoms; but a vessel (the Byron) in 1831, touched upon the ballast she had thrown out.

At Mr. Caldcleugh's first visit to Valparaiso in 1821, the town consisted of one narrow causeway with houses on one side, and part of the road which wound round an old fort, was washed by the sea at every high tide. On a late visit to the port, he found that two lines of houses had been built to seaward of the original street, and that vessels of three or four hundred tons, were obliged to anchor much further out.

With respect to the dependence which ought to be placed on the preceding observations, he says, that the facilities for making them were great, as vessels, to avoid the gusts from the gulleys, almost always anchor on the same spot; and he remarks in explanation of this great accumulation of detritus, that the rivers of Chili partake, with few exceptions, of the nature of mountain torrents, swollen in winter by the rains, and in summer by the melting of the snow in the great Cordillera.

2. *Evidences of vertical movements.*—The author then proceeds to point out the evidences of change between land and sea, which cannot be accounted for, by the accumulation of loose materials.

In Concepcion Bay there are two or three rocks which are not noticed by Frezier or Ulloa, but of which seamen are now warned; and the Belem rock has at present two fathoms upon it at low water, while in the chart of Ulloa it is not laid down.

In the Bay of Valparaiso, outside of the inner point near the Quebrada de los Angeles, at a cable and a half or two cables from the shore, is a rock which Ulloa directs to be looked out for with care as it was not visible; at present it is not above 100 fathoms from the shore; and there is a ripple upon it at all times of the tide. Other rocks near the Cruz de Reyes, which in 1821 were always covered by the sea, are now four feet above the level of high water mark.

In the port of Coquimbo are three rocks called the Pelicans, which rise twelve feet above low tide; in 1710, according to Feuillée, they were *à fleur d'eau.* Another rock, about twelve feet long, called the Tortoise, in the time of Frezier and Feuillée, rose five or six feet out of the water; it is now nine feet above high water mark.

Mr. Caldcleugh then alludes to the beds of recent shells which rest upon the edges of the sea cliffs from Concepcion to Copiapo, and in consequence of there being found at levels varying from 14 to 300 feet, he conceives that the coast has been raised *per gradus.*

He next states, in addition to the evidences afforded by Mrs. Calcot of the change of level produced by the earthquake of 1822, that persons who escaped on board vessels, remarked that the sentries before an old fort on the summit of the hill over the ruins of the town, and previously visible from the feet upwards, had, subsequently to the event, half the body concealed by the fore part of the cliffs*. He also says that the street or causeway, which wound round an old fort, and in 1821 was washed by the sea at every high tide, is now seven feet above the wash of the sea at the high water line of ordinary tides.

In conclusion, Mr. Caldcleugh gave an account of the effects produced by the earthquake of 1835, chiefly from the observations of Capt. Fitzroy, full details of which have been published in the Transactions of the Royal Society † and the Royal Geographical Society ‡.

The President then announced that he had received from the Foreign Office the translation of an article published in the South American Journal, El Arancano, by Don Mariano Rivero; but as none except original communications were read before the Society, he could only state that Don Mariano dissents entirely from the belief, that earthquakes have produced vertical changes of level on the coast of Chili.

This communication was accompanied by a letter from Col. Walpole addressed to Lord Palmerston, an extract from which, read by the Secretary, strongly supported Don Mariano Rivero's views.

A paper entitled "Observations of proofs of recent elevation on the coast of Chili, made during the survey of His Majesty's ship Beagle, commanded by Capt. Fitzroy, R.N.," by Charles Darwin, Esq., F.G.S., was afterwards read.

The subject of recent elevations on the coast of Chili being, in the opinion of many, still open to discussion, Mr. Darwin gives, in this memoir, the results of his own observations. The portion of the coast, more particularly examined by the author, extends from the river Rapel, about sixty miles south of Valparaiso, to Conchali, about eighty miles north of it.

Close to the mouth of the Rapel, dead barnacles occur adhering to rocks three or four feet above the highest tidal level; and in the neighbouring country recent marine shells are scattered abundantly to the height of about 100 feet. Ten miles to the north, and at an equal distance from the sea, is the village of Bucalemu, in the neighbourhood of which are very extensive beds of recent shells. At the bottom of the great valley of Maypo, and some miles from the coast, marine shells of existing species are also numerous; and at St. An-

* In the following page a part of the fort previously invisible is stated to have become visible; but this apparent discrepancy arises from the observations alluded to by Mr. Caldcleugh having been made from the shipping, and those by Mr. Darwin from a point on the land.

† Mr. Caldcleugh on the Great Earthquake in Chili, 1835. Phil. Trans. 1836, p. 21.

‡ Sketch of the surveying Voyage of His Majesty's Ship Beagle. Journal Royal Geographical Society, vol. vi. p. 319.

tonio, near the northern point of that river, are large quarries of shells. Between this point and Valparaiso in the ravine, Quebrada Onda, the remains of a species of shell common on the coast, were noticed by the author. Along the bold granitic coast south of the promontory which forms the bay of Valparaiso, are numerous level and horizontal beds of shells, constituting an almost continuous band, elevated from 60 to 230 feet above the level of the sea. The shells are brittle, but of various kinds, and are all similar and in similar proportional numbers to those on the beach. They are mingled with some earth, though packed closely together, and overlie a partially consolidated breccia of granitic fragments which rests on the solid rock. After a careful examination of these deposits, first by himself, and afterwards with Mr. Alison, guarded by a recent inspection of the heaps of shells accumulated by the natives in Tierra del Fuego, Mr. Darwin was convinced that the shelly beds near Valparaiso, were formed when the sea occupied a different level. The following are the principal circumstances which lead to this conviction. The great number of the shells forming extensive, horizontal beds, whereas the heaps in Tierra del Fuego collected by the inhabitants, always retain a conical figure: their position, at the extremities of headlands inaccessible from the sea, and unfit for strongholds, being without fresh water: the large proportional number of extremely small shells: and lastly, their brittle and decayed condition, the state of decomposition having an evident relation to the comparative heights at which the shells were lying. Comminuted shells were noticed by Mr. Darwin at the heights of 560 and 1300 feet, but the evidence of their having been part of a beach was not convincing.

At San Lorenzo in the bay of Callao, Mr. Darwin traced a similar process of decay from perfect shells in the lowest beds to a mere layer of calcareous powder in the highest. This phenomenon, he adds, can be observed only in countries where rain never falls.

On the north side of the bay of Valparaiso, near the Viña del Mar, is an abundance of elevated shells. Mr. Alison, by climbing a point of rock about fourteen feet above high water, and removing the dung of sea fowls, discovered Balani adhering to the stone.

With respect to the historical evidence of the earthquake of 1822, Mr. Darwin says that he met with no intelligent person who doubted the rise of the land, or with any of the lower order who doubted that the sea had fallen. He mentions also the altered position of the wreck and of the rock in the bay; and from a part of the fort being invisible from a point on the land before the earthquake, but visible afterwards, he infers that the movement of the land was unequal*. A further proof of change, obtained for the author by Mr. Alison, is shown by the remains of a sea-wall built in 1680, and over which, up to 1817, the sea broke during the northerly gales. Mr. John Martin, a ship carpenter of Valparaiso, remembers walking in 1819 on the beach at the foot of this wall, and he has been frequently obliged to climb up to the street to avoid the sea. This wall is now separated from the bay by two rows of houses, but a portion of what

* See note * in the preceding page.

appeared to be its base, carefully levelled by a resident engineer, was found to be 11 feet 6 inches above high water mark. Mr. Darwin does not ascribe the whole of this change to the earthquake of 1822, and is of opinion that the alteration then produced was under three feet. The church of San Augustin is believed to have been built in 1634, and the base of its walls is 19 feet 6 inches above high tide level; but there is a tradition that the sea formerly approached very close to its foundations. Allowing, therefore, 4 feet 6 inches for its protection when built, the amount of change in 220 years is only 15 feet. The granite rocks which form the coast are also water-worn and hollowed at about the same height, namely, 14 feet above the present sea level. These data, Mr. Darwin is of opinion, prove, that though the changes in 220 years have been small, yet that they were preceded by a period of comparative rest, during which there was time for any former marks on the rocks to become obliterated.

The author then described the beds of recent shells between Concon and Quintero, about 100 feet above the sea level; the deposits near Plazilla and Catapilco; and in the valley of Longotomo. On the hills to the north of the latter, about 200 feet above the sea, immense quantities of recent shells coat the surface or the sides of the ravines; and hence Mr. Darwin infers that the action of the sea determined the minor inequalities of the land. Similar deposits, more or less abounding in shells, were noticed by him near Guachen, and in the valley of Quilimap. Close to Conchali, on the south side of the bay, are two very distinct terrace-like plains, the lower being about sixty feet high.

Mr. Darwin then gave a very brief notice respecting the marine origin of the terraces at Coquimbo, described by Capt. Basil Hall and discussed by Mr. Lyell. The proofs of the origin assigned to them rest on the occurrence of recent shells in a friable calcareous rock elevated 250 feet above the sea. This calcareous stratum passes downwards into a shelly mass chiefly composed of fragments of Balanideæ, and this again overlies a sandstone abounding with silicified bones of gigantic sharks mingled with extinct species of oysters and Pernæ of a great size The intermediate bed contains some shells in common with the upper, in which all are recent, and with the lowest in which the greater number are extinct. The phenomena of the parallel terraces and the elevated shells occur in a strongly marked manner in the villages of Guasco and Copiapo, the latter being 350 miles to the north of Valparaiso: recent shells also occur at different elevations at an equal distance to the south of it at Concepcion and Imperial. Mr. Darwin believes that the land on the coast of Chili has risen, though insensibly, since 1822. In the Island of Chiloe he is fully convinced, from oral testimony and the state of the coast, that a change effected imperceptibly is now in progress. In support of this gradual rise, independent of earthquakes, he states, that the eastern coast of South America, bordering the Atlantic from the Rio Plata to the Strait of Magellan, presents terraces containing recent shells; yet in the provinces near the mouth of the Plata, earthquakes are never experienced; and it is impossible to suppose that the most violent of the Chilian earthquakes could produce these effects, as the shocks are scarcely transmitted to the plains at the western foot of the Cordilleras. Hence, he concludes, that the earthquakes, volcanic eruptions, and sudden elevations on the coast line of the Pacific, ought to be considered as irregularities of action in some more widely extended phenomenon.

January 18.—Benjamin Tucker, Esq., of Mecklenburgh Square; Cæsar Coldough, Esq., of Tintern Abbey in the county of Wexford, Ireland; George Such, M.D., F.L.S., New Street, Dorset Square; Travers Twiss, Esq., B.C.L., Fellow of University College, Oxford; Joseph Henry Barchard, Esq., of Putney Heath, Surrey; Gilpin Gorst, Esq., of the Old Trinity House, and William Edmund Logan, Esq., of Swansea, were elected Fellows of this Society.

A paper entitled, "An Account of a deposit containing land shells at Gore Cliff, Isle of Wight," by J. S. Bowerbank, Esq., F.G.S., was first read.

During a recent examination of the greensand of Gore Cliff, Mr. Bowerbank discovered on the top of the cliff and overlying the chalk marl by which it is capped, a bed consisting of detritus of chalk and chalk marl, and inclosing, in every part examined by him, numerous specimens of existing species of land shells. The deposit extends from nearly the edge of the cliff to the foot of St. Catherine's Down, a distance of about 660 yards. The range of the deposit he could not ascertain, as at a short distance from the spot examined, the cliff assumed its usual perpendicular form; but he is of opinion that it is considerable, or else that there are many such deposits, as he found fallen masses of a similar bed near St. Lawrence and between Ventnor and Bonchurch.

A letter addressed to Dr. Buckland by J. Wyatt, Esq., respecting a trap dyke in the Penrhyn Slate Quarries near Bangor, Carmarthenshire, was then read.

These quarries were opened fifty years since, and the excavation is now about 700 yards in length, 300 in breadth, and 90 below the natural surface. In carrying on the highest opening of the quarry, the men, a few months since, came suddenly in contact with a trap dyke, which has since been cut through and proved to be 11 feet in width. Its direction appears to be between W.N.W. and N.W., and it intersects the bedding of the slate nearly at right angles. The dip at present is almost 90°, the slight inclination being to the N.E. The "cheeks" of the dyke on the N.W. side, are broken conformably with the natural joints of the schist. The slate immediately in contact with the trap is, in some parts, quite flinty, having lost its fissile properties, and the colour is changed from purple to black; but at the distance of two or three feet the slate recovers its natural colour and cleavage.

A notice of a successful attempt at boring for water at Mortlake in Surrey, by William Richardson, Esq., F.G.S., was next read.

In the year 1834, Mr. John Randell of Mortlake, being desirous of procuring a large supply of spring water, sunk a well on his premises, and within 100 feet of the Thames.

In the first instance, an augur seven inches in diameter was used in penetrating twenty feet of superficial gravel mixed with marl, and 200 feet of London clay. An iron tube, eight inches in diameter, was then driven into the opening to dam out the land springs and the percolation from the river. A four-inch augur was next introduced through the iron tube, and the boring was continued, until the London clay, having been perforated to the depth of 240 feet, the sands of the plastic clay were reached, and water of the softest and purest nature was obtained; but the supply was not sufficient, and it did not reach the surface. The work was proceeded with accordingly, and after 55 feet of alternating beds of sand and clay had been penetrated, the chalk was touched upon. A second tube, $4\frac{1}{2}$ inches in diameter, was then driven into the chalk to stop out the water of the plastic sands, and through this tube an augur $3\frac{1}{2}$ inches in diameter was introduced and worked 35 feet into hard chalk abounding with flints. To this succeeded a bed of soft chalk into which the instrument suddenly penetrated to the depth of 15 feet. On the augur being withdrawn, water gradually rose to the surface and overflowed in considerable quantities, the supply averaging, for a time, 5000 gallons daily.

The general summary of the work is as follows:

	Feet.
Gravel	20
London clay	240
Plastic sands and clays	55
Hard chalk and flints	35
Soft chalk	15
	305

The expense of the work did not exceed 300*l.* With respect to the chalk itself being the reservoir whence the water is obtained, Mr. Richardson mentioned an analogous case in the cliff on which stands Dover Castle, where water issues from a bed of soft chalk marl between the chalk with flints and that without flints*.

A paper "On the Strata usually termed Plaistic Clay," by John Morris, Esq., and communicated by the President, was then read.

The author commences by objecting to an arrangement of tertiary formations in different countries according to the classification of the Paris basin by MM. Cuvier and Brongniart. He then refers to the memoirs of Mr. Webster, Dr. Buckland, and Mr. Richardson, on the strata immediately above the chalk in England, and proceeds to show that they ought to be considered as belonging to the London clay.

For the sake of convenience in arranging their organic remains, Mr. Morris makes three divisions of these beds: 1. those containing

* Conybeare and Phillips, Outlines, p. 88.

the Reading oyster; 2. the Woolwich and Upnor strata; and 3. the Bognor or lower arenaceous beds of the London clay.

The first division has been long well known in consequence of the sections given by Mr. Webster * and Dr. Buckland † of the Catsgrove pits near Reading; and has been subsequently described in a paper by Mr. Rofe on the same district ‡. Mr. Morris gives the following sections of this deposit at Northaw in Hertfordshire, and Headley in Surrey.

		Feet.
Northaw, Top,	grey sand	20
	green sand with oysters	1
	grey sand	2
	iron flint bed	8 inches.
	chalk	

		Feet.
Headley, Top,	red and green variegated marls	4
	clay and sand	3
	grey sand with oysters	1
	ash-coloured sand	
	chalk	

2. The Woolwich strata, also described by Mr. Webster § and Dr. Buckland ¶, extend along the south side of the Thames, and patches of them are said to occur near Stifford** and Plaistow in Essex. They are chiefly composed of sand, clay, pebbles, and calcareous rock, the strata varying greatly in their thickness in different parts of even the same pit; and in their order of succession in different localities. At Woolwich, Sundridge park, Upnor, and some other places, there is also a marked distinction in the fossils of the upper beds from those of the lower; the former being characterized by the prevalence of freshwater or estuary shells of the genera Cyrena, Neritina, Melanopsis and Planorbis, associated with marine shells. How far this distinction may be owing to the action of a river, Mr. Morris says it may be difficult to determine, as the recent species of the above genera have variable habits. The principal localities at which the Woolwich beds have been noticed are, Sundridge park near Bromley, Chiselhurst, Orpington, Beckenham, Sydenham, Counter Hill, Loam-pit hill near Lewisham, the Thames Tunnel, Vauxhall, the road leading from Oldfield to Plumstead; the ninth milestone beyond Shooter's Hill, Erith ballast-pit, Bexley Heath, Swanscombe Wood, Green Street near Stoke, and Upnor near Rochester.

The following sections presented at the last locality, illustrate the variations in different parts of the same pit.

		Feet.
South End, Top,	brown clay with fragments of chalk and chalk flints	10
	fine calcareous clay	3
	sand with bluish flint pebbles, and numerous re-	

* Geol. Trans., First Series, vol. ii. p. 198. † Ibid. vol. iv. p. 278.

‡ Geol. Proceedings, vol. ii. p. 72.

§ Geol. Trans., First Series, vol. ii. pp. 196—221.

¶ Ibid. vol. iv. p. 284. ** Ibid. vol. ii. p. 196.

South End (*continued.*)

mains of Cyrena, Cerithium, Planorbis, Cytherea, Pectunculus, Cardium, and Natica..	Feet. 1
white sand, with occasionally layers of shells....	4
blue and brown clay with compressed Cyrena, Cerithium and Ostrea	4
lignite in grey sand	1
white sand, lower part containing pebbles	20
North End, Top, brown clay, &c.	14
sand with pebbles and shells	1½
sand chiefly white, in the upper part thin seams of shells	15
brown and blue clay, with compressed shells intermingled with sand	6
purplish sandy clay with ochreous concretions ..	2
lignite in sulphur-coloured clay and sand........	8 inches.
white sand	

With respect to the geological position of the Woolwich beds, Mr. Morris is of opinion that they ought to be assigned to the lower part of the London, as they occupy the same position, with reference to the chalk, as the Bognor strata.

3. The Bognor or lower arenaceous beds of the London clay are then described, and the following list given of the localities at which they have been noticed: Pegwell Bay (Isle of Thanet): Herne Bay*, Faversham, Hampstead well†, Watford, Egham, Bray, Binfield‡, Catsgrove quarry near Reading§, Alum Bay, Bognor¶ and Stubbington. At all these localities the strata are considered by Mr. Morris to be contemporaneous and to belong to the lower part of the London clay, reposing in some instances immediately on the chalk. Their mineral character is remarkably persistent, consisting of greyish green sands with layers of pebbles, but sometimes passing into sandstone and limestone. The fossils, which in some localities are numerous, agree specifically with the well-known Bognor shells; those imbedded in the sands being in good preservation but those in the rock chalky and friable. From the position occupied by these beds Mr. Morris is induced to consider them as the equivalents of the lower beds of Woolwich, Upnor, &c., and in support of this opinion alludes to the strata of calcaire grossier which rest immediately upon chalk at Meudon.

A Memoir on the Geology of Suffolk, by the Rev. W. B. Clarke, F.G.S., was then commenced.

February 1.—Jonathan Thompson, Esq., of St. Edmund's Hall, Oxford, and of Temple Grove, East Sheen, Surrey, was elected a Fellow of this Society.

* See Abstract of Mr. Richardson's Memoir, Geol. Proceedings, vol. ii. p. 78.
† Abstract of Mr. Wetherell's Memoir, Geol. Proceedings, vol. ii. p. 93.
‡ Mr. Warburton's Memoir, Geol. Trans., Second Series, vol. i. p. 52.
§ Abstract of Mr. Rofe's paper, Geol. Proceedings, vol. ii. p. 72.
¶ Mr. Webster's paper, Geol. Trans., First Series, vol. ii. p. 190.

A paper, "On the occurrence of Keuper-Sandstone in the upper region of the New Red Sandstone formation or *Poikilitic system* in England and Wales," by Professor Buckland, D.D., V.P.G.S., was first read.

The term Keuper is applied in Germany to the entire series of red and variegated marls and sandstones, which lie between the lias and muschel-kalk. Several of these sandstone beds afford a valuable building stone, specimens of which from the quarries of Stuttgard and of Sinzheim, near Heidelberg, were presented by the author to the Society. Dr. Buckland has identified several varieties of this German Keuper-sandstone with sandstones which occupy an analogous position in England in the lower region of the red rock marl.

The total absence of the Muschel-kalk in this country, has left us without that obvious division which it affords in Germany, between sandstones of the era of the red marl or Keuper, and those more ancient new red sandstones which are distinguished on the Continent by the name of Grès bigarré, or Grès de Vosges, and which in England, occupy a large space between the red rock marl and magnesian limestone.

In the vicinity of Warwick, which forms the principal example cited in the present memoir, an excellent section is seen in Guy's Cliff, and a considerable extent of surface is occupied by Keuper-sandstone, which emerges from beneath the red rock marl, near that town and Leamington, and occupies a breadth of three or four miles between Warwick and Kenilworth; at the latter place the Vosges sandstone rises from beneath it, affording the materials for the construction of the castle of Kenilworth, as the Keuper-sandstone has afforded those of the castle and other ancient buildings at Warwick.

In the absence of the Muschel-kalk, there is here no obvious proof of any interval between the deposition of the new red sandstone of Kenilworth, and of the olive-coloured Keuper-sandstone which rests immediately upon it, and although the mineral condition of this latter sandstone agrees with that of the Keuper-sandstone of Germany, some doubt might have remained as to the identity of strata so distant from each other, without the aid afforded by organic remains. In 1823, part of the jaw and other bones of a Saurian, found in the sandstone of Guy's Cliff near Warwick, were presented to the Oxford Museum, by the late Butic Greathead, Esq.; Dr. Buckland has identified these with the remains of the Phytosaurus, which in 1835 he saw in the Museum at Wirtemberg; and, as this genus has hitherto been found in no other formation than the Keuper, it leaves little doubt as to the identity of the Warwick sandstone with the Keuper-sandstone of Germany. Fragments of vegetables also are dispersed through the Warwick sandstone, in the same state of imperfect preservation as the greater part of those in the Keuper of Stuttgard.

In October 1836, further remains, apparently of Phytosaurus, were found at Warwick by Dr. Lloyd of Leamington, who is engaged in tracing the extent of the Keuper throughout this district.

Dr. Buckland has also recognised the Keuper-sandstone in the uarries of Sutton Mallet near Bridgewater; and of Rumwell Heale and Oake near Taunton; the latter have supplied the freestone used in the towers and bridges at the town of Taunton.

In the cliffs at Oreham, two miles E. of Exmouth, there are beds of sandstone, probably referrible to the Keuper formation, which have supplied the olive-coloured sandstone of which the cathedral of Exeter is built; and at Pyle, in Glamorganshire, a few miles E. of Neath, a valuable building-stone lately employed in constructing the castle of Margum, is obtained from strata, which the author also refers to the Keuper-sandstone of Germany.

Mr. Murchison has noticed Keuper-sandstone in several localities in Gloucestershire and Worcestershire, near Tewkesbury and Newent.

A paper "On the Geological Structure and Phenomena of the northern part of the Cotentin, and particularly of the immediate vicinity of Cherbourg," by the Rev. W. B. Clarke, F.G.S., was then read.

In an account of the Cotentin published in the 35th volume of the Journal des Mines, M. Alexander Brongniart gives a full account of the limestone, slates, quartz rock and syenite or granite composing the country; but the chief object of that memoir is to prove the comparatively recent origin of the granitic rocks.

Mr. Clarke, in detailing the characters of the formations follows closely the account of M. Brongniart, and adopts fully the views of that geologist respecting the age of the granite. He also quotes Prof. Sedgwick's observations on the comparatively recent origin of the granite of Cornwall, and the adjacent portion of Devonshire; and points out the general agreement in structure of that district with the Cotentin.

The country near Cherbourg consists of hills, and ridges of quartz rock alternating with valleys of slate, occasionally associated with syenite and greenstone, under circumstances which lead to the conclusion that the igneous formations are of posterior origin.

The quartz rock varies in colour and hardness, seldom assumes an arenaceous character, and the fracture is sometimes vitreous. The beds are generally inclined at a considerable angle, the dip changing in different localities.

The slates vary greatly in their characters, being sometimes argillaceous, at others talcose, and occasionally assume a form called by M. Brongniart *steaschiste noduleux* which has a base of green golssy slate inclosing nodules of quartz.

The slates and the quartz rock alternate frequently, and pass into each other by insensible gradations.

The quartz rock splits naturally into irregular masses, which have nevertheless some of the angles of fixed dimensions viz. 103°, 64°, and 83°. These measurements Mr. Clarke has been enabled to obtain in some instances, by producing two sides, which in the specimens were cut off by the intersection of a third plane. On measuring fragments of the green variety of schist, he found the same angles under the same circumstances of position, proving that similar causes had acted on the two formations *en masse*; the same sets of joints, bedding lines, and cleavage, being found in each formation.

The rock of Le Roule, near Cherbourg, is stated by Mr. Clarke to present to the eye two lines of fracture, "one parallel to the horizon the other nearly perpendicular to it; and from these with the lines of dip and direction the fragments assume their forms."

The author then offers some remarks on the probable effects of crystalline action in the first place, and of subsequent forces in the second. Veins of a light ochre colour traverse the beds of Le Roule from top to bottom; whilst other veins and threads of pure milk-white, opaque quartz, sometimes studded with crystals, range through them in a direction from S.E. to N.W. where the general dip of the beds is from N.E. to S.W. at an angle of 30°. This direction of the veins precisely agrees with that of the transverse fissure or ravine through the Montagne du Roule, the latter also ranging from S.E. to N.W.

This transverse rectangular direction of the ravine, Mr. Clarke says, corresponds with the mechanical effect of elevation, and may be compared to the case of Corfe Castle in Purbeck, where the nearly vertical beds of hard chalk have been fractured at right angles.

The memoir concludes with a general recapitulation of the structure and phenomena of the Cotentin, and a comparison of them in other countries.

TRANSACTIONS

OF THE

GEOLOGICAL SOCIETY OF LONDON,

SECOND SERIES.

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CONTENTS. 18. Buckland, on Agates in Dolomitic Strata of the New Red Sandstone in the Mendip Hills. 19. Buckland, on the Iguanodon. 20. Clift, on the Megatherium. 21. Pratt, on the Anoplotherium of the Isle of Wight. 22. Brewster, on the Diamond. 23. Sedgwick, on Slaty Cleavage, and on the Structure of Rocks, &c. 26. Extracts from Minute-Book :—I. Gordon, on Blue Clay, south side of Murray Firth. II. J.R. Wright, on Basalt of Titterstone Clee Hill. III. Maxwell, on a large Boulder, shore of Appin. IV. Anker, on the Bones in coal near Gratz. V. Captain Hall, on Sir James Hall's Machine for regulating high temperatures. VI. Colquhoun, on Meteoric Iron from Mexico and Potosi. VII. Burnes, on the banks of the Indus, &c. VIII. Necker, on Metalliferous deposits.

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CONTENTS. 1. Buckland and De la Beche, on Weymouth. 2. Sedgwick, on the Cumbrian Mountains. 3. Sedgwick, on the Carboniferous Chain from Penigent to Kirkby Stephn.

VOLUME IV. PART II. Price to Fellows 1*l.* 18*s.*; to the Public 2*l.* 5*s.*

CONTENTS. 4. Fitton, on the Strata below the Chalk in the South-east of England. 5. Bell, on a Fossil Species of Chelydra. 6. Sedgwick, on the New Red Sandstone in the Basin of the Eden. 7. Sykes, on a portion of the Deccan. 8. Horner, on the Environs of Bonn. Index.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1837. No. 49.

AT THE

ANNUAL GENERAL MEETING,

17th February, 1837,

The following Report from the Council was read:

The Council has again to congratulate the Society upon a considerable increase in the number of its Members, evincing the interest taken by the public in the advancement of Geological science. Fifty-three new Fellows have been elected during the past year. The Council, under the alteration in the by-law adopted by the Society at a Special General Meeting, held 27th of April last, have removed the names of two Fellows from the list of the Society; the deaths and resignations amount to 15, so that the Society, which at the end of 1835 consisted of 774 Members, at the end of 1836 was increased to 810.

The state of the finances (the details of which will be found fully set forth in the annexed accounts) may be considered even more encouraging than the corresponding one at the last anniversary.

The expenditure has been less than the estimates then submitted to the Society. Those now presented are arranged according to the probable demands of the Society for the ensuing year, which in some departments have required enlargement, owing to the increase in the numbers of the Society.

The funded property of the Society has been increased, a sum (including a purchase in January,) having been invested more than equal to the compositions of the past year, and the Council is proceeding gradually to accomplish the recommendation of the auditors in 1833, viz., to invest in Stock a sum equal to the entire amount of compounded subscriptions. The property last year was valued at 2102*l.* 18*s.*; it is now calculated to be worth 2563*l.* 5*s.* 5*d.*

Out of the proceeds of the Wollaston Fund at the Society's disposal, the Council has this year awarded two Medals, one to Captain Proby Cautley of the Bengal Artillery, and the other to Dr. Hugh

Falconer, of the Bengal Medical Service, for their Geological researches, and their discoveries in Fossil Zoology in the Sub-Himalayan Mountains.

The following is the Report of the Committee appointed to examine into the state of the Library and Museum.

REPORT of the Committee appointed to examine and report on the state of the Museums and Library.

Museums.

In consequence of the uninterrupted pressure of other business during the Session of the Society, and the urgent recommendation of the Council that the Curator should be absent during the recess with a view to the reestablishment of his health, no further progress has been made this year in the arrangement of the collections. The plan of arrangement, so far as relates to the British collection, has been stated on various occasions, and is sufficiently known; but your Committee have thought it desirable, in order to render the Fellows more conversant with the nature and extent of the Foreign collections, to subjoin a table exhibiting the geographical divisions which, for the present, have been adopted, and the number of drawers occupied by these divisions respectively.

The duplicate specimens in the Society's possession are numerous, and the number is constantly increasing. The Committee suggest the propriety of distributing these, as soon as can conveniently be done, among Foreign Institutions. Were the duplicates from the tertiary, cretaceous, oolitic, carboniferous, and older sytems, which are already arranged to a certain extent, transmitted to different Foreign Museums, situated in the vicinity of those formations respectively, they would be most valuable as objects of comparison. It is in this way only that the geographical boundaries of fossil species can be satisfactorily determined.

The important department of organic remains, though large, is still very defective.

It will be necessary, during the present year, to provide two tiers of additional cabinets, comprising 42 drawers, the cost of which is estimated at 35*l.*; and the Committee would further suggest to the consideration of the Council, the propriety of putting up an additional glass case in the hall, which will occasion an expense of about 12*l.*

The principal donations to the Museum, since the last Anniversary, are as follows:

1. Extensive collections of the remains of the Mastodon, Elephant, Rhinoceros, and other animals from the Sewalik Hills, collected and presented by Capt. Cautley. Of the importance of this donation, the Committee are not called upon to offer any opinion, the Council having marked their sense of its value by awarding to Capt. Cautley one of the Wollaston Medals of the year.
2. From Col. Sykes a series of Cutch Fossils, collected for the Society at his suggestion. In a paper read during a former Session on some specimens brought to England by Capt. Smee, the close

agreement of several of the shells with some of the oolitic fossils of England was distinctly shown; and the collection recently presented by Col. Sykes has been made to assist in determining how far the comparison may be extended.

3. From Mr. Austen, an extensive series of fossils from the limestone of Southern Devonshire has been received.

4. The Royal Geographical Society has presented a collection of specimens from Guiana, collected by M. Schombergk.

Summary of the Foreign Collection.

	Drawers.
Spitzbergen	3
Iceland	6
Feroe Islands	2
Sweden	5
Norway	8
Denmark	1
Waygate Straits	1
Russia	3
—— Volhynia	1
—— Crimea	1
Poland	2
Austria, including Styria and Tyrol	11
Hungary	20
Bavaria, with Franconia, Bayreuth, and Solenhofen	13
Hanover with the Hartz	7
Wirtemberg	16
Saxony, Freyberg	9
Nassau	6
Baden	3
Hesse	2
Lower Rhine, including Bonn, the Eifel, and Maestricht	62
Belgium	3
Holland	1
France, rich in specimens from the Cantal and Auvergne	56
Portugal	2
Spain, confined to Gibraltar and the provinces of Granada and Murcia	12
Sardinia	1
Piedmont and Savoy	9
Switzerland	19
Italy	9
Environs of Rome	4
Environs of Naples	22
Sicily	6
Malta	2
Greece and Grecian Archipelago	3
Asia Minor	1
Palestine	3
Persia and Persian Gulf	7
East Indies: Bombay and Western coast	22
—— Madras	1
—— Bengal and Upper Provinces	42
Ava	8
China	1
Islands in the Indian Ocean	12
Australia—West Coast	3
—— East Coast and interior adjacent to	9
—— North Coast	3
Van Diemen's Land	3
Egypt	14
Madagascar	1
Cape of Good Hope	3
St. Helena	2
Ascension	3
Cape de Verde Islands	1
Madeira	2
Azores	1
Greenland	5
Davis's Straits, Baffin's Bay, Melville Bay, Prince Regent's Inlet, Hudson's Bay, &c.	9

	Drawers.		Drawers.
Labrador	4	Potosi	2
Nova Scotia	1	Peru	8
Newfoundland	3	Chili	6
Upper Canada and Arctic Regions	16	Brazils	9
United States	29	Buenos Ayres	2
West Indies	29	Straits of Magellan	2
Mexico	7	——— exclusive of Capt. King's Collection	1
Panama	2		
Caraccas	1	Otaheite	1
Bolivia	6		

Library.

Many additions have been received during the past year; but the Committee cannot help noticing that several publications of essential importance are wanting.

The collection of Maps and Charts has been considerably augmented by presents from the Admiralty, the Board of Ordnance, the Lord Lieutenant of Ireland, and the East India Company; but several foreign geological Maps of established reputation are not yet in the Library.

Since the last Anniversary, alphabetical catalogues of every geological map, section, plan, diagram and view, scattered through the works in the Library, have been prepared, the value of which, as affording increased facilities of reference, is too obvious to be insisted upon.

Comparative Statement of the Number of the Society at the close of the years 1835 *and* 1836.

	31st Dec. 1835.	31st Dec. 1836.
Fellows having Compounded	90	97
——— Contributing	232	251
——— Non-resident	348	361
	670	709
Honorary Members	44	43
Foreign Members	57	55
Personages of Royal Blood	3	3
	774	810

Return explanatory of the difference in the total number of *Fellows* at the close of 1835 and 1836.

Number of Fellows, Compounded, Contributing and Non-resident, 31st Dec. 1835, as in the preceding Comparative Statement		670
Add, Fellows elected during 1836		53
		723
Deduct, Deceased during 1836	2	
——— Resigned	10	
——— Removed from the Society	2	
		14
Total Number of Fellows, Compounded, Contributing, and Nonresident 31st Dec. 1836, as in the Comparative Statement		709

Deceased Fellows. *Compounder:* Earl of Kerry. *Resident:* none. *Nonresident:* Rev. George Rowley, D.D.

Honorary Member: William Henry, M.D.

Foreign Members: Professor Hoffmann, Baron Ferussac.

Removed from the Society by virtue of the Bye-law passed at the Special General Meeting held 27th of April, 1837, (see p. 407): Lord Glenlyon, William Higgins, Esq.

The following Donations to the Museum have been received since the last Anniversary:—

British and Irish Specimens.

Crag Fossils and a large fragment of bone from the base of the Diluvial Cliffs near Southwold, Suffolk; presented by E. Charlesworth, Esq. F.G.S.

Petrified wood with hazel nuts, from a submarine forest and bog on the Irish coast, described in the Geological Transactions, 1st series, vol. iv. p. 443; presented by the Rev. James Yates, F.G.S.

Fossils from Hordwell Cliff; presented by Charles Stokes, Esq. F.G.S.

Head of *Ichthyosaurus communis*, and a specimen of *Scaphites Hillsii* from Maidstone; presented by the Right Hon. the Marquis of Northampton, F.G.S.

Fossils from the Greensand, and the Transition limestone of Devonshire; presented by Alfred Cloyne Austen, Esq. F.G.S.

Specimens from the Coal-measures and the Silurian system of Coalbrook Dale; presented by Joseph Prestwich, jun. Esq.

Specimens from the Lias at Lyme Regis; presented by Viscount Cole, M.P. F.G.S.

Speeimens from the Marlstone at Lyme Regis; presented by Viscount Colc, M P. F.G.S. and Sir Philip Grey Egerton, Bart. M.P. F.G.S.

Coal shale with *Ammonites Listeri* from the Bradford Coalfield; presented by Viscount Oxmantown, F.G.S.

Specimens from the London Clay, near Chalk Farm; presented by Nathaniel Thomas Wetherell, Esq. F.G.S.

Remains of the Elephant, &c., from Bollingdon Hill, Essex; presented by J. Brown, Esq. F.G.S.

Specimens from the Chalk at Buxton, Norwich; presented by John Wright, Esq.

Specimens from the Chalk of Gogmagog Hill near Cambridge; presented by Rev. Belfield Dennys.

Specimens from the Chalk of various parts of England; presented by H. C. White, Esq. F.G.S.

Fossils from the Limestone at Teignmouth; presented by George Harvey, Esq. F.G.S.

Specimen of a Fossil Crustaceous Animal from the Coal Formation near Glasgow; presented by John Scouler, M.D. F.L.S.

Specimens of Fossil Wood, found in rounded Boulders of Cornbrash at the summit of Blisworth ridge, Northamptonshire; presented by Richard Creed, Esq.

Specimen of New Red Sandstone, found in the Fenland of Lancashire at the depth of 512 feet; presented by George Bellas Greenough, Esq. V.P.G S.

Specimens from the New Red Sandstone and Conglomerate at Allesley, Warwickshire; presented by the Rev. James Yates, F.G.S.

Specimens of Granite from Penryn, Cornwall; and specimen of Ammonites in Flint from Box Hill, near Dorking; presented by George Rennie, Esq.

Specimens from a Fossil Tree at Allesley, Warwickshire, and of New Red Sandstone in which it was found; presented by the Rev. William Buckland, D.D. F.G.S. and the Rev. James Yates, F.G.S.

Specimens from the Freshwater Deposit at Grays, and from the Plastic Clay at Woolwich and Upnor; and a specimen of Fossil Wood from Bayswater; presented by John Morris, Esq.

Foreign Specimens.

A Specimen of Bone Breccia and Fossils from Cerigo; presented by Lord Nugent.

Mesotype from Mount Ecchio, near Verona; presented by the Rev. James Yates.

Remains of the Mastodon, Mammoth, Hippopotamus, Pig, Ox and Deer, from the Sewalik Mountains, at the southern base of the Himalayas, between the Sutluj and the Kamgunga rivers; presented by Captain Cautley, F.G.S.

Specimens from the Lipari Isles, Etna, &c.; presented by the Hon. John Stuart Wortley.

Selenite from Prince Regent's Inlet, lat. 73° 27′ 23″, long. 90° 50′ 34″; presented by Captain Sir Edward Parry, R.N.

Specimen of Fossil Wood from Egypt; presented by Lord Prudhoe.

Specimens from Balmen, Badra and Linput, in Cutch, from Sinde, and the banks of the Indus; presented by Lieut. Burnes.

Specimens of Coal Plants from Cape Breton; presented by — Brown, Esq.

A Collection of Specimens from Guiana, collected by Robert Schomburgk, Esq.; presented by the Royal Geographical Society, and Mr. Schomburgk.

A Specimen of Fossil Wood from Van Diemen's Land; presented by — Williamson, Esq.

Fossils from Barbadoes; and casts of shells in Selenite from Australia; presented by G. B. Greenough, Esq. V.P.G.S.

Boulders from the sea-shore at Barcelona, and a specimen of shelly limestone from Tarragona; presented by W. P. Hunter, Esq. F.G.S.

Specimen of Iron Pyrites from the Peat associated with the warm springs of Egra, Bohemia; presented by A. Bozzi Granville, M.D. F.G.S.

Fossils from Cutch; presented by Lieut.-Col. W. H. Sykes, F.G.S.

Casts of *Crioceras Emerici*, of *Hamites*, *Orthoceras*, and *Scaphites Yvanii*; presented by M. Puzos.

Fossils from Barbadoes; presented by Joseph Cowhurst, Esq.

The Library has been increased by the Donation of about 120 Books and Pamphlets.

Charts and Maps.

Numbers 51, 52, and 60 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.

Ordnance Townland Survey of the counties of Armagh, Monaghan, Louth and Donegal; presented by Lieut.-Col. Colby, by command of His Excellency the Lord Lieutenant of Ireland.

Map of the county of Sutherland, constructed by direction of His Grace the Duke of Sutherland, on the basis of the trigonometrical survey of Scotland; presented by His Grace the Duke of Sutherland.

Map, Sections and Book of reference of the intended Midland Counties Railway; presented by Thomas Dicey, Esq.

Admiralty Charts, Sailing Directions and Tide Tables, published during the years 1834 and 1835; presented by Capt. Beaufort, R.N., presented by direction of the Right Hon. the Lords Commissioners of the Admiralty.

Sheets 72 and 109 of the Trigonometrical Survey of India; presented by the Hon. the Directors of the East India Company.

Sheet I. of a Geological Map of Saxony; presented by the Council of Mines of Saxony.

The SECOND Part of the Fourth Volume of the Society's Transactions has been published since the last Anniversary.

The following LIST contains the NAMES of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received during the past year.

Academy of Natural Sciences of Philadelphia.
Allen & Co., Messrs. W. H.
American Philosophical Society, held at Philadelphia.
Ashburton, Lord.
Athenæum Club.

Bahama Society for the Diffusion of Knowledge.
Beaufort, Capt. R.N., Hon. Mem. G.S.
Bohn Mr. J.
Booth, Mr.
Brewster, Sir David, F.G.S.
British Association.
Broderip, W. J., Esq. F.G.S.
Bronn, Dr. H. J.
Brown, —, Esq.
Bryant, Mr. J.
Buckland, Rev. Prof., D.D. F.G.S.
Burnes, Lieutenant.

Cawdor, Earl of, F.G.S.
Cautley, Captain, F.G.S.
Charlesworth, Edw., Esq. F.G.S.
Colby, Lieut.-Col. F.G.S.
Cole, Robert, Esq.
Cole, Viscount, F.G.S.
Colin, M.
Council of Mines of Saxony.
Creed, Richard, Esq.

Daubeny, Charles, G.B. M.D. F.G.S.
De Bylandt Palstercamp, Le Comte A.
De la Beche, H. T., Esq. For. Sec. G.S.
De la Rive, M. Auguste.
Dennys, Rev. Belfield.
Des Jardins, M.
Des Moulins, M. Charles.
Dicey, Thomas Edward, Esq.
Dufrénoy, M., For. Mem. G.S.
Dujardin, M.

East India Company.
Eaton, Amos, Esq.
Edwards, M.
Egerton, Sir P. Grey, Bart. F.G.S.
Elie de Beaumont, M., For. Mem. G.S.
Elliston, Allen, Esq.
English, Henry, Esq. F.G.S.

Faraday, Michael, Esq. F.G.S.
Fitton, W. H., M.D. F.G.S.
Forbes, James David, Esq., F.G.S.

Gemmelaro, Signor C.
Geological Society of France.
Geological Society of Pennsylvania.
Granville, A. B., M.D. F.G.S.
Greenough, G. B., Esq. F.G.S.
Gregory, Henry, Esq.
Griffith, Richard, Esq. F.G.S.

Hay, Richard W., Esq.
Hall, Capt. Basil, F.G.S.
Harlan, Richard, Esq.
Harvey, George, Esq.
Hœninghaus, M. Fred. G.
Horner, Leonard, Esq. F.G.S.
Hunter, W. P., Esq. F.G.S.

Institute of British Architects.
Institution of Civil Engineers.

Ireland, His Excellency the Lord Lieutenant of.

Jenyns, Rev. Leonard, F.G.S.

Laird, James, M.D. F.G.S.
Lhotsky, Dr. John.
Linnean Society of Bordeaux.
Linnean Society of Normandy.
London Institution.
Loudon, John Claudius, Esq. F.G.S.

Mackintosh, T. S., Esq.
MacLean, Mr. Thomas.
Main, Mr. James.
Manchester Mechanics' Institution.
Mantell, Gideon, Esq. F.G.S.
Marcel de Serres, M.
Master-General and Board of Ordnance.
Medico-Botanical Society.
Millard, John, Esq.
Milne, David, Esq. F.G.S.
Morris, John, Esq.
Mudge, Lieut.-Col. R.E. F.G.S.
Muséum d'Histoire Naturelle de Paris.

Nattali, Mr.
Northampton, Marquis of, F.G.S.
Nugent, Lord.

Oxmantown, Viscount, F.G.S.

Parbury and Co., Messrs.
Parish, Sir Woodbine, K.C.H. F.G.S.
Parry, Sir Edward, Capt. R.N.
Paxton, Mr. J.
Phillips, John, Esq. F.G.S.
Phillips, Richard, Esq. F.G.S.
Potts, Dr.
Prestwich, Jos., Esq. F.G.S.
Prudhoe, Lord.
Prinsep, James, Esq.

Reich, Professor.
Rennie, George, Esq. F.G.S.
Repertory of Patent Inventions, Editor of.
Rhind, William, Esq.
Roemer, M. Frederique A. von.
Rogers, W. B., Esq.
Rogers, Henry D., Esq. F.G.S.
Royal Academy of Lisbon.
Royal Academy of Science at Berlin.
Royal Asiatic Society of Great Britain and Ireland.
Royal Astronomical Society.
Royal College of Surgeons.
Royal Cornwall Polytechnic Society.
Royal Geographical Society.
Royal Society of Edinburgh.
Royal Society of London.
Royle, J. Forbes, M.D., Sec.G.S.
Rüppell, Dr. Edward.

Scarborough Philosophical Society.
Schombergk, Robert, Esq.
Scouler, John, M.D.
Scott, Rev. T. H. F.G.S.
Silliman, Benjamin, M.D. Hon. Mem. G.S.
Silvertop, Brigadier C. F.G.S.
Society for exploring Central Africa.
Société Imperiale des Naturalistes de Moscou.
Société de Physique et d'Histoire Naturelle de Géneve.
Société de Physique et d'Histoire Naturelle de Paris.
Society of Arts.
Sopwith, Thomas, Esq. F.G.S.
Stokes, Charles, Esq.
Sutherland, The Duke of.

Taylor, Richard, Esq. F.G.S.
Taylor, William, Esq. F.G.S.
Tenore, Signor.

Von Buch, Herr Leopold, For. Mem. G.S.
Vander Maelen, M., For. Mem. G.S.

Warren, Mrs.
Walker, Frederick, Esq. F.G.S.
Weale, Mr. J.
Wetherell, N. T., Esq. F.G.S.
Whewell, Rev. William, F.G.S.
White, H. C., Esq.
Williamson, —, Esq.
Woodward, Mr. Samuel.
Wortley, Hon. John Stuart, F.G.S.
Wright, John, Esq.

Yarrell, William, Esq.
Yates, Rev. James, F.G.S.

Zoological Society.

The following Persons were elected Fellows during the year 1836.

January 6th.—William Anstice, Esq., of Madely Wood, Shropshire.

January 20th.—Arthur William Tooke, junr., Esq., M.A., of Russell-square; J. B. Jukes, Esq., B.A., of St. John's College, Cambridge, and of Pattingham, near Wolverhampton, Staffordshire; Philip Worsley, Esq., of Great Ormond-street; and Richard Zacchary Mudge, Esq., Lieut.-Col. in the Royal Engineers.

February 3rd.—James Thomson, Esq., F.R.S., of Primrose-hill, near Clitheroe, Lancashire; J. W. Scott, Esq., M.P., of Rotherfield Park, Hants, and Grafton-street; and George Warde Norman, Esq., of Bromley, Kent.

February 24th.—Thomas Collett, Esq., of the Middle Temple; and William John Prescott, Esq., of Threadneedle-street.

March 29th.—John Brown, Esq., of Stanway, near Colchester; and the Rev. George Brett, A.M., of Jesus College, Cambridge, and of Chelsea.

March 23rd.—Henry Atkinson, of Grove End; Henry Harpur Spry, Esq. of the Bengal Medical Service, Member of the Physical Class of the Asiatic Society of Calcutta; and Frederick Edwards, Esq., of Southampton-place, Euston-square.

April 13th.—Frederick Christian Clarke, Esq., of Chapel-street, Bedford-row; John Alfred Burgon, Esq., of Bucklersbury; and James White, Esq., of Newington-green, Middlesex.

May 11th.—Thomas Bland, Esq., of 43, Bedford-row; John Thomas Woodhouse, Esq., of Ashby-de-la-Zouch; William Holl, Esq., of Birmingham; George Owen Rees, Esq., of Clapham-road; Michael Jones, Esq., F.S.A., Barrister-at-Law; and George Cornwall Legh, Esq., of High Legh, Cheshire.

May 25th.—Golding Bird, F.L.S., of Seymour-street, Euston-square; James Smith, Esq., of Jordan's-hill, near Glasgow; and Octavian Blewitt, Esq., of Charlotte-street, Bloomsbury-square.

June 8th.—Henry Hubert, Esq., F.R.A.S., of New Bridge-street, Blackfriars; the Hon. Bingham Baring, M.P., of Great Stanhope-street; the Hon. William Lascelles, of 36, Wilton Crescent; the Hon. John Stuart Wortley, of 15, Curzon-street, May-fair; and the Right Hon. Baron James Parke, of Parke-street.

November 2nd.—J. Talbot, Esq., of Evercreech House, Shepton Mallet, Somersetshire.

November 16th.—James Philips, Esq., of the Royal Navy; Lieutenant Henry Drummond, of the Bengal Army; Louis Hunton, Esq., of Loftus, Yorkshire; and Henry Glassfore Potter, Esq., of Ridley-place, Newcastle-on-Tyne.

November 30th.—Charles Darwin, Esq., A.B., of Christ's College, Cambridge; Thomas White Collard, Esq., of Prospect House, near Herne, in the county of Kent; Rev. John Pye Smith, D.D., of Homerton College, near London; William Cubitt, Esq., of Gray's Inn-lane; and William Railton, Esq., of Carlton Chambers, Regent-street.

December 14th.—William Perceval Hunter, Esq., of the Albany; E. Parry, Esq., of the Court of Bankruptcy; Major William Harding, of Ilfracombe, Devon; John Hey, Esq., M.R.C.S., Curator of the Leeds Philosophical Society; William Stanger, Esq., of Wisbeach, Cambridgeshire; W. C. Henry, M.D., F.R.S., Vice President of the Literary and Philosophical Society of Manchester; William Gray, junr., Esq., of York, Secretary to the Yorkshire Philosophical Society; James Thomson, Esq., of Kirk House, near Brampton, Carlisle; the Hon. Henry Upton, of Whitehall-place; William Darley Hull, Esq., of the Woodhouse, Ross-trevor, Ireland; Thomas Cabbell, Esq., Barrister-at-Law, of Essex-court, Temple; and William Mathews, Esq., of Greenhill, near Dudley.

List of PAPERS *read since the last Annual Meeting, February* 19, 1836.

February 24th.—Observations on a patch of red and variegated Marls containing Fossil Shells, at Collyhurst, near Manchester; by J. Leigh, Esq., and E. W. Binney, Esq., and communicated by Roderick Impey Murchison, Esq., F.G.S.

——————— A Notice, by Francis Offley Martin, Esq., inclosing communications from Col. Brown and Lieut. Laurence of the Rifle Brigade, and Mr. Stevens, on the streams of sea-water which flow into the land in the Island of Cephalonia.

——————— A Notice, accompanying Rock Specimens from the Caves of Ballybunion, on the Coast of Kerry; by Lieut.-Col. W. H. Sykes, F.G.S.

——————— An Account of some Fossil Vegetable Remains found in the Sandstone which underlies the lowest bed of the Carboniferous Limestone, near Ballisadiere, in the county of Sligo, Ireland; by Sir Alexander Crichton, M.D., F.G.S., &c.

March 9th.—On the Remains of Mammalia found in the Sewalik Mountains, at the southern foot of the Himalayas, between the Sutlej and the Ganges; by Captain Cautley, F.G.S., and communicated by J. F. Royle, Esq., F.G.S.

March 23rd.—A Description of various Fossil Remains of Three distinct Saurian Animals, discovered in the Autumn of 1834, in the Magnesian Conglomerate on Durdham Down, near Bristol; by Henry Riley, M.D. and Mr. Samuel Stutchbury, and communicated by Charles Lyell, Esq., P.G.S.

March 23rd.—On the Ossiferous Cavern of Yealm Bridge, six miles south-east from Plymouth; by Capt. Mudge, Royal Engineers, F.G.S., F.R.S., &c.

April 13th and 27th.—On the Geology of Coalbrook Dale; by Joseph Prestwich, junior, Esq., F.G.S.

——————— A Letter from R. W. Fox, addressed to Sir Charles Lemon, Bart., M.P., F.G.S., On the Formation of Mineral Veins.

May 11th.—On the Silurian and other Rocks of the Dudley and Wolverhampton Coal-field, followed by a Sketch proving the Lickey Quartz Rock to be of the same age as the Caradoc Sandstone; by Roderick Impey Murchison, Esq., F.G.S., V.P.R.S.

May 25th.—On the part of Devonshire between the Ex and Berry Head and between the Coast and Dartmoor; by Robert Alfred Cloyne Austen, Esq., F.G.S.

——————— On the supposed existence in Africa of the Lias Formation; by Roderick Impey Murchison, Esq., F.G.S.

——————— A Notice on Maria Island, on the east coast of Van Diemen's Land (S. lat. 42° 44′, E. lon. 148° 8′); by Robert Frankland, Esq., Surveyor-General of the Colony, and communicated to the Society by Robert W. Hay, Esq., Under Secretary of State for the Colonies.

——————— A Letter on the Geology of the Country included in the south-west quarter, or 55th sheet of the Ordnance Survey; by J. Robison Wright, Esq., F.G.S., and addressed to Captain Mudge, Roy. Eng., F.G.S.,

——————— On the occurrence of Marine Shells in a bed of Gravel, at Narley Bank, Cheshire; by Sir Philip Grey Egerton, Bart., M.P., F.G.S.

——————— Accompanying Remarks to a section of the Upper Lias and Marlstone of Yorkshire, showing the limited vertical range of the species of Ammonites and other Testacea, with their value as Geological Tests; by Louis Hunton, Esq., and communicated by John Forbes Royle, Esq., F.G.S.

——————— A Letter from Robert Fitch, Esq., of Norwich, to Edward Charlesworth, Esq., F.G.S., on the Discovery of the Tooth of a Mastodon in the Crag at Thorpe, near Norwich.

June 8th.—Notice respecting a piece of Wood partly petrified by Carbonate of Lime, with some remarks on Fossil Woods which it has suggested; by Charles Stokes, Esq., F.G.S.

——————— Further Notice on certain peculiarities of structure in the Cervical Region of the Ichthyosaurus; by Sir Philip Grey Egerton, Bart., M.P., F.G.S., &c.

——————— A Communication on the Coal-fields on the north-western coast of Cumberland, &c. &c.; by the Rev. Professor Sedgwick, M.A., F.R.S., F.G.S., and Williamson Peile, Esq., of Whitehaven, F.G.S.

November 2nd.—A General Sketch of the Geology of the western part of Asia Minor; by Hugh Edwin Strickland, Esq., F.G.S.

November 16th.—On Indications of Changes in the relative Level of Sea and Land in the West of Scotland; by James Smith, Esq., of Jordan Hill, F.G.S.

November 16th.—On the distribution of Organic Remains in the Oolitic Formations on the coast of Yorkshire; by W. C. Williamson, Esq., Curator of the Natural History Society of Manchester and communicated by Charles Lyell, Esq., P.G.S.

November 30th.—On certain elevated Hills of Gravel containing Marine Shells, in the vicinity of Dublin; by John Scouler, M.D., F.L.S., Professor of Mineralogy in the Royal Dublin Society, and communicated by Robert Hutton, Esq., F.G.S.

——————— On the Geology of the Thracian Bosphorus; by Hugh Edwin Strickland, Esq., F.G.S., and William John Hamilton, Esq., Sec. G.S.

December 14th.—On Impressions in Sandstone resembling those of horses' hoofs; by Charles Babbage, Esq., and communicated by the President.

——————— On the occurrence of Silicified Trunks of large trees in the lower region of the Poikilitic Group, or New Red Sandstone Series, at Allesley, near Coventry; by the Rev. William Buckland, D.D., F.G.S., Professor of Geology in the University of Oxford.

———————Further Notice on a partially petrified piece of Wood from an ancient Roman Aqueduct at Eilsen, in the principality of Lippe, Buckebürg; by Charles Stokes, Esq., F.G.S.

——————— Description of a raised Beach in Barnstaple Bay, on the north-west coast of Devonshire; by the Rev. Professor Sedgwick and Roderick Impey Murchison, Esq., F.G.S.

January 4th, 1837.—Observations on the Elevation of the Strata on the coast of Chili; by Alexander Caldcleugh, Esq., F.R.S., F.G.S.

——————— On Proofs of recent elevation on the coast of Chili, during the Survey of His Majesty's Ship Beagle, communicated by Capt. Fitzroy; by Charles Darwin, Esq., M.A., F.G.S. &c.

January 18th.—An account of a Deposit containing Land-shells, at Gore cliff, Isle of Wight; by J. S. Bowerbank, Esq., F.G.S.

——————— A Letter addressed to Dr. Buckland, by J. Wyatt, Esq., respecting a Trap Dyke in the Penrhyn Slate Quarries, near Bangor, Carmarthenshire.

——————— A Notice of a successful attempt at boring for Water at Mortlake, in Surrey; by Wm. Richardson, Esq., F.G.S.

——————— A paper on the Strata usually termed Plastic Clay; by Mr. John Morris, and communicated by the President.

——————— The commencement of a Memoir on the Geology of Suffolk; by the Rev. W. B. Clarke, F.G.S.

February 1st.—A Notice on the occurrence of Keuper Sandstone in the upper region of the Poikilitic System or New Red Sandstone Formation of England and Wales; by the Rev. William Buckland, D.D., Professor of Geology and Mineralogy in the University of Oxford.

——————— A Paper on the Geological Structure of the Arrondissement of Cherbourg; by the Rev. W. B. Clarke, M.A., F.G.S.

Sums actually Received and Expended,

RECEIPTS.

Balances in hand January 1, 1836:				£.	s.	d.	£.	s.	d.
Banker (including 41*l.* 8*s.* 4*d.* Wollaston Fund)				399	10	10			
Accountant				40	0	0			
							439	10	10
Arrears:				£.	s.	d.			
Admission Fees				132	6	0			
Annual Contributions				154	7	0			
Alteration Fund				25	0	0			
							311	13	0
Ordinary Income:				£.	s.	d.			
Annual Contributions				530	5	0			
Overpaid by Collector				0	4	0			
Admission Fees:	£.	s.	d.	530	9	0			
Residents	170	2	0						
Non-Residents	147	0	0						
				317	2	0			
							847	11	0
Compositions, 7 at 31*l.* 10*s.* 0*d.*				220	10	0			
Ditto 1 at 28*l.* 7*s.* 0*d.* being less, the Annual Contribution 3*l.* 3*s.* 0*d.*				28	7	0			
							248	17	0
Subscriptions to Alteration Fund							25	0	0
				£.	s.	d.			
Transactions sold during 1836				178	2	6			
Ditto in former years, paid for in 1836				1	7	0			
							179	9	6
Proceedings							11	17	0
				£	s.	d.			
Wollaston Donation Fund, Interest on 1084*l.* 1*s.* 1*d.* 3 per cent. Reduced							32	10	4
Dividends, 500*l.* 3 per cent. Consols, 12 months				15	0	0			
Ditto 300*l.* 3 per cent. Red. 12 months				9	0	0			
							24	0	0
							£2120	8	8

during the Year ending December 31, 1836.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes				8	15	0
General Expenditure:						
Repairs of House	6	0	0			
House Expenses	178	2	4½			
Taxes, Parochial	18	15	0			
——, King's	21	19	8			
				224	17	0½
Insurance				6	0	0
Salaries and Wages:						
Curator and Assistant	181	5	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant	125	0	0			
				381	5	0
Scientific Expenditure				52	17	11
Stationery and Miscellaneous Printing				55	9	2
Investment in the Funds				220	10	0
Tea for Meetings				50	1	9½
Cost of Publications:						
Transactions	537	8	7½			
Proceedings	71	13	6½			
				609	2	2
Award of Wollaston Fund:						
Medal to M. Agassiz	10	10	0			
Award to M. Deshayes	25	0	0			
				35	10	0
Balance in hand Jan. 1, 1837:						
Banker (including 38*l.* 8*s.* 8*d.* Wollaston Fund)	436	0	7			
Accountant	40	0	0			
				476	0	7
				£2120	8	8

We have compared the Books and Vouchers presented to us with these Statements, and found them correct.

January, 31, 1837. *Signed,* R. HUTTON, J. WILLIMOTT, } AUDITORS.

VALUATION *of the Society's Property*; 31*st December* 1836.

PROPERTY.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 38*l*. 8*s*. 8*d*. Wollaston Fund				476	0	7
Arrears due to the Society:						
Admission Fees	119	14	0			
Annual Contributions	484	11	6			
Subscriptions	8	2	0			
Transactions	5	17	6			
Proceedings	1	2	0			
				619	7	0
Estimated value of unsold Transactions	777	13	6			
——— Proceedings	15	0	0			
				792	13	6
500*l*. Stock, 3 per cent. Consols	450	0	0			
550*l*. 18*s*. 7*d*. Stock, 3 per cent. Red.	495	0	0			
				945	0	0
				£2833	1	1

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l*. 1*s*. 1*d*. *in the Reduced 3 per cent. Annuities; the dividends thereof being appropriated to the purposes suggested by the Founder.*]

JOHN TAYLOR, TREASURER.

Jan. 31, 1837.

DEBTS.

	£.	s.	d.	£.	s.	d
Bills outstanding:						
Collector's Poundage	33	16	6			
Taxes	10	0	0			
Scientific Expenditure	7	10	6			
				51	7	0
Cash belonging to the "Wollaston Fund"				38	8	8
Arrears not likely to be received				180	0	0
Balance in favour of the Society				2563	5	5
				£2833	1	1

Estimates *for the ensuing Year*, 1837.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d
Arrears due to the Society, Dec. 31, 1836. (See valuation sheet)				619	7	0
Ordinary Income estimated:						
Annual contributions (170 Fellows)				535	0	0
Admission Fees:						
Residents (25)	157	10	0			
Non-Residents (15)	157	10	0			
				315	0	0
Sale of Transactions				300	0	0
—— Proceedings				10	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends, 500*l.* Consols	15	0	0			
Ditto 1103*l.* 8*s.* 4*d.* 3 per cent. Red.	33	2	0			
				48	2	0
				£1859	19	4

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31, 1836. (See valuation sheet)				51	7	0
General Expenditure:						
Repairs of House	20	0	0			
Taxes	50	0	0			
Insurance	6	0	0			
House Expenses	180	0	0			
Household Furniture	100	0	0			
				356	0	0
Salaries and Wages:						
Curator and Assistant	200	0	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant	125	0	0			
Collector's Poundage	35	0	0			
				435	0	0
Scientific Expenditure				120	0	0
Stationery and Miscellaneous Printing				65	0	0
Tea for Meetings				55	0	0
Cost of Publications:						
Transactions	400	0	0			
Proceedings	85	0	0			
				485	0	0
Arrears not likely to be received				180	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				1779	17	4
Balance in favour of the Society				80	2	0
				£1859	19	4

The Reports having been read, it was resolved:

That these Reports be received and entered on the Minutes of the Meeting; and that such parts of them as the Council may think fit, be printed and distributed among the Fellows.

The President then addressed the Meeting in the following manner:

Gentlemen,

You have just learnt from the Report of the Council that they have this year awarded two Wollaston medals; one to Captain Proby Cautley of the Bengal Artillery, and another to Dr. Hugh Falconer of the Bengal Medical Service, for their geological researches and their discoveries in fossil geology in the Sub-Himalayan mountains. I shall now request one of our Secretaries, Dr. Royle, to take charge of these medals.

The President then addressed Dr. Royle:

Dr. Royle,

It will, I am sure, be most gratifying to you to be intrusted with the care of these testimonials of our regard for two gentlemen with whom you are connected by the ties of private friendship. The Geological Society awards these medals to Capt. Cautley and Dr. Falconer as an expression of the sympathy which they feel for those who are so zealously labouring in a distant country to promote a common cause.

In the Address which I am now about to deliver to this Meeting, I shall have an opportunity of enlarging on the discoveries which these gentlemen have made in a region previously unexplored, at the southern base of the Himalaya between the Sutledge and the Ganges. I shall then speak of their perseverance and industry in examining the structure of the hills, and in collecting the remains of extinct quadrupeds and reptiles, and the talent displayed in their anatomical determination of new species and new types of organization. I shall now merely request that in forwarding these medals, the first which the Geological Society has sent to India, you will express to Capt. Cautley and Dr. Falconer the lively interest which we continue to take in their researches, and our ardent hopes for their future welfare and success.

Dr. Royle in reply expressed the high satisfaction he felt on being requested to take charge of the medals, which it would give him great pleasure to forward immediately to India. When in that country, he had had personal opportunities of witnessing the zeal and enthusiasm with which his friends had laboured, and the great difficulties which they had overcome when far separated from the scientific world, and without museums, books, or skilful naturalists to consult.

He was assured that these marks of attention so honourably conferred by the Geological Society on Capt. Cautley and Dr. Falconer, would not only encourage and stimulate them to fresh exertions, but inspire others among our countrymen in India with a desire to cultivate Geology and its kindred sciences.

It was afterwards resolved :—

1. That the thanks of this Society be given to Sir Philip de Malpas Grey Egerton, Bart., M.P., retiring from the office of Vice-President. Mr. Whewell and Mr. Murchison, by whom this motion was proposed and seconded, felt that they expressed only the sentiment of every Fellow of the Society, in declaring their deep regret at being prevented from including in the motion the name of Dr. Turner, who had been one of the Vice-Presidents, but whose loss the Society had then to deplore.

2. That the thanks of this Society be given to Sir Alexander Crichton, M.D., William John Hamilton, Esq., Viscount Oxmantown, and Lieut.-Col. W. H. Sykes, retiring from the Council.

On the balloting glasses having been duly closed, the scrutineers reported that the following gentlemen had been duly elected the Officers and Council for the ensuing year:—

OFFICERS.

PRESIDENT.

Rev. William Whewell, M.A. F.R.S.

VICE-PRESIDENTS.

Rev. W. Buckland, D.D. F.R.S. & L.S. Professor of Geology and Mineralogy in the University of Oxford.
William Henry Fitton, M.D. F.R.S. & L.S.
George Bellas Greenough, Esq. F.R.S. & L.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.

SECRETARIES.

Robert Hutton, Esq. M.R.I.A.
John Forbes Royle, M.D. F.L.S. Professor of Materia Medica and Therapeutics in King's College, London.

FOREIGN SECRETARY.

H. T. De la Beche, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S.

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F. Baily, Esq. Treas. R.S. F.L.S.
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C. Lyell, jun. Esq. F.R.S. L.S.
Marquis of Northampton, F.R.S.
Sir Woodbine Parish, K.C.H. F.R.S.
Rev. Prof. Sedgwick, F.R.S. L.S.
Henry Warburton, Esq. M.P. F.R.S.

Address to the Geological Society, delivered at the Anniversary, on the 17th of February, 1837, by Charles Lyell, *Jun., Esq., President.*

Gentlemen,

You will have learnt from the Treasurer's Report that the finances of the Society are flourishing, and they would have appeared in a still more prosperous condition, had we not expended above 500*l.* within the year on our Transactions. Part of this sum has already been repaid by the sale of the volume just published, of which I may safely say that it yields to no preceding number in the value of its contents or the extent and beauty of its illustrations.

The total number of Fellows of the Society, exclusive of Honorary and Foreign Members, at the close of the year 1835, was 670; at the close of 1836, 709; being an actual increase, after deducting 14 for deaths, removals, and resignations, of 39 Fellows*.

We have to lament the loss of Dr. Henry, of Manchester, so highly distinguished as a chemist and philosopher, and who took a warm interest in the progress of our science. Our list of Foreign Members has been diminished by two deaths, those of Professor Hoffmann of Berlin, and Baron Férussac of Paris.

Professor Frederick Hoffmann was suddenly cut off in his 39th year, at the moment when the scientific world were impatiently expecting his account of the Geology of Sicily. You are probably best acquainted with him as the author of the great Geological Map of Western Germany, in which he made known the results of many years of patient and accurate research. This Map, published in 1829, was divided into twenty-four sheets, and was followed in 1830 by an Atlas containing sections, and a more general map on a smaller scale of the same country. In the same year the author's Geography and Geology of North-western Germany appeared†, which may be regarded as a commentary on the great map, comprising a descrip-

* The return of the number of Fellows, and the deaths alluded to in this Address, refers exclusively to the year 1836, and not to the period intervening between the last and present Anniversary.

† Orograph. und Geognost. Verhältnisse vom Nordwestlichen Deutschland, 2 vols. Leipzig, 1830.

tion of the physical outline of the country, its mountains, valleys, plains, and river-courses, and a sketch of a portion of its geological structure, embracing the transition and secondary rocks of the Hartz, Thuringerwald, and Lower Rhine. In the larger map all the tertiary and alluvial deposits are represented by one colour, the author having never entered upon the subdivision and classification of these formations. He had studied, however, the newer secondary formations, which were depicted by several distinct colours, and their history would have been included in the work above alluded to, had he not been interrupted by his tour in Italy and Sicily in 1830.

Among his other writings, I may enumerate an Account of Magdeburg, Halberstadt, and the adjoining territory, and various papers which will be found scattered through the journals of Poggendorff and Karsten, the Hertha, and other German periodicals. The only fruits which we as yet possess of the scientific expedition sent by the Prussian Government under Hoffmann's direction to Italy and Sicily, are some letters written by him during the journey, and an excellent Memoir on the Lipari Islands; and a valuable work by one of his companions, Dr. Philippi of Berlin, who published in Latin a detailed account of the recent testacea of Sicily, and the tertiary fossil shells collected in the course of the expedition*.

From Hoffmann's letters it clearly appears that the novelty of the volcanic and tertiary phænomena of Southern Italy and Sicily had made a deep impression on his mind. He had been astonished, on recognising the identity of the modern trap rocks of the Val di Noto with those of ancient date in Germany, and the no less striking similarity of the Sicilian tertiary limestones, containing recent shells to many calcareous secondary formations of northern Europe. The Lipari Islands afforded him a field for the examination of modern igneous rocks, and the slow effects of volcanic heat in modifying aqueous deposits. The picture which he has given of the fumeroles of the western coast of Lipari, the principal island of the group, is graphic and highly instructive. At St. Calogero numerous fissures are seen permeated by heated vapours which are charged with sul-

* Philippi, "Enumeratio Molluscorum Siciliæ tum viventium tum in tellure tertiaria fossilium, quæ in Itinere suo observavit Auctor." 280 pages 4to, and 12 lithographic plates, Berlin, 1836.

phur, oxide of iron, and other minerals, in a gaseous state. Here the tufaceous and other rocks are variously discoloured wherever the steam has penetrated, and are sometimes crossed with ferruginous red stripes, so as to assume a chequered and brecciated appearance. In one place a felspathic lava has been turned by the vapours into stone as white as chalk marl, in another, a dark clay has become yellow or snow-white, and these effects are not limited to a small space, but are seen extending for four miles through horizontal strata of tuff, which rise occasionally to the height of more than 200 feet. The greater part however of the alterations are referred to what are properly called extinct fumeroles, or the action of volcanic emanations which have now ceased, but which must at one period have resembled those of St. Calogero. Some of these have produced veins of fibrous gypsum, calcedony, and opal, minerals which must have been introduced into the rents in a state of sublimation.

In some places there are tufaceous marls, regularly alternating in thin beds, with still thinner and countless layers of granular gypsum, the whole mass being again run through everywhere by irregular branching veins of silky fibrous gypsum. These strata, thus intersected, present a perfect counterpart to some of the secondary gypseous marls, both of the keuper and variegated sandstone formations in Germany*.

When reading the Professor's description of these phænomena, we share in the pleasure and surprise which he felt on comparing strata of high antiquity with others of so recent a date, and which, moreover, owe a portion of that resemblance to changes now daily in progress.

The writings of Baron Daudebard de Férussac were not devoted principally to Geology, but we are indebted to him for several memoirs, and among others for an Essay, published in 1814, on freshwater formations, with a catalogue of the species of land and freshwater shells which were then known to enter into their composition. Monsieur de Férussac contributed largely to the Geological section of the Bulletin Universel des Sciences Naturelles, a journal, of which

* Liparischen Inseln, p. 41. Leipzig, 1832.

he was the chief editor and original projector. This Bulletin had, for its object, to give a monthly analysis or brief abstract, usually unmixed with criticism, of the contents of all new publications in every department of science. The work was first carried on for a year on a smaller plan, and then assumed in 1824 its enlarged and permanent form, being divided into eight sections, one of which was devoted to Geology, Palæontology, and Natural History. A monthly number appeared regularly, on this and each of the other seven sections, the whole forming together a large octavo volume. In the organization and direction of this scheme, the Editor was indefatigable, and he succeeded in obtaining the co-operation of a great number of the most able and eminent writers. In announcing the original aim and scope of the undertaking, he laid stress on the difficulties under which men of science labour in procuring intelligence of new works, written in a great variety of languages in different parts of the world, and frequently buried in the voluminous and costly transactions of learned societies. He therefore expressed a hope that his Bulletin would serve as "a kind of telegraph" for the rapid conveyance of the earliest intelligence of inventions and discoveries, so as to prevent philosophers from wasting their time and money in slowly feeling their way to results already found out by others, and attaining with great labour the very points from which they might have started. The Geological section of the Bulletin was ably supported by MM. Boué, Brongniart, and other writers, and survived the other sections for some time, maintaining itself for seven years, till at length it was given up in 1831 for want of sufficient encouragement.

The works of Baron Férussac on Natural History, and especially Conchology, would deserve from me a fuller notice, if they were not irrelevant to the subject of this address.

HOME GEOLOGY.

I shall now commence my retrospect of the proceedings of the Society, during the last year, by considering those papers which have been devoted to the Geology of the British Isles. There is probably no space on the globe, of equal area, which has been so accurately surveyed as this kingdom; yet the most experienced geologists are now exploring several parts of it with the feeling that they are entering upon terra incognita. Not only do they find it necessary to trace out more correctly the limits of formations previously known, but also to introduce new groups of fossiliferous strata and new divisions, in districts before supposed to have been well investigated.

The carboniferous deposits which are alike interesting, in a scientific and economical view, have deservedly occupied of late the particular attention of many able geologists, and we have received communications on the subject from Mr. Murchison, Mr. Prestwich, Professor Sedgwick, and Mr. Peile. The observations of Mr. Prestwich relate to the coal-measures of Coalbrook Dale, and the formations immediately above and below them, together with the accompanying trap-rocks.

There is perhaps no coal-field in the whole country of equal size in which the strata have been so much dislocated and shattered. Mr. Prestwich gives a detailed description both of the principal and minor faults, their direction, extent, inclination, breadth, and fall, and the difference of level produced by them in their opposite sides, which is sometimes slight, but sometimes amounts to 600 or 700 feet. In some instances the change of level is by steps or hitches, which, it is truly said, may be owing either to unequal resistance, or to a series of small dislocations. The walls of the fissures in the disjointed strata are sometimes several yards apart, the interval being filled with the debris of the strata. In other places they are in contact. In this last case it is particularly remarked that the surface of the ends of the fractured beds of coal and shale is shining and striated. You are aware that this appearance has usually been attributed, and I believe rightly, to the rubbing of the walls of the rent one against the other, the lines of the polished and striated surfaces indicating the direction of the motion, but I have lately seen it objected to this theory, that the striæ are not always parallel, but often curved and irregular, and that the earthy contents of veins and faults often present the same glittering and striated faces, or slickensides as they have been called. I am familiar with the fact, and have always inferred that the movements were irregular and complicated, occasionally changing their direction, and that even when uniform, they may have acted unequally on materials varying in hardness and pliability. It is much to be desired that scientific travellers who visit countries shaken by earthquakes would observe with minute care all the phenomena attending the fissuring of rocks and buildings. I have been informed by an eye-witness of one of the late minor earthquakes in Chili, that the walls of his house were rent vertically, and made to vibrate for several minutes during each shock, after which they remained uninjured and without any opening, although the line of the crack was still visible. On the floor, at the bottom of each rent, was a small heap of fine brickdust, evidently produced by trituration. In such instances it would be desirable to obtain fragments of the rent building, and to compare them with the walls of natural fissures.

In his examination of the fossils of the coal-measures, Mr. Prestwich has shown that beds containing marine remains alternate with others in which fresh-water shells and land plants occur, appearances which he attributes to the flowing of a river, subject to occasional freshes, into the sea, rather than to repeated changes in the relative level of land and sea.

It is certainly the safer course to incline to this hypothesis whenever there are no unequivocal signs, as in the Purbeck strata in Portland, of land plants having become fossil on the very spots where they grew. For although there may be many river deltas like that of the Indus, where the land is subject to be alternately upheaved above, and then let down below the waters of the sea, yet such oscillations of level must be considered as exceptions to the general condition of the earth's surface near the mouths of rivers at any given period. Even in a case like the delta of the Indus, both the causes above alluded to may be expected to cooperate in producing alternate fluviatile and marine strata; for in the long intervals between great movements of the land, the river will annually advance upon the sea with its turbid waters, and then retreat again as the periodical flood subsides, and the salt waters, after being driven back for a time, will reoccupy the area from which they have suffered a temporary expulsion.

In the conclusion of his valuable paper, Mr. Prestwich observes that the carboniferous strata of Coalbrook Dale must once have been entirely concealed under a covering of new red sandstone, and they owe their present exposure partly to those movements which have shattered and elevated the coal measures, and partly to extensive denudation. It is natural therefore to inquire how many other coal-fields may still lie buried beneath the new red sandstone of the adjoining district.

In relation to this point of great practical importance, Mr. Murchison formerly offered some conjectures, when speaking of the probable passage of the 10-yard coal of the Dudley field beneath the new red sandstone, which there flanks it on the east and west. That geologist now informs us that his conjectures have been verified, and that at Christchurch, one mile beyond the superficial boundary of the coal-field, the 10-yard and other seams have been reached by borings carried down to the depth of nearly 300 yards. Adverting to this discovery, he directs attention to the possible extension of other carboniferous tracts beneath the surrounding new red sandstone of Shropshire, Worcestershire, Staffordshire, and other central counties.

It is clear that these geological considerations must be duly weighed by those who speculate on the probable future duration of British coal, according to the actual or any assumed rate of consumption.

Mr. Murchison, in describing the Dudley and Wolverhampton coal-fields, informs us that he has not yet found any fossil remains of decidedly marine origin, like those observed by Mr. Prestwich in Coalbrook Dale. The shells seem to be all of fresh-water genera, and the *Megalichthys Hibberti*, and other fish occurring at Dudley, of species identical with those of the coal measures of Edinburgh, may have inhabited fresh water.

The same author has coloured on an Ordnance Map the superficial area of the Silurian rocks connected with the coal-fields above mentioned, and has shown that the Lickey quartz rock between Bromsgrove and Birmingham, of which the geological position has remained hitherto uncertain, is in fact nothing more than altered Caradoc sandstone, a member of the lower Silurian group. The same appears as a fossiliferous sandstone in one district, while in another, it passes into a pure quartz rock, a modification attributed to the proximity of underlying trap, for analogous changes have been seen at neighbouring points where the absolute contact of the sandstone with the trap is visible.

We are also indebted to Mr. Murchison for some interesting remarks on the dislocations of the strata in the neighbourhood of Dudley, and particularly for a description of some dome-shaped masses, from the centre of which the beds have a quâquâversal dip. He speculates on the probable dependence of these phænomena upon the protrusion of volcanic matter from below, at points where it has been unable to find issue. It would, I think, have been more satisfactory, if, in confirmation of his theory, some natural section of one of these dome-shaped masses could be pointed out, where not only a nucleus of trap was apparent, but could be shown to have taken up its actual position in a soft or fluid state. Even if we should find in some instances a subjacent central mass of trap, porphyry or granite, not sending out veins or altering the strata, the folding of the beds round such a protuberance might admit of an explanation like that suggested by Dr. Fitton. He has supposed a set of yielding horizontal strata to be pressed upon by a subjacent hill or boss of hard rock, in which case the effect of upward pressure might resemble that seen, on a small scale, in the paper of a bound book, where a minute knob in one leaf has imparted its shape to a great number of other leaves without piercing through them*. Whatever hypothesis we favour, it is essential to observe that such hills as the Wren's Nest near Dudley, and others of similar ellipsoidal forms and internal structure, do not correspond to the type of volcanic hills, such as Etna, Mount Dor, or the Cantal. In both cases there may be an approach to a cone, and the beds may dip everywhere outwards from a common centre; but, in the volcanic mountain, the beds having an outward dip, thin off as they approach the base or circumference of the cone, which is not the case in inclined beds composing the hills alluded to in the neighbourhood of Dudley: nor in the last-mentioned instances do the lowest or subjacent rocks crop out round the circumference of the cone, as happens in the instance of the volcanic eminences before alluded to, where the granite of the country round Mount Dor, the fresh-water beds and mica schist in the Cantal, the marine deposits around Mount Etna in Sicily,—each appear at the surface as soon as we have left the slope of the cone, and advance upon the surrounding low country.

* Dr. Fitton, Geol. Trans. 2nd Series, vol. iv. p. 244.

In attempting to explain the principal transverse faults of the Dudley coal-field, Mr. Murchison refers frequently to the theoretical principles expounded by Mr. Hopkins in his Researches in Physical Geology, a paper printed in the 6th volume of the Transactions of the Cambridge Philosophical Society. Mr. Hopkins has there endeavoured to develop, by reasoning founded on mechanical principles, and by mathematical methods, the effects of an elevatory force acting simultaneously at every point, beneath extensive portions of the crust of the earth. He is aware that in nature such a force must usually act under complicated conditions, so as to produce irregular phænomena; but he observes that in order to have a clear conception of the manner in which it would operate in producing movements and dislocations, it is useful to assume certain simple conditions to which mathematical investigations may be applied. When we have deduced in this manner some results free from all uncertainty, these may serve as standard cases to which the geologist may refer more complex problems. Thus for example, a portion of the earth's crust may be assumed to be of indefinite length, of uniform depth, and bounded laterally by two vertical parallel planes, beyond which the disturbing force does not extend. It is then supposed that a quantity of subterranean vapour or melted rock, existing at a certain depth, is expanded by heat so as to elevate the superincumbent mass, the resulting fissures in this mass may then become matters of calculation. According to Mr. Hopkins, rectilinear lines of dislocation will give rise to a set of longitudinal parallel fissures, and simultaneously to others precisely at right angles to them; whereas in conical elevations, the fissures will diverge from a centre. If the general axis of elevation be curvilinear, the longitudinal fissures preserving their parallelism with it will be also curvilinear, while the transverse fissures being perpendicular to the former at their points of intersection will no longer be parallel.

To return from this digression, I must now recall your attention to other papers relating to the carboniferous deposits of England. The coal-measures of the north-western coast of Cumberland have been examined by Prof. Sedgwick and Mr. Williamson Peile, who have described the Whitehaven and other fields in great detail, illustrating their account with a map and sections. The recorded observations in numerous sinkings and borings, both in relation to the succession of the strata and to the complicated faults which intersect them, would have been involved in hopeless confusion, if they had simply consisted of a statistical collection of facts attested by miners; but in this paper, Professor Sedgwick, aided by Mr. Peile's practical and scientific knowledge, has compared the different sections and generalized the phænomena, giving unity and consistency to the whole, throwing the strata into distinct groups, and referring the several faults to different movements to which successive periods of time may be assigned.

In connection with these recent contributions to the history of our carboniferous strata, I am happy to mention the excellent volume lately published by Professor Phillips, forming the second part of his Illustrations of the Geology of Yorkshire. It is almost entirely devoted to a description of the carboniferous or mountain limestone of Yorkshire and the North of England, a subject already admirably treated in some papers read before this Society by Professor Sedgwick, particularly in his account of the carboniferous chain from Penigent to Kirkby Stephen*. As these geologists had separately explored the same ground, it is satisfactory to perceive that the leading divisions which they have proposed for the classification of the mountain limestone and associated strata, agree in every essential point. Mr. Phillips has described the physical geography of the district occupied by these rocks, their lithological character, stratification, jointed structure, and the most remarkable faults which affect them, especially those which have been called the great Penine and Craven faults. He also treats of the trap dykes which cut through the limestone, and discusses the probable epochs of the displacement of the strata, judiciously pointing out the difficulties unavoidably opposed to the rigorous determination of the date of such dislocations. A large and very valuable portion of the work is filled with descriptions and plates of organic remains, especially of the brachiopodous and cephalopodous mollusca. Most of the species of these classes were probably inhabitants of the deeper parts of the sea, but there are fossil shells in the mountain limestone, which the author supposes

* Trans. Geol. Soc. 2nd Series, vol. iv. part 1. p. 69.—1835.

to have lived near the shore, and belonging to genera formerly regarded as foreign to the carboniferous limestone, such as Isocardia, Nucula, Pecten, Patella, Turritella, and Buccinum. Many species of Zoophytes and Crinoidea are also described and figured in this excellent monograph.

We are indebted to Mr. Austen for a description of the South of Devonshire between the river Ex and Berry Head, and between the coast and Dartmoor, a district consisting of transition rocks, new red sandstone, greenstone, and trap. His speculations on the origin of the different formations and the causes which gave rise to the existing features in the physical geography of the country display much talent and are full of instruction.

The structure of Devonshire has also furnished a fertile field of inquiry to Messrs. Sedgwick and Murchison since our last Anniversary. They have attempted the difficult task of establishing a classification of the older rocks so largely developed in that county. In every geological map hitherto published of Devonshire, all the stratified deposits of higher antiquity than the new red sandstone had been represented by one common colour, the limestones being all included as integral parts of one great formation called greywacke*. But these gentlemen, after examining this region, announced at Bristol to the geologists assembled at the Meeting of the British Association, that the great mass termed greywacke, and previously undivided, comprised in it several formations of great thickness, ranging in age from the Cambrian system of Professor Sedgwick up to the true carboniferous series inclusive. The first groups mentioned by them in ascending order are the Cambrian and Lower Silurian, which great mass contains many distinct courses of limestone; and is separable into several formations, distinguishable from each other by stratigraphical position and by lithological and zoological characters.

There appears, however, to be a great hiatus in the succession of rocks in Devonshire, as compared to South Wales, there being no

* The Abstract of the Report of Messrs. Sedgwick and Murchison, published with a section in the Athenæum, August, 1836, and in other scientific journals, is the same as that written for insertion in the Proceedings of the Association. From that document, and from a written explanation of their views, which I obtained from the authors, the present observations are deduced.

traces of the upper Silurian strata, nor of the old red sandstone, nor even of the mountain limestone in its ordinary aspect. On the contrary, the next group met with in ascending order, is a culmiferous series, the base of which distinctly reposes upon the above-mentioned ancient rocks. This culmiferous deposit, far from appearing as a mere band, or at detached points, occupies about one third of the large county of Devon, and a considerable adjacent part of Cornwall; its southern boundary ranging from Exeter on the east, by Launceston, to St. Gennis in Cornwall on the west; its northern frontier running by Barnstaple and South Moulton to near Wellington in Somersetshire. These culmiferous beds are shown to contain thick beds of limestone, entirely dissimilar in structure and fossil contents from any limestones of the underlying "grauwacke," in which they had previously been merged. The culm measures consist of grit, sandstone, shale and limestone; and these rocks, it is said, are never affected by a slaty cleavage like the lower Silurian and Cambrian rocks on which they rest. From this character, as well as from their prevailing mineralogical structure and imbedded fossil plants, the authors regard the culmiferous formation of Devon as perfectly identical in age with other coal-fields, and as more particularly analogous to the culm-bearing strata of Pembrokeshire; a part of which also once passed for "grauwacke," but Mr. Murchison has recently shown that it belongs to the South Welsh coal-field, which is known by all geologists to rest upon mountain limestone.

Thus referred to the age of our ordinary coal, these strata of North Devon are further proved to lie in a great trough, their southern edges being turned up against the granite of Dartmoor, where they acquire, in contact with the granite, when traversed by elvan dykes, many characters of the metamorphic rocks, or those commonly termed primary. The phænomena of interference and alteration at the junction are such as to give a comparatively modern date for the eruption of the Dartmoor granite, and to explain why so much difficulty and ambiguity has prevailed in determining the age of some of the altered culm beds.

Among other points which this survey of Professor Sedgwick and Mr. Murchison has settled, so far as Devon is concerned, is one of the highest theoretical interest, and on which for more than two years the Society has been anxiously desiring more accurate information; I allude to the true stratigraphical position of certain shales near Bideford in North Devon, containing fossil plants of the same species as those which are found abundantly in the coal. I may first remind you that a discussion had previously arisen respecting the alleged discovery by Mr. Weaver of anthracite, with the usual carboniferous plants, in the greywacke or transition rocks of Ireland*. Notwithstanding the value justly attached to the opinion of so experienced and long-practised an observer, your Council hesitated to print his statement, and requested him to reexamine the ground. At the same time Mr. Griffiths, to whom we are looking for the publication of a Geological Map of Ireland, had come to a different conclusion, and Mr. Weaver having been induced to repeat his observations, became convinced that he was in error, and has since studiously availed himself of every opportunity of announcing this change in his views.

You are aware that as yet in the British islands, scarcely any vegetable impressions have been met with in rocks more ancient than the carboniferous strata above the old red sandstone, so that we know not what species of plants belong to the greywacke or transition group. We can only presume from analogy that since the shells, corals, and other organic remains of that ancient group differ from those found above the old red sandstone, the plants also, if ever discovered, will differ as greatly. Considerable surprise was therefore excited when, during the Presidentship of my predecessor in this chair, a letter was read, addressed to him from Mr. De la Beche, stating that he had found, near Bideford in North Devon, many well known coal plants in the lower greywacke, or far down in the transition series†. Such of the plants as were determinable had been identified by Professor Lindley with species characteristic of the true coal measures, and which had never been found elsewhere below the coal. The anomaly, therefore, in the supposed position of these fossils was so great, that between the ordinary geological site of such remains, and that in which they were here inferred to present themselves, there would be interposed if the series were complete the whole of the old red sandstone, and at least the two upper forma-

* Proceedings Geol. Soc., vol. i. p. 231.

† Proceedings Geol. Soc., vol. ii. p. 106.

tions of the Silurian system. When this point was considered, I expressed to the Society my opinion, in common with Mr. Murchison, as to the insufficiency of the proofs relied on by our Foreign Secretary, and we felt that we had a right to call for more conclusive evidence. The simple fact of shales having been found charged with true coal plants, raised so strong a presumption in favour of their belonging to the regular carboniferous series, that the burthen of proof rested with him who wished to assign to them either a higher or lower position. Our scepticism was regarded by Mr. Greenough as implying too marked a bias for a preconceived theory, and this he afterwards hinted in his Anniversary Address*. I may affirm, however, that in the first place it implied on my part no distrust of Mr. De la Beche's skill or experience in geological surveying, and that had Professor Sedgwick and Mr. Murchison advanced a similar opinion on analogous proofs, I should equally have withheld my assent. Suppose, for example, they had announced to us that they had found fossil fruits and leaves identical with those of Sheppey in strata of the age of the white chalk with flints. I should have demanded from them, in corroboration, the most clear, unequivocal, and overwhelming evidence. If it were a region of disturbed and vertical strata, I should expect them first to have resorted in vain to every hypothesis of inverted stratification with a view of explaining away such an exception to the general rule.

I might perhaps be told that we are unacquainted with the flora of the upper cretaceous period, and I admit that we are as ignorant of it as of that which belonged to the transition period, but when we consider the contrast of the shells and other fossils of the chalk and London clay, we naturally anticipate that if plants are ever found of the precise age of our chalk with flints, they will not prove to be of the same species as those of the Sheppey clay. There is a like presumption from analogy against the conclusion that the same vegetation continued to flourish on the earth from the period of the lower greywacke to that of the coal, because we know that in the course of the intervening epochs the testacea, zoophytes, fish, and other classes of organic beings were several times changed.

In regard to the proofs relied on by Mr. De la Beche, I should observe that he never attempted to show that the plant-bearing

* Proceedings Geol. Soc., vol. ii. p. 164.

shales at Bideford were interstratified with rocks charged with shells or other fossils known to belong to rocks older than the old red sandstone.

Since writing the above sketch of the different views recently published of the structure of Devonshire, I have received a letter from Mr. De la Beche, from which I am happy to learn, that it is his intention before concluding his report on the Ordnance Map of Devon, to reexamine Devonshire. He is far, he says, from pretending that his first views were perfect, and if he finds reason to modify any of them, he shall not hesitate to announce the change of opinion. In the mean time he no longer contends that the culmiferous strata are referable to the lower greywacke, and considers the point of difference to lie within a narrower compass, namely, whether the culm beds are to be considered as upper greywacke or coal. This question, on which he is not yet satisfied, evidently appears to him of much less theoretical importance than, I confess, it does to me. It is fair, however, that I should state the arguments which influence his mind. If the plants, he says, found at Bideford in the culmiferous series should belong to strata more ancient than the old red sandstone the fact would not stand alone, for he has lately received a letter from M. Elie de Beaumont, detailing analogous phænomena in Brittany. It is stated that the greywacke there closely corresponds in general character with that of Devon, the upper part like the Devonian series containing anthracite. With this anthracite or culm are found at Montrelais, Chatelaison, and other places, fossil plants, the greater part of which are identical with those in the coal measures; but there are others which have not hitherto been detected in the latter rock. Patches of true coal measures rest in unconformable position upon these upper greywacke beds of Brittany. Now I regret that I have not seen any printed account of the geology of this part of France; for until we learn whether the plants in question are associated with true Silurian fossils, the testimony is quite incomplete. We know not, for instance, whether the plant-bearing series in question is old red sandstone or a Silurian formation, or whether it is a lower part of the true carboniferous system of which the strata had been disturbed before a higher portion was superimposed.

Similar remarks hold in regard to the observations made by

M. Virlet in the Dictionnaire d'Hist. Naturelle, where in his late article " De l'Origine des Combustibles Minéraux," he speaks of certain carboniferous deposits of Ireland, (those alluded to by Mr. Weaver before mentioned,) as well as others examined by M. Voltz in the Black Forest, also the culm beds of Brittany, and those of the department of La Sarthe, as all belonging in age to the newest transition formations, " *terrains de transition les plus récens.*"

Mr. De la Beche alludes to another discovery of coal plants implying as great an anomaly as that which he had imagined to occur in Devonshire, and by which he was himself once led into error during an Alpine excursion, about eighteen years since, when he met with coal plants in the schists of the Col de Balme, in Switzerland. He then inferred that the beds belonged to the true coal measures, but M. Elie de Beaumont afterwards proved them to be lias; that is say, he identified them with other rocks not far distant in the Alps, which were shown to be lias by containing Belemnites and other fossils. Mr. De la Beche was at first sceptical on the point, but after revisiting the Alps, he came round to the same opinion. Having therefore been in one instance misled by relying on the fossil vegetables of the coal as affording a good chronological test, he naturally attached but small value to the same testimony as a criterion of the age of another set of rocks in Devonshire. Now you will easily understand that a geologist, who is once persuaded that the same plants flourished in European latitudes from the period of the true coal to that of the lias, will be ready to concede without difficulty the probable existence of the same plants at an era long antecedent to the coal. We know that between the deposition of the coal and the lias there were successive revolutions in the races of animals which inhabited the waters, the zoophytes, mollusca, fish, and, as far as we know them, the reptiles having been changed again and again; so that the fossils of the mountain limestone differ from those of the magnesian limestone or zechstein, these again from the organic remains of the muschelkalk, and these last from those of the lias. If we are to believe that the same plants survived on the land, while such fluctuations in animal life occurred in the waters, why should we not imagine the longevity of the same species to have been still greater, so that they began to exist even before the deposition of the old red sandstone? But let me remind you that botanists have been led to very different conclusions respecting the laws governing the distribution of fossil vegetables from the study of undisturbed districts. You are not ignorant that the strata of the Alps are involved in extreme confusion and complexity, mountain masses having been completely overturned and twisted, so that the same set of strata have been found at the top and bottom of the same section separated by several thousand feet of beds belonging to an older formation. So obscure is the order of position in Alpine geology, that the cretaceous and greensand series have been classed by experienced geologists as more ancient than the oolite, under which, in point of fact, they occasionally lie.

Professor Studer, in his work on the Bernese Highlands, after years of personal investigation, has published a map in which he has given a coloured ground plan without venturing to commit himself by sections, or a table of the regular order of superposition.

After devoting a summer to the investigation of the same portion of Switzerland, with the advantage of Mr. Studer's map and work, I was unable to satisfy myself that I had found a key to the classification or superposition of the formations, so enormous is the scale on which they have been deranged. I collected fossil plants on the Col de Balme, but I have not examined the precise localities further to the west appealed to by M. de Beaumont. I am far, therefore, from denying his facts or inferences, hoping at some future period more carefully to inquire into the evidence on the spot. No one, I am aware, is more desirous that others should visit the southern Alps and verify or criticise his facts than M. de Beaumont. Meanwhile I am reminded of an expression of our mutual friend M. von Buch. When I related to him some geological phænomena which surprised him; "I believe it," he said, "because you have seen it, but had I only seen it myself, I should not have believed it."

But to conclude, and to recall your attention to the structure of Devonshire, you will perceive that Mr. Murchison and Professor Sedgwick have endeavoured, and I think successfully, to work a great reform in the classification of the ancient rocks of that country, by applying to them the arrangement which they had previously made for the deposits termed by them Cambrian and Lower Silurian in Wales and the adjoining parts of England. According to their survey and sections the coal plants of Bideford, so far from constituting any anomaly, so far from affording any objection to the doctrine that particular species of fossil plants are good tests of the relative age of rocks, do in reality from the place which they occupy, confirm that doctrine; for the culmiferous rocks distinctly overlie the so-called grauwacké, and are not referable to any of the well defined and normal types, which compose the old Red Sandstone and Silurian System.

I shall now pass on to the consideration of other memoirs on English Geology. The limestone which the Germans call muschelkalk, and the numerous fossils which are peculiar to it, have not yet been detected in England in any part of that great series of beds which intervene between the lias and the coal. In those parts of Germany where it occurs, it divides the beds of red marl and sandstone which occupy that great interval into two divisions, the upper of which is called keuper, and the lower bunter sandstein. In the absence of the muschelkalk in this country, it has been impossible for us to separate our new red sandstone into two well defined masses; but Dr. Buckland considers that certain portions of the upper beds in Warwickshire and elsewhere may be identified with the keuper by their mineral character, and near Warwick by the remains of a Saurian, which he believes to be of the genus Phytosaurus, a genus characteristic of the keuper of Wirtemberg.

An examination in the South-east of England of the strata usually termed plastic clay, has led Mr. John Morris to offer several new, and as they appear to me, judicious suggestions in regard to the classification of these beds. It is well known that wherever the tertiary strata are seen in immediate contact with the chalk, they consist of alternations of sand, clay, and pebbles, and in some few places a calcareous rock,—all these varying greatly in their thickness, and in their order of succession in different places. Mr. Morris divides those of Woolwich into two parts, and states that the upper is characterized by a mixture of marine and freshwater shells, the freshwater genera being Cyrena, Neritina, Melanopsis, and Planorbis. The lower division contains exclusively marine shells. The author refers this intermixture to the influx of a river into the sea, in which the London clay was formed. Mr. Morris considers the Bognor strata, which rest immediately upon chalk, as the equivalents of the lower Woolwich deposit, observing that the shells agree with those of the London clay. These remarks seem to confirm the conclusion to which he had been previously led by the grand section at Alum Bay in the Isle of Wight, namely, that the beds usually styled plastic and London clays belong to one zoological period.

MINERAL VEINS.

Your attention has been called to the origin of mineral veins by Mr. Fox, who has endeavoured to explain why so large a proportion of the metalliferous veins in England and other parts of the world should have an east and west direction. He supposes fissures filled with water, containing sulphurets and muriates of copper, tin, iron, and zinc in solution, through which currents of voltaic electricity are transmitted. The metals separated from their solvents by this action are deposited in the veins, and most abundantly in veins running at right angles to the direction of the earth's magnetism; for as the magnetic currents of the earth pass from north to south, they cause those of electricity to move east and west, although considerable deviations from this direction must be occasioned in the course of geological epochs by variations in the magnetic meridian.

Since Mr. Fox first ascertained the existence of electric currents in some of the metalliferous veins in Cornwall*, Mr. Henwood has made many experiments on the same subject, together with observations on the distribution of metallic and earthy minerals in veins. He considers the results obtained by him to be in a great degree opposed to the theory of Mr. Fox†.

Mr. Fox conceives the fissures in which metalliferous substances occur, to have been at first small and narrow, and to have increased gradually in their dimensions. This doctrine has also been propounded in a work with which you are probably familiar, and from which I have derived much instruction, I mean M. Fournet's Essay on Metalliferous Deposits. This Essay was originally included in the 3rd

* Phil. Trans. 1830, p. 399.

† See Mining Journal, Supplement 9. p. 34, December 1836, and Annals of Electricity, No. 2. vol. i. on Electric Currents, &c. by W. T. Henwood Esq.

volume of M. Burat's continuation of D'Aubuisson's Treatise on Geology (1835), but it is now published separately, and gives the clearest general view which I have seen of the application of geological theories to phænomena observed in mining. It is written by one who has acquired much practical knowledge as a miner, and who is well versed in chemistry and mineralogy*.

Werner, when he published his justly celebrated Essay on Mineral Veins, had come to the conclusion that the same rent, after being wholly or partially filled, has sometimes been reopened; and M. Fournet has endeavoured more fully to explain the successive dilatation of the same veins at distinct periods. He has given examples in mines worked under his direction in Auvergne, in which the sulphurets of iron, copper, lead, and zinc, besides quartz, barytes, and other minerals, seem evidently to have been introduced at different periods by chemical action accompanied by new fractures and dislocations of the rocks, and the widening of preexisting fissures†.

You will find in M. Fournet's treatise a copious analysis of a great variety of books on mining, besides a detail of facts which have fallen under his own observation. He has described first those veins which are decidedly connected with rents produced in rocks by mechanical movements, and which are supposed to have been chiefly filled from below by sublimation, more or less obviously connected with volcanic action. He afterwards passes on to the consideration of those masses which have been called stockwerks by the Germans, which are imagined by some to have their origin in the contraction of granite, porphyry, and other rocks as they cooled, numerous rents being then formed, in which metallic particles were concentrated. In treating the subject in this order the author appears to me to have followed the most philosophical course, beginning with cases of undoubted rents of mechanical origin filled with minerals and metals introduced by sublimation, and then carrying with him as far as possible the light derived from these sources to dissipate a part of the obscurity in which all theories respecting the nature of Plutonic rocks and their minerals must, I fear, be for ever involved. Much will still remain unexplained; but

* Etudes sur les Dépots Métallifères, par M. I. Fournet.

† See "Etudes," &c. Section 3.

those who proceed in an opposite direction often throw doubt and confusion upon the simplest phænomena, as has sometimes happened in an analogous case, when geologists have begun with the examination of granite and granite veins, and have then endeavoured to apply the ideas derived from this study to the trap rocks and volcanic dykes.

Among the most interesting conclusions deduced by M. Fournet from his examination of the mining districts of Europe, I may mention the modern periods at which the precious metals appear to have entered into some veins: thus, to select a single example, some veins of silver of Joachimsthal in Bohemia are proved to have originated in the tertiary period*.

FOREIGN GEOLOGY.

Among the researches into the geology of foreign countries in which our members have been recently engaged, I have great pleasure in alluding to the labours of Mr. H. E. Strickland and Mr. Hamilton in Asia Minor. These gentlemen first examined the neighbourhood of Constantinople, and found on both sides of the Thracian Bosphorus an ancient group of fossiliferous strata, consisting of schist, sandstone, and limestone. From the character of the fossils it is inferred that these rocks may probably be the equivalents of the upper transition or Silurian strata of England. The shells belong to the brachiopodous genera Spirifer, Producta, and Terebratula, with which the remains of corals and Crinoidea were associated, and fragments of a Trilobite.

The rarity of any fossiliferous deposits of higher antiquity than the old red sandstone in any of the countries bordering the Mediterranean, or indeed to the south of the Alps and Pyrenees, lends considerable interest to this observation. In their way through France, our travellers examined the well known region of extinct volcanos in Auvergne, and afterwards found a counterpart to it in the Catacecaumene, a district in Asia known by that name in the time of Strabo, from its burnt and arid appearance. Some of the volcanos in Asia are of very modern appearance, although no notice of their eruptions falls within the limits of history or tradition. The vol-

* See "Etudes," &c. Section 2.

canic hills rise partly through lacustrine limestone in the Valley of the Hermus, and partly cover the slope of the schistose hills which bound it to the south. There are about thirty older cones, worn by time, and of which the craters are effaced or only marked by a slight depression; and three newer cones, which preserve their characters unaltered, the craters being perfectly defined and the streams of lava still black, rugged, and barren. Here, as in the country of corresponding structure in France, we find streams of lava following the course of existing valleys, and yet frequently cut through by rivers. We find also a tertiary freshwater formation, sometimes resembling chalk with flints, like that of Aurillac in France, and forming detached hills capped with basalt, while more modern lavas have flowed at the base of the same hills. The extent of this analogy will be best appreciated by those who compare Mr. Strickland's drawings with Mr. Poulett Scrope's masterly illustrations of the French volcanic region.

The countries watered by the rivers Meander and Cayster are described as having a simple geological structure. There are granitic rocks, with saccharine marble, there are also hippurite limestone and schist, and tertiary deposits unconformable to these, besides igneous rocks of various ages. The tertiary formations are chiefly lacustrine, and occur in nearly every large valley. They are composed of horizontal beds of calcareous marl and white limestone, in which are layers and nodules of flint; they also consist of sandstone, sand, and gravel.

The only representative of the secondary rocks of Europe is termed by Mr. Strickland "hippurite limestone", which appears to be very sterile in fossils. In this respect and in its other characters it agrees with that great calcareous formation described by MM. Boblaye and Virlet in their splendid work on the Geology of the Morea*. According to these French geologists, three quarters of the Peloponnesus are occupied by a compact limestone several thousand feet thick, in which they could discover scarcely any organic remains, except a few hippurites and nummulites, but which is supposed to be the equivalent of our chalk and oolites. Nothing,

* Paris, 1833, in folio. It is to be regretted that this work cannot be procured separately from other folios containing the scientific information collected during the French expedition to the Morea.

they say, can be more monotonous in character than this calcareous mass in the South of Europe, which appears to represent the larger part of our upper secondary formations of the North, where the rocks are so varied in lithological aspect and so distinguishable from each other by their well preserved fossils.

Ancient fossiliferous strata resembling those of the neighbourhood of Constantinople are said to be largely developed in the Balkan, a mountain chain of which we may soon expect to receive information from the pen of M. Ami Boué. That indefatigable geologist has already explored a large part of Servia, a country of whose physical and moral condition we are perhaps more ignorant than of any other in Europe, and he is rapidly extending his survey over various parts of the Turkish empire, to the examination of which he proposes to devote several years. Meanwhile our late Secretary, Mr. Hamilton, is continuing, with great zeal, his investigation of the borders of the Black Sea and other parts of Asiatic Turkey.

In a paper on the structure of part of the Cotentin near Cherbourg, the Rev. W. B. Clarke describes that country as consisting of hills or ridges of quartz rock alternating with valleys of slate occasionally associated with syenite and greenstone, which appear to be of posterior origin. A curious fact is mentioned: the quartz rock splits naturally into irregular masses, which have, nevertheless, some angles of fixed dimensions, namely, 103°, 64°, and 83°. Fragments of a green variety of schist exhibit the same angles under the same circumstances of position, proving that similar causes had acted on the two formations *en masse*, the same sets of joints, lines of stratification, and cleavage being found in both. Besides these facts, which are illustrated by diagrams, the author mentions others calculated to throw light on the cleavage and jointed structure of rocks.

PROOFS OF MODERN ELEVATION AND SUBSIDENCE.

Under this head I shall first consider several notices of beds of gravel, sand, clay, and marl, containing recent marine shells, which have been observed in various parts of Great Britain, a subject very frequently brought before our notice of late years. Deposits of this kind have been found by Dr. Scouler in the vicinity of Dublin, where they rise to the height of 80, and in some places of even 200 feet above the level of the sea. Besides marine shells of existing species, he has ascertained that some of the lower beds of this formation contain bones of the extinct Irish elk, by which we learn that this quadruped, although belonging to a comparatively modern period, and found in peat-mosses, had nevertheless begun to inhabit this part of the world at a period anterior to some of the last changes in the position of land and sea, changes which are proved by the upraised shelly beds just alluded to. Now Professor Nilsson of Lund in Sweden, although ignorant of these facts, had remarked to me that some great alteration must have occurred in the shape and extent of dry land and sea in Great Britain and the surrounding parts subsequently to the time when the Irish elk existed, otherwise so many entire skeletons of so large an herbivorous quadruped as the *Cervus megaceros*, would not have been found in so small an island as the Isle of Man. That island may at no remote geological period have been united to the main land, and may have since been separated from it by subsidences, on a scale equal to the elevations of which there is such clear evidence in Ireland and elsewhere.

Changes in the relative level of land and water, in the estuary of the Clyde, are indicated by facts described in another paper by Mr. Smith of Jordan Hill, near Glasgow. Superficial deposits, in which a great number of marine shells of recent species are imbedded, are found on the banks of the Clyde below Glasgow, at the height of 30 or 40 feet above the sea. I had myself an opportunity of verifying during the last summer several of these observations of Mr. Smith, and found equally clear proofs that the Island of Arran had participated in the upward movement, so that a circle of inland cliffs may be traced all round that island, between the base of which and the present high-water mark a raised beach occurs, and in some places beds of marine marls, formed of recent shells, as in the bay of Lamlash. Mr. Smith has also traced sea-worn terraces on each side of the Clyde below Dumbarton and between the Cloch Lighthouse and Largs.

We are indebted to Sir Philip Egerton for some new details respecting the shelly gravel of Cheshire, of which he had previously treated; and to Mr. Murchison and Professor Sedgwick for a joint-paper on "a raised beach in Barnstaple Bay on the north-west coast of Devonshire." This beach puts on for several miles where it is best exposed, the form of a horizontal under terrace resting upon an indented and irregular surface of the older formations. It presents a cliff towards the sea, in which beds of calcareous grit, sandstone, and shingle are seen perfectly stratified. The bottom of the deposit is chiefly composed of indurated shingles resting on the ledges of the older rocks, and filling up their inequalities. Through the whole cliff, but especially in the indurated grits, shells are abundantly dispersed, identical in species with those now living on the coast, and well preserved, though sometimes waterworn.

The authors point out that these beds cannot have been formed by accumulations of blown sand. They demonstrate an elevation of the coast during the modern period; and there are phænomena both on the north and south coasts of Devonshire and Cornwall, which afford proofs of modern changes in the level of the land, both of upheaval and depression. The raised beach of Hope's Nose, correctly described by Mr. Austen, is the most striking instance in South Devon.

The quantity of rise of land in the modern period is from ten to forty feet in South Devon and Cornwall, nearly seventy feet in North Devon, while in Lancashire, Cheshire, and Shropshire there are marine deposits with recent shells at the height of from 300 to 500 feet above the sea.

It is natural to inquire what changes the surface of the dry land in England may have undergone during the occurrence of such upward and downward movements. Perhaps some observations lately made by Mr. Bowerbank in the south of the Isle of Wight may elucidate this point. He has given us an account of a bed of chalky detritus, containing recent land shells, at Gore Cliff. This bed is ten feet thick, and rests immediately upon chalk marl. Many of the shells, which are plentifully scattered through it, retain their colour. As the deposit ranges to the foot of St. Catherine's Down, it is possible that the waste and denudation of that chalk hill may have supplied the materials. I have lately seen similar detritus resting on the chalk with flints, and arranged in numerous thin layers in the section exposed in cutting the railroad at Winchester, where a black layer of peaty earth and carbonized wood intersects thin layers of white chalk rubble, from twenty to thirty feet thick. Such appearances are, in fact, very general in chalk districts; a bed of flints not waterworn occurring on the highest downs, while fragmentary chalk, often inclosing land shells, occurs on their slopes and at lower levels. Violent rains have been known even of late years to tear off the turfy covering from certain points near Lewes, and to wash away flints and chalky mud, and leave them in the hollow combs or flanks of the hills. This action of the elements would be most powerful at periods when the chalk first emerged from the sea, or whenever it assumed in the course of subterranean disturbances a new position or physical outline.

We must, I think, infer from the occurrence of certain recent marine shells and shingle in the bottom of what has been termed the elephant-bed at Brighton, that the chalk in the South-east of England has undergone some movements of a modern date, the land having subsided there to the depth of fifty or sixty feet, and having been subsequently raised up again to a level somewhat higher than its original position*.

If it should appear upon careful research that the land shells found in terrestrial alluviums covering the chalk are almost universally of recent species, I should not conclude that the emergence of the chalk hills from the sea had generally occurred at a very modern period, but merely that these hills had been modified in shape in recent times, and that during that modification alluviums of older date had been washed away, or the land shells which they may once have contained have decomposed and disappeared. In regard to the great numbers of these shells preserved throughout the bed at Gore Cliff, and in many other places even at greater depths, it will not seem surprising to those who have observed the number of dead land shells which are strewed over the surface of the chalk downs, or lie concealed in the green turf in numbers almost as countless as the blades of grass. If the slightest wash of water should pass over such a soil, it must float off myriads of these shells, and they would immediately be involved in that white cream-coloured mud which descends from wasting hills of chalk after heavy rains. Land shells so buried may retain their colour for indefinite periods, as is shown by the state of species in the loess of the Rhine, and even in tertiary strata of much higher antiquity.

While a variety of geological monuments are annually discovered

* See Principles of Geology, 4th edit., vol. iv. p. 274.

which attest modern alterations in the level of the land, it is important to remark that new testimony is also daily obtained of the rising and sinking of land in our own times. I discussed at some length, in my last Anniversary Address, the evidence for and against the upheaval of the coast of Chili during the earthquake of 1822, a controverted point to which our attention has lately been again recalled. I may remark, however, that since we have ascertained the fact of a rise of three, five, and even ten feet in parts of the same country in 1835, so distinctly attested by Captain Fitzroy, all doubts entertained as to the permanent effects of a preceding convulsion are comparatively of small interest. Don Mariano Rivero dissents from the opinion that a change of level occurred at Valparaiso in 1822, and Colonel Walpole, after seeing the ground and conversing with persons who were on the spot in 1822, and who still reside there, also considers the statement of a rise to have been inaccurate. On the other hand Mr. Caldcleugh, who was formerly sceptical on the same point, has now come round to the opinion of Mrs. Callcott (Maria Graham), and believes that an elevation of land did take place.

Mr. Darwin, whose opportunities of investigation both in Chili and other parts of South America have been so extensive, thinks it quite certain that the land was upheaved two or three feet during the earthquake of 1822, and he met with none of the inhabitants who doubted the change of level. He states that the rise of land, even in the bay of Valparaiso, was far from being uniform, for a part of a fort not formerly visible from a certain spot has, subsequently to the earthquake, fallen within the line of vision. The most unequivocal proof of a recent rise is drawn from the acorn-shells, *Balanidæ*, found adhering to the rock above the reach of the highest tides. These were observed by Mr. Darwin sixty miles south of Valparaiso, and at Quintero, a few miles to the north of it; but his friend Mr. Alison detected them on a projecting point of rock at Valparaiso itself. The attached shells were there seen at the height of fourteen feet above high-water mark, and were only exposed upon the removal of the dung of birds, by which they would have been concealed from ordinary observation. In Mr. Darwin's paper you will find many other facts elucidating the rise of land at Valparaiso, and he has also treated of the general question of the elevation of the whole coast of the Pacific from Peru to Terra del Fuego. Beds of shells were traced by him at various heights above the sea, some a few yards, others 500 or even 1300 feet high, the shells being in a more advanced state of decomposition in proportion to their elevation. Mr. Darwin also shows that parallel terraces such as those of Coquimbo, described by Captain Basil Hall and others, which rise to the height of 300 feet and more, are of marine origin, being sometimes covered with sea-shells, and they indicate successive elevations. There are also grounds for believing that the modern upheaval of land has proceeded not only by sudden starts during convulsions of the earth, but also by insensible degrees in the intervals between earthquakes, as is now admitted to be the case in parts of Norway and Sweden.

This gradual and insensible rising is supposed to affect, not only the region of the Andes, but also the opposite or eastern coast of South America, where earthquakes are never experienced: for the Pampas of Buenos Ayres bear marks of having risen to their present height during a comparatively modern period, while the coast line of the Pacific, or the region of earthquakes and volcanic eruptions, has been the theatre of more violent movements.

It is curious to reflect that if in one portion of a large area of the earth's surface a rise of land takes place at the rate of a few inches in a century, as around Stockholm, while in another portion of the same area land is uplifted about a yard during an equal period, there will be caused, if sufficient time be allowed, a group or chain of lofty mountains in one place, and in the other a low country like the Pampas of South America.

Evidence of a sinking down of land, whether sudden or gradual, is usually more difficult to obtain than the signs of upheaval. I shall therefore mention some facts which have been lately communicated to me by Professor Nilsson, from which it appears that Scania, or the southernmost part of Sweden, has been slowly subsiding for several centuries, in the same manner as was lately shown to be the case with part of Greenland. In the first place there are no elevated beds of recent marine shells in Scania, like those near Stockholm and further to the north. Linnæus, with a view of ascertaining whether the waters of the Baltic were retiring from the Scanian shore, measured in 1749 the distance between the sea and a large stone near Trelleborg. Now Mr. Nilsson informs me that this same stone is a hundred feet nearer the water's edge than it was in Linnæus's time, or eighty-seven years before. He also states that there is a submerged peat moss, consisting of land and freshwater plants, beneath the sea at a point to which no peat could have been drifted down by any river. But what is still more conclusive, it is found that in sea-port towns, all along the coast of Scania, there are streets below the high-water level of the Baltic, and in some cases below the level of the lowest tide. Thus when the wind is high at Malmö the water overflows one of the present streets, and some years ago some excavations showed an ancient street in the same place eight feet below, and it was then seen that there had evidently been an artificial raising of the ground, doubtless in consequence of that subsidence. There is also a street at Trelleborg and another at Skanör a few inches below high-water mark; and a street at Ystad is just on a level with the sea, at which it could not have been originally built. I trust that we shall soon receive more circumstantial details of these curious phænomena, which are the more interesting because it has been shown that the elevatory movement in Sweden diminishes in intensity as we proceed southward from the North Cape to Stockholm, from which it seems probable that after passing the line or axis of least movement, where the land is nearly stationary, a movement may be continued in an opposite direction, and thus cause the gradual sinking of Scania.

I cannot take leave of this subject without remarking that the occurrence in various parts of Ireland, Scotland, and England, of recent shells in stratified gravel, sand, and loam, confirm the opinion which I derived from an examination of part of Sweden, namely, that the formations usually called diluvial have not been produced by any violent flood or débacle, or transient passage of the sea over the land, but by a prolonged submersion of the land, the level of which has been greatly altered at periods very modern in our geological chronology. I now believe that by far the greatest part of the dispersion of transported matter has been due to the ordinary moving power of water, often assisted by ice, and cooperating with the alternate upheaval and depression of land. I do not mean wholly to deny that some sudden rushes of water and partial inundations of the sea have occurred, but we are enabled to dispense with their agency more and more in proportion as our knowledge increases.

ORGANIC REMAINS.

Gentlemen, you have been already informed that the Council have this year awarded two Wollaston Medals, one to Captain Proby Cautley of the Bengal Artillery, and the other to Dr. Hugh Falconer, Superintendent of the Botanic Garden at Saharunpore, for their researches in the geology of India, and more particularly their discovery of many fossil remains of extinct quadrupeds at the southern foot of the Himalaya mountains. At our last Anniversary I took occasion to acknowledge a magnificent present, consisting of duplicates of these fossils, which the Society had received from Captain Cautley, and since that time other donations of great value have been transmitted by him to our museum. These Indian fossil bones belong to extinct species of herbivorous and carnivorous mammalia, and to reptiles of the genera crocodile, gavial, emys, and trionyx, and to several species of fish, with which shells of fresh-water genera are associated, the whole being entombed in a formation of sandstone, conglomerate, marl, and clay, in inclined stratification, composing a range of hills called the Siwâlik, between the rivers Sutledge and Ganges. These hills rise to the height of from 500 to 1000 feet above the adjacent plains, some of the loftiest peaks being 3000 feet above the level of the sea.

When Captain Cautley and Dr. Falconer first discovered these remarkable remains their curiosity was awakened, and they felt convinced of their great scientific value; but they were not versed in fossil osteology, and being stationed on the remote confines of our Indian possessions, they were far distant from any living authorities or books on comparative anatomy to which they could refer. The manner in which they overcame these disadvantages, and the enthusiasm with which they continued for years to prosecute their researches when thus isolated from the scientific world is truly admirable. Dr. Royle has permitted me to read a part of their correspondence with him when they were exploring the Siwalik mountains, and I can bear witness to their extraordinary energy and perseverance. From time to time they earnestly requested that Cuvier's works on osteology might be sent out to them, and expressed their disappointment when, from various accidents, these volumes failed to arrive. The delay perhaps was fortunate, for being thrown entirely upon their own resources, they soon found a museum of comparative anatomy in the surrounding plains, hills, and jungles, where they slew the wild tigers, buffalos, antelopes, and other Indian quadrupeds, of which they preserved the skeletons, besides obtaining specimens of all the genera of reptiles which inhabited that region. They were compelled to see and think for themselves while comparing and discriminating the different recent and fossil bones, and reasoning on the laws of comparative osteology, till at length they were fully prepared to appreciate the lessons which they were taught by the works of Cuvier. In the course of their labours they have ascertained the existence of the elephant, mastodon, rhinoceros, hippopotamus, ox, buffalo, elk, antelope, deer, and other herbivorous genera, besides several canine and feline carnivora. On some of these Dr. Falconer and Captain Cautley have each written separate and independent memoirs. Captain Cautley, for example, is the author of an article in the Journal of the Asiatic Society, in which he shows that two of the species of mastodon described by Mr. Clift are, in fact, one, the supposed difference in character having been drawn from the teeth of the young and adult of the same species. I ought to remind you that this same gentleman was the discoverer, in 1833, of the Indian Herculaneum or buried town near Behat, north of Seharunpore, which he found seventeen feet below the surface of the country when directing the excavation of the Doab Canal*.

But I ought more particularly to invite your attention to the joint paper by Dr. Falconer and Captain Cautley on the Sivatherium, a new and extraordinary species of mammalia, which they have minutely described and figured, offering at the same time many profound speculations on its probable anatomical relations. The characters of this genus are drawn from a head almost complete, found at first enveloped in a mass of hard stone, which had lain as a boulder in a water-course, but after much labour the covering of stone was successfully removed, and the huge head now stands out with its two horns in relief, the nasal bones being projected in a free arch, and the molars on both sides of the jaw being singularly

* Journ. of Asiatic Society, Nos. xxv. and xxix. 1834. Principles of Geology, 4th and subsequent editions. See Index, Behat.

perfect. This individual must have approached the elephant in size. The genus Sivatherium, say the authors, is the more interesting, as helping to fill up the important blank which has always intervened between the ruminant and pachydermatous quadrupeds; for it combines the teeth and horns of a ruminant, with the lip, face, and probably proboscis of a pachyderm. They also observe, that the extinct mammiferous genera of Cuvier were all confined to the Pachydermata, and no remarkable deviation from existing types had been noticed by him among fossil ruminants, whereas the sivatherium holds a perfectly isolated position, like the giraffe and the camels, being widely remote from any other type.

I have not space to enter upon the warm discussion which has arisen in France between MM. Blainville and Geoffroy St. Hilaire respecting the amount of analogy which exists between the Sivatherium and the Giraffe; but I observe with pleasure that in the course of that controversy those distinguished naturalists do justice to the zeal and talents displayed by our countrymen Captain Cautley and Dr. Falconer, and to the services which they have rendered to science.

While these discoveries were made on the banks of the tributaries of the Indus and the Ganges, Mr. Darwin was employed in collecting the bones of large extinct mammalia, near the banks of the Rio Plata, in the Pampas of Buenos Ayres and in Patagonia. Mr. Owen has enabled me to announce to you in a few words some of the most striking results which he has obtained from his examination of the specimens liberally presented by Mr. Darwin to the College of Surgeons, and of which casts will soon be made for our own and other public museums. In the first place, besides a cranium with teeth of the Megatherium, Mr. Darwin has brought home portions of another animal as large as an ox, and allied to the Megatherium. Fragments of its armour are preserved, as well as its jaws, femur, and other bones. There is also a third creature of the order Edentata, and belonging to this same family of Dasypodidæ, in the shape of a gigantic Armadillo, as large as a Tapir. Of the ruminant order there is also a no less remarkable representative in the remains of a gigantic Llama from the plains of Patagonia, which must have been as large as a camel and with a longer neck: and lastly, of the Rodentia there is the cranium of a huge animal of the size of a rhinoceros, with some modification in the form of the skull resembling that in the Wombat.

These fossils, of which a description will shortly be given to the Society by Messrs. Clift and Owen, establish the fact that the peculiar type of organization which is now characteristic of the South American mammalia has been developed on that continent for a long period, sufficient at least to allow of the extinction of many large species of quadrupeds. The family of the armadillos is now exclusively confined to South America and here we have from the same country the Megatherium, and two other gigantic representatives of the same family. So in the Camelidæ, South America is the sole province where the genus Auchenia or Llama occurs in a living state, and now a much larger extinct species of Llama is discovered. Lastly, among the rodents, the largest in stature now living is the Capybara, which frequents the rivers and swamps of South America and is of the size of a hog. Mr. Darwin now brings home from the same continent the bones of a fossil rodent not inferior in dimensions to the rhinoceros.

These facts elucidate a general law previously deduced from the relations ascertained to exist between the recent and extinct quadrupeds of Australia; for you are aware that to the westward of Sydney on the Macquarie River, the bones of a large fossil kangaroo and other lost marsupial species have been met with in the ossiferous breccias of caves and fissures.

A cavern has lately been examined at Yealm Bridge, six miles south-east from Plymouth, by one of our members, Lieut. Col. Mudge, R.E., from whose account it appears that the bones of hyænas are very numerous there. They are associated with those of the elephant, rhinoceros, horse, and other animals usually found in caves. The number of fossil Carnivora, such as the hyæna, wolf, fox, and bear, which have now been met with in districts of cavernous limestone in Great Britain, is so great that we are the more struck with the rarity and general absence of such remains in surrounding and intervening districts, over which the same beasts of prey must have ranged. The Pachydermata, as the elephant, rhinoceros, and hippopotamus, are often discovered in ancient alluvial or fluviatile deposits; but had there been no caves and fissures we should scarcely have obtained any information respecting the existence of lions, tigers, hyænas, and other beasts of prey which inhabited the country at the same period.

The remains of at least two distinct Saurian animals have been discovered by Dr. Riley and Mr. Samuel Stutchbury, in the dolomitic conglomerate of Durdham Down near Bristol. They are allied to the Iguana and Monitor, but the teeth, vertebræ, and other bones exhibit characters by which they are seen to be generically distinct from all existing reptiles. They are particularly deserving of your attention as occurring in the bottom of the magnesian limestone formation, the oldest strata in which the bones of reptiles have as yet been found in Great Britain. The most ancient examples of fossil reptiles known on the continent of Europe occur also in the zechstein of Germany, a formation of about the same age.

I alluded last year to a memoir of Sir Philip Egerton's, in which he pointed out some peculiarities in the structure of the cervical vertebræ of the Ichthyosaurus. He has now proved that in all the species of this genus there are three accessory bones, which he proposes to call, from their shape and position, subvertebral wedge bones. They are supplementary to the atlas, axis, and third vertebra of the neck, and seem to have escaped the observation of Cuvier and other osteologists.

Mr. Lewis Hunton has communicated to the Society an elaborate account of a section of the upper lias and marlstone in Yorkshire, showing that different beds in those formations are characterized by particular species of Ammonites and other Testacea, each species having a limited vertical range. His observations are valuable not only as illustrating the distribution of fossils on the coast near Whitby, but also as furnishing a point of comparison between that district and many others in Great Britain. Mr. W. C. Williamson of Manchester has had the same object in view in studying the fossils of the oolitic formations of the coast of Yorkshire, and informs us, as the result of his patient investigation, that although certain assemblages of fossils abound in particular subdivisions of the oolite, many species range from the lowermost to nearly the highest beds. This inference is confirmed when we compare the lists drawn up by Mr. Williamson, and those published by Professor Phillips and other competent authorities. Thus some of the shells of the inferior oolite, mentioned in Mr. Williamson's list (*Trigonia gibbosa*, for example), occur also in the Portland-stone of Wiltshire; another, as *Ostrea Marshii*, is characteristic of the cornbrash in the same county; others pass downwards to the lias, as *Orbicula reflexa* and *Ammonites striatulus*. If you consult the tables of organic remains which Dr. Fitton has annexed to his excellent monograph on the strata below the chalk, just published in our Transactions, (2nd Series, vol. iv. part 2.) you will see that a considerable number of shells pass from the upper oolitic groups into the green-sand. We are not to conclude from these facts that certain sets of fossils may not serve as good chronological tests of geological periods, but we must be cautious not to attach too much importance to particular species, some of which may have a wider, others a more limited vertical range. The phænomena alluded to are strictly analogous to those with which we are familiar in the more modern deposits, where different tertiary formations contain some peculiar Testacea, together with others common to older or newer groups, or where shells of species now living in the sea are associated with others that are extinct.

An assemblage of fossil shells has been presented to our museum by Mr. J. Leigh and Mr. J. W. Binney, found at Collyhurst near Manchester, in red and variegated marls, which were referred by them at first to the upper division of the new red sandstone group; but Professors Sedgwick and Phillips consider them to be a red and variegated deposit, belonging to the magnesian limestone series. As these fossils are new and characteristic of a particular subdivision of the beds between the lias and coal, it is to be hoped that they will soon be described and figured.

The petrifaction of wood, and more especially its silicification, still continues to present obscure problems to the botanist and chemist. The first step towards their solution will probably be made by carefully examining vegetables in different stages of petrifaction; and with this view Mr. Stokes has procured several specimens of wood, partly mineralized and partly not. Among these is a piece found in an ancient Roman aqueduct in Westphalia, in which some portions are converted into spindle-shaped bodies consisting of carbonate of lime: while the rest of the wood remains in a comparatively unchanged state. The same author has pointed out cases both of siliceous and calcareous fossils, where the lapidifying process must have commenced at a number of separate points, so as to produce spherical or fusiform petrifactions, independent of each other, in which the woody structure is apparent, while in the intervening spaces the wood has decayed, having after removal been replaced by mineral matter. In some petrifactions the most perishable, in others the most durable portions of plants are preserved, variations which doubtless depend on the time when the mineral matter was supplied. If introduced immediately on the first commencement of decomposition, then the most destructible parts are lapidified, while the more durable do not waste away till afterwards, when the supply has failed, and so never become petrified. The converse of these circumstances gives rise to exactly opposite results. As to the manner in which the minutest pores and fibres discoverable by the microscope, even the spiral vessels themselves can be turned into stone, or have their forms faithfully represented by inorganic matter, no satisfactory explanation has ever yet been offered. In considering, however, this question, you will do well to consult the important suggestion which a celebrated chemist, our late lamented Secretary, Dr. Turner, has thrown out on the application of chemistry to geology. He reminds us that whenever the decomposition of an organic body has begun, the elements into which it is resolved are set free in a state peculiarly adapting them to enter into new chemical combinations. They are in what is technically termed a nascent state, the constituent molecules being probably of extreme smallness and in a fluid or gaseous form, ready to obey the slightest impulse of chemical affinity, so that if the water percolating a stratum be charged with mineral ingredients, and come in contact with elements thus newly set free, a mutual action takes place, and new combinations result, in the course of which solid particles are precipitated so as to occupy the place left vacant by the decomposed organic matter. In a word, all the phænomena attendant on slow putrefaction must be studied whenever we attempt to reason on the conversion of fossil bodies into stone; and in regard to silicification, Dr. Turner has shown how great a quantity of silex is set free as often as felspar decomposes, and how abundantly siliceous matter may be imparted from this source alone to running water throughout the globe.

As I have mentioned the name of Dr. Turner, I cannot pass on without an expression of sorrow for the untimely death of that amiable and distinguished philosopher. Mr. Whewell and Mr. Murchison alluded in most feeling terms this morning at the General Meeting to this melancholy event, which is too recent and too painful to myself and others to allow me now to dwell longer upon it.

Before quitting the subject of vegetable petrifactions, I ought to mention a memoir just published, by Mr. H. R. Göppert, Professor of Botany at Breslau, "On the various Conditions in which Fossil Plants are found, and on the Process of Lapidification*." He has instituted a series of most curious experiments, and his success in producing imitations of fossil petrifactions has been very remarkable. I have only space to allude to one or two examples. He placed recent ferns between soft layers of clay, dried these in the shade, and then slowly and gradually heated them, till they were red hot. The result was the production of so perfect a counterpart of fossil plants as might have deceived an experienced geologist. According to the different degrees of heat applied, the plants were obtained in a brown or perfectly carbonized condition, and sometimes, but more rarely, they were in a black shining state, adhering closely to the layer of clay. If the red heat was sustained until all the organic matter was burnt up, only an impression of the plant remained.

The same chemist steeped plants in a moderately strong solution of sulphate of iron, and left them immersed in it for several days until they were thoroughly soaked in the liquid. They were then dried and kept heated until they would no longer shrink in volume, and until every trace of organic matter had disappeared. On cooling them he found that the oxyd formed by this process had taken the form of the plants. Professor Göppert then took fine vertical slices of the Scotch fir, *Pinus sylvestris*, and treated them in the same way; and so well were they preserved, that, after heating, the dotted vessels so peculiar to this family of plants were distinctly visible. A variety of other experiments were made by steeping animal and vegetable substances in siliceous, calcareous, and metallic solutions, and all tended to prove that the mineralization of

* Poggendorff, Annalen der Physik und Chemie, vol. xxxviii. part 4. Leipsic, 1836.

organic bodies can be carried much further in a short time than had been previously supposed.

These experiments seem to open a new field of inquiry, and will, I trust, soon be repeated in this country. In endeavouring, however, to verify them, the greatest caution will be required, or we may easily be deceived. We must ascertain, for example, with certainty that every particle of animal or vegetable matter is driven off before we attempt to determine the full extent to which mineralization may have proceeded. Professor Göppert is doubtless aware that coniferous wood may be burnt and reduced to charcoal, and after having been kept for some time at a red heat, will continue to exhibit, on being cooled, the discs or reticulated structure to which he alludes. If, therefore, some small particles of carbon remain in the midst of the oxide of iron, such portions may retain traces of the vessels peculiar to coniferous wood; and an observer not on his guard, might infer that the same structure was preserved throughout the mass.

In my last address, I alluded to Mr. Lonsdale's detection of vast numbers of microscopic corallines and minute shells in the substance of the white chalk of various counties in England, where this rock had not been suspected of consisting of recognisable organic bodies. I cannot deny myself the pleasure of mentioning the still more singular and unexpected facts brought to light during the last year, by Professor Ehrenberg of Berlin, respecting the origin of tripoli. I need scarcely remind you, that tripoli is a rock of homogeneous appearance, very fragile and usually fissile, almost entirely formed of flint, and which was called polir-schiefer, or polishing slate, by Werner, being used in the arts for polishing stones or metals. There have been many speculations in regard to its origin, but it was a favourite theory of some geologists that it was a siliceous shale hardened by heat. The celebrated tripoli of Bilin in Bohemia consists of siliceous grains united together without any visible cement, and is so abundant that one stratum is no less than fourteen feet thick. After a minute examination of this as well as of the tripoli from Planitz in Saxony, and another variety from Santa Fiora in Tuscany, and one from the Isle of France, Ehrenberg found that the stone is wholly made up of millions of siliceous cases and skeletons of microscopic animalcules. It is probably known to you, that this distinguished physiologist has devoted many years to the anatomical investigation of the infusoria, and has discovered that their internal structure is often very complicated, that they have a distinct muscular and nervous system, intestines, sexual organs of reproduction, and that some of them are provided with siliceous shells, or cases of pure silex. The forms of these durable shells are very marked and various, but constant in particular genera and species. They are almost inconceivably minute, yet they can be clearly discerned by the aid of a powerful microscope, and the fossil species preserved in tripoli are seen to exhibit in the family Bacillaria and some others the same divisions and transverse lines which characterize the shells of living infusoria.

In the Bohemian schist of Bilin, and in that of Planitz in Saxony, both of them tertiary deposits, the species are freshwater, and are all extinct. The tripoli of Cassel appears to be more modern, and the infusoria in that place, which are also freshwater, are some of them distinctly identical with living species, and others not. In the tripoli brought from the Isle of France, the cases or shells all belong to well-known recent marine species.

The flinty shells of which we are speaking although hard are very fragile, breaking like glass, are therefore admirably adapted when rubbed for wearing down into a fine powder fit for polishing the surface of metals. It is difficult to convey an idea of their extreme minuteness, but I may state that Ehrenberg estimates that in the Bilin tripoli there are 41,000 millions of individuals of the *Gaillonella distans* in every cubic inch of stone. At every stroke therefore of the polishing stone we crush to pieces several thousands if not myriads of perfect fossils.

Gentlemen,—Although I have already extended this Address beyond the usual limits, I cannot conclude without congratulating you on the appearance of Dr. Buckland's Bridgewater Treatise, a work in the execution of which the author has most skilfully combined several distinct objects. He has briefly explained the manner in which the materials of the earth's crust are arranged, and the evidence which that arrangement affords of contrivance, wisdom, and foresight. He has also given us a general view of the principal facts brought to light by the study of organic remains; thus contributing towards the filling up one of the greatest blanks which existed in the literature of our science, while at the same time he has pointed out the bearing of these phænomena on natural theology.

He has shown that geology affords one kind of testimony perfectly distinct from natural history of the adaptation of particular means and forces to the accomplishment of certain ends for which the habitable globe has been framed. These proofs are illustrated in the author's chapters on the origin and mechanism of springs, on the distribution of metallic and other minerals in the earth, and the position of coal in stratified rocks. In reference to these points it is demonstrated that some even of the most irregular forces have produced highly beneficial results, in modifying the subterranean economy of the globe. But I shall not dwell on this part of the Treatise, but pass on at once to that which constitutes the body of the work, and which relates to palæontology.

In considering this department, the number and variety of objects which offer themselves to the naturalist are so great, that the choice was truly embarrassing. Dr. Buckland has judiciously selected a few of the most striking examples from each of the great classes of organic remains, and when speaking of extinct animals, has explained the method by which the anatomist and physiologist have been able to restore the organization of the entire individual, by reasoning from the evidence afforded by a few bones or other relics preserved in a fossil state. He has described the parts of the living animal or plant most nearly analogous to those which are found buried in the earth, usually illustrating by figures the distinctness and at the same time the resemblance of the recent and extinct species, showing that all are parts of one great scheme, and that the lost species even supply links which are wanting in the existing chain of animal and vegetable creation.

It is impossible to read the account given of the Megatherium, and to contrast it with that drawn up by Cuvier of the same species, without being struck with the increased interest and instruction, and the vast accession of power derived from viewing the whole mechanism of the skeleton in constant relation to the final causes for which the different organs were contrived.

The chapter on saurian and other reptiles has afforded the Professor another beautiful field for exemplifying the infinite variety of mechanical contrivances and combinations of form and structure which the fossil representatives of that class exhibit.

The account also of the Cephalopodous Mollusca, so many thousands of which are scattered through the strata, and which until very recently have presented so obscure a problem to the naturalist, is full of original observation. The history of the animals which formed the Belemnites, of which it appears that nearly one hundred species are now known, and the proofs adduced that they were provided with ink-bags like the cuttle-fish, the description also of the fossil pen-and-ink fish, or Loligo, and other sections of this part of the Treatise, carry our information respecting the family of naked Cephalopods much further than was ever attempted in any previous work. Nor should I omit to mention the exposition of an ingenious theory for the use of the siphuncle and air-chambers of the Ammonite, which, whether confirmed by future examination or not, becomes in the author's hands the means of conveying to the reader a clear and well-defined notion of the varied forms and complicated structure of these shells, and of awakening a lively desire to understand their singular organization.

I may also recall to your notice the just and striking manner in which certain physical inferences are drawn from the conformation of the eyes of extinct Crustacea, such as the Trilobite. The most delicate parts of these organs are sometimes found petrified in rocks of high antiquity, and it is justly observed, that such optical instruments give information regarding the condition of the ancient sea and ancient atmosphere, and the relations of both these media to light. The fluid in which these marine animals lived at remote periods must have been pure and transparent to allow the passage of light to organs of vision resembling those of living Crustaceans; and this train of reasoning naturally leads us still further, and to more important consequences, when we reflect on the general adoption of the undulatory theory of light, and the connexion between light, heat, electricity, and magnetism.

I have heard it objected, that the zoologist and botanist had already advanced such abundant proofs of design in the construction of living animals, and plants, that the auxiliary evidence of palæontology was useless, and that to appeal to fossils in support of the same views was to add weaker to stronger arguments. In the living animal, it is said, we can study its entire organization, observe its habits, see the manner in which it applies each organ, and so verify with certainty the ends for which any particular member was formed and fashioned. But in the case of the fossil, we have first to infer the greater part of the organization from such parts as alone remain, and then further to infer from analogy the habits and functions discharged, and lastly the former conditions of existence of the creatures so restored. If then we occasionally fall into error when speculating on the use of the organs of living species, how much more easily may we be deceived in regard to the fossil!

In answering this objection, it cannot be denied that the data supplied by palæontology are less complete; but they are nevertheless abundantly sufficient to establish a very close analogy between extinct and recent species, so as to leave no doubt on the mind that the same harmony of parts and beauty of contrivance which we admire in the living creature has equally characterized the organic world at remote periods. If this be granted, it is enough; the geologist can then bring new and original arguments from fossil remains to bear on that part of natural theology which seeks to extend and exalt our conceptions of the intelligence, power, wisdom, and unity of design manifested in the creation.

It can now be shown that the configuration of the earth's surface has been remodelled again and again; mountain chains have been raised or sunk, valleys have been formed, again filled up, and then re-excavated, sea and land have changed places, yet throughout all these revolutions, and the consequent alterations of local and general climate, animal and vegetable life has been sustained. This appears to have been accomplished without violation of those laws now governing the organic creation, by which limits are assigned to the variability of species. There are no grounds for assuming that species had greater powers of accommodating themselves to new circumstances in ancient periods than now. The succession of living beings was continued by the introduction into the earth from time to time of new plants and animals. That each assemblage of new species was admirably adapted for successive states of the globe, may be confidently inferred from the fact of the myriads of fossil remains preserved in strata of all ages. Had it been otherwise, had they been less fitted for each new condition of things as it arose, they would not have increased and multiplied and endured for indefinite periods of time.

Astronomy had been unable to establish the plurality of habitable worlds throughout space, however favourite a subject of conjecture and speculation; but geology, although it cannot prove that other planets are peopled with appropriate races of living beings, has demonstrated the truth of conclusions scarcely less wonderful, the existence on our own planet of many habitable surfaces, or worlds as they have been called, each distinct in time, and peopled with its peculiar races of aquatic and terrestrial beings.

Thus as we increase our knowledge of the inexhaustible variety displayed in living nature, and admire the infinite wisdom and power which it displays, our admiration is multiplied by the reflection that it is only the last of a great series of pre-existing creations of which we cannot estimate the number or limit in past time.

All geologists will agree with Dr. Buckland, that the most perfect unity of plan can be traced in the fossil world throughout all the modifications which it has undergone, and that we can carry back our researches distinctly to times antecedent to the existence of man. We can prove that man had a beginning, and that all the species now contemporary with man, and many others which preceded, had also a beginning; consequently the present state of the organic world has not gone on from all eternity as some philosophers had maintained.

But when conceding the truth of these propositions, I am prepared to contest another doctrine which the Professor advocates, namely, that by the aid of geological monuments we can trace back the history of our terraqueous system to times anterior to the first creation of organic beings. If it was reasonable that Hutton should in his time call in question the validity of such a doctrine, whether founded on the absence of organic remains in strata called primary or in granite, still more are we bound, after the numerous facts brought to light by modern geology, to regard the opinion as more than questionable. I observe with pleasure that Dr. Buckland broadly assumes what I have elsewhere termed the metamorphic theory, having stated in his 6th chapter that beds of mud, sand, and gravel, deposited at the bottom of ancient seas, have been converted by heat and other subterranean causes into gneiss, mica slate, hornblende slate, clay slate, and other crystalline schists. But if this transmutation be assumed, it must also be admitted that the obliteration of the organic remains, if present, would naturally have accompanied so entire a change in mineral structure. The absence, then, of organic fossils in crystalline stratified rocks, of whatever age, affords no presumption in favour of the non-existence of animals and plants at remote periods.

The author, however, in another part of his Treatise contends, that even if the strata called primary once contained organic remains, there is still evidence in the fundamental granite of an antecedent universal state of fusion, and consequently a period when the existence of the organic world, such as it is known to us, was impossible. There was, he says, one universal mass of incandescent elements, forming the entire substance of the primæval globe, wholly incompatible with any condition of life which can be shown to have ever existed on the earth*. Believing as I do in the igneous origin of granite, I would still ask, what proof have we in the earth's crust of a state of total and simultaneous liquefaction either of the granitic or other rocks, commonly called plutonic? All our evidence, on the contrary, tends to show that the formation of granite, like the deposition of the stratified rocks, has been successive, and that different portions of granite have been in a melted state at distinct and often distant periods. One mass was solid, and had been fractured before another body of granitic matter was injected into it, or through it in the form of veins. In short, the universal fluidity of the crystalline foundations of the earth's crust can only be understood in the same sense as the universality of the ancient ocean. All the land has been under water, but not all at one time; so all the subterranean unstratified rocks to which man can obtain access have been melted, but not simultaneously.

Nor can we affirm that the oldest of the unstratified rocks hitherto discovered is more ancient than the oldest stratified formations known to us; we cannot even decide the relations in point of age of the most ancient granite to the oldest *fossiliferous* beds.

But why, I may ask, should man, to whom the early history of his own species and the rise of nations presents so obscure a problem, feel disappointed if he fail to trace back the animate world to its first origin? Already has the beginning of things receded before

* Buckland's Bridgewater Treatise, vol. i. p. 55.

our researches to times immeasurably distant. Why then, after wandering back in imagination through a boundless lapse of years, should we expect to find any resting-place for our thoughts, or hope to assign a limit to the periods of past time throughout which it has pleased an omnipotent and eternal Being to manifest his creative power?

But it is not my intention to advert now to these and other points on which I happen to differ from Dr. Buckland. I would rather express the gratification I feel in finding myself in perfect accordance with him on so many subjects. His work is admirably adapted to convey instruction on organic remains, and other departments of geology, both to beginners and to those well versed in the science, and is characterized throughout by a truly philosophical spirit, which betrays no desire to adhere tenaciously to dogmas impugned or refuted by the modern progress of science. On the contrary, the author has abandoned several opinions which he himself had formerly advocated; and although still attached to the theory which teaches the turbulent condition of the planet when the lias and other fossiliferous rocks were formed, and the general insufficiency of existing causes to explain the changes which have occurred on the earth, he yet refers in almost all parts of his book to the ordinary operations of nature to explain a variety of phænomena once supposed to be the result of causes different in kind and degree from those now acting.

I have now, Gentlemen, only to offer you my acknowledgements for the high honour conferred upon me by my election to fill the President's chair for the last two years; and it is a source of great satisfaction to me to feel assured of the continued prosperity and usefulness of the association when I resign my trust into the hands of a successor so distinguished for his zeal, talents, and varied acquirements as Mr. Whewell.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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February 22.—John Backhouse, Esq., of Hans-place, Sloane-street, was elected a Fellow of this Society.

A paper on the Geology of Cutch, by Captain Grant, of the Bombay Engineers, and communicated by Charles Lyell, Esq., F.G.S., was read.

This district, so highly interesting on account of the phenomena which accompanied the earthquake that devastated it in 1819, is situated near the eastern branch of the Indus, between 22 and 24 degrees of north latitude, and 68 and 72 degrees of east longitude. On the north, it is bounded by the Grand Runn, and the Thur or Little Desert, on the south by the Gulf of Cutch and the Indian Ocean, on the east by the province of Guzerat, and on the west by the eastern branch of the Indus and the territory of Sinde. Its superficial contents are about 6500 square miles. The surface is traversed by three ranges of hills, having in general an east and west direction. The hills constituting the northern chain, which borders the Runn, present a perpendicular capping of sandstone, surmounting towards the north a sloping talus, and towards the south an inclined plane, both composed of laminated clay and slaty limestone, with occasionally layers of sandstone. The second or central range, is constituted partly of the formation last mentioned, and partly of another consisting of sandstone and shale. The third or southern, is formed wholly of volcanic rocks, but has nearly the same linear direction as the others.

To the south of the last range is an extensive flat, composed of a deposit, considered by Capt. Grant to be tertiary, and of an alluvial band, bordering the sea coast.

The first of these formations, which constitutes the northern range of hills, abounds with Ammonites, Nautili, Belemnites, Trigoniæ, and other fossils characteristic of the oolitic system of England. The formation of sandstone and shale, which occupies a much greater surface, contains, in various localities, thin beds of coal, sometimes very impure, but at others tolerably good; also layers of iron ore; and in the shale as well as in the sandstone, casts of reeds and impressions of ferns are stated to occur. With respect to the relative age of these two formations, Capt. Grant was unable to procure any decisive information; but he thinks that the sandstone and shale system, passes beneath that of laminated clay and limestone.

The iron ore is smelted by the natives to some extent, particularly near the town of Doodye. The variety generally selected, on account of the imperfect apparatus employed, has a spongiform texture, small specific gravity, and is easily frangible. The ore is broken into small pieces and disposed in layers, alternately with others of charcoal, in a rude open furnace, acted upon by two small bellows made of sheep skin. The metal on being fused, falls into a small hole at the bottom of the furnace, whence it is removed into an inclosed furnace, and subjected to the same blasts until it acquires a white heat, when it is taken out and beat into a bar. A considerable quantity of iron was formerly made from another variety of ore, found in the superficial soil at the north-western extremity of Cutch.

In one part of the province, the author noticed a deposit of variegated sandstone and marl, but was unable to determine its position with respect to the other formations. It is covered, in part, by an aluminous earth, on which rests a bed of red clay. The former, when visited by Capt. Grant, had been burning spontaneously for a long time, sending forth a suffocating sulphureous smoke. Considerable quantities of alum are made from the earth and exported to Bombay.

Another formation, described by the author, occurs south of Luckput, near the eastern branch of the Indus. It consists of soft and hard, whitish limestone, containing innumerable Nummulites and Fasciolites, also Echini, Spatangi, Ostrea and Corals.

The tertiary deposit consists of a hard, argillaceous grit covered by a conglomerate. The organic remains, which are very numerous, are often disposed in beds confined to one species; the prevaling genera being Arca, Pecten, Ostrea, Cardium, Conus, Cypræa, Ovula, Fusus, Trochus, Solarium, Strombus, and Cassis. Patches of Corals, two or three acres in extent, sometimes also occur.

Under the head of alluvial tracts, Capt. Grant gave an account of changes, produced along the southern coast by the deposition of sediment. At Mandavee is a ruin, at a spot called the old Bunder or quay, now about three miles inland; and in the centre of the town is a small temple, built upon a rocky foundation, but said to have stood in the sea, when the old Bunder was the landing place. At other localities in the Gulf of Cutch, similar processes are going on, rendering it necessary to remove the landing-places frequently further seaward. The rapid progress of these accumulations is ascribed to the sea, during nine months washing back the sandy detritus, brought down by the periodical floods. The same operation is also in progress at places, separated from the main waters of the gulf by small creeks or inlets, some of which penetrate six or seven miles from the coast, through a tract covered with shrubs. At low-water the whole of these plants, are exposed down to their roots, but at high-tide merely their tops are visible, so that boats sail through a completely marine forest. The growth of these shrubs is rapid, and the sailors have constantly to force the boats through the upper branches, particularly at the angles of the creeks, when they wish to save a tack. The stems and lower branches are covered with testacea, whilst the upper are occupied by numerous water-fowl. The land gains in this dictrict, by the deposition of the muddy contents of the small streams during the monsoon, when the water passing very slowly between the stems of the shrubs, a great portion of the matter held in suspension, is precipitated. This alluvial district occurs only on the southern coast of the Province. In August, 1834, the rains were very violent and continuous, and the river which flows past Nurra, on the borders of the Grand Runn, covered with a fine soil a surface of nearly 1000 acres. On the opposite or southern side of Cutch, not far from Mandavee, 300 acres were washed away; and not far from the same spot, half a small village was removed bodily into the sea.

Volcanic Rocks.—Besides the southern range of hills already stated, to be entirely composed of trap or volcanic rocks, other extensive districts of the same nature, occur between the northern and central ranges, and to the south of Luckput; besides innumerable minor outbursts, some of which forming small conical hills, are arranged around a central area. The author noticed no recent crater, unless the hill, called Denudar, be considered as such, and down the flanks of which he traced a lava stream. The volcanic rocks, consist of several varieties of basalt, often columnar, amygdaloid, greenstone, and trachyte. Capt. Grant described these rocks in great detail, as well as the effects evidently produced by them, enumerating a great variety of instances, in which the disturbance of the strata, can be traced, in the clearest manner, to the protrusion of trap. In some cases the volcanic mounds, are themselves cracked or fissured from top to bottom.

That the igneous eruptions occurred at many distinct periods, Capt. Grant showed by sections, in which beds of trap, alternate with others of crystalline limestone, calcareous tuff, and a calcareous grit, which sometimes contains angular fragments of basalt; and by beds of very different characters reposing on each other.

Among the phenomena connected apparently with volcanic action, the author described a number of mounds, varying in diameter from 3 to 20 yards, and covered with small tabular plates of sandstone, the lines of fracture radiating, though irregularly, from a centre. In some instances the summits of these little mounds having been removed, a regular circle of stones appeared, inclosing an area of sandstone, the fracture of the stones decidedly radiating as the stones of an arch. In other instances they resembled small hillocks, from the upper part of which the outer coating or tabular plates, had generally fallen away, and the whole consisted of a heap of broken masses of rock.

The author then described what he considers to be a very recent volcanic outburst. It is situated in the nummulitic limestone, near the village of Wagé-ké-pudda, and forms a rather high flat basin, or table land of about two square miles, composed of calcareous marl, and flanked by low irregular hills of ironstone and gravel. The sides are broken by fissures, ravines, and hollows, and the bed of the basin is covered with hillocks of loose volcanic scoriæ of various colours. Within the basin are also several small craters or circular spaces, surrounded imperfectly by walls of columnar, globular, or friable basalt. These basaltic walls, however, he conceives are of anterior date to the mounds of scoriæ, which he is of opinion cannot be of great antiquity, on account of the facility with which their loose materials are removed by atmospheric agents. Other similar outbursts were also described.

The paper concluded with an account of the Great Runn, a district exclusive of the elevated tracts called "the Bunnee and Islands" of 7000 square miles. This singular region, as already described by Capt. Burns, consists of a sandy flat, dry for the greater part of the year, but during the prevalence of the south-west winds, converted into an inland sea, passable however on camels. Capt. Grant believes that its present oscillating position between land and water, is due to an elevation of the Runn, and not a change in the level of the sea; and in support of his opinion adduced the alterations both of elevation and depression of land, by the earthquake of 1819. He described also several extraordinary walls of rock, thrown up apparently by volcanic action, sometimes assuming a dome shape, at others segments of circles or straight lines.

March 8.—Edward J. Chance, Esq., F.L.S., of Cook's-court, Lincoln's-Inn-Fields; and Mr. Francis Looney, of Manchester, were elected Fellows of this Society.

The reading of a paper "On the Geological structure and phenomena of Suffolk, and its physical relations with Norfolk and Essex;" by the Rev. W. B. Clarke, F.G.S., began on the 18th of January, was concluded.

The observations detailed in this memoir were made during 1827, 1828, and 1829, and are arranged under the heads of the physical features of the county, the geological structure, and the effects produced by causes now in action.

Physical Features.—The general form of Suffolk is an oblong of about 47 miles by 27, bounded on the east by the German Ocean, the south by the river Stour, the west by the Ouse and Lark, and the north by the Little Ouse and Waveney. It is impossible, says Mr. Clarke, not to be struck with the fact, that whilst some of these river-courses have an east and west direction, others flow from N.N.W. to S.S.E., and that the coast section from Harwich to Orford, is nearly parallel with the latter; and he adds, if these observations be extended to Norfolk and Essex, counties similar in geological structure, an accordance will be found in the direction of their rivers and estuaries.

How far these river channels may be due to dynamical action, operating from below, the author thinks it is difficult to determine; but he is of opinion that when they are studied with reference to the proofs of violent derangement in the north, east, and west corners of Norfolk; and the almost unequivocal evidence of disturbance on the coast of Suffolk, there is sufficient reason for assuming, that the drainage of Norfolk, Suffolk, and Essex has been induced by a violent strain acting from below, and throwing the whole mass of the country into a position, by which 1200 square miles of Norfolk and 220 of Suffolk are drained by the Yare, and about 2000 of the latter county at its south-east corner.

In addition to these facts, Mr. Clarke says, that the estuaries of the Alde, the Deben, the Orwell, and the Stour, having an average length of 11 or 12 miles, meet the fresh water at nearly the same distance from the sea, and at the boundary line of the great continuous bed of diluvium, which covers so extensive an area in that part of England; only detached patches of greater or less extent, being found to the east of the line.

The Geological Structure.—The formations of which Suffolk consists, are chalk, the plastic and London clays, crag, diluvium or ancient superficial detritus, and recent lacustrine deposits; the first occupying the N.W. portion of the county, the second, third, and fourth the south-eastern, and the fifth or diluvium, the intermediate part, resting on all the preceding deposits; while the sixth or lacustrine accumulations are of very local occurrence.

Chalk.—This formation in the S.E. of Suffolk, is principally exposed in the banks of the estuaries and rivers, and contains the usual plates and nodules of flints, as well as the fossils characteristic of the upper chalk. In making a well at Harwich, at the depth of 93 feet, and between the white and grey chalk, a stratum 10 feet thick of sandy, gritty chalk was penetrated. The beds are in general nearly horizontal, declining gently to the south-east, but they sometimes dip at considerable angles, and the surface appears to have been violently dislocated and worn into deep gulleys, locally called sand-galls. At Harwich in making two wells only 70 yards apart, the chalk was reached in the northern at the depth of 88 feet, but in the southern at 64 feet. Where the formation has been denuded by the rivers, the tertiary beds frequently rest upon it, but where it rises into an elevation above the river levels, it is covered altogether by diluvium.

Plastic clay.—There is some difficulty in separating this deposit from the diluvium of Suffolk. At certain points, however, it displays the same beds of mottled clay and sands with pebbles, which characterize it in other parts of the kingdom; and it is occasionally exposed between the London clay and chalk. From its local occurrence Mr. Clarke is of opinion, that it has been subjected to denudating agents, and that it has partaken, in part at least, of the dislocations which have affected the chalk.

London clay.—This formation presents, in Suffolk, the usual characters. At Walton on the Naze and Bawdsey, considerable quantities of pyritous vegetable remains are washed up from a bed below the level of the sea; and are said to rival in variety and abundance the Sheppy fossils. The furthest western point at which the formation is visible, is Layham near Hadleigh, the country beyond being covered by diluvial clay. It constitutes, however, the substratum of all the estuaries which intersect the S.E. of Suffolk, and the coast section from Orford Ness to Walton Naze, being everywhere capped by crag. This section is constantly varying in its features, but presented when the author examined it, in 1827, the appearance of beds once horizontal, having been upheaved in some places and depressed in others; but to what extent these disturbances may have been produced by elevatory movements, the action of the sea, or the undermining of land springs, he could not satisfactorily determine. The supply of water obtained from the formation appears to be governed by local phenomena. At East Bergholt, a well was dug to the depth of 40 feet in London clay, without success; but in excavating a cellar a few feet from the well, a copious spring was tapped, and conveyed into it by a channel. In the river Ore is an island of London clay, in which two wells were sunk through 80 feet of clay, 3 inches of rock and 20 feet of sand. The water rose to the surface, had a strong smell of sulphur, but no saline taste, though it overflowed only during high tide in the river. The fossils mentioned by the author, are confined to fishes' teeth, and the occasional occurrence of shells. He mentions that land animals have undoubtedly been found in the London clay, as the tusk of an elephant at Harwich, but he is of opinion that the greater part of such remains, said to have been obtained from the formation, have been washed out either of the crag or the diluvium.

Crag.—Mr. Clarke says the term crag is applied in Suffolk only to the shelly beds, and the word gravel to the associated beds of pebbles, as well as to the accumulation of superficial pebbles. The portion of the county occupied by the deposit, is bounded on the west by a line connecting the water-head of the estuaries; and the most southern point at which it is now visible is Blackbrooke Hill, near Dedham, the patch at Walton Naze having been entirely removed by the partial destruction of the cliffs. Sand, however, containing shells occurs at Ardleigh Wood near Colchester, and it has been said that Danberry Hill, near Chelmsford, is capped by crag; but Mr. Clarke doubts the accuracy of this observation. The general surface of the area assigned to the deposit in Suffolk, is a platform of nearly regular elevation, which appears to have been worn into ridges and valleys by currents acting in parallel lines from N.E. to S.W., and the cliffs both in the interior and on the coast, are sections of these ridges. The dip of the London clay corresponds with that of the crag, and therefore Mr. Clarke infers, that both were acted upon by the same agents, and while they were beneath the level of the sea.

According to the author's observation, the deposit nowhere extends more than twelve or thirteen miles from the coast, and at Pakefield, where the diluvial clay comes to the very edge of the sea, it disappears as a surface deposit, but is visible at intervals further north, between that point and Cromer. Mr. Clarke also states, that though undoubtedly crag is discernible here and there, *in situ*, as a regular formation north of the Waveny, yet he by no means allows that it is regularly stratified, as an undisturbed deposit, between Leiston and Pakefield. He is fully convinced from observation, that the diluvial clay and crag are distinct deposits; and he is almost equally convinced, that if the crag has any share in the formation of the cliffs between the Blithe and Lake Lothing, it has been introduced by disturbances of a similar nature to those, which are presented in the cliffs of East Norfolk. That the localities in dispute may have been once occupied by crag, there is no reason to deny, but they now present no traces of an undisturbed deposit.

To previous descriptions of the structure of the crag, the author states that he has nothing to add, except that where the shells are not visible, the sands contain a slight mixture of calcareous matter.

He objects to the separation of the beds with shells from those without, and shows that the shifting of a sand-bank, would correctly account for the occasional occurrence of beds of sand 30 feet thick, resting upon strata inclosing testacea.

Believing that the true rationale of the crag is to be found in the hypothesis of sandbanks, inhabited by testacea, and situated in a tidal way exposed to violent fluctuations of the sea, as well as subject to drifts of extraneous matter from land waters, the author sees nothing extraordinary in the idea that accumulations of sand and shingle, may have formed a part of that deposit in which the crag is regularly stratified ; but he cannot consent to such accumulations, though contemporaneous with the crag, being classed under that name, much less can he consent to diluvial clay being also included in it.

If then, says Mr. Clarke, we assume that in this tertiary sea, sandbanks were formed, around the shelves and under the lea of which testacea collected, lived and died, as at present, many of the phenomena of the crag may be readily solved, and we shall not need to wonder why the bivalve shells are found lying with the flat sides to the strata of sand ; why the young are congregated in one group, and the old in another ; why pebbles are found covered with balani ; or why the remains of terrestrial mammalia, are associated with those of whales and fishes.

With respect to Mr. Charlesworth's subdivision of the crag into two ages, the author fully agrees with a qualification of the word age. If that gentleman had said different periods of the same age, Mr. Clarke would find no difficulty in admitting the justness of the classification ; as not only species but genera of shells are differently grouped according to localities. The Norwich crag, he also admits, differs from the Suffolk, and on the authority of Mr. Woodward alludes to bouldered Suffolk shells occurring at Thorpe, in Norfolk.

The corals of the lower bed of the Suffolk crag, the author is of opinion, betoken a warmer climate, and he says, if during the crag era the earth gradually cooled, the change from a coralline deposit to one more nearly related to the inhabitants of the present era, would be the natural and inevitable result.

Mr. Clarke fully assents to the observation brought forward by Mr. Charlesworth in a paper, read before the British Association at Bristol, on the mixed nature of the deposits now forming on the coasts of England, in which the remains of the adjacent cliffs are intermingled with the shells of existing species ; and adduces examples with which he was acquainted, long before the reading of that paper.

The author then offers some further remarks on the necessity of separating the diluvium from the crag. He is of opinion, the gravel found in the latter, if carefully observed, will be acknowledged to differ from regular diluvial gravel, and that its occurrence only betokens a diluvial action during the period of the crag. That such actions have been often repeated, he says there can be no doubt, for the beds of superficial gravel of Suffolk and Dorsetshire, are evidently not of the same period ; and no one who has studied gravel deposits accurately, can refuse to admit, that there have been more than one diluvial action, since the deposition of the tertiary formations. In Norfolk, he adds, it is true, the crag is involved in the clay, but if this clay which in that county is 400 feet and in Suffolk 300 feet thick, be one with the crag, it is most curious that a line of demarcation should actually exist, between the districts in Suffolk occupied by these deposits; and that the clay is never found below or intermixed with the crag. Moreover this diluvial clay has been traced not only into Norfolk but into Cambridgeshire and Essex, close up to the metropolis. In Suffolk the same line which bounds the London clay bounds the diluvial. By an extension of Mr. Lyell's argument all diluvial deposits, the author observes, might be included in the crag, and all other formations considered as diluvial. The only rational conclusion in Mr. Clarke's opinion, is, that during the crag era an extraordinary convulsion took place which shook the whole country. He gives also one or two instances in which diluvial clay and gravel, have been introduced into cavities in the crag from overlying beds of superficial detritus.

On the conchological history of the crag, Mr. Clarke offers no remarks, partly because it did not fall within his object in writing the paper, and partly because the data which he formerly collected have been lost.

Diluvium.—The diluvium of Suffolk may be divided into three classes: 1, clay; 2, gravel; and 3, erratic blocks.

1. *Clay.*—This division covers a considerable portion of the county, and extends into Norfolk, Cambridgeshire, and Essex, rising to a considerable elevation in High Suffolk, and attaining near Cromer, a thickness of 400 feet. A considerable portion of the clay, is of a yellowish hue, but the greater part is blue; and both varieties contain chalk pebbles, sometimes disposed in layers but more commonly dispersed, a character by which the diluvial may be distinguished from the London or plastic clay. It is difficult to determine the origin of this argillaceous deposit; but the author is inclined to think, that the yellowish portion may have been derived from the plastic clays, and the blue from the clays below the chalk. Fragments of coal have been found in the diluvium at Lavenham, also fragments of mica slate containing garnets and tourmaline. Specimens of a similar rock were obtained by Mr. R. C. Taylor, at Cromer, with masses of granite, porphyry, trap, oolites, &c. At Ballingdon Hill near Sudbury, Mr. Brown has procured thirty varieties of primary, secondary, and tertiary rocks. Comparatively few flints occur in the clay. At Ickworth a beautiful specimen of the Dudley Trilobite was obtained in making a drain: and at various other localities, numerous species of tertiary and secondary fossils abound.

It is inferred that the clay contains cavities, as streams of noxious air occasionally issue from fissures.

2. *Gravel.*—The gravel is less generally diffused than the clay, and is considered by Mr. Clarke, to have been partly deposited at a distinct period. In some cases, it consists merely of unrolled flints, left *in situ* by the dissolution of the chalk; in others, large masses of flint

slightly mixed with chalk pebbles are imbedded in sand; and occasionally flints are intermingled with boulders of various dimensions, and sometimes unknown origin. Many of these extraneous fragments, he thinks, may have been washed out of the clay; and he shows that the river valleys have been excavated through both the clay and the gravel. With respect to the relative proportional quantity of each ingredient, chalk flints are said to be the most numerous, primary and transition rocks the next in abundance, and secondary and tertiary the fewest in number; the absence of the two latter being explained by their inferior hardness.

3. *Erratic blocks.*—These occur in great abundance, and occasionally of vast size. They are sometimes found in the river valleys, and sometimes on the level platforms and hills. They agree in lithological characters with the smaller fragments of the gravel, and are considered to be of the same diluvial origin; but are so conspicuous as to deserve a distinct notice.

Lacustrine deposits.—Under this head the author alludes to the bed containing freshwater shells, discovered by Mr. Charlesworth and Mr. Wood on the banks of the Stour at Sutton; and that described by Mr. Brown at Copford near Colchester, which contains similar shells, also bones of the ox and deer. Accumulations containing the same testacea, occur at Grays near Purfleet, and at Southend in Essex, but associated with remains of the elephant, rhinoceros, deer, ox, bear, &c. In the bed at Grays rounded pebbles of chalk occur, agreeing with those found in the diluvium, and from which they were probably derived.

Causes in Action.—In this division of the memoir are described, 1stly, the alluvial accumulations; 2ndly, the changes in the river courses; and 3rdly, the action of the sea on the coast. In illustration of the two first, Mr. Clarke enters into a discussion on the supposed position of the Roman station, Ad Ansam, and the alterations which must have taken place, if the site assigned to it be correct. He then proceeds to the action of the tides on the cliffs.

His first acquaintance with the coast about Bawdsey was in 1814, and between that period and 1829, a battery which once stood 100 yards beyond the present low-water mark, has been dismantled; and the life-boat house has been three times removed, to a distance at least a quarter of a mile, in rear of its original position.

The destruction between the Alde and Bawdsey cliff during the last 20 years, is calculated to have been upwards of 100 acres; and the coast between that cliff and Bawdsey Haven, is stated to have diminished about two yards annually. Similar remarks apply to the cliff between the Deben and Harwich harbour, batteries and martello towers having been successively undermined.

In 941 the church at Walton Naze was at a considerable distance inland; about 50 years since the church and burial-ground remained but not a vestige of either is left. In 885 a sea fight took place between Alfred and the Danes at the mouth of the Stour, where the shingle bank now is. Harwich is also stated to have arisen in consequence of the destruction of Orwell, which stood on the spot called the West Rocks, and was overwhelmed by an inroad of the sea, since the Conquest. During the period, however, that these destructive changes having been proceeding on one side of Harwich harbour, sandbanks have accumulated at another, and compelled the Stour and the Orwell to open a new line of communication with the sea.

The author then gives the following conclusions as deducible from the statements in the body of the memoir.

1. The substratum of the whole of Suffolk, Norfolk, and Essex is chalk, which appears to have been dislocated and worn into deep hollows by the action of water, previously to the commencement of the tertiary era.

2. On this abraded surface the plastic clays and sands were formed, but not over the whole area.

3. Partly on these beds and partly on the chalk, the London clay was then deposited, but to no very great thickness.

4. Upon the London and plastic clays as well as the chalk, the crag was next accumulated in sandbanks, produced by the tidal waters, and around projecting masses of chalk.

5. While the crag still lay beneath the sea, a violent catastrophe broke up many of the secondary strata, from the chalk to the lias inclusive, and the debris thus produced, together with numerous masses of ancient rocks, was spread by a rush of water over the surface of the tertiary formations and the chalk, in some places to a depth of 400 feet, constituting the beds of drift clay, &c., which occupy so great an area in Suffolk.

6. Previously to this diluvial action, and after it, the rivers of the then dry land bore to the sea, animal and vegetable remains, vestiges of which occur on the Norfolk coast and elsewhere.

7. The climate of this part of the globe was at that era different from the present.

8. After this period, and probably in prolongation of the first great catastrophe, a series of shocks acting from below, shattered the surface and gradually elevated the whole district, till the crag attained the height of nearly 100 feet above the level of the sea; and by this movement were produced the valleys or lines of fissure, through which the drainage of the county is effected.

9. No great convulsions have since taken place.

10. By the action of springs, and the constant battering of the sea, the superficial contents of the London clay and crag have been reduced several miles, vestiges of their former extent being traceable in rocks and sandbanks nearly always submerged.

11. By the set of the tides vast accumulations of shingle and sand, have been formed at projecting points, protecting in some places the cliffs from further destruction; but at Harwich harbour they have blocked up the ancient estuary, and compelled the Stour and Orwell to form a new outlet.

12. The average amount of annual degradation of the coast is about two yards in breadth; and in consequence of the confirmation of the ridges of crag and London clay, the cliffs will gradually diminish into a low sandy shore. The period estimated by Mr. Clarke for effecting this destruction is another century.

A paper "On the raised beaches of Saunton Downend and Baggy Point;" by the Rev. David Williams, F.G.S., was then read.

The first of these breaches extends from Braunton Burrows to Downend Point; the other on the N. coast of Croyd Bay, from near the limekilns to half way to Baggy Point. These beaches were described in the paper read by Professor Sedgwick and Mr. Murchison on the 15th December, 1836; and Mr. Williams in this paper fully agrees with the conclusions drawn by those authors, relative to the beaches having been raised.

In addition, however, to the proofs afforded by the abundance of remains of existing British marine shells in these accumulations, cemented together by calcareous infiltration into a tough sandstone, he stated that he had discovered in many places, from 6 to 10 feet, above the tidal level, and at the line of contact of the beaches with the old slate rocks of the district, countless Balani attached to the surface of the latter, but so firmly entangled in the substance of the former as to be separated with its fragments. A large granite boulder also rests on the slate, and is involved in the sandstone above any high-water mark. In support also of the land having been raised and not the sea depressed, he referred to the submarine forests of Somersetshire, in the prolongation of the same coast from Blue Anchor to the Parret; and argued that their position could not be accounted for by a subsidence in the sea level, but by an unequal movement of the land.

A communication by Mr. James de Carle Sowerby on his new genus of fossil shells, Tropæum, was then read.

This fossil is described by Mr. Sowerby as an involute chambered shell with sinuated septa; the whorls free, sometimes very distant; siphon in the external margin. The natural place of the genus is between Hamites and Scaphites, and the shells which may be grouped with Tropæum, have been hitherto ranked as Hamites, but have no sudden bend which may be compared to a hook. The species hitherto found have been obtained from the gault and green sand. The species (*Tropæum Bowerbankii*) described in the paper were obtained by Mr. Bowerbank in the Isle of Wight, and were found in the lower green sand on the south side of the Island.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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March 22.—Arthur Capel, Esq., of Charles-street, Berkeley-square; John B. Boileau, Esq., of Upper Brook-street, Grosvenor-square; Henry Still, Esq., employed on the Ordnance Survey; John David Day, Esq., A.B., Brazen Nose College, Oxford; John G. Malcolmson, Esq., Surgeon in the Hon. East India Company's Service; and the Right Hon. T. Frankland Lewis; were elected Fellows of this Society.

A paper "On the Ancient State of the North American Continent;" by Thomas Roy, Esq., Civil Engineer, Toronto, Upper Canada, and communicated by Charles Lyell, Esq., F.G.S., was read in part.

April 5.—The reading of Mr. Roy's paper was concluded.

The author having in the course of his professional duties, discovered in the lake district of Upper Canada terraces or level ridges which agreed in elevation at considerable horizontal distances, he was induced to extend his inquiries and ascertain how far similar phænomena have been observed in other parts of North America,—what may have been the probable extent of the lake or sea by which the ridges were formed,—and by what operations the waters were drained off, leaving only the present detached Canadian lakes.

With a view to ascertain the probable extent of the sea, Mr. Roy traced upwards from Lake Ontario the successive ridges or terraces*, and ascertained that their greatest height was 762 feet above the lake, or 996 feet above the ocean; he therefore assumed, that the boundary of the ancient sea must have had an elevation of at least 1000 feet, and in consequence, that it must have been formed on the west by the rocks and mountains ranging from the table-land of Mexico to the parallel of 47° of latitude; on the north by the barrier which separates the head-waters of the lakes from those of the Arctic rivers, and extending to Cape Tourmente below Quebec; on the east by the hills stretching through the United States to the Gulf of Mexico; and on the south by a mountain ridge which has been destroyed. The area thus circumscribed is calculated to be 960,000 square miles.

* These parallel ridges were exhibited on a section extending obliquely from the mouth of the Niagara to the south of Lake Ontario, and over the ridge north of that lake, to Lake Simcoe.

The chief geological feature connected with Mr. Roy's observations and described in the paper, is the high land which separates Lake Ontario from Lake Simcoe. The distance between these bodies of water is 42 miles, and the greatest elevation of the ridge is 762 feet above Lake Ontario, or 282 above lake Simcoe. The lowest visible formation is a stratified blue clay which effervesces freely and is of unknown depth. Above this are immense masses of clay, sometimes resembling fuller's earth, and sand most irregularly associated. The central and northern divisions of the ridge are thickly strewed, even to the highest peaks, with a great variety of boulders, many of them of immense size, and for the greater part derived from primary or transition formations. Many of them are rounded, and others decayed by weathering, whilst the edges of some are perfectly entire. On the southern side of the ridge boulders are not so common.

The manner in which the materials composing this ridge are arranged, resembles, in Mr. Roy's opinion, that in which drifted matter is now disposed along the margin of the lakes at the breaking up of the ice; and hence he conceives, that the ridges may, to a considerable extent, have been accumulated in a similar manner.

The author then enters into a calculation of the quantity of water hourly discharged by the Saint Lawrence, the Mississippi and the Hudson, amounting, according to his estimate, to 4000 millions of cubic feet; and afterwards proceeds to show, that in order to reduce the ancient lake 30 feet, the distance between two of the highest parallel ridges, fifteen years would be required, supposing the discharge to be double that at present.

Mr. Roy next details with considerable minuteness, the processes by which he supposes this vast sea was drained; but as his descriptions cannot be successfully followed without the aid of diagrams, they do not admit of being given in the Society's Proceedings.

A paper "On the Geology of the neighbourhood of Smyrna;" by Hugh Edwin Strickland, Esq., F.G.S., was then read.

The district described consists of two ranges of high land, running from east to west, separated by the bay of Smyrna and the alluvial plain of Bournabat, at the eastern termination of which is a transverse ridge uniting the two ranges.

The rocks belong to the formations described by the author in his former paper on Asia Minor (p. 424, &c.), and are: 1. Hippurite limestone and schist; 2. Tertiary limestone and marl; 3. Trachytic rocks.

The author supposes that mountains of hippurite limestone formed the boundaries of a lake in which tertiary beds were deposited, which were afterwards broken up by the eruption of trachytic rocks, and that the same event may have produced the drainage of the lake subsequently carried on by the denudation of its outlet, which is now traversed by the Meles.

1. The hippurite limestone on the south side of Smyrna bay is accompanied by much black, greenish, or cream-coloured sandstone, analogous to the macigno of Italy; but it is difficult to decide whe-

ther the schist or limestone is highest in geological position. The latter extends from 15 to 20 miles to the east along the north side of the Tmolus range; but in Mount Corax the limestone is commonly absent, and schistose rocks prevail, in some places yellowish and friable, in others dark-coloured and compact; a fine-grained quartzose conglomerate also occurs.

2. The tertiary lacustrine limestone on the south side of the bay forms a table-land extending south from Smyrna about 15 miles. It consists of whitish limestone in horizontal beds containing nodules and layers of *quartz resinite*. Planorbes and paludinæ abound at certain points, but are not generally diffused. Greenish marls alternate with the limestone, and prevail in the central parts of the area where they contain beds of rolled gravel of nummulitic limestone, schist, and red trachyte. Conglomerate beds also prevail around the margin.

3. A vast mass of trachyte appears near Smyrna, and from thence to spread over the lacustrine beds. It consists chiefly of reddish porphyritic trachyte, in some places stratified on a small scale. A breccia of fragments of blackish trachyte in a red paste is also frequent. The aqueous and igneous rocks do not alternate; the lacustrine beds do not contain igneous materials, and no dikes are observed. On the south side the trachyte overlies the lacustrine formation like a lava coulée, the uppermost bed of the latter in contact with the trachyte being a conglomerate of hippurite limestone and schist with no traces of igneous matter.

Mount Pagus, south of Smyrna, is chiefly trachyte overlying the lacustrine beds, which crop out on the north side and dip towards the centre of the hill, consisting of sandy strata with vegetable remains and shells of helix and unio, and between them and the trachyte is the limestone conglomerate. At the north-east foot of the hill is a small isolated mass of yellowish schist and hippurite limestone about an acre in extent.

The north side of Smyrna bay presents appearances analogous to those on the south. The grey hippurite limestone of Mount Sipylus is accompanied as at Mount Tartali by black and greenish schists. The lacustrine deposits are overlaid by a great mass of trachyte which forms the lofty mountain of Cordileon. The relation of the lacustrine beds to the grey hippurite limestone is well exposed in a ravine north of Bournabat; and a few yards further north they contain beautiful impressions of leaves referred to the genera Laurus, Nerium, Olea, Salix, Quercus, and Tamarix; also shells of Cyclas, Paludina, Planorbis, and Cyprus. In ascending hence to the west the lacustrine marls are surmounted by non-volcanic conglomerate, identical with that of Mount Pagus. Above this are beds of tufaceous conglomerate, and at the top the brown trachyte of Cordileon, resembling that near Smyrna, and like it sometimes laminated, but presenting little variety except in a long ridge opposite Smyrna which consists of whitish decomposed earthy trachyte.

A letter was next read addressed to Sir Charles Lemon, Bart., F.G.S., by R. W. Fox, Esq., "On the process by which Mineral Veins have been filled."

Mr. Fox admits that the non-mechanical deposits in mineral veins may be due, in part, to infiltration from the enclosing rocks; but it appears to him, that such deposits might have been derived in almost indefinite quantities, by the circulation or ascension of currents of heated water from the deeper parts of the original fissures. He says, that water in this state possesses very great powers as a solvent, and would therefore become highly charged with earthy and metallic salts; but that in ascending it would lose its temperature, and consequently deposit the solutions against the sides of the veins.

He is of opinion, that the arrangement of the ore in different rocks, cannot be due to simple chemical affinity only, because the accumulation of the metallic masses is not found, in Cornwall at least, to depend on the nature of the containing rock, the ore of a given metal being sometimes found in granite, sometimes in elvan, sometimes in killas. This preferment of one rock to another he conceives may have resulted from the relative position of the mineral masses, but to be chiefly due to electricity.

Extracts from two letters "On the Earthquake in Syria in January last;" addressed by Mr. Moore, his Majesty's Consul-General at Beyrout, to Viscount Palmerston, and communicated by J. Backhouse, Esq., and the Hon. W. T. H. Fox Strangways, F.G.S., Under Secretaries of State, were also read.

The first letter, dated Beyrout, Jan. 2nd, 1837, announces that the earthquake was felt in that city at thirty-five minutes past four o'clock in the afternoon of the preceding day. It was accompanied by a rumbling noise, which lasted about ten seconds, and appeared to proceed from the north. No buildings were thrown down in the town, but seven or eight without the walls, and one or two lives were lost. In the neighbourhood of Beyrout the course of the river Ontilias was suspended, and mills built on its banks were deprived of water for some hours. When the stream returned it was turbid, and of a reddish sandy colour.

During the day of the earthquake the atmosphere was close and charged with electricity. Fahrenheit's thermometer stood at 66°, but five minutes after the earthquake it rose to 70°. Four or five minutes after the shock the compass was still agitated. The oldest inhabitants did not remember so severe an earthquake.

The second letter was written also at Beyrout, partly on the 9th of January, and partly on the 23rd. It contains detailed accounts of the damage which had been done to numerous towns and villages. At Damascus, four minarets and several houses were thrown down; and at Acre, part of the walls and some buildings. Saffet was entirely destroyed, and nearly all the population, amounting to between four and five thousand, perished. The ground near the city was rent into fearful chasms, and up to the last accounts shocks were felt daily. Tiberiad was also entirely destroyed, except the baths; and the lake rose and drowned many of the inhabitants. The dispatch contains a list of thirty-nine villages which had been totally destroyed, and six partially; and Mr. Moore says, it had been ascertained that the earthquake was felt on a line of five hundred miles in length by ninety in breadth. It was also perceived in the island of Cyprus.

April 19.—Edward Herbert Bunbury, Esq., A.M., Fellow of Trinity College, Cambridge; Henry Boase, M.D., of Burton Crescent; and Thomas Jervis, Esq., Hon. East India Company's Engineers; were elected Fellows of this Society.

A paper was read, entitled "A description of the Cranium of the *Toxodon Platensis*, a gigantic extinct mammiferous species, referrible by its dentition to the *Rodentia*, but with affinities to the *Pachydermata* and the *Herbivorous Cetacea*;" by Richard Owen, Esq., F.R.S., Hunterian Professor of Anatomy to the Royal College of Surgeons.

The author premises his anatomical description of the present fossil, by an abstract from Mr. Darwin's account of the geological structure of the district in which the cranium was found, from which it appears that it was imbedded in a whitish argillaceous earth, forming part of the banks of the Sarandis, a small stream entering the Rio Negro, and about 120 miles distant to the north-west of Monte Video.

The foundation of the whole surrounding country is granitic, but covered, often to a considerable thickness, by a reddish argillaceous soil, containing small calcareous concretions.

The cranium in question equals in size that of the hippopotamus, measuring two feet four inches in length, and one foot four inches in extreme breadth.

The form of the skull is elongate, depressed, and chiefly remarkable for the strength and wide expanse of the zygomatic arches, and the aspect of the occipital foramen and occipital region of the skull, which slopes from below upwards and forwards. The maxillary portion of the skull is compressed laterally, narrow, with large intermaxillary bones, slightly dilated at their extremity.

The teeth consist of molars and incisors. The latter are four in number in the upper jaw, the two middle ones very small, the two external ones very large, curved, and with their sockets extending backwards in an arched direction, through the intermaxillary bones to the maxillary, and terminating, without diminishing in size, immediately anterior to the grinding teeth, where the large persistent pulps of these incisors were lodged. In form and relative size these teeth must have resembled the *dentes scalprarii* of the *Rodentia*.

The molar teeth no less present a close approximation in their form and structure to the molar teeth of the herbivorous rodents; as is demonstrated in the detailed descriptions of one of these teeth found by Mr. Darwin in another locality, but belonging to the same species of *Toxodon*, and to an individual of the same size as that to which the cranium here described belonged; and of a portion of another molar lodged in one of the sockets of the same cranium. The molar teeth are seven in number on each side of the upper jaw, and from the form of the sockets appear to have corresponded with each other in structure.

After this description of the teeth, the form, proportions, disposition and connections of the different bones of the cranium are pointed out; and the structure of the osseous cavities subservient to the organ of sense is adverted to, and deductions as to the aquatic habits of the Toxodon are founded on these observations.

So far as regards the form and position of the external aperture of the bony nostrils, and of the occipital condyles, and the slope of the plane of the occipital region of the skull, the same arguments might be advanced for referring the *Toxodon* to the mammiferous group containing the Dugong, as have been recently urged in reference to the *Deinotherium*, but the existence of air-cells or sinuses in the superior parietes of the cranium in the *Toxodon*, show that the cranial characters above alluded to, are not conclusive as to the cetaceous nature of an extinct mammal.

The general conclusions respecting the affinities which the *Toxodon* bears to existing orders of mammalia, so far as opinions can be formed from the portion of the skeleton preserved, are summed up by the author as follows:

So far as dental characters have weight, the *Toxodon* must be referred to the rodent order; but from this order it deviates in the relative position of the supernumerary incisors, and in the number and direction of the curvature of the molars.

It again deviates in the transverse direction of the joint of the lower jaw, and in the relative position of the glenoid cavities and zygomatic arches. In the aspect of the plane of the occipital foramen, and occipital region of the skull, in the form and position of the occipital condyles,—the aspect of the plane of the bony aperture of the nostrils, and in the thickness and texture of the osseous parietes of the skull, the *Toxodon* deviates both from the *Rodentia* and existing *Pachydermata*, and manifests an affinity to the *Dinotherium* and the *Cetaceous* order.

The author observes, however, that the development of the nasal cavity and the presence of frontal sinuses, render it extremely improbable that the habits of the *Toxodon* were so exclusively aquatic as would result from the total absence of hinder extremities, and concludes, therefore, that it is a quadruped, and not a Cetacean; and that it manifests an additional step in the gradation of mammiferous forms leading from the *Rodentia*, through the *Pachydermata* to the *Cetacea*; a gradation of which the water-hog of South America (*Hydrochœrus Capybara*) already indicates the commencement amongst existing *Rodentia*, of which order it is interesting to observe this species is the largest, while at the same time it is peculiar to the continent in which the remains of the gigantic *Toxodon* were discovered.

May 3.—The Rev. Baden Powell, A.M., F.R.S., Savilian Professor of Geometry in the University of Oxford, was elected a Fellow of this Society.

A paper was first read, entitled "A Sketch of the Deposits containing extinct Mammalia in the neighbourhood of the Plata;" by Charles Darwin, Esq., F.G.S.

Mr. Darwin premised his account of the geological features of the district in which the remains of the *Toxodon*, described at the meeting on the 19th of April by Mr. Owen, (p. 541) were found, by remarking that as the other mammalia and the fossil shells had not yet been accurately examined, the notice was necessarily imperfect.

To the westward and southward of the great estuary of La Plata, extend those level and almost boundless plains which are known by the name of the Pampas. Their geological constitution over many hundred square miles does not vary. It consists of a reddish argillaceous earth, which generally contains irregular concretions of a white aluminous limestone, or indurated marl, often passing irregularly into a compact calcareous stone, traversed by small linear cavities, similar to those which occur in many of the freshwater limestones of Europe. In the province of Entre Rios, the formation which composes the surface of the Pampas overlies and passes into a series of beds of sand, clay, and crystalline cellular limestone; containing sharks' teeth, gigantic oysters, and other shells belonging to the genera arca, Venus and pecten. These shells, with the exception of the oyster, have a general resemblance to existing species. To the northward and eastward of the Plata, the province of Banda Oriental, though very low and level, consists of gneiss, granite and primary slate. These rocks are generally concealed by a considerable thickness of a reddish earth, which, though at first sight like ordinary detritus, belongs to the same formation with that composing the Pampas. This deposit, extending over so wide an area on both sides of the Plata, abounds with very numerous remains of various extinct mammalia; among which the *Toxodon*, *Megatherium*, *Mastodon*, an animal covered with an armadillo-like case, and as Mr. Darwin believes, the horse, co-existed in the same district.

Proofs of the elevation of the land within a recent period, occur in several parts. Mr. Darwin stated that he had seen in the possession of Sir W. Parish, marine shells which occur near Buenos Ayres in great beds, elevated several yards above the level of the river; and these same species the author had found living on the mud banks on another part of the coast. He, therefore, inferred, that at no very remote period a great bay occupied the area both of the Pampas and of the lower parts of Banda Oriental; and that into this bay the several rivers, which now unite to form the Plata, poured down reddish sediment, resulting, as at the present day, from the decomposition of the granites of Brazil, and charged with carbonate and sulphate of lime, perhaps derived from the Cordillera. On the cliff-formed shores of Entre Rios, the line can be distinguished where the estuary mud first encroached on the deposits of the ocean. The author also supposed that the ancient rivers, like those of the present day, carried down the carcases of land animals, which thus became entombed in the accumulating sediment. Since that period, by the gradual rising of the land, the bottom of the great bay has been converted into plains, almost as level as the surface of the former sea; and the rivers now hollowing out courses for themselves, have exposed, in many places, the skeletons of those ancient inhabitants of the neighbouring land.

Mr. Darwin then briefly alluded to a small formation of mud and shingle at Bahia Blanca, some hundred miles south of the Plata, in which the remains of several extinct quadrupeds have been discovered. Amongst these he enumerated the *Megatherium Cuvieri*, the remains perhaps of a smaller species of *Megatherium*; a quadruped closely allied to the armadilloes, but nearly as large as a horse; some small rodents, and other animals. These remains are embedded with one species of terrestrial, and several of marine shells, the latter being identical with some existing in the adjoining bay. It is, therefore, certain that the greater number of the above mammalia found at Bahia Blanca lived within a very recent epoch; and from the position of the bed in which they occur, it is equally certain that the form of the land has undergone, since that period, very little change, even of level, with respect to the ocean.

Several hundred miles further southward, Mr. Darwin found the remains of an animal which Mr. Owen says has an affinity with the Llama or Guanaco, but was of a gigantic size: this animal likewise existed since the Atlantic has been peopled by the shells now living.

The author observed in conclusion, that the comparative recentness of the epoch at which the fossil mammalia lived, is shown, first by the shells associated with them; secondly, by the recent tertiary character of the strata underlying the deposit containing those remains; and thirdly, from the little altitude of such beds above the level of the sea; for in this country, according to the author's observations, the movements seem to have been so regular, that the amount of elevation becomes a measure of time.

These facts relating to the former existence of the inhabitants of a part of the globe so remote from Europe, fully confirm the remarkable law, often insisted upon by Mr. Lyell, that "the longevity of the species" among mammalia has been of shorter duration than among molluscs. The author finally remarked, that although several gigantic land animals, which formerly swarmed in South America, have perished, yet that they are now represented by animals, confined to that country; and though of diminutive size, possess the peculiar anatomical structure of their great extinct prototypes.

An extract of a letter, dated Saharumpore, 18th November, 1836, from Captain Cautley to Dr. Royle, was next read; permitting the announcement of a fact which had long been communicated to the latter, of the finding of the remains of a quadrumanous animal in the Sewaliks, or Sub-Himalayan range of mountains. An astralagus was first found, but latterly a nearly perfect head, with one side of the molars and one orbit nearly complete. The animal must have been much larger than any existing monkey, and allied to Cuvier's Cynocephaline group. Captain C. also announced the discovery by Major Colvin of a specimen of the head of the Sivatherium, in which, in conformity to the conjectures of Dr. Falconer and himself, in their paper, it is found that the animal had four horns, two in front and two large trifurcated ones behind. He considers the animal to be allied to the Dicranocerine group of Major Hamilton Smith.

Capt. C. also mentions the discovery of a large bear, as well as of a camel, respecting which he had, in conjunction with Dr. Falconer, published a paper. Mastodon's heads were also making their appearance, perfectly different in form from the proboscidean Pachydermata of the present day. There appeared to be altogether two if not three species, besides the variety of *M. angustidens*.

A paper was then read "On some recent elevations of the Coast of Banffshire; and on a deposit of clay, formerly considered to be lias;" by Joseph Prestwich, jun., F.G.S.

That an uplifting of the shores of the Moray Firth, has taken place subsequent to its having assumed its present outline, is proved by the existence, in several places, of a raised beach. In Banffshire this beach varies from six to twelve feet above the present high water level; and occasionally abounds in shells now inhabiting the adjacent seas, as *Patella vulgata, P. levis, Trochus ziziphinus, Littorina littorea,* and *Turbo retusus.* To this upheaving of the land the author attributes the draining of the former lowlands, as he conceives is indicated by the remains of drained peat-mosses. A section of one of these presented a total thickness of about four feet, including two irregular layers of gravel, of quartz grit, with freshwater and land shells.

In a paper on the Gamrie Ichthyolites, read before the Society in April 1835*, Mr. Prestwich stated, that having been informed of the occurrence of lias fossils in the dark clay and sand, which in many parts of Banffshire cap the old red sandstone and schistose rocks, he had inferred that these beds might be outliers of lias. Having however subsequently visited the country, and examined that deposit at Blackpots and Gamrie, he found the lias fossils in separate masses and associated with rolled fragments of the older rocks. He also met with at Gamrie, in a bed of light coloured sand, alternating with dark clay and beds of gravel, the following recent shells, *Astarte Scotica, Tellina tenuis, Buccinum undatum, Natica glaucina, Fusus turricola, Dentalium dentalis,* &c. They were extremely friable, but perfect. This deposit or drift attains, in places, a thickness of 250 feet, and rises to a height of 350 feet.

In conclusion, the author attributes the origin of this drift to a denudation of the lias and older formations; and he infers, from the perfect preservation of the fossils, and the superposition of the beds, that its accumulation was gradual.

A paper was afterwards read, entitled "An account of a Tertiary Deposit near Lixouri, in the island of Cephalonia;" by William John Hamilton, Esq., F.G.S., and Hugh Edwin Strickland, Esq., F.G.S.

The authors state that most of the island of Cephalonia which they had an opportunity of examining, consists of a hard white limestone

* Geological Proceedings, Vol. ii, No. 40.

or scaglia, occasionally more or less crystalline, which forms the principal rock of the Ionian islands. It is generally without fossils, but near Argostoli contains numerous organic remains, principally small spiral univalves; and near the middle of this vast formation are two beds of oyster shells, about a foot thick each, and parallel to the stratification which dips to the north-east at an angle of 25°.

The tertiary formation extends for two or three miles to the north and south of Lixouri, forming several parallel lines of hills, sloping to the east according to the dip of the strata, and presenting a succession of steep escarpments toward the west. The beds are all conformable, dipping a few degrees to the north of east by compass, at an angle varying from 45° to 55°. These beds are remarkable for their great thickness, the beauty and number of their fossils; and for the variety of strata through which they extend. The beds, of which sixteen are enumerated, may be classed under three principal heads. First, the calcareo-arenaceous; second, the argillaceous; third, the gypseous beds. Of these, the first is a loose sandy alluvium, rising very gradually from the sea side, and resting unconformably upon the other beds which are conformable. The fossils belong to numerous genera; and some of the species have been identified with those at present existing in the Mediterranean.

May 17th.—Joseph Walker, Esq., of Caldeston House, Liverpool, and President of the Institution of Liverpool, was elected a Fellow of this Society.

"A description of the Geological character of the Coast of Normandy;" by S. Peace Pratt, Esq., F.G.S., begun at the meeting on the 3rd of May, was concluded.

The author commences his paper by observing that the fall of a cliff or the opening of a quarry throws light upon an obscure locality and clears up previous difficulties; and that from frequently examining the coast from Point Antifer to near Grenville, he has had opportunities of correcting some of the views of M. De la Beche and M. De Caumont in their descriptions of the same line of coast.

The chalk cliffs from Point Antifer to Cap la Heve are composed of *craie glauconeuse* equivalent in position to chalk marl. These rest on a bed 40 to 50 feet thick of green sand, containing numerous fossils; the lower part, of a dark olive green, is also full of shells and corals. To these succeed two argillaceous beds with an intermediate one of ferruginous sand, each five to seven feet thick, resting upon a fourth 20 to 25 feet thick of sand, in which the plates of mica are numerous and large. These beds are interesting as indicating the presence of the gault, lower green sand, and Hastings sand. The absence of the characteristic fossils may be explained by the beds appearing to have thinned off towards the coast.

The ferruginous deposit rests upon an argillaceous limestone, separated into thin beds by partings of clay, then rising to the surface at a small angle to the north-east of Cap la Heve. The upper layers of the clay contain *Gryphæa virgula*, *Ostræa deltoidea*, &c., while in the marl stone, though there are few fossils, a *Pholadomya*, *Terebratula*,

&c., were occasionally found in the upper parts with Trigonia and Perna, in the lower parts generally in distinct beds. These therefore represent the Kimmeridge clay, though found immediately under the iron sand.

On the south bank of the Seine, though the cliffs appear similar, yet in consequence of a fault the lower argillaceous bed which covers the ferruginous sand has been brought down to the level of the shore; and has led to the error that the argillaceous beds on the two shores were of the same age; and that the *argile d'Honfleur*, like that on the north bank, was identical with the Kimmeridge clay, though it actually overlies the iron sand.

Beyond Honfleur a marshy plain succeeds, composed to the depth of two feet of a marl containing such freshwater shells as Lymnæa, Cyclas, Planorbis, &c. At Cricque-bœuf a bed of clay, similar to that at Havre, rises to the surface, covered by a few inches of the green and ferruginous sands; and as the characteristic shells are found in its upper part there can be no doubt of this also being analogous to the Kimmeridge clay. About a mile to the westward it is seen resting on a calcareous close-grained rock, which from its nature and fossil shells, and abundance of coral, the author considers equivalent to the coral rag; and states that the upper part cannot represent the Portland beds, for the whole distinctly underlies the Kimmeridge clay. Near the mouth of the Toncque a deposit of clay rises from beneath these calcareous strata, alternating with their lower beds and forming bold cliffs from near Villers-sur-mer to Dives. Fossil remains, both animal and vegetable, are abundant; in the upper part *Gryphæa dilatata* and *Ostrea gregarea* in numerous thin beds. The remains of vertebrated animals are not very numerous, but bones of saurians and fishes are occasionally found. Mr. Pratt gives a list of the fossils found in the Argile de Dives, which he assimilates to the Oxford clay.

This clay is again seen at a short distance from the mouth of the Orne overlying a calcareous oolitic group, consisting of numerous fissile beds full of shells and fragments of coral, usually considered identical with the cornbrash; but which Mr. Pratt considers as approaching much nearer to the forest marble of the west of England. They pass into others less oolitic, containing numerous genera of corals and shells, and overlie two beds of marly rubbly stone passing in their lower parts into a clay filled with fossils chiefly of *Terebratula digona* and *plicata*, *Avicula inæquivalvis*, *Apiocrinites rotundus*, &c. Together they form a mass about eight feet thick, but varying at short distances and resting upon a hard crystalline limestone, very little oolitic, composed of broken shells and corals, stems of Encrinites and Pentacrinites, and the corals for which this locality is famous in the fissures. This stone is generally thought to pass into the freestone of Caen; the author thinks it more probable that it overlies it, but thins off towards the S.W. The Caen stone is usually considered to represent the great oolite, but Mr. Pratt remarks that the few fossils found in it, as *Terebratula spinosa*, &c., resemble those of the inferior oolite. In examining the cliffs near St. Honorine, the lias, in consequence of a fault, may be seen for a few hundred yards forming their base. The contact of the lias filled with Belemnites with the inferior oolite is here marked by a highly ferruginous oolitic bed, only a few inches in thickness, but containing almost as many fossils as when of its greatest thickness. These are generally identical with those found at Dundry. Upon this bed rests the sandy calcareous rock, 25 feet thick, which has been described by M. De la Beche as lias. It contains three or four beds full of sponges, Alcynia, a few shells, and numerous Echini, and is surmounted by an argillaceous deposit varying from light grey to dark blue, and assuming at Port en Bessin a thickness of more than 100 feet, but is not separately distinguished in M. De la Beche's section. From geological position it appears to represent the Fullers' earth. This clay is covered by a calcareous rock slightly oolitic, containing few or no fossils, and forming the summit of the cliffs from St. Coine to Granville.

Mr. Pratt concludes his paper by observing that nearly the whole of the strata found between the chalk and the lias in England are found on the coast of Normandy, though somewhat modified; and that nearly all the characteristic shells are found in each. No bed of any consequence found in Normandy is wanting in the English series; while the Portland and perhaps the Purbeck beds with the Kelloway rock are not seen in this part of France.

Extracts from a letter from Sir John F. W. Herschell to C. Lyell, Esq., dated Fredhausen, Cape of Good Hope, 20th February, 1836, were then read.

The author commences by inquiring, whether it had ever occurred to Mr. Lyell to speculate on the probable transfer of pressure from one part to another of the earth's surface by the degradation of existing, and the formation of new continents, on the fluid or semifluid matter beneath the outer crust? Supposing the whole to float on a sea of lava, the effect would merely be an almost infinitely minute flexure of the strata; but supposing the layer next below the crust to be partly solid and partly fluid, and composed of a mixture of fixed rock, liquid lava and other masses in various degrees of viscidity and mobility; great inequalities may subsist in the distribution of pressure, and the consequences may be local disruptions of the crust where weakest, and escape to the surface of lava, &c.

Referring to the phenomena of volcanos, Sir J. Herschell observes, that it has always been his greatest difficulty in geology to find a *primum mobile* for the volcano, taken as a general and not as a local phenomenon; and referring to the different theories given on the subject, which he considers insufficient, wanting in explicitness and as not going high enough in the inquiry or up to its true beginning, and also as giving in some respects a wrong notion of the process itself;—inquires, how came the gases which are evolved to be condensed?—why did they submit to be urged into liquefaction?—if they were not originally elastic, but have become so by subterranean heat—whence came the heat, and why did it come?—how came the pressure to be removed, or what caused the crack?

It seems clear that if the gases or aqueous vapour were once free at so high a degree of elasticity as is presumed, there exists no adequate cause for their confinement. We are forced therefore to admit that the elastic force has been superadded to them during their sojourn below by an accession of temperature.

Assuming a high central temperature, which many geologists admit, and with which all are familiar; the author agrees with Mr. Lyell's observations, that the ordinary repose of the surface argues a wonderful inertness in the interior, where in fact he conceives that everything is motionless; debarred therefore from the invasion of a circulating current or casual injection of intensely hot liquid matter from below, he conceives that the phenomena may be explained as follows:

Granting an equilibrium of temperature and pressure within the globe, the isothermal strata near the centre will be spherical; but where they approach the surface they will by degrees conform themselves to the configuration of the solid portion, that is, to the bottom of the sea and the surface of continents. If we suppose therefore a state of equilibrium, and that under the concave bottom of any great ocean the lines of equal temperature be parallel to its concavity; when this comes to be filled up by the deposition of matter brought down by rivers, &c., the formerly concave bottom may become horizontal or even convex, and the equilibrium of temperature will immediately be disturbed; because the form of a stratum of temperature depends essentially on the bounding surface of the solid above it, that form being one of the arbitrary functions which enters into its partial differential equation. The temperature, therefore, will immediately begin to migrate from below upwards, and the isothermal strata will gradually change their forms from the concave to the horizontal or convex form. The former bottom of the ocean will then (after the lapse of ages, and when a fresh state of equilibrium is attained) acquire a temperature corresponding to its then actual depth; while a point as deep below it, as itself is below the surface, will have acquired a much higher temperature, and may become actually melted, and this without any bodily transfer of matter in a liquid state from below. But if the temperature of this supposed deep stratum be already at the melting point, then will this rise to the former bottom of the ocean and the strata become melted, *water included*, with which, from the circumstances of the case, they must be saturated.

If the process of deposition go on, until by accumulation of pressure on the bottom or sloping sides, some support gives way, a piece of the solid crust breaks down and is plunged into the liquid below, and a crack takes place, extending upwards. Into this the liquid will rise by simple hydrostatic pressure. But as it gains height it is less pressed; and if it attain such a height that the ignited water can become steam, the joint specific gravity of the column is suddenly diminished and up comes a jet of mixed steam and lava; till so much has escaped that the deposited matter takes a fresh bearing, when the evacuation ceases and the crack becomes sealed up.

By taking this view of the process of heating from below, we have a strictly theoretical explanation of the effects of heat on newly deposited strata ; and this, simply because the fact of new strata having been deposited, the conditions of the equilibrium of temperature become altered, and they draw the heat to them, or rather retain it in them in its transit outwards; the supply from the centre being supposed inexhaustible, and its temperature of course invariable.

As the greatest transfer of material to the bottom of the ocean is produced on the coast line by the action of the sea, while the quantity carried down by rivers from the surface of continents is comparatively trifling ; hence therefore the greatest local accumulation of pressure is in the central area of deep seas, but the greatest local relief takes place along the abraded coast lines : here, therefore, according to this view should occur the chief volcanic vents.

In this view the effects of the removal of matter from above to below the sea, are, 1st. It produces a mechanical subversion of the equilibrium of pressure. 2nd. It also, and by a different process, produces a subversion of the equilibrium of temperature. The last is the most important. It must be an *exceedingly slow process*, and will depend, 1st. On the depth of matter deposited ; 2nd. On the quantity of water retained by it under the great pressure ; 3rd. On the tenacity of the incumbent mass—whether the influx of caloric from below, which *must take place*, acting on that water, shall either heave up the whole mass as a continent ; or shall *crack* it and escape as a submarine volcano; or shall be suppressed until the main weight of the continually accumulating mass breaks its lateral supports at or near the coast lines, and opens there a chain of volcanos.

Thus the circuit is kept up—the *primum mobile* is the degrading power of the sea and rains (both originating in the sun's action) above, and the inexhaustible supply of heat from the enormous resources below, always escaping at the surface, unless when repressed by an addition of fresh clothing at any particular part. In this view of the subject the tendency is outwards. Every continent deposited has a propensity to rise again, and the destructive principle is continually counterbalanced by a reorganizing principle from beneath. Nay, it may go further ; there may be such a tendency in the globe to swell into froth at its surface, as may maintain its dimensions in spite of its expense of heat, and thus preserve the uniformity of its rotation on its axis.

Extract of a letter from Sir John F. W. Herschell to R. I. Murchison, Esq., in explanation of the former, to C. Lyell, Esq., dated Fredhausen, 15th November, 1836, was afterwards read.

In this letter the author recapitulates the views given in the foregoing abstract, stating that his views are not so much a theory as a pursuing into its consequences, according to admitted laws, of the hypothesis of a high central temperature ; and his object to get a geological *primum mobile* in the nature of a *vera causa*, and to trace its workings in a distinct and intelligible manner, so that in future, instead of saying as heretofore, "*Let heat* from below *invade* newly deposited strata, then they will expand, melt," &c., we shall commence a step higher, and say, "*Let strata be deposited*, then, as a necessary consequence, and according to known regular and calculable laws, heat will gradually invade them from below and around; and according to its due degree of intensity at any assigned time will expand or melt them as the case may be," &c. The phenomena of earthquakes, volcanic explosions, &c., may arise, but if all goes on in quiet, the only consequences will be the obliteration of organic remains and lines of stratification, and the formation of new combinations of a chemical nature, &c.; in a word, the production of *metamorphic* or stratified primary rocks.

In the formation of these therefore there is nothing casual; all strata once buried deep enough, and due time allowed, must assume that state. None can escape; all records of former worlds must ultimately perish.

"An account of a Well at Beaumont Green in the County of Hereford, fifteen miles from London, about a mile to the west of the road to Ware;" by J. Mitchell, LL.D., F.G.S., was last read.

This well was dug in 1833, in the premises of Mr. Munt, a magistrate of the county, and the information respecting it obtained from two gentlemen accustomed to collect evidence with the strictest scrutiny.

The strata passed through, were one foot vegetable mould, 15 feet gravel, one foot sand with flints, 83 feet gravel clay, 15 feet blue sand with black pebbles, 10 feet blue clay, $1\frac{1}{2}$ feet fine soft white sand, or $126\frac{1}{2}$ feet down to the chalk, which was penetrated for 40 feet when a spring was met with; but the digging continued 17 feet lower to form a reservoir of water, and this was favoured by making the excavation in the chalk of a bell shape, but above this the well was $4\frac{1}{2}$ feet in diameter.

When the well was dug the weather was dry, but on this becoming very wet the 15 feet stratum of blue sand and black pebbles began to emit foul air, by which one of the well-diggers was suffocated in descending. A hawk flying over the well fell into it, and a similar fate befell smaller birds, also wasps, bees and flies. On closing up the mouth of the well, with the exception of an orifice an inch in diameter, so powerful was the force of the issuing current of foul air that it raised a weight of twelve ounces of lead. In fine weather there was on the contrary a strong draft down into the well.

Eight months afterwards the well was again entered when the stratum of blue sand and black pebbles appeared forming into plum-pudding stone. The well was rendered safe by bricking it down to the chalk, applying a thick coating of compost over the whole. Dr. Mitchell explains the phenomena, by observing that the foul air was no doubt sulphuretted hydrogen, produced by the decomposition of water and iron pyrites. After long-continued rain, water penetrating into the bed dislodged the gas accumulated in the interstices where it was formed; while, after dry weather had continued for some time, the openings produced in this bed on drying up would draw for a short time a supply of air to fill up the vacuities, and hence the draft observed to pass down into the well. The whole of the neighbouring district, to the extent of four miles, is called by the well-diggers, foul country. Similar phenomena were observed in digging a well on the opposite hill at Applebury, and also in forming some wells in the immediate vicinity of London.

May 31.—James Heywood, Esq., of Manchester; Richard Owen, Esq., F.R.S., Hunterian Professor in the Royal College of Surgeons, London; Robert William Mackay, Esq., of Lincoln's Inn; and Charles Humfrey, Esq., A.M., of Downing College, Cambridge; were elected Fellows of this Society.

"On certain areas of elevation and subsidence in the Pacific and Indian oceans, as deduced from the study of Coral Formations;" by Charles Darwin, Esq., F.G.S.

The author commenced by observing on some of the most remarkable points in the structure of Lagoon islands. He then proceeded to show that the lamelliform corals, the only efficient agents in forming a reef, do not grow at any great depths; and that beyond twelve fathoms the bottom generally consists of calcareous sand, or of masses of dead coral rock. As long as Lagoon islands were considered the only difficulty to be solved, the belief that corals constructed their habitations (or speaking more correctly, their skeletons), on the crests of submarine craters, was both plausible and very ingenious; although the immense size, sinuous outline, and great number, must have startled any one who adopted this theory. Mr. Darwin remarked that a class of reefs which he calls "encircling" are quite, if not more, extraordinary. These form a ring round mountainous islands, at the distance of two and three miles from the shore; rising on the outside from a profoundly deep ocean, and separated from the land by a channel, frequently about 200 and sometimes 300 feet deep. This structure as observed by Balbi resembles a lagoon, or an atoll, surrounding another island. In this case it is impossible, on account of the nature of the central mass, to consider the reef as based on an external crater, or on any accumulation of sediment; for such reefs encircle the submarine prolongation of islands, as well as the islands themselves. Of this case New Caledonia presents an extraordinary instance, the double line of reef extending 140 miles beyond the island. Again the Barrier reef, running for nearly 1000 miles parallel to the North-East coast of Australia, and including a wide and deep arm of the sea, forms a third class, and is the grandest and most extraordinary coral formation in the world.

The reef itself in the three classes, encircling, barrier and lagoon, is most closely similar; the difference entirely lying in the absence or presence of neighbouring land, and the relative position which the reefs bear to it. The author particularly points out one difficulty in understanding the structure in the barrier and encircling classes, namely, that the reef extends so far from the shore, that a line drawn perpendicularly from its outer edge down to the solid rock on which the reef must be based, very far exceeds that small limit at which corals can grow. A distinct class of reefs however exists, which the author calls "fringing reefs," which extend only so far from the shore, that there is no difficulty in understanding their growth. The theory which Mr. Darwin then offered, so as to include every kind of structure, is simply that as the land with the attached reefs subsides very gradually from the action of subterranean causes, the coral building polypi soon again raise their solid masses to the level of the water; but not so with the land: each inch lost is irreclaimably gone:—as the whole gradually sinks, the water gains foot by foot on the shore, till the last and highest peak is finally submerged. Before explaining this view in detail, the author offered some considerations on the probability of general subsidences,—such as the small portion of land in the Pacific, where many causes tend to its production, an argument first suggested by Mr. Lyell, and the extreme difficulty (with the knowledge that corals grow at but limited depths) in explaining the existence of a vast number of reefs on one level, without we grant subsidence, so that one mountain top should be submerged after another; the zoophytes always bringing up their stony masses to the surface of the water. Subsidence being thus rendered almost necessary, it was shown by the aid of sections, that a simple fringing reef would thus necessarily be converted by the upward growth of the coral into one of the encircling order, and this finally, by the disappearance through the agency of the same movement of the central land, into a lagoon island. In the same manner a reef skirting a shore would be changed into a barrier extending parallel to, but at some distance from, the mainland.

Mr. Darwin then showed, that there existed every intermediate form between a simple well characterized encircling reef, and a lagoon island; that New Caledonia supplied a link between encircling and barrier reefs; that the different reefs produced by the same order of movement were always in juxtaposition, of which the Australian barrier associated with encircled islets and true lagoons, affords a good example. He then proceeded to show that within the lagoon of Keeling Island, proofs of subsidence might be deduced from many falling trees and a ruined storehouse; these movements appearing to take place at the period of bad earthquakes, which likewise affect Sumatra, 600 miles distant. It was thence inferred as probable, that as Sumatra rises, (of which proofs are well known to exist,) the other end of the lever sinks down; Keeling Island thus acting as an index of the movement of the bottom of the Indian Ocean. Again at Vanikoro, where the structure indicates according to the theory recent subsidence, violent earthquakes are known lately to have occurred.

The author then removed an apparent objection to the theory, namely, that subsidence would form a disc of coral but not a cup-shaped mass or lagoon, by showing that the corals which grow in tranquil water are very different from those on the outside, and less effective; and that as the basin becomes shallower they are subject to various causes of injury. The lagoon nevertheless is constantly filling up to the height of lowest water spring tides, (the utmost possible limit of living coral,) and in that state it long remains, for no means exist to complete the work. Mr. Darwin then proceeded to the main object of the paper, in showing that as continental elevations act over wide areas, so might we suppose continental subsidences would do, and in conformity to these views, that the Pacific and Indian seas could be divided into symmetrical areas of the two kinds; the one sinking, as deduced from the presence of encircling and barrier reefs, and lagoon islands, and the other rising, as known from uplifted shells and corals, and skirting reefs. The absence of lagoon islands in certain wide tracts, such as in both the West and East Indies, Red Sea, &c., was thus easily explained, for proofs of recent elevation are there abundant. In a like manner, in very many cases where islands are only fringed with reefs, which according to the theory had not been subsiding, actual proofs of elevation were adduced. Mr. Darwin remarked that, excepting on the theory of the configuration of reefs being determined by the order of movement, the circumstance that certain classes which are characteristic and universal in some parts of the sea, being never found in others, is quite anomalous, and has never been attempted to be explained.

Mr. Darwin then pointed out the above areas both in the Pacific and Indian Oceans, and deduced the following as the principal results. 1st. That linear spaces of great extent are undergoing movements of an astonishing uniformity, and that the bands of elevation and subsidence alternate. 2. From an extended examination, that the points of eruption all fall on the areas of elevation. The author insisted on the importance of this law, as thus affording some means of speculating, wherever volcanic rocks occur, on the changes of level even during ancient geological periods. 3. That certain coral formations acting as monuments over subsided land, the geographical distribution of organic beings (as consequent on geological changes as laid down by Mr. Lyell) is elucidated, by the discovery of former centres whence the germs could be disseminated. 4. That some degree of light might thus be thrown on the question, whether certain groups of living beings peculiar to small spots are the remnants of a former large population, or a new one springing into existence. Lastly, when beholding more than a hemisphere, divided into symmetrical areas, which within a limited period of time have undergone certain known movements, we obtain some insight into the system by which the crust of the globe is modified during the endless cycle of changes.

A letter to Charles Lyell, Esq. "On some changes of level which have taken place during the historical period in Denmark"; by G. Forchammer, Phil. Doct. Copenhagen, Foreign Member of the Society.

The author referring to the observations of Mr. Lyell and of Mr. Nilsson, on the unequal elevations of Sweden and subsidences of Scania; as proving that not only does elevation go on at a different rate, but that motion takes place in opposite directions, adduces, as instances of similar phenomena, the islands of Saltholm and of Bornholm as well as the Danish coast of the Sound. The island of Saltholm opposite to Copenhagen, and hardly five feet above the level of the Sound, being mentioned from the thirteenth century as a source of income to the chapter of Roeskilde; must have been elevated at a slower rate than Bornholm, which rises about one foot in a century; for if it were now to sink only two feet a very small portion of the island would be left.

On the Danish coast however of the Sound, six miles to the north of Copenhagen, a well characterized beach is observed, six feet above sea-level; hence the author infers that the change of level on the Danish, proceeds in a different proportion from that on the Swedish shore; which he ascribes to the slight earthquakes so frequently felt in Sweden, but never observed in Denmark.

With respect to the Danish island of Bornholm, the author observes, that its whole eastern shore is composed of a granitic rock, rising abruptly out of the sea, and covered to the height of 250 feet by a stiff loamy soil, containing numerous fragments of the slates and limestones of the transition formation; of which the calcareous specimens may easily be traced to the island of Gothland. From these facts, and the absence of the plutonic rocks so frequent in the boulder formation of Denmark, and from the absence of this clayey loam on the western side of the granitic ridge; he conceives that it is the result of a violent inundation from the north-east of the Baltic. The effects of this may be seen both in the form of the Danish coast, and in the deposits of sand which cover a great part of Denmark; but which have been evidently swept away from the more easterly beds of the boulder formation.

At a height of about forty feet may be observed the first beach formed on Bornholm: wherever by the receding of the granitic mountains from the coast, small bays were formed, these became choaked up by the granitic pebbles of the beach, and small ponds were thus formed and separated from the sea; and in the course of ages became filled up with peat. This peat moss is separated from the sea by a beach of small breadth, ten feet high, sloping at an angle of 15°, and abutting on a horizontal plain, 160 feet in breadth, formed entirely of beach stones. Beyond this is a second plain, 100 feet broad, which slopes to the sea at an angle of 9° to 10°, and is followed by the present beach sloping at an angle of 12° to 13°. The pebbles of all are similar in size, and composed of the same granite as the solid rock.

The author, referring to the existence on the sloping beach of graves, marked only by a ring of stones, and to the testimony of antiquarians, that it was the custom to bury Christians on the beach, where the land and sea separated, about the year 900; obtains materials for a rough calculation as to the time when this beach was formed. The continuous but very slow elevation of the island, as shown by the sloping beach, would thus have been about one foot in a century; and the beginning of the regular elevation of the island about 1600 years ago. Previous to this there must have been a long and perfectly quiet time, during which the horizontal beach was formed. Supposing the rise of the island and the lateral addition to the sloping beach to have been quite regular, and the lateral extension of the horizontal beach to have been equally uniform, we require for its formation a period of 2500 years. This would carry back the sudden elevation of the island of ten feet, marked by the narrow and abrupt, as well as highest beach, which the author thinks may have been caused by a great earthquake, to a period of 4000 years from the present time.

The author also informs us that over all Denmark, Sleswig, and Holstein, shells of the German ocean of the present day, may be found sometimes at considerable elevations above the level of the sea. Thus not far from Börnhövel and Holstein, at a height which exceeds 150 feet, a bed of fossils and pebbles occurs, containing *Cardium edule, Littorina littorea, Buccinum undatum, Ostrea edulis*; the latter shell is however smaller than that now living on the coast, but agrees with that found fossil in the raised beds of recent marine shells of England. Subsidences must also have occurred, as between the island of Römöe and the shores of the kingdom of Sleswig, a submarine forest (said to be of fir) is found at nine feet below the present high water mark.

The author also calls the attention of geologists to the traces of an inundation of about sixty feet above the present high water mark, on the islands of the western shores of Sleswig; and which appears to have taken place since these were inhabited by man, since Tumuli are found partly destroyed by the inundation.

A paper "On the Physical Structure of Devonshire, and on the subdivisions and geological relations of its old stratified deposits;" by the Rev. Adam Sedgwick, F.G.S., & R.S., Woodwardian Professor in the University of Cambridge; and Roderick Impey Murchison, Esq., V.P.G.S., F.R.S., was commenced.

June 14.—Raikes Currie, Esq., of Hyde Park Terrace; Rev. Joseph Walkin Barnes, Fellow of Trinity College, Cambridge; Thomas Webster, Esq., A.M., Trinity College, Cambridge, Secretary to the Institute of Civil Engineers; and John Nash Sanders, Esq., of Bristol, were elected Fellows of this Society.

The paper by Prof. Sedgwick and Mr. Murchison, on Devonshire, began at the last meeting, was concluded.

Chap. I.—After a few preliminary remarks the authors proceed to describe the general structure of Devonshire, which they consider as divided into five distinct geological regions.

1. The first region extends through the most eastern portions of the county, and is principally occupied by formations of new red sandstone and green sand.

2. The second region (which is prolonged into the north-west corner of Somersetshire) occupies the most northern portions of the

county, being bounded to the north and west by the sea, to the east by the plains of new red sandstone connected with the Vale of Taunton, and to the south by a line which stretches across the county in a direction almost east by south, commencing at the coast on the south side of Barnstaple, and thence ranging north of South Molton, Bampton, and Holcombe Rogos, to the plain of the new red sandstone.

3. The third region stretches across the county; being bounded to the north by the line above indicated, and to the south by a line which, commencing at Boss Castle on the coast of Cornwall, ranges to the south side of Launceston, and thence in a somewhat devious course to the northern edge of Dartmoor. This southern boundary also descends considerably on the east side of Dartmoor, inclosing some of the country near Chudleigh. The region thus bounded is composed of one great formation (occupying more than a third of the whole county), to which the authors give the name of *Culm Measures*.

4. The fourth region includes all the country occupied by slate rocks, extending from the granite of Dartmoor and the Culm Measures to the south coast of Devon.

5. The last region is occupied by the granitic rocks, which extend through the whole of Dartmoor.

Of the regions above enumerated few notices are offered respecting the first, but the other four are described in considerable detail, and in the above order.

Chap. II.—Succession of deposits between the north coast of Devon and the Culm Measures.

The authors commence with a description of the rocks in the north-west corner of Somerset, which are identical in structure with a part of the region here described. They divide them into two great groups; the lower group abounding in a coarse arenaceous strong-bedded rock (greywacké), often of a red colour, and sometimes variegated like specimens of new and old red sandstone; the upper containing some beds of like character, but abounding more in rotten thin-bedded slates (*shillot*), in which some portions are highly calcareous, and pass into irregular bands of limestone, and contain encrinital stems and obscure traces of organic remains. They then go on to describe the successive groups occupying the region of North Devon, and by help of natural sections (from the coast to the north boundary of the Culm Measures) prove, that there is an enormously thick ascending series of rocks, interrupted however by numerous contortions and by a great anticlinal line, ranging with the strike of the beds, about west by north or west-north-west. This line runs into the sea a little south-west of Linton, and in consequence one of the great groups is repeated twice over; first on the coast north-east of Linton, and secondly on the coast extending from the Valley of Rocks to Coomb Martin. From these facts it follows that the lowest rocks in North Devon are in the denudation of the Lynn river, which nearly defines the position of the anticlinal region; and from the south side of that river to the Culm Measures is an ascending section, interrupted only by local contortions. They then describe the successive groups of the ascending section.

1. Lowest group. Valley of the Rocks and gorge above Linton. The structure of this group is very varied. Some beds coarse and arenaceous; others passing into a fine glossy schist, sometimes chloritic. The finer beds often contain innumerable casts of organic remains, and impressions of shells are not unfrequent in the coarser arenaceous bands. Near the fossiliferous schists the beds become calcareous, and in one place pass into an impure limestone: many of the beds have a slaty cleavage transverse to the stratification, and cutting through the non-calcareous portions and the lines of organic remains. The thickness of this group is great, but its base is not exposed.

2. The preceding division passes by almost insensible gradations into the great red arenaceous groups already mentioned. The beds of greenish slate, shillot, &c., become quite subordinate, and the whole character of the formation is derived from the coarse arenaceous beds, sometimes passing into a siliceous conglomerate. These coarser beds are commonly red or variegated; among them, however, are grey and greenish grey beds, the colours, as might be expected, being inconstant. Oxide of iron traverses some portions of these rocks in thin veins, and that mineral abounds so much in some of the beds, that they have been regularly quarried (e. g. near Comb Martin and to the south-east of Porlock), and smelted in the iron foundries. The slaty cleavage transverse to the bedding almost disappears among these rocks, but they are much intersected by joints, some quite irregular in bearing; but two sets, one ranging with the beds and the other transverse to these (respectively called *strike joints* and *dip joints*), are described to be of common occurrence. The authors found no organic remains in this group, but they have been found, though very rarely, in some of the shillots and finer schistose masses, which are subordinate to the coarser red siliceous sandstones. Its whole thickness is computed (especially from the coast section west of the Valley of Rocks) to be five or six thousand feet.

3. The next group differs greatly from the former, in having comparatively few of the coarse siliceous sandstones, wanting the red colour; abounding in bands of rotten slate, sometimes like dark indurated slate, but more frequently greenish and chloritic, and commonly exhibiting a cleavage distinct from the stratification. It also contains many calcareous bands (in some places not less than eight or nine), which occasionally swell out into masses of limestone, and numerous organic remains, not however generally well preserved. Its thickness is estimated at two or three thousand feet, and notwithstanding some contortions, it dips on the whole towards the south: its strike, like that of the beds near the coast, is about east-south-east and west-north-west. This formation is traced far into the interior, and is identified with the calcareous system flanking the Quantock Hills.

4. The next group has the same strike as the preceding, and is of enormous thickness, though not so great as might at first sight be imagined from its breadth or the surface of the country and its high inclination, as many parts of it are violently contorted. The authors divide it into two portions, the *lower* abounding in fine glossy chloritic schist, much contorted, and having a true cleavage transverse

to the bed, and generally presenting a succession of parallel fissile planes, dipping at a high angle to the south; the *upper* beds containing similar masses alternating with coarse, thick, arenaceous bands, some of which resemble the rocks of the second group of the section.

5. The last group in this part of the ascending section commences on the south side of a line drawn from Baggy Point on the coast in the direction of the strata, or east and by south. It is composed of arenaceous flag stones and soft earthy slates, alternating with harder and coarser bands: it conforms to the mineral type commonly found in the lowest part of the Silurian system, has abundance of organic remains, and is in parts calcareous; but the fossils are often ill preserved and partially destroyed by the cleavage passing through them. The group is several thousand feet thick, and though much contorted (the anticlinal and synclinal lines coinciding with the strike) at length dips regularly under the base of the Culm Measures. Such is the succession in this portion of the section across Devon. Three distinct groups of calcareous and fossiliferous slates, separated from each other by deposits of vast thickness, very little calcareous, and almost without fossils. The base of the series is not exposed, and the last ascending term conforming to the type, and probably of the date of the lowest portion of the Silurian system.

These last-mentioned rocks much resemble the lowest Silurian strata of Pembrokeshire, which also graduate into the Cambrian system, and in which the specific character of the shells is often obliterated or obscured by transverse lines of slaty cleavage. Impressions of crinoidal stems abound; trilobites occur but rarely, and among the shells are two or three which cannot be distinguished from lower Silurian fossils. As however no fixed line of demarcation has yet been established between the lower Silurian and upper Cambrian groups, their zoological contents being, as far as we know, very similar, the place of this member of the Devon series must, for the present, be considered provisional.

The sandstones of this division are in one district pretty abundantly charged with impressions of plants, for an acquaintance with which the authors express their obligations to Major Harding and the Rev. D. Williams, both of whom have sent collections to the Geological Society. Professor Lindley is of opinion that none of these plants are similar to those described in the sequel as common to the Culm Measures: some resemble decorticated *Lepidodendra*, and others *Sternbergia*?. One specimen resembles *Calamites Voltzii* of the Terrain d'anthracite inférieur (Voltz).

The authors conclude their remarks on the whole region by some account of joints.

Dip joints and strike joints abound in all the groups, and though not constant in their inclination are generally inclined at a high angle, separating the great masses into rhombohedral solids. The transverse cleavage planes are not parallel to joints, and are regarded by the authors as forming a distinct class of phænomena.

Chap. III.—Deposits of the fourth region.

The natural groups are determined by help of sections; one from

Dartmoor to the coast of Torbay; another from Torbay to Start Point; and a third from Dartmoor to Bolt Head. In describing these sections the authors enter on many details not given in this place, and from a review of the whole division, the following groups, beginning, as before, with the lowest.

1. An ill-defined group near the granite, supposed to be metamorphic.

2. A great complex slate group, with two subordinate calcareous zones, in some places swelling out to a great thickness. The lower calcareous mass (called the Ashburton bands) pass into Cornwall, and range through the greater part of the county; the upper are represented in the most striking form by the Plymouth and Torbay limestone.

3. A coarse red arenaceous group, like the second group of the preceding chapter, immediately surmounts the Plymouth and Torbay limestones, and like them is of enormous thickness.

4. A great schistose deposit, striking with the other rocks in the southern region, nearly east and west. The prevailing dip is south, and it is not much contorted, but at length it is reversed to the north, being thrown off by an anomalous mass of chlorite and mica slate which occupies the promontories of Start Point and Bolt Head.

5. Mica and chlorite slate;—the relation of which to the other part of the series is unknown.

The authors then contrast the two regions above described. In the southern, trap rocks appear occasionally; in the northern they are wanting. The slaty cleavage so common in the northern is wanting in the southern region, though the rocks are in many places so fissile as to make good roofing slate, but in such cases they exfoliate parallel to the stratification.

In comparing the two regions they endeavour, first, to identify the calcareous group of Linton (No. 1 of chapter ii.) with the calcareous bands (No. 2) of this chapter. Secondly, to identify the coarse red group of North Devon (No. 2, chap. ii.) with No. 3 of South Devon. Lastly, to identify the great slate group of South Devon (No. 4) with Nos. 3 and 4 of North Devon. The absence of the calcareous band of North Devon (No. 3) is not considered to throw much difficulty in the way of this classification. By way of general conclusion, the authors consider all the above groups of North and South Devon to be *newer* than the rocks of Snowdon and central Cumberland (lowest part of the Cambrian system), and *older* (with a very limited exception in North Devon) than the Silurian system: they therefore place them in the upper and middle parts of the Cambrian system, from the more ordinary appearance of which they are chiefly distinguished by the greater abundance of calcareous matter and fossils.

The organic remains of the lower strata of South Devon are indeed so very dissimilar from those of the Silurian system that they cannot have been formed in that æra. These fossils will be described and published*.

* The Rev. — Hennah has placed his rich and valuable collection of Plymouth fossils at the disposal of the authors. Mr. Austen, F.G.S., has also

Chap. IV.—Culmiferous series of the third region.

The authors first describe many sections to prove that the Culm Measures occupy a great trough, and dip away on both sides from the other rocks with which they are in contact; hence whatever may be their age, the Culm Measures are the newest stratified deposits described in this memoir. *Along their northern boundary they rest on the highest group described in* Chap. ii; *and on their southern boundary they partly rest on the granite and partly on the oldest slate rocks of Devon and Cornwall. Hence they cannot form (whatever be the mineralogical appearance) a true passage into the different schistose masses on which they rest.* Again, they are overlaid by no rocks older than the new red sandstone; their age can therefore only be determined by their structure and organic remains.

The authors then describe sections of the Culm series in great detail, showing its enormous thickness and endless contortions; the anticlinal lines generally ranging with the strike, or nearly east and west.

For convenience, the series is divided into two groups.

The lower is made up of dark carbonaceous shales, sandstones, micaceous and siliceous flagstones, and calcareous shale, here and there containing subordinate beds of black limestone. All the *Wavellite* of Devon is found in this lower group. These beds are beautifully brought out both along the northern and southern boundaries.

The upper group is made up of an indefinite alternation of shales and sandstones, variable in structure, but generally rather thin-bedded: commonly, the shales are considerably indurated and resemble "greywacké," but in other places they are soft and earthy like ordinary coal-shale.

The sandstone bands vary much in texture; there are large quarries of them not to be distinguished from coarse coal grits; very rarely they put on a conglomerate form; most frequently they are close-grained, but even in that respect do not differ much from the grit-stone bands in the carboniferous system of a part of South Wales. Pyrites abounds and ironstone is occasionally found associated with the shale and sandstone.

Carbonaceous stains and impressions of plants occur in many parts of this great formation, and thin laminæ of anthracite are common in both the upper and lower group; but large masses of anthracite and beds fit to work for use are only found in the upper. The authors then describe the Culm works in the neighbourhood of Bideford, where three beds have been worked: the best is stated to average nearly four feet in thickness, while in some places it swells out to twenty feet, and in others contracts almost to nothing.

The plants differ essentially from those found in the older rocks, but are all identical with those species which are most abundant in the coal-fields of the central counties of England and in the South

contributed largely from the neighbourhood of Newton Bushel. Major Harding, F.G.S., and the Rev. D. Williams, F.G.S., have been the most zealous collectors in North Devon.

Welsh basin, among which *Cyperites bicarinata, Neuropteris cordata, N. gigantea, Pecopteris lonchitica,* and *P. abbreviata* are perhaps the most widely distributed. In their lithological aspect also, and in containing vast quantities of small sedge-like vegetables, these culm-bearing strata of Devon are undistinguishable from the coal measures of Pembrokeshire. No animal remains have been discovered in them, nor in the underlying sandstone (millstone grit), in which negative features these rocks further coincide with those of the Pembrokeshire coal field.

The subjacent black limestone has indeed no exact parallel in England, its organic remains being for the most part peculiar and undescribed; they are all apparently of marine origin. Among them are two genera of large, transversely ovate bivalve shells, one of which has a strong resemblance to a *Possidonia* of the Yoredale series of the Mountain Limestone (Phillips). Another is like, but not identical with *Gervillia laminosa* (Phillips). *Chambered shells* also occur, some of which are considered to be *Goniatites*, a genus which has never yet been found in the Silurian or older rocks, but is most characteristic of the carboniferous system.

In mineral characters this black limestone approaches closely to the *calp* of Ireland, which though now clearly acknowledged to be a part of the carboniferous group, is nearly devoid of characteristic fossils.

As the whole formation is of enormous thickness and exhibits no plants with distinct specific characters in its lower parts, and as the black limestone contains no species of shell absolutely identical with fossils of the mountain limestone, the authors consider the base line of the series as in a position not yet completely ascertained; though they distinctly prove that it never passes down into the older rocks on which it rests. As however, the upper group contains a fine series of vegetable fossils, every one of which agrees specifically with true carboniferous plants, they have no hesitation in placing these culm measures on the same parallel with the true carboniferous series of Great Britain. The evidence of fossils is in favour of the conclusion, and the sections, instead of opposing, confirm it; in short the culm-bearing beds of Devon are identical with the coal measures of Pembrokeshire both in mineral character and organic remains.

Chap. V.—Granite of Dartmoor, &c.

The jointed structure of this rock is described in detail, and the joints are shown to agree in their direction with those described by Messrs. Fox, Enys, and other geologists in Cornwall. The authors also confirm a remark of Dr. Boase that the same master joints often affect the granite and bedded rocks near it: they show that the granite has in some places broken through the stratified formations without much changing their strike; hence the successive members of the culm measures abut against the granite on the north-west side of Dartmoor. In all such cases, following the beds along the line of strike, they are changed in structure as they approach the granite, the siliceous bands being converted into quartz rock, the shales into Lydian stone, felspar, porphyry, &c. They regard these facts as perfect proofs of the metamorphic nature of the rocks in contact with the granite of Devon. Lastly, they describe granite veins and elvan dykes as traversing the Culm Measures.

The conclusion is, that no rocks in Devon or Cornwall are older than the Upper or Middle Cambrian; that a magnificent development of the Upper Cambrian terminates in the ascending order about the base of the Silurian system; that these rocks are surmounted by an immense culmiferous trough, the upper portion of which is identical in fossils with the upper division of our coal measures; and that the granite is posterior to all these, but probably anterior to the new red sandstone.

A paper was then communicated, "On the upper formations of the New Red System in Gloucestershire, Worcestershire and Warwickshire, showing that the Red (Saliferous) marls with an included band of sandstone, represent the Keuper or Marnes iriseés, and that the underlying sandstone of Ombersley, Bromsgrove and Warwick, is part of the 'Bunter Sandstein,' or 'Grès bigarré' of foreign geologists;" by Roderick Impey Murchison, F.R.S., V.P.G.S., and Hugh E. Strickland, Esq., F.G.S.

In previous communications* Mr. Murchison has shown, that the system of New Red Sandstone in the central counties of England is divisible into four formations. 1. *Marls with salt and gypsum, and one included band of sandstone,* (Foreign Equiv. Keuper or marnes iriseés.) 2. *Quartzose Sandstones,* (Bunter Sandstein, or Grès bigarré.) 3. *Calcareous Conglomerate,* representing the magnesian limestone or dolomitic conglomerate, (Zechstein, &c.) 4. *Lower New Red Sandstone,* (Rothe todte liegende.)

The object of the present communication is to mark, with precision, the distinctive characters of the two upper formations of this system, and to point out how the one can be separated from the other over a wide area, by stratigraphical, lithological, and zoological distinctions.

The rocks are described in descending order.

1. *Red and Green Marls and Sandstone,* (Keuper.)—This formation includes all the variegated marls which lie between the lowest beds of Lias, and the uppermost strata of the underlying formation of sandstone.

The highest of these marls graduate into the lias, are occasionlly gypseous, and at a depth of about 200 feet beneath the lias, are underlaid by a peculiar sandstone, which appears to have escaped the notice of former observers.

Tracing this rock from the borders of Gloucestershire, through Worcestershire into Warwickshire, the authors show, by various sections at Burg Hill, Ripple, Wallsfarm, Inkberrow, Hervington, and Shrawley Common, that this band, which never exceeds forty feet in thickness, invariably occupies the same stratigraphical position. It is a thin bedded, hardish, quartzose sandstone, usually of whitish colour, but sometimes tinted light green and red; the grains of sand being frequently cemented by decomposed felspar,

* Proceedings, vol. i, p. 471; vol. ii, p. 115.

and the beds separated by thin way-boards of greenish marl. The courses of stone are of very irregular extension, thinning out amid the marls. The lower strata are sometimes, (as at Inkberrow,) sufficiently thick bedded to be used as building stones, but the flag-like character prevails (tombstones, &c.).

This thin bedded sandstone is characterized throughout its course, by a small bivalve shell, somewhat resembling a *Cyrena* in form, but the genus has not been determined. *Ichthyodorulites* occur and seem to belong to the genus *Hybodus* (Agassiz) also teeth of fishes have been observed*.

At Shrawley Common, near Warwick, the surface of some of the beds is impressed with foot-marks of an animal, probably a crocodile or saurian, having feet with four claws.

The marls beneath the sandstone are of great thickness, and have been sunk through at Stoke Prior, near Droitwich, to a depth of near 600 feet. Besides gypsum they contain masses of rock salt, and are the sources of brine springs. In piercing these marls no bed of sandstone has ever been met with, and no fossils have been observed. This great marly formation, comprising the fossiliferous sandstone, is compared with the Keuper of Alsace and Suabia and proved to be its equivalent. The discovery of ichthyodorulites of a genus so abundant in the lower lias, but of an undescribed species, is considered by the authors to be a good zoological confirmation of the age of the sandstone, as indicating an approach to the types which characterize the lower lias.

New Red Sandstone, (Bunter Sandstein, Grès bigarré).—The upper beds of this arenaceous formation, rising from beneath the marls, are usually light coloured; the tints of the sandstone varying from dingy yellow, to white and grey, greenish grey and red. These light coloured sandstones are occasionally covered by thin courses of red sandstone, which graduate into the overlying marl; but they invariably pass down (sometimes by alternations) into the great red sandstone of the central counties, and are thus inseparable from that formation. This order is clearly seen at Ombersley, Hadley, Elmley Lovett, and Bromsgrove, in Worcestershire. This sandstone is lithologically distinguishable from the overlying Keuper sandstone in being softer, much *thicker bedded*, and more micaceous, though like that rock, some of the upper strata are wedge-shaped and inosculate with marl. This lower rock is the same as that described by Mr. Murchison, at Hawkstone and Grinshill in Shropshire, in which localities it is one of the best building stones in the kingdom.

In its range from Ombersley, by Hadley to Elmley Lovett, and again near Bromsgrove, the sandstone contains many *plants*, usually in a state approaching to charcoal, the jet black colour forming a striking contrast to the light coloured matrix.

Among these plants, the greater part of which are too imperfect to be identified, Professor Lindley has, however, recognized the

* It is proposed to call the Ichthyodorulite *Hybodus Keuperi*.

strobilus of a species of *Echinostachys;* (*E. oblongus*) figured by M. Ad. Brongniart as peculiar to the grès bigarré; a portion of a flabelliform palm leaf; parts of dicotyledonous stems with their bark; a broad leaf of some monocotyledon and a species, probably of *Convallirites*, (Brogn).

As these fossils bear no affinity to the well-known plants of the Keuper, but have on the contrary a strong resemblance to the Flora of the "Grès bigarré," offering in one instance a specific identification with a vegetable peculiar to that formation, the authors have no doubt that this light coloured sandstone of Worcestershire forms part of the same deposit.

By sections extending from Warwick to the north-west, the sandstone of Guy's Cliff and Leamington is shown to be of the same age as that of Bromsgrove, being also a soft, light coloured, slightly micaceous and thick-bedded sandstone: and rising up immediately from *beneath* the red marl, it cannot be confounded with the upper or Keuper sandstone, which at Rowington Tunnel and Shrawley Common is seen to *overlie* the great mass of red marl in manner before described.

Portions of bones of saurians abound in what the workmen call the dirt bed of the Warwick sandstone; but the fragments are so mutilated, and generally in such a decomposed state, that they cannot be identified. Plants also occur, but from a similar cause their recognition is very difficult. In addition to the fossils collected by Dr. Buckland, the authors have found teeth of fishes.

As no attempt has been made to prove that the animal found in Guy's Cliff is of the same species as either of the *Phytosauri* of the Keuper of Wirtemberg; the authors throw it out as a probable conjecture, that if ever accurately determined, it will prove of the same species as one of the saurians in the bunter sandstein of the continent.

The sandstone of Warwick is therefore identified with the rock of Bromsgrove and Ombersley in Worcestershire, and Hawkstone and Grinshill in Shropshire, which has been shown to be a portion of the red sandstone representing the grès bigarré or bunter sandstein.

Although assiduous search has been made to discover a calcareous stratum between the two formations above described, which might represent the "Muschelkalk," no traces of such a rock have been detected except in Shropshire, where Mr. Murchison has noticed a band of very impure limestone, occupying the same intermediate position, but as yet no organic remains have been observed in it.

On the whole the authors conclude, that the most exact parallel exists between the upper formations of the new red system of England, and those of a large part of France, where the muschelkalk being also absent, the marnes irrisées and grès bigarré pass into each other in the manner above described*.

* See the writings of M. Dufrénoy and M. Elie de Beaumont. (*Mémoires pour servir à une déscription géologique de la France*, vol. i. p. 313 et seq.)

A letter addressed to C. Lyell, Esq. was then read from Dr. Mc Cleland, who has been associated with Mr. Griffith in the scientific deputation sent under Dr. Wallich into Upper Assam to investigate the natural history of the country where the tea-plant is found growing wild. The deputation left Calcutta in the end of August, and reached the Kossia Mountains early in October. In crossing the Delta of the Ganges and Bramaputra (Burrampooter), a high tract of land, two or three hundred feet above the level of the plain, was observed but not examined near Dacca. Between this and the Kossia Mountains, distant sixty miles, the old channel of the latter river extends, so that the above high land is situated between the channels of the two great rivers. The country is generally composed of silt, but at Mymensing (where the navigation is most obtructed), the Bramaputra crosses a bed of yellow clay containing ferruginous and calcareous (the *kunkar* of India) concretions. The author thinks this bed of clay extends from the above high land to the foot of the Kossia Mountains, or the extreme point of the portion called the Garrow Hills, where the late Mr. Scott found the fossil remains of animals. The partially inundated plain at the foot of these mountains is interspersed throughout with small rounded hills, which reposing on the above-mentioned yellow clay are themselves composed of various layers of sands, clays, gravels, and boulders, even at the greatest heights. These appear to be the remains of a talus of great extent, which had covered the foot of these mountains and been swept away by the Soorma and other great rivers falling from them.

The foot of the mountains is composed of a rock in which Nummulites are imbedded in a compact calcareous basis. Sandstones seemed to rest upon this, but the relative position of the two rocks could not be clearly ascertained from the dense vegetation and the short time available for the examination.

On ascending to Cherraponji, a sanatory station established at an ascertained height of above 5000 feet, the limestone was soon lost sight of; but great masses of sandstones presented themselves, which had been rent and the fissures filled up with boulders and gravel. If the mountain acclivity be supposed to be divided into three stages, the first forms a steep slope covered with deep soil and vegetation; the second is precipitous and more or less naked; and the third is composed of sloping ridges terminating in mountain and table lands from 5, to near 6000 feet high.

At the top of the first stage, or at about fifteen hundred feet above the sea level, the author discovered a well-defined marine beach, containing shells and other marine exuviæ about two feet deep, and reposing upon sandstone and covered with soil. The shells consist of Pectens, Cardia, Ostreæ, Terebratulæ, and Melaniæ, mineralized by a fine yellow sandy matter, and united together by a brown indurated clay. Between the curved slaty layers of animal matter and shells, as well as in nests, loose sand is found. The whole presented the form of shingles caused on a beach subject to tides. In the course of an hour several hundreds were, and with more time many thousands might have been obtained. These shells were compared with a collection of about one hundred and fifty species from the Bay of Bengal and the estuaries of the great rivers, but not one was found to correspond; nor with those found by the late Dr. Gerrard in the secondary strata on the north of the Himalaya; but a small collection of about one hundred species from the Paris basin were at once recognised by the author as familiar objects, from his acquaintance with those from Kossia and Cherraponji : these consisted of about an equal number of species, and on being submitted to systematic comparison about twenty species were found to be identical in the two collections.

On crossing this deposit, the rock, composing the superficial strata of sandstone forming the precipices of the second part of the ascent, was found to contain the impressions of shells and other organic remains, which the author believes to be ramose Alcyonia; these continued to appear all the way up to Cherraponji, where they occurred in the greatest numbers.

On this sandstone reposes a deposit of compact limestone, from which twenty-seven species of shells were extracted, as sp. of Trochites, Cerithia, and of Modiola of Lamarck, with *Piliolus plicatus* of Sowerby. On this formation reposes a bed of coal to the depth of above twenty or thirty feet, in which was found an exogenous plant. On descending towards the plain from a point five or six miles west of Cherraponji, and one or two miles below the village of Mumloo, an elongation of the same fossil beds and sea beach was met with at about the same elevation. The shells and characteristic remains, with six species of Medusæ, were found imbedded in a red sandstone, or rather indurated sand, immediately beneath the soil.

On crossing the mountains towards the centre of the group, the sandstone, on which the limestone and coal rest at Cherraponji, was found for fifteen or eighteen miles, forming in horizontal strata lofty undulating lands, with little variation except in ravines and the banks of streams. Beyond the above distance the strata displayed marks of confusion, and in the first deep river valley, a mass of greenstone was found with the adjoining sandstone tilted up in highly inclined tabular masses, formed of quartzose pebbles imbedded in felspar. This form continued to the second deep valley, where the greenstone was again met with, and the adjoining sandstone compact, glossy, and columnar.

Leaving this (the Boga Pany) and ascending the opposite acclivity, all traces of the earthy sandstone are lost, and the centre of the mountains from Mufling to the highest ridges is composed of syenite. Granular quartz, slaty and in vertical strata, is found in contact with this, and interposed between it and the common sandstones; displaying progressive changes from one to the other. The northern side of the mountains from Muflong into Assam is composed of granular foliated felspar, penetrated by quartzose veins, and more irregularly with beds of mica. Extensive beds of syenite and central nuclei of granite are found as far as the Valley of Lower Assam, which here is about thirty miles broad, and bounded on the north by the Bustan Mountains. Groups of rocky hills extend from the Kossia and Garrow Mountains across the valley, threatening as it were to interrupt the waters of the Bramaputra and convert the interior of the valley into a lake. These, called the Meeker Hills, are composed of insulated rocky protrusions of metamorphosed gneiss, in some instances syenitic, in others as a sandstone whose base is earthy felspar containing crystals of the same mineral, and in others as hornblende slate; all, and especially the second, with veins and beds of quartz projecting upwards, the veins often radiating irregularly from the beds. Along the veins a laminated structure is produced in the rock; this structure follows the course of the vein, and disappears as you recede from one vein, re-appearing again as you approach another.

These, as well as many other objects of geological interest, could only be cursorily observed from the necessity of accompanying the expedition. Hot and salt springs,—from the latter the natives derive a muriate of soda,—as well as fossil bones, as first discovered by the late Mr. Scott, present themselves along the base of the mountains.

The author also collected about one hundred and sixty species of the animals, chiefly birds, from the forests of Assam, which have been forwarded to the India House, as well as one hundred and twenty species of the fishes of the Bramaputra in Upper Assam; many of which are identical with Hamilton's Gangetic species, but several are new; regarding the habits and peculiarities of which the author states having collected considerable details.

On the remains of a fossil Monkey from the tertiary strata of the Sewalik Hills in the north of Hindoostan; by Captain P. T. Cautley, F.G.S., Bengal Artillery, and H. Falconer, M.D., Bengal Medical Service.

The authors commence their paper with some general observations on the differences in habit in different animals, which prevent the remains of some being so frequently preserved as those of others in a fossil state, and they adduce as instances birds and quadrumanous animals. So speedily are the remains of these carried away by the hyæna, the chacal and wolf, the scavengers of torrid regions; that in India, the traces of casualties are so seldom seen, even where monkeys occupy in large societies the groves of mango trees round villages; that the simple Hindoo believes they bury their dead by night.

The authors since engaged in the examination of the Sewalik fossils, were early led to anticipate the finding of some quadrumanous animals, and several months ago obtained an astragalus of the right hind leg, which they minutely describe, and compare with that of the recent *Semnopithecus Entellus*; which, though certainly belonging to a distinct species, it closely resembles both in size and general form, as is exemplified in the specimen sent with the fossil astragalus. This was completely mineralized, having a sp. gr. of about 2·8 and appearing to be impregnated with hydrate of iron. Although only a solitary bone of the foot, the relations of structure are so fixed that the identity of the fossil is as certain as if the entire skeleton had been found. But the authors deferred making the announcement, in the hopes of soon finding specimens of the cranium and teeth; these have been discovered by Messrs. Baker and Durand of the Bengal Engineers, who have obtained a considerable portion of the face, and the whole series of molars of one side of a quadrumanous animal, belonging to a much larger species than theirs.

In the debris or different beds of the formation which yielded the quadrumanous fossil astragalus, the authors have also discovered *Anoplotherium Sivalense,* F. and C., with *Crocodilus biporcatus* and *C.* (*Leptorhyncus*) *gangeticus* or the Magar, and Garial (Gavial), which now inhabit the Ganges, showing that quadrumana existed, with a member of the oldest Pachydermatous genus of Europe and reptiles of the present day.

The camel (*Camelus Sivalensis,* F. and C), antelope, and anoplotherium have been exhumed from the same bed. There have been found also the elephant, mastodon, hippopotamus (*H. Sivalensis* and *H. dissimilis,* F. and C.), rhinoceros, hog, and horse, together with the *Sivatherium giganteum,* a huge ruminant, exceeding in size the largest rhinoceros, armed with four enormous horns, divided and foliated like the dicranocerine antelopes. There is also a musk deer scarcely larger than a hare; specimens of the cat (*Felis cristata,* F. and C.) and of the dog tribe; the hyæna, bear (*Ursus Sivalensis,* F. and C.), and ratel, with other carnivora. Of the feathered tribe, there are Grallæ much larger than the gigantic crane of Bengal (*Ciconia Argala*). Of reptiles, besides the magar and gavial, there are other crocodiles of enormous size (*C. Leptorhyncus crassidens,* F. and C.); and of Testudinata ordinary-sized species of emys and trionyx, with humeri and femora as well as corresponding fragments of the bucklers of a species as large as the corresponding bones of the Indian rhinoceros. The authors refer to the "Journal" and "Researches of the Asiatic Society of Bengal" for descriptions of their new species.

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TO THE PAPERS READ DURING THE SESSION 1836—1837.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1837—1838. No. 52.

Nov. 1, 1837.—The Society assembled the first time, this evening, for the Session.

Alexander Crichton, Esq., of Charles-street, Grosvenor-square; Major-General Sir Patrick Ross, K.C.M.G., K.C.H., of Richmond, Surrey; John Slade, M.D., of Brock-street, Bath; Philip Hardwick, Esq., of Russell-square; Thomas Eyton, Esq., of Eyton, Shropshire; and the Rev. Robert Wilson, of Ashwelthorpe Hall, near Wymondham, were elected Fellows of this Society.

A Letter "On Fossil Fishes in the Lancashire Coal Field," by W. C. Williamson, Esq., Curator of the Manchester Natural History Society, was read.

The author first refers to his account of the Ardwick Limestone, published in the 9th vol. of the Philosophical Magazine for 1836, (p. 241.), where short descriptions are given of the ichthyolites which had been then met with, consisting of scales of Megalichthys, scales and teeth of Palæoniscus, and coprolites. Mr. Williamson, in conjunction with Professor Johnstone, has since come to the conclusion, that the bed in which these remains occur, is entirely a coprolitic mass, the portions preserved being such as would not be destroyed by the action of the stomach. With the above remains, was also described a tooth of *Diplodus gibbosus*, (Agassiz), numbers of which of various sizes have been found at Bradford, near Manchester, in the roof of the great mine, a bed of coal four feet thick, and one of the highest in the series that is worked. The roofstone abounds with Entomostracous remains. The fishes' teeth resemble one figured by Dr. Hibbert in his Memoir on the Limestone at Burdie-house, and referred by him to Gyracanthus*. The author has met with no traces of the thorny ray of this fish. The coprolites contain 72·5 phosphate of lime, 12·5 carbonate of lime, 12·5 bitumen, 2·5 insoluble matter; and therefore resemble in composition the analysis given by Dr. Hibbert†.

The author, in examining, at Peel, near Worsley, the "Black and White Mine," a coal 6 feet 6 inches thick, and about 1000 yards below the Rodte Todte Liegende, found, in its black roofstone, remains of *Palæoniscus Egertonii.* The fine blue colour of the scales forms a curious characteristic. Two other forms of scales have been met with,

* Edinb. Phil. Trans., vol. xiii. p. 218. † Ibid., p. 222.

evidently belonging to distinct species of fish; one is small, rhomboïdal, and coated with a bright enamel; the other is peculiar from the mucronate and grooved character of one extremity, and the cycloid outline of the other. At the same place were found scales resembling those of Megalichthys, several small teeth of *Diplodus gibbosus*, and several osseous portions of some large fish not yet determined. Near Ringley, about five miles from Peel, the same roofstone was found in another pit, which the author has not yet further examined; but in both pits one or two species of Unio occur, as well as remains of *Stigmaria ficoides*, *Calamites nodosus*, and other plants.

A paper "On the geology of the island of Zante," by Hugh Edwin Strickland, Esq., F.G.S., was next read.

The author commences by stating, that his observations were the result of only a few days' residence. The structure of Zante is more simple than that of the other Ionian islands; and seems to present an epitome of their component rocks in an almost unbroken succession.

The geological phenomena of Zante may be arranged under the three heads of, 1. Apennine Limestone; 2. Tertiary deposits; and 3. Mineral Springs.

1. *Apennine Limestone.*—This name is adopted as being the most convenient appellation for the vast deposit of compact, light-coloured limestone in the south of Europe, especially on the shores of the Adriatic. It is uniform in character for many thousand feet of vertical thickness, and many hundred miles of horizontal extent. Its fossils, though rare, show it to be the equivalent of the cretaceous, and perhaps also of the oolitic series of Northern Europe. The formation constitutes an anticlinal ridge, extending along the west coast of the island, in a direction about N.N.W. and S.S.E., and it seems to be the continuation of a similar ridge which passes through Cephalonia. Along the E. side of the ridge, the strata dip from 30° to 45° E.N.E. but to the west of Point Skinari an opposite dip commences, and prevails, with local exceptions, to near Point Cheri, where it resumes the eastwardly inclination.

The tertiary strata occur only on the eastern side of this mountainous ridge; the western being formed of a series of almost perpendicular cliffs, upwards of 600 feet high.

This white limestone often assumes the character of the hard chalk of England; and though no flints were noticed in it in Zante, yet they are not unfrequent in the same formation in Corfu. Organic remains are occasionally found, and consist of Nummulites, fragments of Hippurites, &c. The limestone abounds in faults and fractures, as well as caverns, subterranean rivers, and thermal and mineral springs. In these respects no less than in mineral structure, the Apennine limestone presents a close analogy to the carboniferous limestone of Northern Europe, for which it has often been mistaken.

2. *Tertiary deposits.*—These strata repose on the eastern flank of the limestone range, and extend thence to the east coast. They form

several detached hills rising through the alluvial matter, which constitutes the central plain of the island. They have partaken of the same elevation which raised the limestone range, from which they dip away regularly to the eastward. The uppermost strata resemble those which occur near Lixouri in Cephalonia. In Zante, near the Castle-hill, they consist of an aggregate of calcareous and arenaceous particles, forming a pale yellow, porous stone, which is easily worked. Few fossils are found except on the east coast, where numerous casts of Cerithia and other Mollusca occur. These strata are succeeded by a thick deposit of blue clay and marl, containing *Pectunculus auritus*, Broch., *Buccinum semistriatum*, Broch., and *Natica glaucina*, Lam.

The gypseous beds which succeed the argillaceous at Lixouri, are not here visible, but in the south coast of Zante they form the commencement of a section which extends much further down in the series than the lowermost beds examined at Lixouri.

The strata above the gypsum clearly belong to the Pliocene epoch; many of their fossils being identical with those of the subapennine hills. Whether the strata which underlie the gypsum, in the section on the north of the Bay of Cheri, belong to the same, or to an older epoch, is not so clear. They contain but few fossils, as crushed Echini and obscure bivalves; but in one situation a bed of indurated bluish marl contains great abundance of the shells of the two genera of pteropodous mollusca, Hyalea and Creseis, but the species are larger than the *Hyalea cornea*, and *Creseis spinifera*, now living in the Mediterranean.

The argillaceous beds are succeeded by yellowish calcareous sandstone and loosely aggregated limestone, which dip 18° S.W., but no traceable sequence could be observed, in consequence of a great subsidence, which appears to have taken place between this point and the range of secondary limestone forming the marshy plain of Port Cheri, towards which the tertiary strata dip on both sides. Some of the calcareous strata are fine-grained, and approach the texture of Portland-stone. Minute Foraminifera are abundant in it, and two small species of Pecten were observed.

On the west side of Port Cheri is a low cliff of blue marl and clay, containing a few scales and vertebræ of fishes, and a few species of *Vermiculum*, Mont., (Quinqueloculina, D'Orbigny). This argillaceous mass has probably been brought down from some higher part of the tertiary series, by the subsidence which seems to have formed the valley and bay of Port Cheri, and of which a striking proof may be seen in a fault in the Apennine limestone, where a smooth surface of rock descends to the sea, and which is scored with numerous parallel striæ, not perpendicular, but at an angle of 65° to the horizon. The enormous friction and pressure of the descending mass, has imparted to this surface of rock a remarkable degree of hardness, and a darker colour. This change penetrates about two or three inches from the surface; but at a greater depth the rock is softer and white, much resembling the compact chalk of Yorkshire.

3. *Mineral Springs.*—The sources of bitumen for which Zante has been celebrated since the time of Herodotus, rise in the midst of the marshy plain at Port Cheri. The principal is a well 5 feet deep; and

the bitumen oozes up from the bottom, and above it the well is filled by a spring of clear, cool, and tasteless water. No bubbles of gas were observed to be given out by the bitumen. About forty barrels are produced here annually.

From the different situations in which bitumen is produced, and from there being nothing in the composition of either the tertiary or secondary rocks to account for its production, as well as from its rising where there has been a great dislocation of the strata; the author is induced to infer, that it is derived from the region of volcanic action, which may be almost demonstrated to underlie the Ionian islands. On the northern coast, there is another mineral spring, which rises on the line of a considerable fault in the Apennine limestone, about half a mile to the north of the junction of the tertiary and secondary rocks. It consists of turbid water, resembling diluted milk in appearance, and issuing at the foot of the cliffs, flows on the surface of the sea-water, in a stratum a few inches thick. Flakes of a slimy white substance abound in this water, and may be seen floating in the sea for a considerable distance. A strong smell of sulphuretted hydrogen is diffused around. The spring indicated a temperature of 65°, which is near the mean temperature of the latitude of Zante. This, therefore, cannot be reckoned among thermal springs, though from its close resemblance to the mineral waters of many volcanic regions, as the Aquæ Albulæ near Rome, its origin may be referred to some analogous cause.

A paper was afterwards read "On the Formation of Mould," by Charles Darwin, Esq., F.G.S.

The author commenced by remarking on two of the most striking characters by which the superficial layer of earth, or, as it is commonly called, vegetable mould, is distinguished. These are its nearly homogeneous nature, although overlying different kinds of subsoil, and the uniform fineness of its particles. The latter fact may be well observed in any gravelly country, where, although in a ploughed field, a large proportion of the soil consists of small stones, yet in old pasture-land not a single pebble will be found within some inches of the surface. The author's attention was called to this subject by Mr. Wedgwood, of Maer Hall, in Staffordshire, who showed him several fields, some of which, a few years before, had been covered with lime, and others with burnt marl and cinders. These substances, in every case, are now buried to the depth of some inches beneath the turf. Three fields were examined with care. The first consisted of good pasture land, which had been limed, without having been ploughed, about twelve years and a half before: the turf was about half an inch thick; and two inches and a half beneath it was a layer or row of small aggregated lumps of the lime forming, at an equal depth, a well-marked white line. The soil beneath this was of a gravelly nature, and differed very considerably from the mould nearer the surface. About three years since cinders were likewise spread on this field. These are now buried at the depth of one inch, forming a line of black spots parallel to and above the white layer of lime. Some other cinders, which had been scattered in another part of the same field, were either still lying on the surface, or entangled in the roots of the grass. The second field examined was remarkable only from the cinders being now buried in a layer, nearly an inch thick, three inches beneath the surface. This layer was in parts so continuous, that the superficial mould was only attached to the subsoil of red clay by the longer roots of the grass.

The history of the third field is more complete. Previously to fifteen years since, it was waste land; but at that time it was drained, harrowed, ploughed, and well covered with burnt marl and cinders. It has not since been disturbed, and now supports a tolerably good pasture. The section here was, turf half an inch, mould two inches and a half, a layer one and a half inch thick, composed of fragments of burnt marl (conspicuous from their bright red colour, and some of considerable size, namely, one inch by half an inch broad, and a quarter thick), of cinders, and a few quartz pebbles mingled with earth; lastly, about four inches and a half beneath the surface was the original, black, peaty soil. Thus beneath a layer (nearly four inches thick) of fine particles of earth, mixed with some vegetable matter, those substances now occurred, which, fifteen years before, had been spread on the *surface*. Mr. Darwin stated that the appearance in all cases was as if the fragments had, as the farmers believe, worked themselves down. It does not, however, appear at all possible, that either the powdered lime or the fragments of burnt marl and the pebbles could sink through compact earth to some inches beneath the surface, and still remain in a continuous layer. Nor is it probable that the decay of the grass, although adding to the surface some of the constituent parts of the mould, should separate, in so short a time, the fine from the coarse earth, and accumulate the former on those objects, which so lately were strewed on the surface. Mr. Darwin also remarked, that near towns, in fields which did not appear to have been ploughed, he had often been surprised by finding pieces of pottery and bones some inches below the turf. On the mountains of Chile he had been perplexed by noticing elevated marine shells, covered by earth, in situations where rain could not have washed it on them.

The explanation of these circumstances, which occurred to Mr. Wedgwood, although it may at first appear trivial, the author does not doubt is the correct one, namely, that the whole is due to the digestive process, by which the common earth-worm is supported. On carefully examining between the blades of grass in the fields above described, the author found, that there was scarcely a space of two inches square without a little heap of the cylindrical castings of worms. It is well known that worms swallow earthy matter, and that having separated the serviceable portion, they eject at the mouth of their burrows, the remainder in little intestine-shaped heaps. The worm is unable to swallow coarse particles, and as it would naturally avoid pure lime, the fine earth lying beneath either the cinders and burnt marl, or the powdered lime, would, by a slow process, be removed, and thrown up to the surface. This supposition is not imaginary, for in the field in which cinders had been spread out only half a year before, Mr. Darwin actually saw the castings of the worms heaped on the smaller fragments. Nor is the agency so trivial as it, at first, might be thought; the great number of earth-worms (as every one must be aware, who has ever dug in a grass-field) making up for the insignificant quantity of work which each performs.

On the above hypothesis, the great advantage of old pasture land, which farmers are always particularly averse from breaking up, is explained; for the worms must require a considerable length of time to prepare a thick stratum of mould, by thoroughly mingling the original constituent parts of the soil, as well as the manures added by man. In the peaty field, in fifteen years, about three inches and a half had been well digested. It is probable, however, that the process is continued, though at a slow rate, to a much greater depth; for as often as a worm is compelled by dry weather or any other cause to descend deep, it must bring to the surface, when it empties the contents of its body, a few particles of earth. The author observed, that the digestive process of animals is a geological power which acts in another region on a greater scale. In recent coral formations, the quantity of stone converted into the most impalpable mud, by the excavations of boring shells and of nereidous animals, is very great. Numerous large fishes (of the genus *Sparus*) likewise subsist by browsing on the living branches of coral. Mr. Darwin believes, that a large portion of the chalk of Europe was produced from coral, by the digestive action of marine animals, in the same manner as mould has been prepared by the earth-worm on disintegrated rock. The author concluded by remarking, that it is probable that every particle of earth in old pasture land has passed through the intestines of worms, and hence, that in some senses, the term "animal mould" would be more appropriate than "vegetable mould." The agriculturist in ploughing the ground follows a method strictly natural; and he only imitates in a rude manner, without being able either to bury the pebbles or to sift the fine from the coarse soil, the work which nature is daily performing by the agency of the earth-worm*.

* Since the paper was read Mr. Darwin has received from Staffordshire the two following statements:—1. In the spring of 1835 a boggy field was so thickly covered with sand that the surface appeared of a red colour; but the sand is now overlaid by three quarters of an inch of soil. 2. About 80 years ago a field was manured with marl; and it has been since ploughed, but it is not known at what exact period. An imperfect layer of the marl now exists at a depth, very carefully measured from the surface, of 12 inches in some places, and 14 in others, the difference corresponding to the top and hollows of the ridges or butts. It is certain that the marl was buried before the field was ploughed, because the fragments are not scattered through the soil, but constitute a layer, which is horizontal, and therefore not parallel to the undulations of the ploughed surface. No plough, moreover, could reach the marl in its present position, as the furrows in this neighbourhood are never more than eight inches in depth. In the above paper it is shown, that three inches and a half of mould had been accumulated in fifteen years; and in this case, within eighty years (that is, on the supposition, rendered probable from the agricultural state of this part of the country, that the field had never before been marled) the earthworms have covered the marl with a bed of earth averaging thirteen inches in thickness.

Nov. 15.—Henry Edmund Goodhall, Esq., of Guildford Street, Russell Square; Frederick William Mullins, Esq. M.P., of Beaufort House, County of Kerry, and Great Ryder Street, London, were elected Fellows of this Society.

A Letter from Walter Calverly Trevelyan, Esq., F.G.S., to Dr. Buckland, V.P.G.S., on "Indications of Recent Elevations in the Islands of Guernsey and Jersey and on the coast of Jutland, and on some Tertiary Beds near Porto d'Anzio" was first read.

On the shore near the point where the road descends towards the rock or islet of Lihou, on the east of Guernsey, may be seen a section, in which, above the present high-water mark, the granite rock bears evident marks of having been worn by the action of the waves, previously to the deposition on it of a bed of gravel, which now covers the granite and fills up the inequalities of its surface. The gravel, which is firmly bound together by a ferruginous sand, consists of pebbles of the neighbouring rocks, also of chalk flints, some not much rounded, and extends to about 8 feet above the present high-water mark, and apparently ranges a little inland. On the gravel is a bed, about 3 feet thick, of disintegrated granite, mixed with angular fragments of that rock, and covered by the surface soil.

On the N.W. of the island, near Fort Doyle, there occurs, near the shore, a similar bed of gravel, about 8 feet above high-water mark, resting on the surface of the syenitic rocks of a low cliff, which bears evident signs of disturbance from subterranean agency. Here the gravel, previously lying upon the rock, has fallen into and filled up the fissures which have been created, and has even been forced under some parts of the rock, which seem still to be in connexion with their original masses.

In St. Catherine's Bay, Jersey, the author also observed a section which affords evidence, though to a small extent, of an elevation of the old beach.

The author then calls attention to a fact regarding the elevation of land bordering on the Baltic, which he conceives has not before been noticed. On the coast of Jutland, near Frederickshavn (not far from the Scaw), the author observed, that the country abounded with sepulchral tumuli, except on a low and extensive tract bordering the sea, where none occurred. He therefore supposes, that the latter has been elevated since the period when the above mode of burial was disused in that country, which he believes was about the eighth or ninth century*.

The author concludes his letter with some account of a visit paid to Porto d'Anzio (the ancient Antium), and of some extensive tertiary (pliocene) beds found there. These deposits form cliffs about 50 feet high, and contain numerous shells, but little altered, and apparently of the same species as those now inhabiting the neighbouring sea. *Pecten Jacobæus* and *P. opercularis*, not at all water-

* A similar inference was drawn by Dr. Forchhammer with respect to Bornholm in a paper "on some changes of level during the historical period in Denmark", read May 31, 1837. See *ante*, p. 555.

worn, are the most numerous, often forming considerable beds in a loose or indurated calcareous sand. The dip of the strata is considerable and to the south-east. The deposit may be traced some way into the interior, and to elevations of 200 or 300 feet above the sea, where there are quarries worked in ancient times; and on the east to Nettuno, about a mile and a half from Antium, at which point the upper beds rise to the surface. Passing thence to the west, and beyond Antium, lower beds successively crop out for about a mile, when the lowest, a sandy clay, appears, and continues for some distance, nearly horizontal. It is overlaid in part by a bed of sand, containing a layer of gravel in the lower part, and the two strata form together a cliff 30 or 40 feet high. In the clay the fossils are not so abundant, but are apparently of the same species as in the upper beds.

About two miles from Antium, a thin bed of tertiary sandstone, containing numerous abundance of the same fossils, begins to make its appearance resting on the clay, and it gradually increases in thickness to about 20 feet; but then gradually thins out again to the west, extending altogether between a quarter and half a mile. Below it, 20 feet of clay are exposed, and above it, a ferruginous sand, about 15 feet thick, through the lower 6 feet of which, some fine siliceous gravel is interspersed, like the flint gravel of the plastic clay of England, and agreeing in character with that of the present beach. The masses which have fallen on the shore, from above, look, when washed by the waves, exactly like a rock abandoned by the sea for merely a few tides, in consequence of the fresh appearance of the shells and corals with which they are covered.

In the tertiary rock of the neighbourhood, specimens were met with, in which the calcareous matter of the shells had been replaced by sulphur, and the author conceives the change to have been effected through the percolation of water, of which a stream exists, containing a strong solution of sulphuret of iron with excess of acid. Near this spot, called Solfarata, are some pits, apparently in the upper sand, and from which sulphur is dug in winter.

A letter from Sir Robert Smirke was then read, forwarding another from Mr. Edge to himself, in which the latter states, that when engaged in erecting some works in the neighbourhood of St. Peter's, Guernsey, he found it necessary to have a well dug. At the depth of 45 feet from the surface, the workmen came to a block of granite, which they were forced to blast, and ascertained to be 6 feet in thickness. A few feet beneath the granite, they were surprised at finding a small quantity of peat, with several pieces of fossil timber (specimens of which have been sent to the Society) in the state of bog-wood, and conceived to be oak.

The reading of a paper was afterwards commenced "On the Fossils of the Eastern Portion of the Great Basaltic district of India," by J. G. Malcolmson, Esq., F.G.S., of the Madras Medical Establishment.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. II. 1837–1838. No. 53.

Dec. 16, 1837.—Levett Landen Boscawen Ibbetson, Esq., North Kyme, Lincolnshire; Charles Manby, Esq., John Street, Adelphi; and Colonel John Briggs, York Gate, Regent's Park, were elected Fellows of this Society.

Mr. Malcolmson's paper on the eastern portion of the Great Basaltic district of India, begun on the 15th of November, was concluded.

The principal objects of this paper are to describe the eastern boundary of the great basaltic formation of India, with its associated stratified deposits, and to arrive at a proximate conclusion respecting the age of the basalt.

Extent of Country.—The region noticed generally in the paper, is included between the 14th and 21st degrees of north latitude, and the 75th and 82nd degrees of east longitude; but the districts more particularly described, are those watered by the Pennar river (lat. 14°), the pass of the Sichel hills, near Neermul (lat. 19° 18′, long. 79° 33′), and the plains extending from the northern base of that chain to Nagpoor.

Physical Features of the Country.—The region forms part of the great, elevated plateau which includes all the countries to the south of the Nerbudda (lat. about 22° N.), and connects the provinces watered by the southern branches of the Ganges with the Deccan. It is traversed on the north by the Sichel or Shesha hills, locally called the Neermul range, which extends from the junction of the Wurdah and Godavery rivers (lat. about 18° 48′, long. 80°), till lost in the gradual rise of the country near Lonar (lat. 20°, long. 76° 30′). The principal rivers which traverse the region are the Wurdah, the Godavery, the Kistnah and the Pennar. The first flows north and west of the Sichells, the second south of that chain, till its waters unite with those of the Wurdah, when it takes a south-easterly direction to the Indian ocean. The Kistnah flows nearly W. and E., between the parallels of 16° and 17°; and the Pennar traverses the southern portion of the region (lat. 14° 30′). In the part watered by the last river, a marked feature is presented in the horizontal summits of many of the ranges of hills, which appear to have been once connected, though they are now separated by extensive plains.

Geological Structure.—The formations consist of granite, gneiss, mica and hornblende slates, trap, argillaceous limestone, red sandstone, with diamond breccia, and tertiary freshwater strata. The granite forms apparently the base of the country, and the trap penetrates all the formations, including the granite and the freshwater beds. In addition to these regular deposits are considerable accumulations of travertine and kunkur, which are scattered over the whole surface of the country.

Granite.—This rock is frequently displayed in all the rivers of southern India, and is occasionally visible as the substratum of the other formations. In the table-land of the Mysore it attains an elevation of 3000 feet above the sea. In the Deccan, between the Kistnah and the Godavery, it is traversed by greenstone dykes, sometimes porphyritic, and ranging, for the greater part, from S. by E. to N. by W., a direction not very different from that of several of the basaltic mountains in the northern part of the region; but on approaching the Godavery, from the south, the granite is penetrated by dykes, which strike N. and S. Beyond Nagpoor the granite has burst through the red sandstone, which is converted into quartz rock; and, still further north, granite veins intersect the argillaceous limestone, which has lost its stratified structure. Granite veins also penetrate the neighbouring hills of gneiss and mica slate.

Gneiss, Mica and Hornblende Slates.—These formations appear to be of limited extent. Hornblende slate was noticed by the author only in the neighbourhood of Deemdoortee, 20 miles E. of Neermul, where it contains the magnetic iron ore used in the manufacture of Damask steel. Gneiss and mica slate are mentioned only at the locality alluded to above, a few miles N. of Nagpoor.

Trap.—Mr. Malcolmson distinguishes the trap of the dykes from that which constitutes the great basaltic ranges, by the absence of olivine in the former, though it is common in the latter. The great masses of basalt are also distinguished by being amygdaloidal and more crystalline.

When *en masse* the trap overlies the granite, as well as the stratified deposits. In the form of veins it traverses the granite, limestone, and sandstone, and the freshwater strata are often imbedded or entangled in it.

In sinking a well near Hutnoor, (lat. 19° 38′ N., long. 78° 30′ E.) seams of pure white, pulverulent limestone were found beneath layers of basalt, and calcareous depositions appear to accompany the formation almost universally. With respect to the minerals contained in the amygdaloids, Mr. Malcolmson is of opinion, that they have not been produced either by infiltration or sublimation, but by molecular attraction, because calcareous spar is much more rare than siliceous minerals, though carbonate of lime abounds throughout the basalt.

Argillaceous Limestone.—Organic remains have not been noticed in this rock. It consists, in the lower part, of thin strata of compact blue or white limestone, and generally, in the upper, of blue, red, green and white schists, or slaty clay. Siliceous matter occurs in both the limestone and schist. Where the formation is in contact with the trap, the limestone is sometimes crystalline, and loses its stratified structure; and at the Pindee Ghàt, in the Sichel Hills, the argillaceous and siliceous ingredients appear to have separated, and the latter to have collected in bands, having partly the aspect of chalcedony, and in black chert. In some districts the limestone is cavernous, and it is often penetrated by circular cavities, which, the author conceives, were formed by the extrication of gaseous fluids, in the same manner as similar cavities are now produced in the mud by the escape of carbonic acid gas.

A jointed structure, dividing the beds into rhombs, prevails in the limestone, the schist, and the overlying sandstone. The strata are often inclined, apparently the result of dislocation.

At Jumulmudagur (lat. 14° 50′, long. 78° 30′) the limestone contains layers of muriate of soda; and Mr. Malcolmson is of opinion, that the salt which is found in the alluvial matter, is obtained solely from this formation, as he did not discover a trace of it in the sandstone.

The limestone and shale are well displayed in the Pennar district, also between the northern foot of the Sichels and Nagpoor; and the author has no doubt that they belong to the same system of strata as the limestone of Bundelcund, described by Major Franklin*, though the red sandstone of that country is stated to underlie the limestone, while in the region examined by Mr. Malcolmson it overlies.

Red Sandstone.—This formation is distinguished by containing the breccia in which are situated the diamond mines of Golconda, on the banks of the Kistnah, and those on the banks of the Pennar. Where the sandstone rests upon the limestone schist, a gradual passage occurs. The rock is more or less compact, and its prevailing colours are red and white. The diamond breccia is considered by the author, as only a variety of the sandstone in which fragments of older rocks have been imbedded. Ninety miles S.W. of Nagpoor traces of coal were noticed, and in the hill of Won (lat. 20° 6′, long. nearly 79°) Mr. Malcolmson found the cast of apparently a hollow vegetable, the only trace of an organic body observed by him. The sandstone, as already noticed, partakes of the same jointed structure as the subjacent limestone. It is penetrated as well as overlaid by trap, and near Nagpoor veins of granite have converted it into quartz rock. In the district drained by the Pennar, the sandstone attains the height of 3000 feet, forming the horizontal or flat summit of the mountains; but in the same district, and at no great distance, it occurs on a level with the plain.

Tertiary Strata.—Masses and fragments of differently coloured chert, a tough, white, argillaceous stone, and a greyish blue crystalline rock, all containing freshwater shells, either project from the trap in which they are entangled, or are scattered over its surface for considerable areas in the Sichel hills. In a precipitous descent, on the northern

* Geol. Trans., 2nd Series, vol. iii., part 2, p. 191 *et seq.*, also Asiatic Researches, vol. xviii. p. 24, *et seq.*

flank, the author also noticed a horizontal bed of white limestone, 12 ft. thick, containing freshwater shells and resting on granite, but covered by basaltic debris. The organic remains, brought to Europe by the author, have been examined by Mr. James De Carle Sowerby, and ascertained to belong to two species of Gyrogonites, two of Cypris, two of Unio, with numerous specimens of Paludinæ, Physæ, and Limneæ. The greater part are siliceous casts, but some retain their original calcareous matter. Silicified portions of palm woods, and fragments of vegetables, in a charred or carbonized state, also occur. In accounting for the different state of preservation of the shells, Mr. Malcolmson suggests, that the lime being in some instances retained, may be explained on the supposition, that the shells were perfectly dry at the time they were acted upon by the basalt.

With respect to the origin of this singular rock, the author is of opinion that the basalt, when it was irrupted, changed the features of the country, and, destroying pre-existing lakes, entangled in its substance the debris and shells which had accumulated at the bottom of the bodies of water, and converted the loose sand into chert or siliceous rock. Of the age of the formation, he does not pretend to offer a precise opinion. None of the shells have been identified with those now inhabiting the rivers of India; and he is, therefore, inclined to consider them as extinct, and to refer them to the tertiary æra.

This fossiliferous chert was noticed by the author over a surface extending 140 miles N. and S.; but shells considered to be identical with those collected by him, were found by Dr. Spilsbury, 18 miles E. from Jubalpore (lat. 23° 45′ N., long. 78° 53′ E.), in a block of indurated clay, resting on basalt*; by Dr. Voysey, in the Gawilghur range (near the table-land of Jillan)†; by Dr. Spry, in a bed of limestone, overlaid by trap, near Saugor‡ (lat. 24° 15′ N., long. 79° E.); by Dr. Voysey, in a siliceous rock in the hills of Medcondah and Swalpigapah south of the Godavery§; also at Jirpah, N. of the sources of the Taptee (about lat. 22° N., long. 78° E.)‖.

Comparative Age of the Formations.—On this head few observations are necessary. North of Nagpoor the granite has been shown to be more recent than the sandstone. The trap in the form of veins penetrates the granite, and affects, *en masse*, the limestone and sandstone, and entangles in its substance the fossiliferous chert. If therefore, the last belongs to the tertiary period, part at least of the basalt of the Sichel hills, forming the eastern boundary of the great basaltic region of India, cannot be assigned to one more ancient. Of the age of the limestone and sandstone Mr. Malcolmson offers no positive opinion, but he objects to their being considered the equivalents of

* Journal of the Asiatic Society of Bengal, vol. ii. pp. 205 and 583.

† Asiatic Researches, vol. xviii. p. 192.

‡ Journal of the Asiatic Society of Bengal, vol. ii. pp. 376, 639.

§ Asiatic Researches, vol. xviii. p. 193, and Journal of the Asiatic Society of Bengal, vol. ii. p. 304.

‖ Journal of the Asiatic Society of Bengal, vol. i. p. 247.

the new red sandstone and lias of England*, because their order of superposition in the district examined by himself, is inverted, the limestone underlying the sandstone; and he only ventures to suggest, that they may belong to the older secondary, or younger transition systems.

Travertine and Kunkur.—Springs charged with carbonate of lime prevail throughout the country, and in the bed of some of the rivers, calcareous matter is so abundantly deposited as to cement the pebbles into a hard rock. "It is impossible," says the author, "to examine these accumulations without immediately perceiving the origin of the nodular limestone or kunkur, which is so extensively distributed in India."

Thermal Springs and Mineral Waters.—At Kair (lat. 19° 55′, long. 78° 56′) and Urjunah, springs having a temperature of 87°, and charged with carbonic acid gas, issue through the limestone; and one, at the former locality, contains also a little muriate of soda, a minute quantity of sulphate of lime, and much carbonate of lime. At Byorah (lat. 17° 57′, long. 80° 20′) is a spring, the temperature of which is 110°; and at Badrachellum, (lat. 17° 43′, long. 80° 79′) one possessing a temperature of 140°, and containing sulphuretted hydrogen, and sulphates and muriates of soda and lime.

A minute description is given of the mineral waters of the Lonar Lake, (lat. 20°, long. 76° 30′) and of the natron which is deposited in a layer beneath its muddy bottom. The water of the lake is clear, its specific gravity is 1027·65; and it has no unpleasant smell; but the mud at its bottom is highly charged with sulphuretted hydrogen. The salt under the mud accumulates slowly, and is extracted only once in several years. It consists of carbonic acid 38·, soda 40·9, water 20·6, insoluble matter ·5, and a trace of a sulphate; and thus corresponds in composition with the Trona, or striated soda from the Lakes of Fezzan, analyzed by Mr. R. Phillips†, and approaches somewhat nearer to the equivalent numbers of the sesquicarbonate established by that analysis. The water of the Lonar lake contains, besides a little potash, muriate of soda 29 grains, sesquicarbonate of soda 4·2 nearly, and sulphate of soda ·1, in 1,000 grains of water. No lime was detected in it, nor any magnesia. The absence of the former Mr. Malcolmson says, is easily accounted for, as the sesquicarbonate of soda and the water itself precipitated the sulphate and muriate of lime, notwithstanding the mutual decomposition they undergo when in a semifluid state. In accounting for the production of the natron, he adopts the theory of Berthollet for the formation of that salt in the lakes of Egypt, viz., a mutual decomposition of the muriate of soda and carbonate of lime, when in a pasty state; but as the natron of Fezzan and the Lonar lake contains half an equivalent more of carbonic acid than can be

* See Major Franklin's memoir on Bundelcund, &c., in the Geol. Trans., 2nd ser., vol. iii. p. 191, *et seq.*, also Asiatic Researches, vol. xviii. p. 24, *et seq.*

† Journal of the Royal Institution, vol. vii. p. 294.

furnished by carbonate of lime, he proposes a modification of that theory, and suggests that the carbonic acid by which the lime is held in solution in the mud, furnishes the acid, and perhaps indicates the existence of an unstable sesquicarbonate of that substance. "Where-ever," adds the author, "I have met with natron, or obtained detailed accounts of its occurrence, muriate of soda and carbonate of lime existed in the soil, and the natron was found on the surface of the moist earth or mud."

December 13.—Lieutenant Ouchterlony, of the Madras Engineers, and the Rev. Christopher Erle, M.A., of Hardwicke Rectory, near Aylesbury, were elected Fellows of this Society.

A paper "On the Geology of the South-east of Devonshire;" by Robert Alfred Cloyne Austen, Esq., F.G.S., was read.

The district described in this memoir, is included within the rivers Exe and Dart, and extends from the coast to the granitic region of Dartmoor.

The formations of which it consists, are first noticed, then the faults, and, lastly, the probable amount of effects produced at each period of disturbance.

1. *Formations.*—These are considered under two heads:—1st. accumulations produced by actual causes; 2ndly, those produced by causes in operation before the most recent disturbances, including tertiary, secondary, transition, and igneous deposits.

The first of these subdivisions contains a description of the shingle, sand-hills, estuary deposits, and peat-bogs; but the south-east of Devonshire presents no phenomena connected with them, deserving of particular notice.

Tertiary Deposits.—To this class Mr. Austen assigns the (*a.*) raised marine deposits in estuaries, and (*b.*) raised beaches; (*c.*) the accumulations of water-worn rocks in valleys; (*d.*) the Bovey deposit; (*e.*) ossiferous caves; and (*f.*) the bed of angular chalk flints, and chert on Haldon and Blackdown.

(*a.*) *Raised Marine Estuary Deposits* are considered to exist in the valleys of the Axe and the Otter, because those rivers, in their present state, could not have accumulated the sediment which forms the surface of the valleys, or have worn the vertical cliffs by which they are partly bounded. In the valley of the Exe, above Topsham, is a bed abounding with marine shells of existing species, but high above the reach of any tide.

(*b.*) *The raised beaches* of Hope's Nose and the Thatcher were described by the author on a former occasion*; but in this paper he shows, that similar deposits occur to the west of Bovey-head, and at intervals along the whole southern coast of Devonshire. The upper limit of these beaches seldom exceeds 60 or 70 feet above the present sea-level. The raised beach to the west of Bovey-head, consists of shingle and indurated sand, associated, in the upper part, with red hæmatite, and it is overlaid by a thick mass of the same ore. This hæmatite is connected with the Upton iron lode.

* Proceedings, vol. ii. p. 102.

(*c.*) *Accumulations of water-worn rocks.*—In every valley, with the exception of that of the estuary of the Teign, are thick heaps of debris, derived principally from the adjacent formations, and occasionally containing bones of the elephant and rhinoceros. Similar detritus caps all the ridges which lead up to the Haldons; also the summit of those hills, Blackdown, &c.; but the fragments are less water-worn on the tops of the ridges than in the valleys.

(*d.*) *The Bovey deposit* is not described in this paper, the author intending to prepare a separate account of it.

(*e.*) *Ossiferous caves.*—No information is given respecting the contents of the bone-caverns, Mr. Austen referring to the accounts already published respecting those at Chudleigh and Kent's Hole.

(*f.*) *The bed of angular flints,* containing in its lower part large tubular and angular blocks of chert and sandstone, and resting on the green sand of Haldon and Blackdown, is referred by the author to the tertiary series; and the angular form of the fragments strongly distinguishes the bed from the overlying superficial debris. The blocks of breccia, composed of angular flints, cemented by a very hard sandstone, and scattered over the surface of the hills and along the valleys, particularly near Sidmouth, are likewise considered as the remains of a tertiary deposit, probably of the same age as the grey wethers of Wiltshire. In the blocks near Sidmouth, Mr. Austen has observed remains of shells, which he is of opinion belong to the freshwater genus *Planorbis,* and in the Haldon beds numerous individuals of the genus *Cypræa.*

Secondary Formations.—These consist of, (*a.*) chalk; (*b.*) green sand; (*c.*) new red sandstone; and (*d.*) coal measures.

(*a.*) *Chalk.*—The prevailing divisions of this formation in the S.E. of England are stated to extend to Maynorst Cliff; but detached masses of lower chalk are found among the debris as far west as Peak Hill; and a white calcareous bed rests on the green sand of Style Hill.

(*b.*) *Green sand.*—This formation the author has traced along the slopes of the hills flanking the valley of Bovey, where it had not been noticed by previous observers. The beds dip towards and form the lining of the Bovey basin. They rest on new red sandstone, coal measures, limestone, slate, and perhaps granite, and, to a certain extent, are composed of the debris of these formations. A list of the fossils is given, and Mr. Austen states, that mollusca are almost wanting on Little Haldon, and he therefore infers, that the Haldon beds are of a more littoral nature than those of Blackdown. The conchifera also occur in single valves, and broken, and appear to have been drifted as well as water-worn.

(*c.*) *New Red Sandstone.*—The subdivisions of this formation are stated to present the following geographical distribution, proceeding from east to west: 1. marls, with gypsum, as far as Sidmouth; 2. sandstone, from that town to a little beyond Dawlish; 3. shingle and conglomerate, to the western boundary of the formation, the pebbles being derived from the adjacent older rocks, and increasing in size towards the edge of the deposit. In some places, however, the shingle is associated with finely-grained fissile sandstone. From this distribution, the author infers, that the conglomerate marks the original shore of the sea in which the new red system was deposited; the sandstone, the finer detritus carried to a certain distance from it; and the marl, the mud diffused through the water, and conveyed to a still greater distance. The jointed structure is not very distinct, but it may be traced even in the conglomerates; and from the best exhibited cases, the author concludes that the strata are divided into octohedral masses. Vegetable remains are found near Sidmouth.

(*d.*) *Culmiferous or Carboniferous Series.*—After alluding to the rectification, in 1836, by Prof. Sedgwick and Mr. Murchison, of the error in the geological position of this series, Mr. Austen states that it occupies, in South Devon, the whole of the valley between Great Haldon and the extremity of Dartmoor.

He subdivides the series as follows:—

1st. Shales, which near the granite or trap, sometimes resemble the older slates.

2nd. Sandstones with beds of thick flagstone, as above Greyleigh and Biddlecomb, and below Lewell House.

3rd. Conglomerates, as at Ugbrook, the Orchard Well valley, and above Ryder Farm.

The limestone of Chudleigh is stated to rise through the culmiferous strata N. of Ugbrook-park, and to the S.W. of the Bovey deposit, to form a continuous band.

The mineral contents of the series are various. Tin and copper occur beneath Ashburton Down and near Christow; lead has been found in the same parishes; and iron ore is contained in large quantities in the shale. Where the rock approaches the granite, it is much altered, and encloses numerous small garnets. Remains of plants are scarce, but impressions of Calamites have been found; and minute portions of vegetable matter occur in some of the beds of sandstone.

Transition System.—The culm measures rest unconformably on a series of deposits belonging to this system, and divided by the author into the following formations, in descending order:—

1. *Rag Limestone.*—A calcareous rock, coarsely laminated, of a dirty red colour, and abounding with stems of encrinites. Locality, Forest of Denbury.

2. *Shale.*

3. *Great Limestone.*—This is the limestone of Newton Bushel and Torquay. It is distinctly jointed, the prevailing strike of the joints being, for one set, N.N.W. to S.S.E., for the other, W.S.W. to E,N.E.; but considerable variations are stated to occur in different quarries.

Organic remains are very numerous, both corals and shells. At its base the deposit presents several alternations of shale and black limestone, and contains some peculiar fossil shells. It passes gradually into the next formation.

4. *Argillaceous Slates and Sandstones, generally Red.*—This deposit is of great thickness, forming the principal part of the slate-

hills, and is sometimes worked for roofing-slate. It contains bands of limestone of a peculiar character. Organic remains occur only in the upper part, and agree apparently with those of the "great limestone."

5. *Lowest Band of Limestone.*—The limestone between Staper-hill and Bickington, and on the highway road by Goodstone to Ashburton and Buckfastleigh, is assigned to this portion; also that of Chudleigh, and the limestone at the base of Great Haldon is perhaps of the same age. The organic remains consist of corals and shells. Thin seams of carbonaceous matter also occur.

Igneous Rocks.—These formations consist of granite, porphyry, and trap. The granite of Dartmoor was shown in 1836, by Prof. Sedgwick and Mr. Murchison, to be more recent than the carboniferous strata; and Mr. Austen adopts the same view, as veins of granite penetrate the culm beds at Higher Alway and Lower Alway, near Bovey. The principal mass of Devonshire granite has in some places a height of 1800 feet, but over the whole of its area there is not the slightest appearance of any stratified deposit. The granite of Dartmoor is considered by Mr. Austen to be of different ages, as veins of coarsely grained are intruded among the common variety. Blocks of hornblendic granite are said also to occur, imbedded in the true granite; and in some places the granite is so felspathic as to resemble trachyte.

Trap Rocks—The author describes, with some detail, the hornblendic trap dyke of Wear, and shows that it must have been irrupted subsequently to the deposition of the chalk, because fissures in the limestone, traversed by the dyke, are filled with fragments of various formations, including chalk, and are charged with manganese, an effect produced by the intrusion of hornblendic trap throughout this part of Devonshire.

In the parish of Kington, veins of trap, on approaching the granite, are said to become more compact, and in the proximity of it, to be distinctly crystalline. Associated with the culm strata are bedded traps, apparently of contemporaneous origin; but the close of the culmiferous period is stated to have been marked by irruptions of the porphyry found at Pocombe-hill, and other places near Exeter. At Western, in the parish of Ide, it rests upon the culmiferous shale; but Mr. Austen says, it might be considered to rest on the new red sandstone, as that formation flanks the base of the hill. In the quarry, however, where the porphyry is worked, it has been cut through, and found to rest upon shale. This rock has contributed largely to the formation of the conglomerates of the new red sandstone. Trap dykes are very common among the older slates, and have produced decided effects on them, and the general features of the country. Their age the author does not attempt to define; but from their being more abundant in the older than in the newer rocks, he conceives that they may have been, in part, irrupted before the latter were deposited. In the coast section, beds of hornblendic trap are included in the transition shale, to which they adhere by the lower surface, but not by the upper. Similar, imbedded, trappean rocks occur at Black Head, west of Babbacomb; the sixth mile-stone between Teignmouth and Torquay; near the village of North Whilborough, and at East Ogwell.

The author then describes the phænomena, which appear to have accompanied the disturbance of the strata at different periods, beginning with those considered to be most recent.

The undulations and deep combs in the new red sandstone, he says, are not due solely to denudations, but to elevations and depressions of the beds while the formation was beneath the sea. On the surface there are no indications of disturbance, the angular irregularities having been rounded before the district became dry land. The Watcomb Fault, however, he conceives, was produced by a subsequent operation, as it preserves its angular outline; and other instances are mentioned of unobliterated faults.

Mr. Austen next describes, with reference to this part of the subject, the raised, marine beds in the estuary of the Exe, the raised beaches at Hope's Nose, the Thatcher, and to the west of Berry Head; he mentions also those which occur at intervals along the southern coast of Devon.

Another system of disturbances, the author assigns to the tertiary era, because it appears to have been in operation, during the time, when the Haldon and Blackdown tertiary beds were formed. The Haldon strata exhibit the following proofs of disturbance:—

1. A partial destruction of the chalk, followed by the formation of a breccia of angular flints and sand.

2. The breaking up of this breccia and the production of a stratum, consisting of chalk flints, the breccia, quartz, granite and other rocks, all rounded.

Mr. Austen then offers some observations on the probable changes in the extent of dry land during the deposition of the secondary systems, indications of which, he conceives, are traceable in the characters, and the thinning out of the formations between the chalk and the new red series. In alluding to the faults which affect the new red sandstone, he says, that the greater part of them may belong to the tertiary epoch.

In the older formations, the evidences of disturbance during periods anterior to the new red sandstone, are referred chiefly to the unconformable position of the culmiferous strata with relation to the transition; and consequently the disturbances, which gave the slates their present position, must have taken place anterior to the deposition of the culmiferous strata.

With respect to the connexion between the age and the direction of the faults, the author says the district is too limited for any observations to be of much value. The older disturbances, however, appear to have a north and south direction. The most remarkable east and west fault is that of the valley of the Teign; and if the Weymouth Fault be prolonged westward, it would strike the coast of Devonshire at the mouth of that river.

Examples of depression as well as of elevation are mentioned in the paper, and it is said that the former are parallel to the latter, ranging S.S.W. and N.N.E.

Jan. 3, 1838.—David Thomas Ansted, Esq., B.A., Jesus College, Cambridge; James Black, M.D., Bolton-le-Moors; Alexander Wilson, Esq., Bryanstone-square; and Major Henry Bullock, Harley-street, were elected Fellows of this Society.

A paper was read on the "Geological Relations of North Devon," by Thomas Weaver, Esq., F.G.S., F.R.S., &c.

The observations, which gave rise to this paper, were made during the autumn of 1837, in consequence of the discussions which had taken place relative to the position of the coal strata of the North of Devonshire. The author states that he derived great assistance, during his investigations, from the Rev. David Williams, who kindly offered to be his guide. The survey, however, convinced Mr. Weaver, that Prof. Sedgwick and Mr. Murchison were perfectly correct in placing the coal with the associated strata at the top of the series, and in removing it from the transition systems to which other observers had assigned it.

The district, more particularly examined by the author, lies between the parallel of Bideford and Chilhampton on the south, and that of the Foreland (E. of Linton) on the north, and is bounded on the east by the meridian of High Down (four miles west of South Molton), and on the west by the Bristol Channel.

Before he proceeds to detail his own observations, Mr. Weaver gives a comparative table of the subdivisions of the strata, exhibited by Prof. Sedgwick and Mr. Murchison at the meeting of the British Association at Bristol, in August 1836; and those employed by the Rev. David Williams, in a section shown at the meeting of the same body at Liverpool, in September 1837. These subdivisions, he states, are essentially the same, though Mr. Williams considers the coal strata as belonging to the transition systems.

The subdivisions, first established at the Bristol meeting, are adopted by Mr. Weaver, but he employs a nomenclature derived, for the greater part, from the localities where the strata are well exhibited. The following list contains the subdivisions in ascending order.

1. Foreland sandstone. 2. Linton calcareous slates. 3. Trentishoe quartzy slates and sandstone, including the Combe Martine limestone. 4. Morte slates. 5. Wollacomb sandstones, flagstones, and slates. 6. Trilobite slates. 7. Wavellite schistus and limestone. 8. Culmiferous shales (coal strata).

The mineral composition, lithological structure, local variations, and relative order of superposition of each formation are fully detailed; and the following inferences are given, as deducible from the whole of the evidence, collected during the survey.

That there is a general sequence of emergence from south to north, or from the culmiferous shales (8) to the Foreland sandstones (1), the dip being generally to the south.

That from the Foreland sandstones (1) on the north to the Trilobite slates (6) on the south inclusive, the angle of dip increases from 20° to 80°, being 20° to 30° in the Foreland sandstones (1) and Linton calcareous slates (2), 45° to 70° in the Trentishoe quartzy slates and sandstone (3), 70° to 80° in the Morte slates (4) and Wollacomb sandstones (5), and generally in the Trilobite slates (6), though in the last a lower angle is sometimes observable on approaching an undulation. The general strike of the beds is from 10° to 15° N. of W. and S. of E. from a true meridian.

That on the other hand the Wavellite schistus, limestone, and shale (7) and culmiferous beds (8) undulate on a very large scale, and are occasionally subject to contortions upon a smaller.

From the Foreland sandstones (1) to the Trilobite slates (6) inclusive, the series is connected throughout, passing from one to the other in such a manner as to form a consistent whole, the parts of which cannot be separated one from another without arbitrary divisions.

Though the beds, from 1 to 6 inclusive, form one consistent, consecutive series, yet the subordinate parts are subject to change in different portions of the field, both mineralogically and in extent, and occasionally thin out, as in the case of the beds of limestone.

On the other hand, the Wavellite schistus and limestone (7) and culmiferous shales (8), though apparently in some places in a parallel (conformable) position with the Trilobite slates (6), do, when thoroughly examined upon the line of outcrop in the district, form a break with number 6, and are unconformable thereto.

That this unconformity denotes two different æras of deposition, an inference supported by the difference in the organic remains; and Mr. Weaver further states, that he does not consider the occurrence of a few coal plants in the Wollacomb sandstones (5) as at all interfering with this inference.

That the preceding data justify the conclusion, that the strata from 1 to 6 belong to a system distinct from that which includes the beds 7 and 8, the former constituting a *peculiar transition group*; and the latter belonging to the true coal measures of England, the old red sandstone being alone wanting.

In conclusion the author dwells upon the importance of attending to mineral composition in surveying extensive systems of rocks; but he adds, that "the only safe guide in researches into the crust of the earth, is to keep constantly united in view, relative position, organic remains, and mineralogical characters; and not to restrict our attention to one of these distinctions when judging of geological formations."

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1838. No. 54.

January 17,—A paper by Dr. Bell, entitled "Geological Notes to accompany Major Todd's Sketch of part of Mazunderān," was first read.

These notes were made during a journey from Teheran (lat. 35° 40′ N., long. 50° 52′ E.), eastward to Feeroozkooh, then northward across the Elboorz mountains, and afterwards along the course of the river Talâr to the Caspian, and back to Teheran by the banks of the river Herâz. The author's observations are given in the order in which they were made during his journey, but the geological details may be classed as follows :—

1. *Alluvium.*—Teheran stands on a plain, consisting chiefly of the debris of limestone and trap rocks. In the bed of a river at the Caravanserai of Dalee Chaee, about 62 miles direct E. from Teheran, is a loose conglomerate composed of fragments of limestone and trap, imbedded in dried mud. A similar deposit forms low hills and valleys in several other places along the line of route, followed by the author, as at the river Gazan Chaee, and on the summits of the hills bordering the plain of Feeroozkooh. Below Pul-i-Seffeed, on the Talâr, is a conglomerate, formed of debris from the neighbouring mountains, united by a calcareous cement. Further down the river, it is finer, and stated to contain minute fragments of shells.

Below Sheergâh, the country, as far as the Caspian, is an alluvial, muddy flat. This sea is stated to be fast filling up, and the discoloured water of the streams, which flow into it, may be traced for five or six miles. Near the shore the water is so fresh that horses drink it; and Dr. Bell says, that the shells are chiefly freshwater. Half imbedded in the banks of mud and sand are innumerable trunks of large trees which have been drifted down by the rivers. A conglomerate similar to that at Dalee Chaee, was noticed at Karoo in ascending the Herzâ; also below the small stream Abi Noor, at the foot of Demavend Peak.

Lithographic Limestone.—A fine-grained limestone, used for lithography in Teheran, forms a high ridge north of the city, the beds dipping to the north, and resting on serpentine, porphyritic claystone, and porcelain stone. In connexion with a blue limestone, it extends over an immense tract to the N. and N.W. of Teheran, on the southern flank of the Elboorz Chain, where it generally rests upon shale and red sandstone, which is underlaid by a calcareous formation, called by the author, mountain limestone. To the east of Teheran, the lithographic stone extends nearly to the village of Demavend.

Sandstone and Coal.—Between Teheran and Demavend, a sandstone of a coal formation is occasionally exposed; and in the bed of the river, Dalee Chaee, are upraised beds of "altered shale, like coked coal." On the north side of the Elboorz Mountains, shale and sandstone, assigned to the same coal deposit, are exposed resting upon the limestone. At Abbassabad is a sandstone, but it is not stated whether it belongs to this formation. A sandstone resting on limestone occurs in the ravine through which the Herâz flows above Amol; also on the summit of the limestone pass between Karoo and Bulkulum. About a mile below the latter village, a precipice 900 or 1000 feet high consists of perpendicular beds of coal and sandstone, but on the opposite bank of the river the sandstone strata are nearly horizontal.

Limestone.—Strata, considered by Dr. Bell as the representatives of the mountain limestone, constitute the hills to the S.E. of Teheran, and overhang the ruined city of Rai. To the westward of Demavend, the range of mountains, both north and south of the road as far as the Caravanserai of Dalee Chaee, consist of the same limestone resting on trap. Above the Caravanserai of Ameenabâd, it occurs resting also on trap; and the hills in the neighbourhood of the plain of Feroozkooh are similarly constituted. On the north side of the Elboorz chain—a coal-shale and sandstone rest on this limestone. Below Pul-i-Seffeed, the Talâr runs for a considerable distance through a gorge presenting perpendicular cliffs of beds of limestone and conglomerate. Limestone, resting on trap, also occurs in the ravine south of Amol. In ascending the river beyond this ravine towards Karoo, the following section is exposed. Trap—limestone—sandstone—shale—indurated slate clay—buhrstone—sandstone—limestone—trap. Between Karoo and Bulkulum is a narrow and deep fissure through a mountain of limestone, capped by the coal strata; and near the tomb of Em Zadeh Hashim, limestone again occurs resting on trap.

Organic Remains.—In the superficial conglomerate near the Dalee Chaee Caravanserai, Dr. Bell observed portions of two small Ammonites imbedded in fragments of compact limestone, but he did not notice the same rock in situ*.

Trap.—Greenstone, basalt, amygdaloid, porphyry, claystone, pitchstone, and serpentine, underlie the limestone at many places.

Travertine.—Springs charged with calcareous matter were often noticed, and it is stated, that the preservation of the remains of Shah Abas's causeway is owing to the calcareous drippings from the

* Near the summit of the ridge of the Elboorz just below the snow line, south of the district Toonikabān, he found a limestone containing bivalve shells; and near Bayazeed, in the neighbourhood of Mount Azarat, limestone inclosing corals and oysters, and resting on sandstone.

mountain side. Siliceous globules are formed by a hot spring in the little capital of Usk.

Thermal and Mineral Springs occur near Usk.

In conclusion the author says, that the ravines through which the rivers Talâr and Herâz flow, are not due to denudation, but to rents; and that though the ravines are narrow, it would be difficult to point out a spot, where the strata on the opposite sides correspond. He noticed along the course of the Herâz, numerous effects of violent modern earthquakes.

A paper was next read entitled "Notes on the Geology of the line of the proposed Birmingham and Gloucester Railway," by Mr. Frederick Burr.

The author of this communication was employed on the survey for the railway, and the following is a general summary of his observations:—

For the first 26 miles, or from Gloucester to within three miles of Worcester, the road passes over the lower lias shale, and for the remainder of the distance over red marl and red sandstone. The lias tract is generally flat, seldom exceeding 100 feet above the level of the sea; but the red marl and sandstone rise considerably higher, and in that portion of the Lickey range intersected by the line of railway, the sandstone attains a height of about 600 feet above the same level. From the Lickey to Birmingham, the country forms an undulating table land, having a mean elevation of from 200 to 300 feet. The author gives numerous bore hole or shaft sections, made during the survey, and is thus enabled to show the nature of the formations in a district, otherwise concealed by its physical features or cultivated surface.

Lias.—The lias strata belong solely to the lower shales, and consist of bluish or blackish slaty clay, containing thin beds of argillaceous limestone. Near the junction with the red marl, there is generally a thick deposit of whitish or yellowish clay, with numerous beds of rubbly limestone, usually blackish. Beds of a light colour, resembling lithographic stone, are exposed in quarries near the Plough, half way between Gloucester and Cheltenham, and white lias is stated to occur at the junction with the red marl near Crawl, four miles N.E. of Worcester. The junction of the red marl is also exhibited in numerous small quarries in the same neighbourhood, but the strata consist of the above-mentioned whitish or yellowish clay, and dark limestone. These junction beds are also exposed at Dunhampstead, three miles S.E. of Droitwich.

Red Marl and Sandstone.—No difference was noticed in this formation from the characters already published. The marl is generally red and brown, but it is occasionally variegated or streaked white, and sometimes it contains a thin bed of red sandstone. The following section is given of the Droitwich brine pits. Red marl, with much water, 40 feet; marl with gypsum, but no water, from 100 to 130 feet in different pits: rock salt, not penetrated through at the depth of 170 feet. A pit at the chemical and salt works at

Stoke Prior, four miles north of Droitwich, was sunk to the depth of 460 feet, first through red marl with much water, 111 feet; then red marl with gypsum, but no water, 195 feet; and afterwards marl interspersed with salt and interstratified with four beds of rock salt, 10 feet, 6½ feet, 39 feet, and 30 feet thick, respectively.

About two miles beyond Stoke Prior, the red marl is replaced by red sandstone. At the junction, the former becomes slaty and contains thin beds of sandstone, and the latter consists of a pale brownish or yellowish argillaceous sandstone. At Finstat, black coaly impressions were noticed. About a mile north of Bromsgrove, the argillaceous sandstone is succeeded by a bright red micaceous sandstone. The rise of this rock to the surface was probably produced by the elevation of the neighbouring Lickey range, as at Stoke Prior, distant only two miles, the sandstone was not reached at the depth of 460 feet. In the ascent of the Lickey, the surface consists of coarse quartzose gravel, derived from the upper part of the range. The summit level of the railway is near Barnes Green Farm, and it is 384 feet above the sea. At this point a shaft was sunk through the following strata:—

	Feet	Inch.
Gravelly sand	6	0
Hard coarse gravel	1	6
Fine gravel	1	0
Hard coarse gravel	8	0
Indurated red marl	2	0
Hard coarse gravel	11	0
Red sandstone	1	0
Hard conglomerate	20	6
	51	0*

Of these beds of gravel, the author considers only the uppermost as superficial gravel, and the remainder as belonging to the new red. To the north of the ridge, the bright red sandstone re-appears, dipping considerably to the east, and alternating with marl and impure siliceous limestone. About a mile from the Lickey, the red marl again constitutes the surface, and extends to Birmingham.

Superficial Detritus.—The lias in the vale of Gloucester is covered by 8 or 10 feet of brownish, greyish, or mottled clay and loam, overlaid by thick deposits of sand and gravel, derived, in the neighbourhood of Gloucester, Cheltenham, and some other places, from the adjacent oolitic hills; but near Bredon and to the north of that village, the detritus consists of siliceous sand and pebbles.

Mineral Springs.—From information obtained during the survey, the author states, that at Walton, one mile east of Tewkesbury, a spring similar in properties to the Cheltenham waters, was found at

* In deep cuttings of the Worcester and Birmingham Canal, 1½ mile south-east of this point, Mr. Burr noticed an anticlinal axis, denudated in the centre. The strata dipped south and north at considerable angles, and consisted of red marl overlying red and white sandstone.

the depth of 90 feet: that in the neighbourhood of Northway, weak brine springs have been discovered in the lias clay at the depth of 40 feet; and likewise on Defford Common. All these springs, Mr. Burr remarks, range N. and S. and in a line with the brine springs of Droitwich and Stoke Prior. Near Stoulton, five miles from Worcester, is a small, brackish marsh.

In conclusion, the author expresses his hopes, that surveyors, employed on similar investigations, will be induced to lay the results of their field work before the Society; and he acknowledges his great obligation to Capt. Morsoom, the superintending engineer of the line, for being permitted to make free use of all the geological information, which he obtained during the discharge of his duties.

A paper on "the Coast Section from White Cliff Lodge, one mile south of Ramsgate, to the Cliff's End, near the "Station Brig" in Pegwell Bay, Kent," by Mr. John Morris, was afterwards read.

The cliffs consist of the upper chalk for about $\frac{3}{4}$ of a mile, and of "the lower or sandy beds of the London clay" for the remainder of the distance. A capping of superficial detritus, of rubbly chalk, chalk flints, and loam, extends the whole way.

The principal object of the communication is to describe a series of dislocations in the chalk, marked by shifts in a layer of tabular flints.

1.	At 52	paces from the commencement of the section is a slight indication of a fault.				
2.	30	paces further the layer of flints is depressed at a fissure				4 feet.
3.	31		ditto	ditto	ditto	4
4.	53		ditto	ditto	ditto	2
5.	33		ditto	ditto	ditto	3
6.	43		ditto	ditto	ditto	2
7.	30		ditto	ditto	ditto	4
8.	11		ditto	ditto	ditto	slightly.
9.	12		ditto	ditto	ditto	1
10.	About 45	paces from the last depression, the vein of flint is brought within 8 feet of the beach, and it is in one place affected by a fault of $1\frac{1}{2}$ feet.				
	340					

Close to fissures 1 and 2, are indications of parts of the bed of flint not having been equally disturbed, as they preserve the same horizontal range, while the portions on each side are depressed: a similar example of irregular movement occurs at number 5. Beyond the fault 10, the cliff recedes, forming a small cove, produced, the author believes, by the action of the sea on a considerable disturbance in the strata, the minor faults being always accompanied at the foot of the cliff by a natural excavation or cave.

Where the layer of flint re-appears, it is curved, and is afterwards traversed by three faults producing unequal depression, one of which is coincident with a vein of tabular flint; beyond the Preventive Station is another depression of 5 feet, the upper part of the fissure being filled with chalk rubble, sand and flint, and the bottom hollowed into a cave 10 feet high, and from 15 to 20 feet deep. At 10 yards from this point the flint layer dips beneath the beach. The chalk cliff continues for about 800 paces further, gradually decreasing in altitude, but capped by sandy loam and chalk rubble. Beyond this point, the tertiary strata commence, consisting, in the upper part, of 7 to 18 feet of sand and sandy clay, with occasional masses of sandstone and layers of shells; and in the lower part of 7 feet of bluish clay, which also incloses shells. These strata are visible for about 570 yards, and then dip beneath the marshes. Mr. Morris considers them the equivalents of the beds between Reculver and Hearne Bay, agreeing in position, mineral characters, and organic remains. They are overlaid by the same superficial detritus as the chalk.

The destruction of the cliffs is calculated to have been, until means were taken to defend them, at the rate of 3 feet annually. At the cove before-mentioned, the sea removed in 25 years, about 20 yards, including two cottages and a garden.

The wells at the Preventive Station and Pegwell, are sunk about 30 feet, through loam and chalk. The water is 10 feet deep, but it is sometimes brackish, being affected by the rise and fall of the tide. It is generally lowest after the tide has flowed one hour, and remains in that state about two hours, after which it rises. Whether this effect is connected with the faults in the cliffs, Mr. Morris doubts; but he states, that a freshwater spring issues from the beach at low water, opposite the well at the Preventive Station.

Jan. 31.—Edward Mammatt Esq., of Ashby de la Zouch; John Hawkshaw, Esq., of Salford, Lancashire; and John Carrick Moore, Esq., of Queen's College, Cambridge, were elected Fellows of this Society.

An extract was first read from a letter addressed by Sir John Herschel to Mr. Lyell, and dated Feldhausen, June 12, 1837.

In former letters addressed to Mr. Lyell and Mr. Murchison, dated Feldhausen, Feb. 20, and Nov. 15, 1836, and read before the Society May 17, 1837*, Sir John Herschel first proposed his theory relative to the encrement of temperature from below, which would be produced in certain portions of the earth's crust by the partial distribution of additional sedimentary matter over the bottom of the ocean; and of the effects which would naturally result from this operation, producing the phænomena of earthquakes, and elevation and depression of strata. In this letter he states, he was not then aware that Mr. Babbage "had speculated on that peculiar mutual re-action of the surface and the interior of the globe, and which must be called the secular variation of the isothermal surfaces of the latter;" nor was he aware of the notice in the Proceedings† of Mr. Babbage's paper on the Temple of Serapis, until his attention was recently called to it by Mr. Lyell and Mr. Murchison, but at the end of which notice a theory identical in the leading point is given.

With respect to the first development of the theory, Sir John Herschel says, "the employment of the pyrometric expansion of

* *ante*, p. 548. † p. 72.

rocks as a motive power was, I feel confident, suggested by some one (the name of Mitscherlich or Laplace is somehow connected in my memory with it) many years ago, certainly before 1833. As regards the course of my own ideas, it was simply this. When I first read your book I was struck with your views of the metamorphic rocks, and I began to speculate how and why the mere fact of deep burial might tend to raise the temperature to the required point. Three modes occurred: 1st. development of heat by condensation; but this cause seemed somewhat feeble, and not very clear in its mode of action, since at every moment an equilibrium of pressure and resistance is established: 2nd. plunging down into an ignited pasty mass; here, however, considering the excessive slowness of the process, it occurred to me that there would be plenty of time for the ignited matter below, not merely to divide its caloric with the newly superposed mass, but to take up fresh from below, and thus to establish a regular gradation of temperature from below upwards; and this led to the 3rd and more general view of the matter, which is that of the variation of the isothermal surfaces, as stated in my former letters."

It was, however, the perusal of Mr. Lyell's 4th Edition which led to the final development of the theory.

Sir John Herschel then observes: "When people think independently at different times, and excited by different original subjects of consideration, bearing on one more general object, if their ideas converge towards one view of the matter, it is a proof, that there is something worthy of further inquiry; and if they think to any purpose, it is hardly possible but that many points will occur to the one which do not occur to the other; and that so a theory may branch out and acquire a body much sooner than it would do by the speculation of one alone; and indeed such is, in some degree, the case in the present instance. Babbage, for example, has speculated not only on the heaping on of matter in some parts, but on its abstraction in others as a cause of variation in the isothermal surface, and justly. It is the case of the algebraic passage from $+$ to $-$ passing through 0. In *envisaging* (as the French call it) the question algebraically, the cases could not be separated. Again, he has confined himself to the pyrometric changes in the solid strata, while I have left these out of view, and relied on what I think to be a far more energetic and widely acting cause—the variation of pressure, and the infinity of supports broken by weight, or softened by heat, to produce tilts. Both causes, however, doubtless act, and both must be considered in further detail. The former alone may account for the phænomena of the Bay of Naples, the latter must I think be called in to account for those of Scandinavia and Greenland, and of the Andes.

"I would observe that a central heat may or may not exist for our purposes. It seems to be a demonstrated fact that temperature does, in all parts of the earth's surface yet examined, increase in going down towards the centre, in what I almost feel disposed to call a frightfully rapid progression; and though that rapidity may cease, and the progression even take a contrary direction long before we reach the centre (as it might do, had the earth, originally cold, been as Poisson supposes, kept for a few billions or trillions of years in a firmament full of burning suns, besetting every outlet of heat, and then launched into our cooler milky-way); still as all we want is no more than a heat sufficient to melt silex, &c., I do not think we need trouble ourselves with any inquiries of the sort, but take it for granted that a very moderate plunge downwards in proportion to the earth's radius, will do all we want."

A paper was next read, entitled "Description of the Insulated masses of Silver found in the mines of Huantaxaya, in the province of Tarapaca, Peru;" by Mr. Bollaert, and communicated by Mr. Darwin, F.G.S.

The mines of Huantaxaya are three leagues from the Port of Iquiqui (lat. 21° 13′ S. long. 70° W.), and in a mountain-hollow 2800 feet above the level of the sea. This depression is bounded towards the west by a hill called Huantaxaya, 3000 feet above the sea level, or 200 feet above the hollow, and on the opposite side by a hill of similar height. The great mass of the mountain consists of a reddish, argillaceous limestone, but the escarpment, towards Iquiqui is covered with loose sand, and near the base, porphyry and granite are visible. The limestone is traversed by numerous argentiferous and other veins, which range from N.E. by E., to S.W. by W., but the mines of Huantaxaya are in a superficial detritus called Panizo.

This deposit is from eighty to one hundred yards thick, and is composed of fragments of limestone not water-worn, and dried mud apparently derived from the same rock. It is divided into beds, some of which, called Sinta, are metalliferous, and others, called Bruto, are barren. The nodules of ore, to which the name of papa has been applied, from their resembling a potatoe in form, consist of pure silver, chloride, and other chemical compounds of silver, sulphurets of copper and lead, and carbonates of copper. The papas are of all sizes, and some have produced 160 ounces of pure silver in a hundred pounds. One celebrated papa weighed about 900 pounds, and resembled in shape the top of a table. The miners believe, that each layer of Sinta has been derived from a particular vein in the limestone, and that they can determine to which vein a papa originally belonged.

The only instruments used in working the Panizo, are an iron bar six inches long and a small iron mallet. With these tools, the Panizero rapidly advances in the soft materials, but rarely makes a larger excavation than is sufficient for his body to pass on hands and knees. In clearing out the contents of these honey-combed galleries, a hide-bag is strapped over the shoulders and under the arms, but in crawling through the narrower parts, the miner transfers the bag to one of his feet and drags it after him.

The danger of working these unconsolidated beds is greatly enhanced by frequent shocks of earthquakes.

The following section of the principal shaft will illustrate the nature of the Panizo deposit.

	yards
1. Caliche. This bed contains near the surface a large quantity of common salt, and occasionally a few small papas are found in it	28 yards.
2. *Sinta Cenisada*, ash-coloured, with a few papas	½
3. Caliche, or Bruto	12
4. *Sinta*, Tisa chiquita, a bed consistingof 96·4 white sand, 3·6 sulphuric salts and water; also a trace of muriatic salts. A few papas	¼
5. Bruto	4
6. *Sinta cascajosa*	¼
7. *Sinta Tiquillosa*	½
8. *Sinta challosa*	¼
9. Bruto manto, many fossil shells	¼
10. Bruto conchado, shelly layer*	½
11. Tisi chiquita, resembling number 4	½
12. *Sinta Tiquillosa*	¼
13. Bruto	4
14. *Sinta Tiquillosa*	¼
15. Bruto	4
16. *Sinta challosa*	¼
17. *Sinta cascajosa*, gravelly layer	¼
18. Bruto conchado, shelly*	¼
19. *Sinta conchado*, shelly*	2
20. *Sinta challosa*	¼
21. *Sinta conchado*, shelly,* few papas	¼
22. *Sinta cascajosa*, gravelly layer	¼
23. *Tisa grande*, similar to 4.	6
24. Bruto	½
25. *Sinta cascajosa*, gravelly layer	¼
26. Bruto	½
27. *Sinta chadosa*	¼
28. Bruto	½
29. *Sinta barrosa*, clayey layer	½
30. *Tisa*, similar to 4	¼
31. Bruto	6
32. *Sinta cascajosa*, gravelly layer	¼
33. Bruto	½
34. *Sinta chadosa*	½
35. Bruto	3
36. *Sinta chadosa*	¼
37. Bruto	1
38. *Sinta barrosa*, clayey layer	½

The layer 38 rests upon the limestone rocks.

A paper was afterwards read " On the peat bogs and submarine forests of Bourne Mouth, Hampshire, and in the neighbourhood of Poole, Dorsetshire;" by the Rev. W. B. Clarke, F.G.S.

The entrance of Bourne Mouth Valley is one of the many chines which intersect the tertiary strata between Poole Harbour and Christ Church Head, and the valley extends from the sea three and a half miles in a N.W. direction. About half way, a fork diverges to the west, and this branch with the lower portion of the main valley is called Bourne Bottom, and the eastern branch of the fork, Knighton Bottom. In each valley is a small current, and their united waters form the brook at Bourne Mouth. At the head of Knighton Bottom is a peat bog, which contains trunks of oak, alder, birch, and beech trees, also hazel sticks and nuts, and fragments of bark. The trunks of the trees lie in the direction of the valley, but the stools are firmly fixed upright in the peat. The wood when extracted is soft, but it becomes firm on exposure to the weather, and it is used for purposes of husbandry. The bark, especially that of the beech, retains its character unaltered. The surrounding district is now sterile, and no oaks of equal size exist within many miles of Knighton

* In these layers, fossil shells, derived from the limestone, are found.

Bottom, the neighbouring plantations being of very recent origin. Traces of fire and of the axe are said to have been noticed in the bog-wood. Ten feet of peat have been excavated, but the depth of the deposit is not known. The peasantry have a tradition, that the forest was burned down during the reign of Stephen, though Mr. Clarke conceives that its destruction was effected during the occupation of England by the Romans. At the head of Bourne Bottom there is also a peat bog, but it incloses only fir trees. The submarine peat and forest off the entrance of Bourne Mouth* contains fir, birch, and alder trees; Mr. Clarke however considers that the two latter have been transported from the bog at the top of Knighton Bottom. Some of the trees, as noticed by Mr. Lyell, are pyritous, but the author of the paper is of opinion, that they have been derived from the neighbouring cliffs of plastic sand, having observed in them, during the summer of 1837, a pyritous trunk. The present position of the forest, Mr. Clarke thinks is due to a subsidence and undermining of the strata, which supported it at a higher level.

Other peat bogs are described on the north of Poole harbour, as between Sterte and Stanley green, at Hatch Pond, Creekmoor and Lytchett. At the first of these localities, in making an excavation to erect a dyke, the workmen found beneath the alluvial soil, gravel, then peat, and afterwards oaks and alders which rested upon mottled clay. The sea, at all states of the tides, overflowed this inlet previously to the erection of the dyke; and the position of the forest Mr. Clarke assigns to an undermining of the strata on which it rested.

At *Hatch Pond*, about two miles north of Poole, in the direction of Winbourn, is an extensive depression through which a brook of some volume flows, and has produced an immense accumulation of peat. This bog communicates with Poole Harbour by a succession of marshy grounds; the whole of which Mr. Clarke conceives were once covered by the sea, as they present phenomena similar to those exhibited at Tottenham, with the exception that no trees have been observed. A branch of a Roman road meets the present highway just upon the edge of the depressed area, and the author infers that that point was, in the time of the Romans, the water head of the bay, though it is now three or four furlongs nearer Poole.

Creekmoor. Another tract of low marshy ground, with a peat-bog containing fir trees, occurs at Creekmoor bridge on the north side of Holes Bay. In draining it, the workmen, about four feet from

* An account of this submarine fir-wood was first given by Mr. Lyell in the 4th edition of the Principles of Geology (1835), from information communicated by Mr. Charles Harris. The present submerged position was explained on the belief, that as the sea is encroaching on the shore, the Bourne Valley may once have extended further; and that its extremity consisted as at present of boggy ground, partly clothed with fir-trees; that the sea laid bare at low tide the sandy foundations, which being undermined by streams of freshwater, several of which burst forth in different parts of the existing beach, the matted superstratum of vegetable matter sank down below the level of the sea.—Vol. iii. p. 276.

the surface, tapped a spring which flows with great violence and throws up white sand.

Lytchett. At various places in this parish, peat bogs and buried trees occur, particularly at Bulbury Bay. They are, however, considerably above the level of the sea; but on the north east side of Lytchett Bay, at the extremity of the canal from the clay works, is a subsided peat bog thirty feet thick, containing trees. It rests upon mottled clay, and is overlaid by nine or ten feet of clay and sand which are constantly covered by two feet of water.

In the pits where the subjacent mottled clay is excavated, springs of great volume burst forth whenever the main body of water is tapped, and the author is of opinion that this subterranean stream may have caused the subsidence of some of the peat bogs, in consequence of its undermining action.

In alluding to the accumulations of mud in Poole Harbour, the author states, that in digging a well in West Street in the town of Poole, a mass of sea-weed was found, with remains of an ancient embankment at the depth of six feet, and a furlong from the present high water mark.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1838. No. 55.

AT THE

ANNUAL GENERAL MEETING,

16*th February,* 1838,

The following Report from the Council was read:—

The Council has on this, as on many preceding Anniversaries, to congratulate the Society on the steady augmentation of its numbers a circumstance gratifying, not only because it adds to the efficiency of the body, but because it evinces on the part of the public a growing attachment to Geological Science. During the year 1837 the number of Fellows, with the Honorary and Foreign Members, has risen from 810 to 837, 47 Fellows having been elected during that period, and the deaths and resignations having amounted to 20.

The business to be transacted by the Society having grown with its growth, it has become necessary to review, and in some instances to remodel, the salaried department. It has appeared desirable to the Council that the laborious and difficult duty of arranging and cataloguing the collections should devolve upon an officer whose time should be given to that single object; but the qualifications required in such an officer are so many and so rare, that though numerous candidates have presented themselves, no one has yet been appointed.

The reforms which the Council contemplate in the salaried department will, it is hoped, when complete, add to its efficiency without any material augmentation of expense. In compliance with a Bye-Law of the Society it is the duty of the Council to state that Richard Beauchamp and his wife have been appointed to the situations of porter and housekeeper, instead of Robert Carrier, deceased.

The Council have great pleasure in observing the state of the finances, of which a detailed statement is appended to this Report.

The estimates of the past year have so far exceeded the expenditure as to warrant the expectation that the reduced estimate now given in will be sufficient to meet the expenditure of the present year, notwithstanding the charges which may be occasioned by increased efficiency in the establishment.

The property of the Society estimated at the last Anniversary at *2563l. 5s. 5d.* is now estimated at *2898l. 5s. 10d.*

In the Auditor's Report for 1833, it was recommended that the Council should, from time to time, make, from the surplus income of the Society, such investments in the Government Funds as would create a capital equal to the amount of sums paid in lieu of annual contributions.

From that period the Council has steadily acted upon the recommendation suggested, and it is gratifying to state, that the Society has now, in funded property, a capital of 1643*l.*, the total amount of compositions received being 3249*l.* 10*s.*

A new part volume of Transactions has been published since the last Report, and from the orderly arrangements now made, there is every reason to hope that this very important department of the Society's concerns will be conducted henceforward with a degree of regularity and despatch which, in the less prosperous state of the Society, it was not found practicable to ensure.

The Council has resolved " that the Wollaston Gold Medal and 21*l.* be assigned to Mr. Richard Owen for his services to Fossil Zoology in general, and especially for that portion of the description of the Fossil Mammalia (collected by Mr. Charles Darwin in the voyage of H. M. S. Beagle) which has already been published."

Report of Museum Committee.

Your Committee, before reporting on the general state of the Museum with reference to the appointment of a new Curator, will first point out what has been principally effected during the past year. A complete suite of all the fossils from the Crag which are in the possession of the Society, has been, for the first time, arranged by Mr. Lonsdale, and they fill ten drawers. All the fossils of the London clay, received from Mr. Stokes and others, have been worked into their proper places, as has been likewise done with those from the chalk. The fossils from the gault and upper green-sand, presented by Dr. Fitton and others, have likewise been arranged. Those of the lower green-sand have been arranged for the first time: the specimens from the green-sand of Devonshire occupy eight drawers. Those from the Portland sand and limestone occupy an equal number. Your Committee in stating what has been done during the last year, wish to observe, that the number of drawers, considerable as it is, gives no just idea of the amount of labour bestowed on the collection. Besides the great care and time required to extract some of the fossils from the rock, in all cases where possible, complete suites of the different species, from their earliest to their most advanced stages of growth, have been formed; the extreme value of which will be at once obvious to every zoologist. On the board on which the specimen is fastened, the locality, name of donor, that of species, and often references to some standard work, are inscribed.

The remainder of the public collection is much in the same state as during former years. Weald clay and Purbeck not arranged. Oolite and lias, specimens labeled but not arranged. The arrangement of the new red sandstone, mountain limestone, and old red sandstone, has been stopped until the publication of Mr. Murchison's work. The formations below the old red sandstone are placed in geographical order, until our knowledge of their relations be more complete. The traps and granites are grouped by themselves. The specimens from Scotland are arranged on the same principle with those from England; but the fossils are comparatively few in number. The arrangement of the Irish collection is geographical. The same principle has been followed in the whole foreign collection, with the exception of a part belonging to the best known formations of France. With respect to the foreign collection, your committee beg to observe, that two of its members having occasion during the last year to consult certain portions of it from distant quarters of the world, namely the Himalaya and the Andes, found the present arrangement the best for their purpose. At p. 461 of the Proceedings a list of the number of drawers, appropriated to specimens from different countries, is given, and therefore it is thought unnecessary here to repeat it.

In the cellars there is a considerable number of boxes containing specimens not yet arranged; and the collection of duplicates is enormous.

After these remarks it may be observed, that the first principle of arrangement in the collection has been geographical; and that, where there existed sufficient data, this has been followed up by a stratigraphical classification. In the latter case, the upper drawers contain the rocks; the next any accompanying minerals, and the lower ones the organic bodies,—beginning with those of the simplest structure, and so proceeding to the higher orders. With respect to catalogues; separate ones have been made by Mr. Lonsdale, of the fossils of some of the English formations. Your committee would suggest the advantage (when time permits) of forming an index of the fossil shells, either according to a natural system, or alphabetically, so that any person might know in which drawer a given species could be found, without having to search the catalogues of the separate formations. And likewise they would suggest, that a brief geographical catalogue of the whole collection should be made, with references to letters pasted on the different cases, so that every member might at once know what specimens were in the collection from any locality. Even the brief list given at p. 461, and before alluded to, with references to the drawers, would, in the opinion of your committee, be extremely useful, and would require very little time.

The mineralogical collection is in the same state as during the previous year. It would, perhaps, be advantageous if attention were called to this collection by a title inscribed over it, instead of over the door of the Library.

With respect to the Library your committee report, that a catalogue has been made by Mr. Humphreys of every book and of the numerous pamphlets in it, with a full title and reference to each. The books themselves have likewise been classed according to the subjects of which they treat, or the system of their publication. Your committee are of opinion, that the catalogue is not only highly useful to the Society, but most creditable to the industry of Mr. Humphreys, who has completed it by himself during the past year. The committee observe that much of Mr. Humphreys's time has been required in supplying books to the members, and in preparing, together with Mr. Bailey, sections for the evening's meetings. The charts were arranged during a previous year, with much care, by Mr. Lonsdale, with references to the printed catalogue. Your committee may remark, that if letters were added to the shelves and cases, a work of very little time, any one consulting the catalogue for the first time would be able immediately to find any chart he wanted. The maps are in a less perfect state of arrangement.

The Committee beg leave to mention as the principal donations to the Museum, since the last Anniversary, the following list:—

Fossils from the Crag; presented by Mr. Brown, F. G. S.

Tooth of a Mastodon from the Crag; presented by Rev. J. Gunn.

Fossils from Grignon, and other tertiary deposits in France; presented by Mr. Stokes.

Specimens of polished Fossil Woods from Antigua; presented by Major Gen. Sir Patrick Ross.

A collection from Cutch; presented by Capt. Grant.

Collection from the Madras Presidency; presented by Mr. Malcolmson.

Specimens from Eastern Australia; presented by Major Mitchell.

Capt. Beaufort has forwarded to the Society several small collections sent to England by officers of the Royal Navy.

Specimens from the countries between Madras and the Neilgherries, and other parts of India; presented by Dr. Benza.

CHARLES LYELL.
CHARLES DARWIN.

Comparative Statement of the Number of the Society at the close of the years 1836 *and* 1837.

	31st Dec. 1836.	31st Dec. 1837.
Fellows having compounded	97	103
——— Contributing	251	253
——— Non-residents	361	382
	709	738
Honorary Members	43	42
Foreign Members	55	54
Personages of Royal Blood	3	3
	810	837

General Statement explanatory of the changes in the Number of Compounders, Residents, and Non-residents, at the close of the years 1836 and 1837.

At the close of 1836			709
Add Fellows elected during 1837 . .			47
			756
Deduct, Deceased,	Residents . .	3	
	Non-residents .	2	
	Compounder .	1	
Resigned,	Residents. . .	10	
	Non-residents on becoming Resident .	2	
			18
Total number at the close of 1837 . . .			738

Deceased Fellows:—

Residents (3): Samuel Daniel Broughton, Esq.; Henry Thomas Colebrook, Esq.; Edward Turner, M.D.
Non-residents (2): Robert Bevan, M.D.; John Hey, Esq.
Compounder (1): James Vine, Esq.
Honorary Member (1): Professor Farish.
Foreign Member(1): M. Gillet de Laumont.

The following Donations to the Museum have been received since the last Anniversary:—

British and Irish Specimens.

Specimens from the Chalk and superficial detritus of Norfolk; presented by C. B. Rose, Esq.
Specimens from Cornwall; presented by James Yates, Esq. F.G.S.
Specimens from Sarn Badrig, Cardigan Bay; presented by Lieut. Sheringham, R.N.
A Collection of British Specimens; presented by Miss Lousada.
Specimens from the Crag of Norfolk; presented by John Brown, Esq. F.G.S.
Pentacrinites Briareus from the Lias, Lyme Regis; presented by Viscount Cole, M.P. F.G.S. and Sir Philip Grey Egerton, Bart. M.P. F.G.S.
Fossils from the Mountain Limestone of Ireland; presented by Viscount Cole, M.P. F.G.S.
Polished Specimens of the Limestone of Kilkenny; a Boulder of the Hertfordshire Pudding Stone; Granite from Newry (on the Road to Belfast); Specimens from the Coal Mines of Burdie-house; Primitive Limestone from Glen Tilt; and Granite and Mica Slate

with Garnets, from between Dunkeld and Blair; presented by William Perceval Hunter, Esq. F.G.S.

Specimens of Coal Plants from Rotherham; presented by — Roberton, Esq.

Tooth of a Mastodon from the Crag of Norfolk; presented by Rev. John Gunn.

Ammonites Lewesiensis from Shakespeare's Cliff, Dover; presented by F. Bonney, Esq.

Vegetable Impressions from the Coal Measures at Rhymney, near Merthyr Tydvil; presented by Thomas Williams, Esq.

Fossils from the Mountain Limestone in the Isle of Man; presented by Captain Bentham, 52nd Regt.

Specimens of Iron Ore from Cornwall; presented by Benjamin Tucker, Esq.

Polished Slab of the Fossil Tree at Cragleith; presented by Messrs. Walker and Burgess.

Stag's Horn, from the Preston and Wyre Railway, Lancashire; presented by Decimus Burton, Esq. F.G.S.

Specimens of the Whitby and Whitehouse Building Stone, and of the Whitby Porcelain Earth in contact with a Whinstone Dyke; presented by the Whitby Stone Company.

Specimens from near the Trap Dyke, in the Penrhyn Slate Quarries; presented by Mr. S. Morris.

Fossils from the Mountain Limestone, Oolitic, and Cretaceous System of England; presented by Miss Bennett, of Norton House.

Vertebra of a Plesiosaurus, from Terry's Pits, Haseley Mill, Oxfordshire, and a Fragment of a Stag's Horn from the same Locality; presented by Rev. T. Birkett, South Taunton, Devonshire.

Specimens from the Slate of Devonshire; presented by Henry Maclauchlan, Esq. F.G.S.

Foreign Specimens.

Specimens from Finland and Norway; presented by Francis Walker, Esq. F.G.S.

Stalagmite from Gibraltar; presented by Louis Hayes Petit, Esq. F.G.S.

Fossils from Grignon, Hauteville, Bordeaux, and Piacenza; presented by Charles Stokes, Esq. F.G.S.

Hippurite from Perigord; presented by Samuel Peace Pratt, Esq. F.G.S.

Polished Specimens of Fossil Wood from Antigua; presented by Major-General Sir Patrick Ross, G.C.M.G. K.C.H. F.G.S.

Osseous Breccia from Cerigo; presented by Dr. Forbes.

Rock Specimens and Fossils from Faxoe; presented by Dr. Forchhammer, For. Mem. G.S.

A Suite of Geological Specimens from New Jersey; presented by Professor D. Rogers, F.G.S.

A Collection of Fossils and Rocks from Cutch; presented by Captain Grant.

Specimens from Sicily, Vesuvius, the neighbourhood of Naples, &c.; presented by John Auldjo, Esq. F.G.S.

Fossils and Specimens of Rocks from the Eastern portion of the Great Basaltic District of India; presented by J. G. Malcolmson, Esq. F.G.S.

Specimens from the country between Madras and the Neilgherries, and other parts of India; presented by Dr. Benza.

Specimens from Cape Horn, the Straits of Magellan, &c.; presented on the part of Charles Collett, Esq. by Capt. Beaufort, R.N. Hon. Mem. G. S.

Specimens from the Pitch Lake at Trinidad; presented by Gilpin Gorst, Esq. F.G.S.

Specimens from the Gold Coast, collected during the voyage of H. M. S. the Chanticleer; presented on the part of Capt. Vidal, R.N. by Captain Beaufort, R.N. Hon. Mem. G. S.

Casts of Basilosaurus, &c.; presented by Dr. Harlan.

Specimens from the shores of the Dead Sea; presented by Henry Beek, Esq.

A collection of Specimens from Australia; presented by Major T. L. Mitchell, F.G.S.

A Specimen of Ficoides; presented by Mrs. Major-General Le Couteir.

A Stone brought up by the lead in eighty fathoms water upon the edge of the bank, about fifty miles east from Cape St. John, Slater Island; presented by Captain Beaufort, R.N. Hon. Mem. G. S.

Specimens from Madras, Beder, &c.; presented by Dr. Cole.

Specimens from Madeira; presented by William Christie, jun. Esq.

Specimen of the Asphaltic Mastic; presented by F. W. Simms, Esq.

Miscellaneous.

Geological Model of the Isle of Wight; presented by Mr. Lowry.

Roman Coin Mould found at Lingwell Gate, near Wakefield, containing remains of Infusoria; presented by J. B. Reade, Esq.

Bust of Dr. William Smith; presented by William Perceval Hunter, Esq. F.G.S.

Model of Clare Island, on the coast of Mayo, Ireland (scale 8 inches to 1 Irish mile); presented by William Bald, Esq. F.G.S.

Two Denarii of Geta and Antoninus Pius; presented by Mr. William Till.

The Library has been increased by the Donation of about 140 Books and Pamphlets.

Charts and Maps.

Admiralty Charts, Sailing Directions and Tide Tables, published during the year 1836; presented by Captain Beaufort, R.N. by direction of the Right Hon. the Lords Commissioners of the Admiralty.

Ordnance Townland Survey of the Counties of Meath, Leitrim, Sligo, and Longford; presented by Colonel Colby, F.G.S., by command of His Excellency the Lord Lieutenant of Ireland.
Sheet 59 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.
Sections and Plans of the Chester Junction, Chester and Trewe, and the Manchester South Union Railways; presented by Sir Philip Grey Egerton, Bart. M.P. F.G.S.
Fifteenth Section of the Geological Map of Saxony; presented by the Council of Mines of Saxony.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received during the past year.

Abich, H., M.D.
Academy of Sciences of Paris.
Admiralty, The Lords Commissioners of the.
Allen and Co., Messrs.
American Philosophical Society.
Asiatic Society of Bengal.
Athenæum Club.
Athenæum, Editor of
Auldjo, John, Esq. F.G.S.

Baily, Francis, Esq. F.G.S.
Bald, William, Esq.
Beaufort, Captain, R.N. Hon.M.G.S.
Beek, Henry, Esq.
Benett, Miss
Bentham, Captain, 52nd Reg.
Benza, P. M., M.D.
Beyrich, Ernest, M.D.
Birkett, Rev. Thomas.
Birmingham Philosophical Institution.
Black, James, M.D.
Benny, F. Esq.
Bennias, M. Henri.
Bouillet, M. J. B.
Boulanger, M. C.
Brede, M. F. Julius.
British Association.
Bronn, Dr. H. G.
Brongniart, M. Alex., For. Mem. G.S.
Brown, John, Esq. F.G.S.
Burkart, Joseph, Esq. F.G.S.
Burton, Decimus, Esq. F.G.S.

Cambridge Philosophical Society.
Capocci, Sig. Ernesto.
Cautley, Capt. F.G.S.
Charlesworth, Edw., Esq. F.G.S.
Christie, William, jun. Esq.
Colby, Colonel Thomas, R.E. F.G.S.
Cole, Dr.
Cole, Viscount, M.P. F.G.S.
Collett, Charles, Esq.
Cooper, Daniel, Esq.
Council of Mines of Saxony.
Coxe, Leonard, S. Esq., F.G.S.

Daubeny, Prof. M.D. F.G.S.
De Blainville, M. H. D. For. Mem. G.S.
De Klipstein, M. A.
D'Orbigny, M. Charles.
De Waldheim, M. G. Fischer, For. Mem. G.S.

Egerton, Sir Philip Grey, Bart. M.P. F.G.S.
English, Henry, Esq. F.G.S.

Falconer, M.D.
Forbes, Dr.
Forbes, Prof. James David, F.G.S.

Forchhammer, Prof. G., For. M. G.S.
Foster, T. Esq.
Fox, Robert Were, Esq.
Freyberg, Directors of the Royal Mines at.

Gemmellaro, Prof. C.
Geological Society of France.
Gesner, Abraham, Esq.
Gordon, Alex., Esq.
Gorst, Gilpin, Esq. F.G.S.
Grant, Captain.
Grateloup, M. le Docteur.
Gray, John Edward, F.G.S.
Gunn, Rev. Alfred.

Hall, Capt. Basil, R.N. F.G.S.
Harkness, Capt. Henry.
Harlan, Dr.
Heuland, Henry, Esq. F.G.S.
Hunter, W. Perceval, Esq. F.G.S.
Hutchison, Graham, Esq.

Institute of British Architects.
Institution of Civil Engineers.
Ireland, His Excellency the Lord Lieutenant of.
Islington Literary and Scientific Society.

Jerdan, William, Esq.

Lea, Isaac, Esq.
Le Couteir, Mrs. Major-General.
Leeds Literary and Philosophical Society.
Lhotsky, Dr. John.
Liebig, Professor.
Linnean Society of London.
Loury, Mr. J. W.
Loudon, John Claudius, Esq.
Lousada, Miss.
Lyell, Charles, Esq. F.G.S.

Maclauchlan, Hen., Esq. F.G.S.
Maclure, William, Esq. Hon. Mem. G.S.
Madras Literary Society, Secretary of the.
Malcolmson, John, Esq. F.G.S.
Master-General and Board of Ordnance
Medico-Botanical Society.
Mitchell, Major T. L., F.G.S.
Morris, Mr. Samuel.

Nattali, Mr.
Newhaven Verd Antique Mining Company.

Parish, Sir Woodbine, K.C.H. F.G.S.
Petit, Louis Hayes, Esq. F.G.S.
Phillips, Prof. John, F.G.S.
Pratt, Samuel Peace, Esq. F.G.S.

Reade, J. B. Esq.
Rees, George Owen, Esq. F.G.S.
Repertory of Patent Inventions, Editor of.
Richardson and Co., Messrs.
Roberton, — Esq.
Rodd, Mr. T.
Rogers, Prof. Hen. Darwin, F.G.S.
Rogers, Prof. William B.
Rose, C. B. Esq.
Ross, Major-Gen. Sir Patrick, G.C.M.G. K.C.H. F.G.S.
Royal Academy of Sciences of Lisbon.
Royal Asiatic Society of Great Britain and Ireland.
Royal College of Physicians.
Royal College of Surgeons.
Royal Cornwall Polytechnic Society.
Royal Geographical Society.
Royal Irish Academy.
Royal Society of Edinburgh.
Royal Society of London.
Royle, Prof. M.D. Sec. G.S.
Rozet, M.

Scarborough Philosophical Society.
Seacchi, Sig. A.
Schloss, Herr.
Schmitz, Herr J. W.
Schumacher, Herr H. C.

Sheringham, Lieut. R.N.
Silliman, Benj., M.D. Hon. Mem. G.S.
Sismonda, Sig. Angelo.
Smith, Rev. Dr. John Pye, F.G.S.
Smith, William, LL.D.
Società delle Scienze di Modena.
Société de Physique et d'Hist. Nat. de Genève.
Société des Sciences Naturelles de Neuchâtel.
Society of Arts.
Sowerby, Mr. George.
Stepney, Mr. Samuel.
Stokes, Charles, Esq. F.G.S.
Strickland, Hugh Edwin, Esq. F.G.S.
Studer, Prof. B.
Sudlow, J. J. J., Esq.

Tagart, Rev. Edward, F.G.S.
Taylor, Richard, Esq. F.G.S.
Templeman, J. Esq.
Till, Mr. William.
Tucker, Benjamin, Esq. F.G.S.
Turner, Wilton G., Esq.

United Service Museum.

Vidal, Capt., R.N.
Virlet, M. Theodore.
Voltz, Prof. P. L., For. Mem. G.S.
Von Humboldt, Baron, For. Mem. G.S.
Von Koch Sternfeld, Ritter. J. C.

Walker and Burgess, Messrs.
Walker, Francis, Esq. F.G.S.
Waterton, Charles, Esq.
Weiss, Prof. C. S.
Whewell, Rev. Wm. Pres. G.S.
Whitby Stone Company.
Williams, Thomas, Esq.
Willimott, J. Esq. F.G.S.

Yates, James, Esq. F.G.S.
Yorkshire Philosophical Society.

Zoological Society of London.

The following Persons were elected Fellows during the year 1837.

January 4th.—John Henry Philipps, Esq. of Williamston, Pembrokeshire; the Hon. Col. G. S. Dawson Damer, M.P. of Tilney Street; William Benford Nelson, Esq. of 11, Essex Street, Strand; and Henry Morley, Esq. of the Grove, Camberwell, Surrey.

January 18th.—Benjamin Tucker, Esq. of 21, Mecklenburgh Square; Cæsar Coldough, Esq. of Tintern Abbey, Wexford, and of 9, Princes Street, Hanover Square; George Such, M.D. F.L.S. of New Street, Dorset Square; Travers Twiss, Esq. B.C.L. Fellow of University College, Oxford; Joseph Henry Barchard, Esq. of Putney Heath, Surrey; Gilpin Gorst, Esq. of the Old Trinity House; and William Edward Logan, Esq. of Swansea.

February 1st.—Jonathan Thompson, Esq. of St. Edmond's Hall, Oxford, and Temple Grove, East Sheen, Surrey.

February 22nd.—John Backhouse, Esq. of Hans Place, Sloane Street, Chelsea.

March 8th.—Edward J. Chance, Esq. F.L.S. of Cook's Court, Lincoln's Inn Fields; and Mr. Francis Looney, of Manchester.

March 22nd.—Arthur Capel, Esq. of Charles Street, Berkeley Square; John B. Boileau, Esq. of Upper Brook Street, Grosvenor Square; Henry Still, Esq. employed on the Ordnance Survey; John David Day, Esq. A.B. Brazen Nose College, Oxford; John G. Malcolmson, Esq. Surgeon in the East India Company's Service; and the Right Hon. T. Frankland Lewis, of Hertford Street, May Fair.

April 19th.—Edward Herbert Bunbury, Esq. M.A. Fellow of Trinity College, Cambridge; Henry Boase, M.D. of Burton Crescent; and Thomas Jervis, Esq. Hon. East India Company's Engineers.

May 3rd.—The Rev. Baden Powell, A.M. F.R.S. Savilian Professor of Geometry in the University of Oxford.

May 17th.—Joseph Walker, Esq. of Caldeston House, Liverpool, and President of the Institution of Liverpool.

May 31st.—James Heywood, Esq. of Manchester; Richard Owen, Esq. F.R.S., Hunterian Professor in the Royal College of Surgeons, London; Robert William Mackay, Esq. of Lincoln's Inn; and Charles Humfrey, Esq. A.M. of Downing College, Cambridge.

June 14th.—Raikes Currie, Esq. of Hyde Park Terrace; Rev. Joseph Watkin Barnes, Fellow of Trinity College, Cambridge; Thomas Webster, Esq. of Trinity College, Cambridge, Secretary to the Institute of Civil Engineers; and John Nash Sanders, Esq. of Bristol.

November 1st.—Alexander Crichton, Esq. of Charles Street, Grosvenor Square; Major General Sir Patrick Ross, A.C.M.G. K.C.H. of Richmond, Surrey; John Slade, M.D. of Brock Street, Bath; Philip Hardwick, Esq. of Russell Square; Thomas Eyton, Esq. of Eyton, Shropshire; and the Rev. Robert Wilson, of Ashwellthorpe Hall, near Wymondham.

November 15th.—Henry Edmund Goodhall, Esq. of Guildford Street, Russell Square; William Frederick Mullins, Esq. M.P. of Beaufort House, County of Kerry, and of Great Ryder Street, London.

December 6th.—Levett Landen Boscawen Ibbetson, Esq. of North Kyme, Lincolnshire; Charles Manby, Esq. 9, John Street, Adelphi; Colonel John Briggs, of Cheltenham, Gloucestershire, and of York Gate, Regent's Park.

December 13th.—Lieut. Ouchterlony, of the Madras Engineers; and Rev. Christopher Erle, M.A. Hardwicke Rectory, near Aylesbury, Bucks.

List of PAPERS *read since the last Annual Meeting, February* 17, 1837.

February 22nd.—On the Geology of Cutch; by Capt. Grant, of the Bombay Engineers, and communicated by Charles Lyell, Esq. F.G.S.

March 8th.—On the Geological Structure and Phænomena of Suffolk, and its Physical Relations with Norfolk and Essex; by the Rev. W. B. Clarke, F.G.S.

————— On the Raised Beaches of Staunton Downend and Baggy Point; by the Rev. David Williams, F.G.S.

————— A Communication by Mr. James de Carle Sowerby, On his new genus of Fossil Shells, Tropæum.

March 22nd.—On the Ancient State of the North American Continent; by Thomas Roy, Esq. Civil Engineer, Toronto, Upper Canada, and communicated by Charles Lyell, Esq. F.G.S.

March 8th.—On the Geology of the Neighbourhood of Smyrna; by Hugh Edwin Strickland, Esq. F.G.S.

————A Letter to Sir Charles Lemon, Bart. F.G.S.; by Robert Were Fox, Esq., On the process by which Mineral Veins have been filled.

———— Extracts from two Letters, On the Earthquake in Syria, in January 1837, addressed by Mr. Moore, his Majesty's Consul General at Beyrout, to Viscount Palmerston, and communicated by J. Backhouse, Esq., and the Hon. W. T. H. Fox Strangways, Under Secretaries of State.

April 19th.—A Description of the Cranium of the Toxodon Platensis, a gigantic extinct mammiferous species, referrible by its dentition to the Rodentia, but with affinities to the Pachydermata and the Herbivorous Cetacea; by Richard Owen, Esq. F.G.S., Hunterian Professor of Anatomy to the Royal College of Surgeons.

May 3rd.—A Sketch of the Deposits containing Extinct Mammalia in the neighbourhood of the Plata; by Charles Darwin, Esq. F.G.S.

————Extract of a Letter dated Saharumpore, 18th Nov. 1836, from Capt. Cautley, F.G.S. to Dr. Royle, F.G.S., permitting the announcement of a fact which had long been communicated to the latter, of the finding of the remains of a quadrumanous animal in the Sewaliks or Sub-Himalayan Range of Mountains.

————On some recent elevations on the Coast of Banffshire, and on a deposit of clay formerly considered to be lias; by Joseph Prestwich, Jun. Esq. F.G.S.

———— An Account of a Tertiary Deposit near Lixouri, in the Island of Cephalonia; by William John Hamilton, Esq. F.G.S., and Hugh Edwin Strickland, Esq. F.G.S.

May 17th.—A Description of the Geological Character of the Coast of Normandy; by Samuel Peace Pratt, Esq. F.G.S.

————Extracts from a Letter addressed by Sir John F. W. Herschel, F.G.S. to Charles Lyell, Esq. F.G.S., and dated Feldhausen, Cape of Good Hope, 20th of February, 1836, On secular variations of the isothermal surfaces of the earth's crust.

———— Extract from a Letter from Sir John F. W. Herschel to Roderick Impey Murchison, Esq. V.P.G.S. in explanation of the letter addressed to Mr. Lyell, dated Feldhausen, 15th of November, 1836.

———— An Account of a Well at Beaumont Green, in the County of Hertford, fifteen miles from London, and about a mile to the west of the road to Ware; by James Mitchell, LL.D.F.G.S.

May 31st.—On certain areas of elevation and subsidence in the Pacific and Indian Oceans, as deduced from the study of Coral Formations; by Charles Darwin, Esq. F.G.S.

———— A Letter to Charles Lyell, Esq. F.G.S., On some changes of level which have taken place, during the historical period, in Denmark; by G. Forchhammer, Phil. Doct., Copenhagen, For. Mem. G.S.

June 14th.—On the Physical Structure of Devonshire, and on the Subdivisions and Geological Relations of its old, stratified deposits; by the Rev. Adam Sedgwick, F.G.S., Woodwardian Professor in the University of Cambridge, and Roderick Impey Murchison, Esq. V.P.G.S.

———— On the Upper Formations of the New Red System in Gloucestershire, Worcestershire, and Warwickshire, showing that the red (saliferous) marls, with an included band of Sandstone, represent the "Keuper" or "Marnes Irisées," and that the underlying Sandstone of Ombersley, Bromsgrove, and Warwick, is part of the "Bunter Sandstein," or "Grès Bigarré," of foreign Geologists; by Roderick Impey Murchison, Esq. V.P.G.S., and Hugh Edwin Strickland, Esq. F.G.S.

———— A Letter addressed to Charles Lyell, Esq. by Dr. McCleland, on the Natural History of Upper Assam, where the Tea Plant grows wild.

———— On the Remains of a Fossil Monkey, from the Tertiary Strata of the Sewalik Hills in the North of Hindoostan; by Capt. Proby T. Cautley, Bengal Artillery, F.G.S. and Hugh Falconer, M.D., Bengal Medical Service.

November 1st.—A Letter on Fossil Fishes in the Lancashire Coal Field; by W. C. Williamson, Esq., Curator of the Manchester Natural History Society.

———— On the Geology of the Island of Zante; by Hugh Edwin Strickland, Esq. F.G.S.

———— On the Formation of Mould; by Charles Darwin, Esq. F.G.S.

November 15th.—A Letter from Walter Calverly Trevelyan, Esq. F.G.S. to Dr. Buckland, V.P.G.S., On Indications of Recent Elevations in the Islands of Guernsey and Jersey, and on the coast of Jutland, and on some Tertiary Beds near Porto d'Anzio.

———— A Letter from Sir Robert Smirke, forwarding another from Mr. Edge, On Peat and Fossil Timber found beneath a mass of Granite at St. Peter's, Guernsey.

November 29th.—On the Fossils of the Eastern Portion of the Great Basaltic District of India, by J. G. Malcolmson, Esq. F.G.S., of the Madras Medical Establishment.

December 13th.—On the Geology of the south-east of Devonshire; by Alfred Cloyne Austen, Esq. F.G.S.

January 3rd, 1838.—On the Geological Relations of North Devon; by Thomas Weaver, Esq. F.G.S.

January 17th.—Geological Notes to accompany Major Todd's Sketch of part of Mazunderān; by Dr. Bell.

———— Notes on the Geology of the Line of the proposed Birmingham and Gloucester Railway; by Mr. Frederick Burr.

———— On the Coast Section from White Cliff Lodge, one mile south of Ramsgate, to the Cliff's End, near the "Station Brig" in Pegwell Bay, Kent; by Mr. John Morris.

January 31st.—Extract from a Letter addressed by Sir John F. W. Herschel, K.C.H. F.G.S., to Mr. Lyell, On Internal Temperature.

——————— On the Mines of Huantaxaya, in Peru; by Mr. Bollaert.

——————— On Submerged Peat Bogs and Forests near Poole; by the Rev. W. B. Clarke, F.G.S.

Valuation *of the Society's Property; 31st December* 1837.

Property.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 49*l.* 19*s.* Wollaston Fund				170	11	0
Arrears due to the Society:						
Admission Fees	74	0	0			
Annual Contributions	390	1	6			
Proceedings	0	14	0			
				464	15	6
Estimated value of unsold Transactions	824	10	6			
——— Proceedings	20	0	0			
				844	10	6
500*l.* Stock, 3 per cent. Consols	450	0	0			
1311*l.* 19*s.* 5*d.* Stock, 3 per cent. Red.	1193	0	0			
				1643	0	0
				£3122	17	0

Debts.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes	9	3	8			
Scientific Expenditure	1	18	6			
Transactions	3	10	0			
				14	12	2
Cash belonging to the "Wollaston Fund"				49	19	0
Arrears not likely to be received				160	0	0
				224	11	2
Balance in favour of the Society				2898	5	10
				£3122	17	0

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes of the Founder.*]

JOHN TAYLOR, Treasurer.

Feb. 2, 1838.

Sums actually Received and Expended,

RECEIPTS.

	£.	s.	d.	£.	s.	d.
Balances in hand January 1, 1837:						
Banker (including 38*l.* 8*s.* 8*d.* Wollaston Fund)	436	0	7			
Accountant	40	0	0			
				476	0	7
Arrears:	£.	s.	d.			
Admission Fees	119	14	0			
Annual Contributions	187	8	6			
				307	2	6
Ordinary Income:	£.	s.	d.			
Annual Contributions	667	5	6			
Admission Fees: £. s. d.						
Residents 144 18 0						
Non-Residents 157 10 0						
	302	8	0			
				969	13	6
Compositions:	£.	s.	d.			
Six at 31*l.* 10*s.*	189	0	0			
One at 28*l.* 7*s.*	28	7	0			
				217	7	0
Subscription to Alteration Fund				5	0	0
	£.	s.	d.			
Transactions	403	1	0			
Proceedings	13	13	0			
				416	14	0
Wollaston Donation Fund, Interest on 1084*l.* 1*s.* 1*d.* 3 per cent. Reduced				32	10	4
	£.	s.	d.			
Dividends, 500*l.* 3 per cent. Consols	15	0	0			
Ditto, 1103*l.* 8*s.* 4*d.* 3 per cent. Red. 6 months	16	11	0			
Ditto, 1311*l.* 19*s.* 5*d.* ditto	19	13	7			
				51	4	7
				£2475	12	6

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, W. J. HAMILTON, WOODBINE PARISH, } AUDITORS

February 2, 1838.

during the year ending December 31, 1837.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Salaries and Wages, Collector's Poundage	28	15	0			
Scientific Expenditure	0	3	0			
Stationery	0	10	6			
Parochial Rates	2	5	0			
Assessed Taxes	2	8	0			
				34	1	6
General Expenditure:	£.	s.	d.			
Repairs of House	31	2	0			
House Expenses	184	16	1			
Taxes, Parochial	7	5	0			
——, King's	22	11	2			
Household Furniture	41	17	4			
———— Linen	7	4	0			
Plate	8	1	0			
				302	16	7
Insurance				6	0	0
Salaries and Wages:	£.	s.	d.			
Curator and Assistant	200	0	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant, including Gratuity to Mrs. Carrier	134	15	0			
Collector's Poundage	37	10	0			
				447	5	0
Scientific Expenditure				89	4	5
Stationery and Miscellaneous Printing				50	10	1
Investment in the Funds				689	0	0
Tea for Meetings				52	13	0
Cost of Publications:	£.	s.	d.			
Transactions	511	9	8			
Proceedings	98	18	3			
				610	7	11
Award of Wollaston Fund:						
Medals to Capt. Cautley and Dr. Falconer				21	0	0
Power of Attorney to receive Dividends				2	3	0
Balances in hand Jan. 1, 1838:	£.	s.	d.			
Banker (including 49*l.* 19*s.* Wollaston Fund)	130	11	0			
Accountant	40	0	0			
				170	11	0
				£2475	12	6

Estimates *for the ensuing year* 1838.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31st, 1837. (See valuation sheet)				464	15	6
Ordinary Income of 1838 estimated:						
Annual contributions (175 Fellows)				550	0	0
Admission Fees:						
Residents (23)	144	18	0			
Non-residents (15)	157	10	0			
				302	8	0
Sale of Transactions	300	0	0			
——— Proceedings	10	0	0			
				310	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends 500*l.* 3 per cent. Consols				15	0	0
Ditto 1311*l.* 19*s.* 5*d.* 3 per cent. Red.				39	7	2
				£1714	1	0
Balance against the Society				5	1	6
				£1719	2	6

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31st, 1837. (See valuation sheet)				14	12	2
General Expenditure:						
Repairs of House	20	0	0			
Taxes	50	0	0			
Insurance	9	0	0			
House Expenses	180	0	0			
Household Furniture	100	0	0			
				359	0	0
Salaries and Wages:						
Assistant Secretary	125	0	0			
Curator	125	0	0			
Clerk	75	0	0			
Porter and Housekeeper	70	0	0			
Servant	28	0	0			
Collector's Poundage	35	0	0			
				458	0	0
Scientific Expenditure				75	0	0
Stationery and Miscellaneous Printing				50	0	0
Tea for Meetings				50	0	0
Cost of Publications:						
Transactions	450	0	0			
Proceedings	70	0	0			
				520	0	0
Arrears not likely to be received				160	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				£1719	2	6

The Reports having been read, it was resolved:

That they be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows.

The President then presented the Wollaston Medal to Mr. Richard Owen, and, on doing so, said,

Mr. Owen,

I have peculiar pleasure in presenting to you this Medal, awarded to you by this Society for your services to Fossil Zoology in general, and, in particular, for the description of the Fossil Mammalia collected by Mr. Darwin. I trust it will be a satisfaction to you to read this our testimony of the success with which you have cultivated that great science of comparative zoology, to which you have devoted your powers. I trust it will add to your satisfaction to consider that the subject which we more peculiarly wish to mark on this occasion, in the study of Fossil Zoology, is one to which the resources of your science were applied, while the subject was yet new, by that great man, John Hunter, whose Museum and whose reputation are so worthily assigned to your care. I trust also that this Medal thus awarded to you at the outset, if I may so say, of an enlarged series of investigations, will convey to you the assurance that, in your progress in such researches, you carry with you our strong interest in your endeavours, and our high esteem of your powers and your objects; and will convince you that in all your successes, you may reckon upon our most cordial sympathy in the pleasure which your discoveries give.

Mr. Owen acknowledged his sense of the distinction conferred upon him in the following terms:—

I wish, Sir, that I had words adequately to express my deep sense of the honour I have now received; but I feel assured that you will grant to me the sincerity of my brief acknowledgments. The study of the animal organization has always abundantly repaid me by the pleasure which naturally flows from the contemplation of the marvellous skill with which, in the complete frame of existing species, structures are modified and designed in relation to particular ends; and from the perception of a subordination of the various instruments to one general plan. But since I have pursued anatomical investigations in connection with fossil remains, I have been rewarded by new and extrinsic pleasures. I trace to this source my connexion with the Geological Society, and the possession of some most valued friendships; and now, Sir, my obligations to the Society, and to Palæontology are increased ten-fold by the unexpected honour I have this day received at your hands. I receive this testimony of your good opinion as a strong stimulus to future endeavours. I cannot permit myself to regard it as a reward for the inadequate contributions which I have hitherto been able to make to the history of lost species; and I pledge myself to lose no available time or opportunity which may be applied to further that branch of geological science which has the extinct animals of this planet for its immediate object.

It was afterwards resolved;—

1. That the thanks of the Society be given to the Rev. William Buckland, D.D. and George Bellas Greenough, Esq., retiring from the office of Vice-President.

2. That the thanks of the Society be given to Robert Hutton, Esq. M.P., and Professor J. F. Royle, M.D., retiring from the office of Secretary.

3. That the thanks of the Society be given to Francis Baily, Esq.; William John Broderip, Esq.; William Clift, Esq.; Henry Hallam, Esq.; and Henry Warburton, Esq. M.P., retiring from the Council.

After the balloting glasses had been duly closed, and the lists examined by the scrutineers, the following gentlemen were declared to have been elected the Officers and Council for the ensuing year.

OFFICERS.

PRESIDENT.

Rev. William Whewell, M.A. F.R.S.

VICE-PRESIDENTS.

William Henry Fitton, M.D. F.R.S. & L.S.
Charles Lyell, Jun. Esq, F.R.S. & L.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.
Rev. Adam Sedgwick, F.R.S. & L.S., Woodwardian Professor in the University of Cambridge.

SECRETARIES.

Charles Darwin, Esq.
William John Hamilton, Esq.

FOREIGN SECRETARY.

H. T. De la Beche, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S. & L.S.

COUNCIL.

Henry Boase, M.D. F.R.S.
Rev. William Buckland, D.D. F.R.S. L.S. Professor of Geology and Mineralogy in the University of Oxford.
Viscount Cole, M.P. D.C.L. F.R.S.
Charles Giles Budle Daubeny, M.D. F.R.S. L.S. Regius Professor of Botany, and Aldrich's Professor of Chemistry in the University of Oxford.
Sir P. Grey Egerton, Bart. M.P. F.R.S.
G. B. Greenough, Esq. F.R.S. & L.S.
Leonard Horner, Esq. F.R.S. L. & E.
Robert Hutton, Esq. M.P. M.R.I.A.
Sir Charles Lemon, Bart. M.P F.R.S.
Marquis of Northampton, F.R.S.
Richard Owen, Esq. F.R.S.
Sir Woodbine Parish, K.C.H. F.R.S.
John Forbes Royle, M.D. F.R.S. & L.S., Professor of Materia Medica and Therapeutics in King's College, London.
T. Weaver, Esq. F.R.S. M.R.I.A.

Address to the Geological Society, delivered at the Anniversary, on the 16th of February, 1838, *by the* Rev. William Whewell, M.A. F.R.S. *President of the Society.*

Gentlemen,

You have heard in the Reports just read, statements which show that the Society is in a state of healthy progress both in respect to its numbers and its funds. The total number of Fellows of the Society, exclusive of Honorary and Foreign Members, at the close of the year 1836, was 709. At the close of the last year it was 738, the increase being 29, after deducting 18 Members deceased or resigned.

A Part of the Transactions has recently been published, which is worthy of its predecessors in the interest of its matter, and which is not inferior to them in its appearance and illustrations. I believe it will be found that improvements have been introduced, especially in the colouring of the maps.

Our collections have also gone on increasing, and have, as in previous years, derived great additional value from the labour and knowledge bestowed upon them by our excellent Curator. But your Council has found itself compelled to attend to the great, and I may say intolerable amount of labour which has fallen upon Mr. Lonsdale, and certain alterations in the Society's arrangements, directed to the object of remedying this evil, are now in progress or in contemplation. When they are completed I shall have the satisfaction of announcing them to the Society.

The Council have awarded the Wollaston Medal, as you have already been informed, to Mr. Richard Owen, for his general services to Fossil Zoology, and especially for his labours employed upon the fossil mammalia collected by Mr. Darwin in the voyage of Captain Fitz Roy. I need not remind you, Gentlemen, how close are the ties which connect the study of living and of fossil animals; how much light the progress of comparative anatomy throws upon the interpretation of geological characters; and what important steps in our knowledge of the past condition of the earth are restorations of the animal forms which peopled its surface in former times, but have long vanished away. Since the immortal Cuvier breathed into our science a new principle of life, the value of such researches has ever been duly appreciated; and the award of the Wollaston Medal last year is an evidence how gladly your Council take that method of congratulating the successful cultivators of such studies. I am sure that all who are acquainted with Mr. Owen's labours will rejoice that we have in this manner marked our sense of his success. His earlier researches, those for instance on the Nautilus, have been of exceeding use and interest to geologists. And the first part of his description of the fossil mammalia, collected by Mr. Darwin in South America, contains matters of the most striking novelty, interest, and importance. We have there the restoration, performed with a consummate skill, such as fitly marks the worthy successor of Hunter and the disciple of Cuvier, of two animals, not only of new genera, but occupying places in the series of animal forms, which are peculiarly instructive. For the one, the Toxodon, connects the Rodentia with the Pachydermata by manifest links, and with the Cetacea by more remote resemblances; and thus contributes to the completion of the zoological scale just in the parts where it is weakest and most imperfect: while the other animal, the Macrauchenia, the determination of which is considered by anatomists as an admirable example of the solution of such a problem, appears to be exactly intermediate between the horse and the camel. But this creature is also interesting in another way, since it closely resembles, although on a gigantic scale, an animal still existing in that country and peculiar to it, the Llama. Thus, in this as in some other instances, the types of animal forms which distinguish a certain region on the earth's surface are clearly reflected to our eyes as we gaze into the past ages of the earth's history, while yet they are magnified so as to assume what almost appear supernatural dimensions. The Llama, the Capybara, and the Armadillo of South America are seen in colossal forms in the Macrauchenia, the Toxodon, and the Megatherium. I will not omit this occasion of stating that the profound and enlarged speculations on the diffusion, preservation, and extinction of races of animals to which Mr. Darwin has been led by the remains which he has brought home, give great additional value to the treasures which he has collected, and make it proper to offer our congratulations to him, along with Mr. Owen, on the splendid results to which his expedition has led and is likely to lead. Mr. Owen and Mr. Darwin are engaged in the restoration of other animals from the South American remains in their possession, and I am able to announce that two or three other new genera have already been detected. I am sure I am conveying your feeling, Gentlemen, as well as my own, when I express a cordial hope that these two naturalists, so fitted by their endowments and character to advance the progress of science, may long go on achieving new triumphs; and may have the satisfaction—higher even than that which they derive from the honours we so willingly bestow—of finding the great principles which it is given to them to wield, becoming every year more powerful instruments of discovery; and of seeing, as they pursue their researches, light thrown upon the darkest and widest of the vast problems which they have proposed to themselves.

I will now say a few words concerning a few of the most conspicuous of the names which have been obliterated by death from our list during the year.

Among the members of our body, whom we have lost, there is one whom we cannot but mention with more than common emotion, endeared as he was to many of us by private friendship, and admired by all for his talents, his knowledge, and his services. Dr. Edward Turner, Professor of Chemistry in the London University, filled the office of our Secretary for five years, and subsequently was two years Vice-President, which situation he held at the time of his death in February 1837. Several of you may remember, Gentlemen, that our last anniversary meeting was in some measure clouded by the recollection of this then recent calamity; and that many of the Fellows of the Society, on that occasion, expressed their intention of testifying their respect and regard for the departed by attending his funeral. Of Dr. Turner's private virtues, and of the charm of his society, I must not here speak. I will not allow myself to dwell upon the admirable clearness and precision of his thoughts as expressed in conversation,—upon the delightful openness and candour of his character,—upon the kind and gentle cheerfulness of his demeanour, the genuine fruit of a deep habitual religious feeling. But I may take this occasion to say, that in him chemistry suffered a loss, not only great,—for that all would at once say,—but much greater and more difficult to repair than may at first sight appear. Dr. Turner entertained a conviction (I am stating the result of many interesting conversations which I have held with him) that the time was come when the chemist could not hope to follow out the fortunes of his science, and to read in her discoveries their full meaning, without being acquainted with the language, and master of the resources of mathematics. Acting upon this enlightened view, he did not hesitate to encounter the great labour and exertion of a course of study in the higher mathematics; and he succeeded entirely in making himself a good mathematician. And he was one of the very few who, in our country, labour at a branch of chemistry which is of the highest importance to us as geologists; but which,—we may suppose from its laborious and intricate nature,—appears to repel our most active chemists; I mean that portion of chemistry which is connected with mineralogy.

Yet this department is, in truth, more inviting than it may at first appear. No doubt in it clear mathematical conceptions are necessary, and perhaps some little training in mathematics; but there is good promise that the labour which this line of investigation demands will be rewarded. I am fully persuaded that there is no portion of the frontier line of our knowledge of which we can so certainly say, "Here we are on the brink of great discoveries." Had Dr. Turner been spared to us some years longer, I know no one who was more likely to have had a principal share in such discoveries. Two papers of his, in the Philosophical Transactions,* show that he was able to deal with the atomic theory in a mode which combines the resources of the skilful analytical chemist with the rigour of the mathematical reasoner; a combination which the right prosecution of that theory requires, but which has not always been found in its cultivators.

Dr. Turner lectured on chemistry at the London University from its first foundation in 1828; he was there surrounded by students, whose affection he gained by his kindness, as well as their admiration by the clearness of his teaching. He also gave a course of lectures on geology, in conjunction with Dr. Grant and Mr. Lindley, such of those gentlemen taking a division of the subject with which he was most familiar. Dr. Turner was snatched from science at the early age of thirty-nine, having been born in the island of Jamaica in 1796. He studied anatomy at Edinburgh, and chemistry at Göt-

* On the Composition of Chloride of Barium, 1829; Researches on Atomic Weights, 1833.

tingen, under the able chemist Friedrich Von Stromeyer, to whom he dedicated his Elements of Chemistry; a work which has had, as it well deserves, a very wide circulation among students.

In William Farish, B.D., Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge, the Society has lost an honorary member, elected as such soon after its original foundation, namely in November 1808, and one of a number of our countrymen who were at that period placed upon the honorary list. Professor Farish never employed himself peculiarly in geological pursuits as we now understand the term; but it is to be recollected, that within a few years of the date of his election, which I have mentioned, the investigation of the earth's structure made a rapid progress, and, in consequence, assumed a more fixed and technical form. Professor Farish's scientific studies were mainly directed to the arts, manufactures, and machinery of the empire; on these subjects he delivered courses of lectures full of interest and instruction; and he was thus led to describe our mines, and the mode of working them.

But no reference to particular portions of Professor Farish's labours can convey a just notion of the impulse which he gave to the progress of scientific knowledge within his own sphere of influence, by the habit of seizing, with an active and vivid apprehension, upon prominent parts of modern science, and conveying them, in a manner singularly clear and simple, to his audience. For a long course of years his lectures were more efficacious than any other circumstance in stimulating the minds of men in his university to philosophical thought on physical subjects; and to this day these lectures are never mentioned by those who attended them at that period, without admiration and pleasure. His merit was well recognised by the university in which he spent his life. He received the highest mathematical honours of that body on taking his degree of B.A. in 1778, was elected Professor of Chemistry in 1794, and Jacksonian Professor in 1813; and at the institution of the Cambridge Philosophical Society in Nov. 1819, he was its first president.

I cannot refrain from adding, that although I have here to speak of him principally as a man of science, such pursuits were in his case little more than episodes, in a life the main action of which was directed to the ends of religion and benevolence. In his duties, as a minister of Christianity, he was most zealous and indefatigable; and every attempt to relieve the misery, the ignorance, the unjust restraints of any portion of mankind, found in him a strenuous advocate and ready agent. His childlike simplicity, genuine kindness of heart, and untiring religious earnestness were such as well suited his kindred with Bernard Gilpin, "the Apostle of the North," from whom, through his mother, he derived his descent. He was born at Carlisle in 1759, and died at the age of 78.

Henry Thomas Colebrooke, member of the Supreme Council of Calcutta, was one of those extraordinary men whom our Indian empire has produced; and who show the animating effects of the great scene in which they are there placed, by the variety of subjects to which they extend their attention, and by the vigour with which they combine speculative and practical employment. Mr. Colebrooke went to India as a writer in 1782, and about 1792 began to attend peculiarly to Sanscrit literature. A little later we find him beginning to enrich the Asiatic Researches with a series of memoirs on the religion, the literature, and, above all, the science of the Hindoos. In this department his labours on the Zodiac of the Indians*, and on their notions of the Precession of the Equinoxes and the motions of the Planets†, are highly deserving of notice; as were at a later period the account of the Indian Algebra, given in his translations of the Lilawati and Vijaganita. But Mr. Colebrooke was also ready to contribute a share in sciences with which we are more nearly concerned, He took a lively interest in the correction of errors respecting the physical geography of India, and was one of the first to declare (in 1815) his opinion that the Himalaya mountains were higher than the Andes, an opinion soon afterwards fully confirmed. He also was one of the first to enter upon a subject, to which we may now look with the greatest hope. The first part of vol. i. of our New Series of Transactions (published in 1822) contains two papers by him, one upon the geology of the valley of the Sutledge, which had been explored by Lieut. Gerard; the other upon the north-east of Bengal, where Mr. D. Scott had noticed various rocks, and, among the rest, a deposit which contained fossils, resembling, as he conceived, those of the London clay. I shall have occasion, in the course of this address, to refer to a recent repetition of this observation of an identity

* Asiat. Res., vol. ix. † Ibid., vol. xii.

between the fossils of the east of India and those of the London and Paris basin. I may observe that these, and other contributions to Indian geology by other writers, contained in the volume of which I spoke, and a preceding one, induced the Secretaries of that time to insert a map, on which the localities of these observations were indicated; and to express in the volume a hope, that these were merely an earnest of the information which might be expected from the activity of British subjects in that quarter.

Among our foreign members deceased within the year, I regret much to have to mention one, to whom is due, in no small degree, a revolution in the mode of treating the subject of geology, which has taken place in our own times, and the formation of a new branch of geology. This revolution consists in the endeavour, now so familiar to us, to identify geological with recent changes, instead of classifying the great past changes in the surface of the earth which its structure discloses to us, as separate from the newer and slighter modifications of which history and tradition gives us evidence; and the study of the discernible causes of change to which we are thus led, I shall have occasion to speak of under the name of Geological Dynamics. You are well aware that Mr. Lyell is the person who has, with a bold and vigorous hand, moulded the whole scheme of geology upon this idea; but the power which he had of doing this was derived in no small degree from Von Hoff's admirable survey of the evidence of those changes which can be proved by tradition. The extent and universality of the facts thus brought into notice, might well forcibly strike a philosopher already seeking to apply such a principle to geology; and Mr. Lyell has always been forward to acknowledge his obligations to M. Von Hoff. Indeed the idea of such an identification of geological with historical changes was by no means new; it had been both expressed and acted on by Deluc; and must have been present to the minds of those persons who framed the question which gave rise to Von Hoff's book. This question was proposed in 1818 by the Royal Academy of Science of Göttingen. "Considering," they said, "that we have, in the crust of the earth, evidence of great revolutions, which have happened at different times, in different portions, and of which the period and duration are unknown, we are led to ask whether certain more partial alterations may not lie within the domain of tradition, and give us the means of knowing at what period they took place, and what time the formation of certain portions of the earth's crust required; whereby some light may be thrown on those changes which lie beyond the limits of history."

M. Von Hoff's work,—"The history of those natural changes in the earth's surface which are proved by tradition"—appeared (the first part) in 1822, and had the Academy's prize assigned it. This part of the work contained an account of the changes due to the agency of water; and by the wide range of reading and study which it included, and the philosophical manner in which its copious materials were arranged, well justified the distinction which it received. The view presented in it of the great changes which have gone on from the beginning of historical times,—the yielding or advancing of coasts, the disappearing of islands, the union of seas,—appear to give a new face to the globe. But the portion of the judgement of the Academy which the author most valued was, that in which they said that he had used the sources of his information *conscientiously*, In 1824 appeared the second part, containing the history of volcanos and earthquakes; and, although the previous labours of Humboldt and Von Buch had done much to connect and generalise facts of this kind, Von Hoff's labours were an important step: "At least," he himself says, "he was not aware that any one before him had endeavoured to combine so large a mass of facts with the general ideas of the natural philosopher, so as to form a whole." Among other large views, we may see much which, as to kind of change supposed, agrees with the opinions of Mr. Darwin, of which I shall have to speak; for instance, Von Hoff conceives that the island of Otaheite is undergoing a gradual elevation out of the sea.* Finally, the third volume of this work appeared after an interval of ten years, in 1834; in which he considers other causes of change; as rising and sinking of the land; alterations of rivers and seas; the operations of snow and ice; and also the geological results to which the whole survey had led him. In this volume he expresses his pleasure at the appearance of Mr. Lyell's work, which had taken place in the intervening period, and by which he had found much new light thrown upon his own speculations.

In the interval of time between the publication of the second and third volumes, M. Von Hoff published "Geological Observations on Carlsbad," (1825) and "Measures of Heights in and near Thuringia"

* Part II. Pref. p. xiv.

(1833). In this last work he not only gave a great number of his own barometrical measurements, but discussed all extant measures of the heights of points in Thuringia, to the amount of above 1100. He also employed himself in meteorological observations.

Karl Ernest Adolph Von Hoff, Knight of the order of the White Falcon, and invested with several offices of honour and dignity at the Ducal Court of Gotha, died at Gotha the 24th of May last. He was 66 years of age, having been born in the same city Nov. 1, 1771.

Besides the history I have mentioned, which must always continue to be a classical work on the subject of which it treats, he was at the time of his death employed in compiling a continuation of his Notices of Earthquakes and Volcanic Eruptions; and also a new work, which was considered to be an important one, and was to be entitled "Germany according to its Natural Conditions and Political Relations."

In attempting a rapid survey of the contributions to geological knowledge which have come under our notice during the past year, I may perhaps be allowed to advert to a distinction of the subject into Descriptive Geology and Geological Dynamics; the former science having for its object the description of the strata and other features of the earth's surface as they now exist; and the latter science being employed in examining and reducing to law the causes which may have produced such phænomena. We appear to be directed to such a separation of our subject by the present condition of our geological studies, in which we and our predecessors have accumulated a vast store of facts of observation, and have laboured with intense curiosity, but hitherto with very imperfect success, to extract from these facts a clear and connected knowledge of the history of the earth's changes. Nearly the same was the condition of astronomy at the time of Kepler, when the accumulated observations of twenty centuries resisted all the attempts of that ingenious man and his contemporaries to construct a science of physical astronomy. But though checked by such failures, they were not far from success; and when for the next succeeding century philosophers had employed themselves in creating a distinct science of Dynamics, the science of physical astronomy, full and complete, made its appearance, as if it were a matter of course ; and thus showed the wisdom of separately cultivating the study of causes, and the classification of facts.

DESCRIPTIVE GEOLOGY.

If we begin with geological facts, our attention is first drawn to that district on the earth's surface within which the facts have been subjected to a satisfactory comparison and classification, which may be considered, in a general way, as including England, France, Italy, Germany, and Scandinavia. The language which the rocks of these various countries speak has been, in a great measure, reduced to the same geological alphabet. The questions of the determination of any member in one country, or the identification of similar members in two countries, are, for the most part, problems admitting of a definite and exact solution. In countries out of this district, on the other hand, we have not only to explore but to classify. We have to divine their geological alphabet;—to decipher as well as to read. We have not only to discover of what British rocks the observed ones are the equivalents, but we have to ascertain whether there be an equivalence; and where this relation vanishes, we have to discover what new resemblances and differences of members are most worthy our notice. The great difference in the nature of the geologist's task in these two cases seems to me to make it desirable to employ the familiar division of *Home* and *Foreign* Geology in a wider sense than has hitherto been common, including in the former all that region of Europe which has had its order of strata well identified with our own; this distinction then I shall employ.

1. *Home* (*North European*) *Geology*.—If we attempt, in this part of our subject, to follow an order of strata, we must begin with the oldest stratified rocks, though they are undoubtedly the most obscure; for the same reason which compels the historian of states to begin with the dim twilight of their savage or heroic times; namely, because at the other extremity of the series there is no boundary; since the events of past ages and their records form an unbroken series, leading us to the unfinished occurrences and works of to-day. Going then as far back as the historian of the earth can discern any light, and, for reasons which may hereafter be spoken of, shaping our course by the stratified rocks alone, we should first have to ask what addition has been made during the past year to our acquaintance

with those formations which have generally been called *transition.* And here, gentlemen, many of you well know, that if I had had to address you at a period a little later, I might have hoped to be able to point out, among the labours of our members, some which may be considered as events of primary importance in this part of our knowledge;—steps which may be described as a new foundation rather than a mere extension of this portion of European geology;—a separation and arrangement of transition rocks, which is likely to become the type and classical model of that part of the geological series, as Smith's arrangement of the oolites became the type of that portion of the strata. I speak of Professor Sedgwick's views on the Cambrian rocks, which occupy the north-west of Wales, and Mr. Murchison's on the Silurian formations which cover the remainder of the principality and the adjacent parts of England. Mr. Murchison's work, which cannot but be one of first-rate value and interest, will, I trust, be in our hands in a few weeks; and I should grieve to think that Professor Sedgwick will be not only so unjust to his own reputation, but so regardless of the convenience and expectations of geologists, as to withhold from the world much longer the views which his sagacious and philosophical mind has extracted from the accumulated labour of so many toilsome years, on a subject abandoned to him mainly from its difficulty and complexity.

Turning then to the researches which have been laid before us upon the earlier stratified rocks, I am first led to notice the important memoir of the two gentlemen I have just mentioned, upon the structure of North Devonshire. According to the views of these gentlemen, founded upon an extended examination of the county, this portion of England forms a great trough, having an east and west position, in which a series of culmiferous beds rest at their northern and southern extremities upon older rocks. The plants found in the culmiferous beds are said to be all identical with species which are abundant in the coal-fields of the central counties of England, and of the South Welsh coal basin: and it was at first conceived that these plants differed essentially from the scanty and imperfect remains of vegetables which are found in the older rocks. More recently, however, the same fossil plants which occur in the culm measures are said to have been detected in the subjacent strata. Before this fact was known, the identity of the fossils and the resemblance of mineralogical character seemed irresistibly to prove the culm-bearing beds of Devon to be the same formation with the culm or coal-bearing measures of Pembrokeshire on the opposite side of the Bristol Channel. How far this apparent anomaly admits of explanation, and in what manner it is to be allowed to modify the conclusion previously drawn, we may perhaps most properly consider as questions hereafter to be decided. The rocks which support the culmiferous formation on the north are conceived by Messrs. Sedgwick and Murchison to be a series, of which the last ascending term is probably of the date of the lowest portion of the Silurian system. On the south the culmiferous strata rest partly upon the granite, and partly upon the oldest slate rocks of Devon and Cornwall.

The same general view of the nature of the transverse section of Devon, and of the age of the culm, has been presented, perhaps I ought to say adopted, by the authors of two other papers upon the same region which have been brought before us,—Mr. Austen and Mr. Weaver;—and also, at least so far as the section is concerned, by the Rev. D. Williams in a communication made to the British Association in September last. Nor am I aware that it has been dissented from by any one who has examined the county in question since this view was made generally known. Resting on the concurrence of so many able observers, I should conceive, therefore, that we may look upon this view as *established*, so far as the time which has elapsed allows us to use the term. No truths should be termed incontestable till a considerable period has been left for the antagonists to show themselves and to try their force.

Although this view has thus so good a claim to acceptance, you are aware, gentlemen, that it is entirely different, both as to the form of the section and the age of the members, from that which was entertained up to the time when these gentlemen turned their attention to the subject. Their opinion respecting Devonshire being adopted, along with the views of the same eminent geologists respecting Cumberland and North and South Wales, one-third of our geological map of England will require to be touched with a fresh pencil.

Nor is this wonderful. It is rather a matter of extraordinary surprise, that when the rest of the geological map of England is again drawn, there are scarcely any but microscopic alterations which require to be made. No higher evidence can be conceived of the vast knowledge and great sagacity of its author.

Such modifications we must ever expect to have to make of a first approximation; and I should think it a misfortune to our researches if we should attempt to elude this necessity by giving up the key of all our geological knowledge of our country,—the doctrine that there is a fixed order of strata, characterized mainly by their organic fossils. If we have not advanced so far as to prove this, what have we proved? If our terms do not imply this, what is their meaning? Is it not true, in our science as in all others, that a technical phraseology is real wealth, because it puts in our hands a vast treasure of foregone generalizations? And if we evade the difficulties which may occur in the application of this phraseology to new cases, by declaring that our terms are of little importance, is not this to deprive our language of all meaning and all worth? Do we not thus refuse to recognise as valuable the tokens which we ourselves circulate, and plainly declare ourselves bankrupts in knowledge? When certain strata of Devon have thus been identified with the coal measures of other regions, can we still term them grauwacke? Either this term implies members having a definite place in our series of strata, or it does not. If it do, it is certain that these strata have not that place. If it do not, it conveys no geological knowledge at all. But if it be used to imply a rejection of such series, it involves a denial of all geological knowledge hitherto asserted concerning the older rocks of this county. . . .

The transition downwards from the culmiferous beds of Devon to the older strata on which they rest, is, according to almost all who have studied the subject, wrapt in great obscurity. In this obscurity, if it be true that the fossil plants of the culm measures are found also in the subjacent rocks, there is nothing which need make us mistrust the clear and positive part of our knowledge. And even if this be so, it will not be the less necessary to separate the culmiferous from the subjacent Silurian and Cambrian systems, by a different name in our lists, and by a different colour in our geological maps, if they are to represent the present state of our information.

The interest of this question has induced me to dwell upon it longer than I had intended, and I must on that account be very brief in my notice of many other communications. I may observe that the very nature of several of these indicates very remarkably the European character which our geology has assumed, since they have for their object the identification of some members of the recognised series of England, and of France, or Germany. Thus Mr. Murchison and Mr. Strickland have attempted to show, by the evidence of organic fossils, now for the first time adduced on this point, that the red saliferous marls of Gloucester, Worcester, and Warwick shires, with an included bed of sandstone, represent the keuper or *marnes irisées* of Germany; and that the underlying sandstone of Ombersly, Bromsgrove, and Warwick is part of the bunter sandstein or grès bigarré of foreign geologists. They are thus led to conclude that though the muschelkalk, which intervenes between these formations in Germany, is absent in the new red system of England, and of a large part of France, its other members may be identified over the whole of the north of Europe.

Proceeding from the new red to the oolite system, we have a memoir from Mr. Pratt containing an examination of the geological character of the coast of Normandy, which necessarily implies a comparison of this series of rocks with those of England. The identification is found to be complete, as had already been believed; but Mr. Pratt has made some alteration in the received doctrines on this subject; for instance, the Caen stone, which is usually considered to represent the great oolite, he finds to resemble in its fossils the inferior oolite.

Ascending still, we have to notice Mr. Clarke's elaborate geological survey of Suffolk, which, of course, refers entirely to the chalk and overlying beds. With regard to the crag of this district, I may remark that M. Desnoyers, in a communication made to the Geological Society of France, has endeavoured to identify this formation with the *Faluns* of the Touraine. M. Deshayes had referred the latter to the *Miocene*, and the crag to the *Pliocene* formations of Mr. Lyell. The point is one of great interest, since it involves the question of the value and right mode of application of the test of the relative number of recent species, on which Mr. Lyell's classification, or at least his nomenclature, is founded. I conceive that in a matter of arrangement any arbitrary numerical character must lead to violations of nature's classifications; and can only be considered as an artificial method, to be used provisionally till some more genuine principle of order is discovered.

Mr. Clarke, in his survey, has noted as one division of the diluvium of his district, a clay of a yellowish or bluish hue, containing rolled pieces of chalk. This deposit is of great extent and thickness in East Anglia and the neighbouring parts; and is worth notice, since this deposit is one main cause of the geological confusion and obscurity in which that region is involved. In the neighbourhood of Cambridge this diluvial deposit is called the *brown clay*; and I can state, from my own experience, that the recognition of it as a separate bed at once rendered the stratification clear, where it had long been unintelligible.

Before quitting our stratified rocks, I may notice the communications respecting some of their fossils which we have received, particularly that of Mr. Williamson on the fossil fishes of the Lancashire coal field, and the establishment of the new genus Tropæum, separated from the Hamites of the green sand by Mr. Sowerby.

In attempting to pursue a stratigraphical order, we are compelled to reserve for a separate head the notice of unstratified rocks, since their age and history are only known by the mode in which they interrupt and disturb the rest of the series. We have not had many communications respecting European rocks of this character; but we cannot but be struck by the subversion of ancient ideas which result from the investigations of Messrs. Murchison and Sedgwick. They have shown that the granite of Dartmoor, and consequently that of Cornwall, formerly considered as one of the earliest monuments of the primeval ages of the earth's history, is posterior to the deposit of the culm measures.

Advancing to newer phænomena, we find the evidences of change still unexhausted. We cannot but reflect how familiar those views of the elevation and depression of portions of the earth's surface are become, which were at first considered so strange and startling. This is remarkably shown by the number of communications concerning raised beaches which we have recently received. When we visit places where these occur, and look at the winding shore, where the sea line is faithfully followed or distantly imitated by terraces, sands and pebbles a little above it, we wonder that we should so long have been blind to this kind of evidence. Such raised beaches have been described during the past year, by Mr. Prestwich, as occurring in the Murray Frith; by Mr. Austin, in the valley of the Axe, the Exe, and the Otter. Dr. Forchammer has given us the evidence of recent elevation in the island of Bornholm; Mr. Trevelyan has given us similar evidence for the coast of Jutland, and the islands of Guernsey and Jersey.

Mr. Morris's paper, describing a series of dislocations in the chalk cliffs to the south of Ramsgate, marked by shifts in a bed of tabular flint, may perhaps be considered as also affording evidence of violent elevation. But since a small derangement of the conditions of support of any stratum might occasion dislocations of the scale of those here described, it would probably be hazardous to consider them as otherwise than local accidents.

Among descriptions of the most recent geological phænomena, I must notice Mr. Clarke's paper on certain peat marshes and submarine forests, which occur near Poole in Devonshire; and in his investigation of the causes which have produced the results now visible, we may see by how easy a gradation descriptive geology passes into the other portion of the subject, the study of the processes by which change is produced.

Finally, in concluding this survey of our descriptive home geology, I notice, with great pleasure, Mr. Burr's communication of his notes on the geology of the line of the proposed Birmingham and Gloucester Railway. In a country like this, in which the order and boundaries of the strata are, for the most part, well ascertained, an additional accuracy of measurement, of great value to us, may be supplied by the operations of civil engineers employed on canals, roads, and the like works. With this persuasion, and acting with the advice of the Council, I wrote letters to a great number of engineers, begging them to communicate to us the levels and sections which they might obtain in the course of their professional employments; and I am happy to see so excellent an example as Mr. Burr's paper supplies, of the advantage which may be derived from materials of this class.

2. *Foreign (South European and Trans-European) Geology.*—In proceeding beyond the Alps, and still more as we advance beyond the shores of Europe, we can no longer, so far at least as geologists have hitherto discovered, trace that remarkable correspondence of the strata of different countries which we can study so successfully in our *home circuit.* With the mountain masses

of those more distant regions we are, it would seem, hardly authorised as yet in making any more detailed distinctions than the general one of secondary and tertiary strata; the latter including the strata in which we trace an approach to the existing species of animals, and the former implying a general comparison with our chalk, oolites, and lower strata. Perhaps we may further distinguish in most countries which have been visited, a great mass of transition slates; but the establishment of such divisions must be the business of geological observers.

We have had several valuable additions to this portion of our knowledge, including, as we must do, Greece and its islands in this foreign district. That the Apennine limestone is the predominant mass of the Morea, had been made known by the researches of MM. Boblaye and Virlet. Mr. Strickland and Mr. Hamilton have told us that the same rock forms a large mass of the island of Zante and other islands in that sea, and of the neighbourhood of Smyrna. They find also tertiary beds, as on the south side of the bay of Smyrna; on the east side of the island of Zante; and at Lixouri in Cephalonia, where the tertiary beds are remarkable for the number and beauty of their fossils, some of which have been identified with species existing in the Mediterranean. Dr. Bell, who travelled from Teheran to the shores of the Caspian, has given us an account of the rocks which he observed in Mazanderan. From the statements made by him, we are led to believe, that a more continued and detailed observation of the country would give the true geological order of the deposits in this region; which might then, perhaps, serve as a connecting link between western Asia and India.

It is among the favourable omens for the geology of India, of which we now see many, that a temperate spirit of generalization has recently been applied to the examination of her soil; a spirit which contents itself with such a general reference of the foreign to the home strata as we have described, till by its own labours it has earned the right of asserting some closer correspondence. If to deny the value of our geological terms within the home district, where they mark an order which has been repeatedly verified, would be a suicidal scepticism in geologists, there would be a rashness and levity no less fatal in applying them to distant regions where no order has yet been ascertained.

Captain Grant in his account of Cutch, and Mr. Malcolmson in his description of a large portion of the Indian peninsula, have not ventured to call the strata which they have examined by the names which describe European formations. We may trust that, hereafter, the admirable activity and resource which our countrymen display in that wonderful appendage of our empire, will enable them to communicate to us a genuine Indian arrangement of secondary strata. In the mean time, Mr. Malcolmson has most laudably employed himself in determining the age of the wide-spread igneous rocks of the peninsula of India, with reference to the contiguous strata. And Dr. McCleland, who was associated with Mr. Griffith in the scientific deputation sent under Dr. Wallich into Upper Asam, has, among other geological observations, noted a raised bed, at 1500 feet above the sea level, in which none of the species are identical with those of the Bay of Bengal on the one hand, or the secondary strata on the north of the Himalaya on the other; but in which a resemblance was at once recognised with the species of the Paris basin.

This resemblance between the extinct animal population of regions so remote from each other, is in itself remarkable enough. It is still more curious to observe, that the same coincidence of the ancient animals of France and India has recently been detected in another case; and what makes the circumstance still more remarkable is, that the animal was not only new in both countries as a fossil genus, but involved a transgression of the supposed boundaries of fossil forms. Not only had no human bones been found in genuine strata, but as it had been generally held, no traces of those creatures which most nearly imitate the human form. This rule now no longer holds good; for during the past year the bones of monkeys have been discovered both at Sansan, in France, in the Sewalik Hills in the north of Hindostan, and more recently under the city of Calcutta.

That this is a highly interesting and important discovery, no one who attends to the signification of geological speculations can doubt. I do not know if there are any persons who lament, or any who exult, that this discovery tends to obliterate the boundary between the present condition of the earth, tenanted by man, and the former stages through which it has passed. For my own part I can see no such tendency. I have no belief that geology will ever be able to point to the commencement of the present order of things, as a problem which she can solve, if she is allowed to make the attempt. The gradation in form between man and other animals, a gradation which we all recognise, and which, therefore, need not startle us because it is presented under a new aspect, is but a slight and, as appears to me, unimportant feature, in looking at the great subject of man's origin. Even if we had no Divine record to guide us, it would be most unphilosophical to attempt to trace back the history of man without taking into account the most remarkable facts in his nature: the facts of civilization, art, government, writing, speech—his traditions—his internal wants—his intellectual, moral, and religious constitution. If we will look backwards, we must look at all these things as evidences of the origin and end of man's being. When we do thus comprehend in our view the whole of the case, it is impossible for us, as I have elsewhere said, to arrive at an origin homogeneous with the present state of things; and on such a subject the geologist may be well content to close his own volume, and open one which has man's moral and religious nature for its subject.

In order to complete the notice of the contributions to foreign geology, I must mention Mr. Roy's account of Upper Canada: in which country he conceives that he has detected terraces which exhibit the beaches of the lakes when the level of their surface was more elevated than they are at present. I must refer also to Mr. Bollaert's paper on alluvial accumulations containing large masses of silver ore in Peru. And, finally, I have to direct your attention to the very curious information respecting the geology of South America, which we have received from Mr. Darwin. In a communication made to us, he gave a very striking view of the structure of a large portion of that continent; and, as I have already had occasion to observe, he has brought to this country the remains of various fossil animals of entirely new kinds, of exceeding interest to the zoologist as well as the geologist. I need only remind you of the gigantic mammifer which has been reconstructed in idea by Mr. Owen, upon the evidence of a fossil skull, and has been named by him the *Toxodon Platensis*. This animal, although a *Rodent*, according to its dental characters, in other respects manifests an affinity to the *Pachyderms*; and also to the *Dinotherium*, and to the *cetaceous* order. Many other fossil animals have been discovered in South

America; and all, from their magnitude, fitted to excite our wonder, when we compare the diminutive size of the present races of animals which inhabit that country. The animal remains found by Mr. Darwin comprise, besides the Toxodon, which extraordinary animal was as large as a hippopotamus,—(2, 3, 4, 5, 6.) the Megatherium, and four or five other large Edentata;—(7.) an immense Mastodon; —(8.) the Horse;—(9.) an animal larger than a horse, and of very singular character, of which a fragment of the head has been found; —(10, 11, 12.) parts of Rodents, one of considerable size;—(13.) a Llama, or *Guanaco,* fully as large as the Camel.

But I should very ill convey my impression of the great value of the researches of Mr. Darwin, by any enumeration of special points of geology or palæontology on which they have thrown light. Looking at the general mass of his results, the account of which he has been kind enough to place in my hands, I cannot help considering his voyage round the world as one of the most important events for geology which has occurred for many years. We may think ourselves fortunate that Capt. Fitz Roy, who conducted the expedition, was led, by his enlightened zeal for science, to take out a naturalist with him. And we have further reason to rejoice that this lot fell to a gentleman like Mr. Darwin, who possessed the genuine spirit and zeal, as well as knowledge of a naturalist; who had pursued the studies which fitted him for this employment, under the friendly guidance of Dr. Grant at Edinburgh, and Professor Henslow and Professor Sedgwick at Cambridge; and whose powers of reason and application had been braced and disciplined by the other studies of the University of which the latter two gentlemen are such distinguished ornaments. But some of the principal of these results may be most conveniently mentioned, when we pass from mere descriptive geology, to that other division of the subject which I have termed Geological Dynamics. And this I now proceed to do.

GEOLOGICAL DYNAMICS.

This term is intended to express generally the science, so far as we can frame a science, of the causes of change by which geological phænomena have been produced. Without here speaking of any classification of such changes, I may observe that the gradual elevation and depression, through long ages, of large portions of the earth's crust, is a proximate cause by which such phænomena have been explained: and this class of events, its evidence, extent, and consequence, is brought before our view by Mr. Darwin's investigations, with a clearness and force which has, I think I may say, filled all of us with admiration. I may refer especially to his views respecting the history of coral isles. Those vast tracts of the Pacific which contain, along with small portions of scattered land, innumerable long reefs and small circles of coral, had hitherto been full of problems, of which no satisfactory solution could be found. For how could we explain the strange forms of these reefs; their long and winding lines; their parallelism to the shores? and by what means did the animals, which can only work near the surface, build up a fabric which has its foundations in the deepest abysses of ocean? To these questions Mr. Darwin replies, that all these circumstances, the linear or annular form, their reference to the boundary of the land, the clusters of little islands occupying so small a portion of the sea, and, above all, the existence of the solid coral at the bottom of deep seas, point out to us that the bottom of the sea has descended slowly and gradually, carrying with it both land and corals; while the animals of the latter are constantly employed in building to the surface, and thus mark the shores of submerged lands, of which the summits may or may not remain extant above the waters. I need not here further state Mr. Darwin's views, or explain how corals, which when the level is permanent fringe the shore to the depth of twenty fathoms, as the land gradually sinks, become successively encircling reefs at a distance from the shore; or barrier reefs at a still greater distance and depth; or when the circuit is small, lagoon islands:—how, again, the same corals, when the land rises, are carried into elevated situations, where they remain as evidences of the elevation. We have had placed before us the map, in which Mr. Darwin has, upon evidence of this kind, divided the surface of the Southern Pacific and Indian oceans into vast bands of alternate elevation and depression; and we have seen the remarkable confirmation of his views in the observation that active volcanos occur only in the areas of elevation. Guided by the principles which he learned from my distinguished predecessor in this chair, Mr. Darwin has presented this subject under an aspect which cannot but have the most powerful influence on the speculations concerning the history of our globe, to which you, gentlemen, may hereafter be led. I might say the same of the large and philosophical views which you will find illustrated in his work, on the laws of change of climate, of diffusion, duration and extinction of species, and other great problems of our science which this voyage has suggested. I know that I only express your feeling when I say, that we look with impatience to the period when this portion of the results of Captain Fitz Roy's voyage shall be published, as the scientific world in general looks eagerly for the whole record of that important expedition.

And I cannot omit this occasion of mentioning with great gratification, the liberal assistance which the Government of this country have lent to the publication of the discoveries in natural history which Mr. Darwin's voyage has produced. The new animals which he has to make known to the world will thus come before the public described by the most eminent naturalists, and represented in a manner worthy of the subject and of the nation. I am sure that I may express the gratitude of the scientific world, as well as my own, for this enlightened and judicious measure.

I may here notice Mr. Darwin's opinion, so ably exposed in a paper read before us, that the change by which a variety of materials thrown on the earth's surface become vegetable mould, is produced by the digestive process of the common earth worm.

I will here also advert to Mr. Fox's paper on the process by which mineral veins have been filled up. This he conceives might be produced by the circulation or ascension of currents of heated water from the deeper parts of the original fissures. The discovery of the causes of the formation and filling of metallic veins, one of the earliest subjects of geological speculation, will remain probably as a problem for its later stages, when our insight into the laws of slow chemical changes is far clearer than it is at the present day.

If, from these proximate causes of change of which I have spoken, we proceed to those ulterior causes by which such events as these are produced;—to the subterraneous machinery by which islands and continents appear and vanish in the great drama of the world's physical history;—we have before us questions still more obscure, but questions which we must ask and answer in order to entitle ourselves to look with any hope towards geological theory. Of late years an opinion has taken root among us, that the dynamics of geology must invoke the aid of mathematical reasoning and calculation, as the dynamics of astronomy did, at the turning point of its splendid career. Nor can we hesitate to accept this opinion, and to look forwards to the mathematical cultivation of physical geology, as one of the destined stages of our progress towards truth. But we must remember, that in order to pursue this path with advantage, we have, in every instance, two steps to make, each of which demands great sagacity, and may require much time and labour. These two steps are, to *propose* the proper problem, and to *solve* it. Last year an important example of this kind was brought under your notice by my predecessor. The supposition that there are, beneath the crust of the terrestrial globe, liquid or semiliquid masses which exert a pressure upwards, leads to the inquiry what phænomena of fissure, disruption, and dislocation, this subterraneous strain would produce. The answer to this inquiry must be given by mathematical reasoning from mechanical principles; and Mr. Hopkins, who proposed, and to a considerable extent solved this problem, has put forth a set of results, with which, so far as they are definite and decisive, it will be highly important to compare the existing phænomena of disturbed geological districts. The same assumption, of an incandescent mass existing deep below the earth's surface, has led two other distinguished members of our body to another train of speculations; which, however, though highly interesting, I should be disposed to consider as only the enunciation of a problem, requiring no small amount of mathematical skill for its solution. I speak of the speculations of Professor Babbage and Sir John Herschel, concerning the subterraneous oscillations of the isothermal surfaces of great temperature. They remark that such oscillations will arise, when thick and extensive deposits take place on any parts of the surface of the earth, (as for instance at the bottoms of seas,) because such deposits increase the thickness of the coating over a given subterraneous point; and thus removing the cooling effect of the surface, bring a high temperature to a place where it did not exist before. The deposited strata might thus be invaded by violent heat advancing from below; and there might result both changes of position arising from extension and contraction, and a metamorphic structure in the rocks themselves. It is highly instructing to have this chain of conceivable effects pointed out to us; but we may venture to observe that in order to render the suggestion of permanent use, it will be necessary, to express, in some probable numbers, the laws of the result as affected by the conductivity of the earth's mass, the rate and thickness of the deposit, and other circumstances. For instance, we know that a deposit of one thousand feet thick would be quite insufficient to occasion a metamorphic operation in its lower strata. Would then a deposit of ten thousand or of twenty thousand feet call into play such a process? To answer questions like these, of which a vast number must at once occur to our minds, we have many experimental data to collect, many intricate calculations to follow out. And it would be easy to point out problems of a still more abstruse kind, in which we no less require aid from the mathematician, before we can proceed in our generalizations. May we not hope to see some fortunate man of genius unveil to us the mechanics of crystalline forces? And when that is done, can we doubt that we shall have a ray of new light thrown upon those extraordinary phænomena of slaty cleavage in mountain masses which have lately been brought under our notice? Or, recollecting the experiments of Sir James Hall, (a striking step in geological dynamics,) may we not hope then to learn how those crystalline forces are stimulated by heat; and thus follow the metamorphic process into its innermost recesses? These and a thousand such questions lie before us;—tangled and arduous inquiries no doubt, but connected by their common bearing upon one great subject;—'a mighty maze, but not without a plan.' And through this maze we must force our way in order to advance towards any sound geological theory. The task is one of labour and difficulty; but I well know, gentlemen, that you will not shrink from it on that account. Those who aspire to the felicity of knowing the causes of things, must not only trample under foot the fears of a timid unphilosophical spirit, which the poet deems so necessary a preparation, but they must look with a steady eye upon difficulty as well as violence. They must regard the terrors of the volcano and the earthquake, the secret paths by which hot and cold and moist and dry ran into their places, the wildest rush of the fluid mass, the latent powers which give solidity to the rock,—as operations of which they have to trace the laws and measure the quantities with mathematical exactness. And though there can be no doubt that the greater part of us shall be more usefully employed in endeavouring to add to the stores of descriptive geology, than in these abstruse and difficult investigations, yet we must always receive, with great pleasure, any communications containing real advances in the mathematical dynamics of geology, from those whose studies and whose powers enable them to lay an effectual grasp upon these complex and refractory problems.

I have but a single word to add in conclusion. This Society has always been an object of my admiration and respect, not only from the importance and range of its scientific objects, the wide and exact knowledge which it accumulates, the philosophical spirit which it calls into play, the boundless prospect of advance which it offers; but also for the manner in which its meetings and the intercourse of its members have ever been conducted; the manly vigour of discussion, tempered always by mutual respect and by good manners; the deep interest of all in the prosperity of the Society, to which, whenever the hour of need comes, private differences of opinion and resentments have given way. To be placed for a time at the head of a body which I look upon with such sentiments, I must ever consider as one of the greatest distinctions which can reward any one who gives his attention to science. I trust, by your assistance and kind sympathy, gentlemen, I shall be able to preserve the spirit and temper which I so much admire;—to hand that torch to my successor burning as brightly as it has hitherto done. And there is one consideration which will make me look with an especial satisfaction upon such a result. I have not myself the great honour of being one of the members of the Society who are connected with it by an early interest in its fortunes, and by long participation in its labours. I may consider myself as only belonging to its second generation. Now if there be a critical and a perilous time in the progress of a voluntary association like ours, it is when its administration passes out of the hands of its founders into those of their successors. It is like that important and trying epoch when the youth quits the paternal roof. I will say however, gentlemen, for myself and for my fellow-officers, some of whom are in the same condition, that our best cares shall not be wanting that the Society may suffer as little as possible by this change. And among our grounds for hope and trust, the main one is this: that though the offices of the Society may be in younger hands, the parental cares of its founders are not withdrawn. We have to discharge our office with the aid and counsel of those excellent persons to whom the prosperity of the Society up to the present time has been owing. Surrounded by such men, knowing their generous and ready sympathy for the attempts and exertions of their followers and disciples, I feel a cheerful confidence in the future destinies of the Geological Society; and a persuasion that it will not only preserve but extend its influence as a bond of scientific and social union among its members.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Feb. 21.—William Blount, Esq., of Cumberland Place, and José Estavão Cliffe, Esq., of Cuijaba, Brazils, were elected Fellows of this Society.

A paper "On part of Asia Minor," by William John Hamilton, Esq., Sec. G.S., was read.

In this paper, the author gives an account of the geological structure of the country from the foot of Hassán Dagh, a few miles S.S.E. of Akserai (lat. 38° 20′ N., long. about 34° E.), to the great salt lake of Toozla or Kodj-hissar, and thence eastwards to Cæsarea and Mount Argæus.

The formations, noticed by Mr. Hamilton, are trachytic conglomerates, considered by him one of the oldest formations of the country; a system of highly inclined beds of red sandstone, conglomerates and marls, which rest upon the trachytic conglomerate, and are apparently connected with the saliferous deposits of the country, though the author did not observe any beds of salt in the sandstone*; a limestone belonging to the vast, calcareous, lacustrine formation of the central part of Asia Minor; a great system of volcanic tufts, trachytes and basalts, apparently of comparative modern origin; and a grey granite which is newer than the sandstone, as it penetrates and disturbs that formation near Kodj-hissar; but pebbles of a grey granite identical in composition also occur in the conglomerate.

Hassán Dagh, upwards of 8000 feet above the sea, consists entirely of trachyte, and trachytic and porphyritic conglomerates, and rises from the eastern termination of a great calcareous plain. Several volcanic cones, composed of trachytic conglomerates and scoriæ, occur near the base on the S.S.W. and N.W. sides. All the latter, with the exception of one, are in the present valley, and below the tufaceous beds which cap the hills on its north side, and were, therefore, produced subsequently to the excavation of the valley. From one of them a considerable stream of black, vesicular lava proceeds, and encircles some of the smaller cones.

* The extensive beds of rock salt on the borders of Pontus and Galatia, occur in troughs or small basins resting upon the perpendicular edges of a red and brown sandstone conglomerate.

From the foot of Hassán Dagh to the great salt lake of Kodj-Hissar, the road traverses a plain, bounded on the south by low hills of the lacustrine limestone; and on the north by hills having narrow peaks and steep escarpments, of red and yellow sandstone, sometimes associated with calcareous conglomerates, sand and marl, and capped towards the east and north-east by beds of tuff and a white pumiceous rock, which passes into trachyte. Still further east, is a hill in which the sandstone rests upon a trachytic conglomerate.

The phenomena presented in this district, the author conceives, indicate the following operations:—

1. The irruption of the trachyte, from which the trachytic conglomerate was formed.
2. The deposition of the sandstones, conglomerates and marls.
3. The ejection of the igneous matter constituting the overlying beds of volcanic tuff and pumiceous rock.
4. The excavation of the valley.
5. The formation of the volcanic cones at the foot of Hassán Dagh.

The water of the salt lake of Kodj-hissar is so highly charged with saline matter, that no fish can live in it; and if the wings of a bird touch it, they become instantly stiff and useless with incrustation. Mr. Hamilton could not ascertain the exact dimensions of the lake, but he was informed, that it is about thirty hours or leagues in circumference. The bottom is a soft mud, incapable of supporting the slightest weight; but at the part examined by the author, a thick, solid crust of salt, which bore the weight of a horse, rested upon the soft mud, and was covered by about six inches of water, which he was informed would be dried up in another month.

The sandstone formation extends beyond the village of Kodj-hissar, towards the N.N.W., dipping in the same direction. It is penetrated near the town by a mass of finely-grained, grey granite, which also sends veins into the sandstone, and produces an anticlinal inclination, the dip towards the south being 80°. In the sandstone conglomerate, of the neighbourhood, Mr. Hamilton, however, noticed pebbles of a grey granite similar in composition to that of the protruded mass. About a mile N.W. of Kodj-hissar are detached portions of the horizontal white limestone, either resting unconformably against the sandstone, or filling up irregularities in its surface. In some places it caps the hills, which flank the valley a little to the north of the village.

The only fossils noticed in the sandstone, were impressions resembling fucoids, and similar to those found in the Alpine limestone near Trieste.

The author then describes the structure of the country between Kodj-hissar and Cæsarea, a distance of about 108 miles. It consists of the same sandstone system containing gypsum, and occasionally overlaid by horizontal beds of the lacustrine limestone and volcanic tuff; but the latter constitutes likewise large districts, the fundamental rock of which is not visible. Granite forms a range of hills thirty miles in extent, about midway between Kodj-hissar and Sari-karaman, and is traversed in one place by a N.N.E. and S.S.W. dyke of claystone porphyry: granite occurs also between the latter town and Tatlar. Trap and trachyte were noticed at several places, likewise serpentine and greenstone near Sari-karaman; and basaltic rocks form table lands overlying the volcanic tuff near Tatlar and Baktash; and close to Nembscheher beds of basalt alternate with the volcanic tuff. To the east and north-east of Tatlar the author remarked several volcanic hills, from which streams of basalt or lava appear to have flowed. To the south-east of the village he also saw a stream of a more recent date than that which caps the neighbouring hills; for it not only flows at a lower level, but below the steep escarpments of the older basalt. In the ravine near Tatlar, and in the vallies of Utch-hissar and Urjub, the tuff has been worn into cones from 150 to 300 feet high. They are principally detached from the sides of the vallies, but are connected at the base; and are in some places so numerous and close together, that they resemble at a distance a grove of lofty cypresses. Where the cones occur on the sides of the vallies, they exhibit every stage of development, from the first indication of a mound near the summit of the slope, to the full-formed cone at the bottom. In the valley of Urjub some of them are capped by a mass of hard rock, which projects like the head of a mushroom. The production of these cones the author ascribes to the action of running or atmospheric waters.

One of the principal objects of Mr. Hamilton's visit to this part of Asia Minor, was to ascend to the summit of Mount Argæus, which had not previously been reached by any traveller.

This mountain rises abruptly from the alluvial plain of Cæsarea, sending out prolongations and spurs into the plain which stretches to the north, between Injesu and Cæsarea; but it is connected at its eastern base with other ranges of mountains. It rises, like Hassán Dagh, to a single peak, and it resembles in outline, the summit of Ararat. The highest part consists of a reddish brecciated and scoriaceous conglomerate, full of fragments of trap and porphyritic trachyte, and may be said to be the point of junction of two enormous, broken craters, one of which opens to the N.E., the other to the N.W., the steep sides of which are covered to the north with eternal snow for 2000 or 3000 feet below the summit. The height of the mountain was ascertained by Mr. Hamilton to be about 13,000 feet, the following being the results of his observations.

By barometer	13,293
By angle of elevation from the Greek Convent	13,242
By angle of elevation from Kara-hissar	12,809

A little below the summit, on the S.E. side, rugged, serrated ridges rise through the snow, some of them consisting of a compact trachytic rock, with a highly conchoidal fracture, resembling that of hornstone; but others are composed of porphyritic trachytes of various colours and textures. Near the foot of the great cone, on the S.E., W., and N. sides, rise numerous smaller ones of pumice and lapilli, from some of which on the N.W. side, streams of basalt or lava may be traced.

In conclusion the author expresses his regrets, that the want of organic remains, prevents him from determining the comparative antiquity of the formations, with respect to those in Europe. In only one instance, the fucoid impressions near Kodj-hissar, did he observe a trace of an organic body in the sandstone; and the only occurrence of fossils in the limestone series which he noticed, was in the neighbourhood of Sevri-hissar W.S.W. of Angora, where he discovered, in the upper beds of the formation, Limnea and Planorbis.

March 7th.—Charles William Hamilton, Esq., M.R.I.A., Sec. G.S. Dublin, Dominick Street, Dublin, was elected a Fellow of the Society.

A notice was first read, on some remarkable dikes of calcareous grit at Ethie, in Ross-shire, by Hugh Edwin Strickland, Esq., F.G.S.

These dikes, which traverse the lias schist, are displayed only at low water. Two of them are parallel to the strata of schist; but another, which sends off branches in various directions, is in no part of its course parallel to those strata. Their thickness varies from one to three feet; but that of some of the lateral branches does not exceed three inches. They exhibit no variation in texture or composition, and show no signs of lamination, but are frequently fractured transversely to their direction. The transition from the dike to the lias shale is immediate; no change being apparent in the latter at the point of junction. The shale, from its greater softness, has been removed between the dikes, leaving them like walls from one to three feet in height.

These dikes, and similar ones in other places, were noticed by Mr. Murchison, in his examination of the coast of Scotland, in 1826.

By what means the dikes were produced, the author does not venture to inquire; his only object being to draw the attention of geologists still further to them.

A paper, on the connexion of certain volcanic phænomena, and on the formation of mountain-chains and volcanos, as the effects of continental elevations, by Charles Darwin, Esq., Sec. G. S., was then read.

The author first gave a detailed account of the volcanic phænomena, which accompanied the earthquake that destroyed Concepcion on the morning of the 20th of February, 1835; and then deduced from volcanic phænomena, certain inferences with respect to the formation of mountain-chains, and continental elevations.

In describing the phænomena of the earthquake of 1835, Mr. Darwin quotes the published accounts by Captain Fitzroy* and Mr.

* Journal of the Royal Geographical Society, vol. vi., p. 319, 1836.

Caldcleugh*; likewise communications received by him from Mr. Douglas, a resident on the island of Chiloe.

A few days after the earthquake, several volcanos within the Cordilleras, to the north of Concepcion, though previously quiescent, were in great activity. It is doubtful, however, if the volcano of Antujo, in nearly the latitude of Concepcion, was affected, while the island of Juan Fernandez, 360 miles to the north-east of the city, was apparently more violently shaken than the opposite shore of the main land. Near Bacalao Head, a submarine volcano burst forth in sixty-nine fathoms water, and continued in action during the day as well as part of the following night. That island was also affected in a remarkable manner, by the earthquake which overthrew Concepcion in 1751.

In Concepcion, the undulations of the surface appeared, to the inhabitants, to proceed from the south-west; and this direction was likewise inferred, from the effects observed in the buildings; for those walls, which had their extremities towards the point of disturbance, remained erect, though much fractured, whilst those (and the streets cross each other at right angles) which extended parallel to the line of the vibration, were hurled to the ground. This was strikingly exemplified in the cathedral, where the great buttresses of solid brick-work were cut off, as if by a chisel, and thrown down; while the wall, for the support of which they had been built, though much shattered, remained standing.

In Chiloe, south of Concepcion, the shocks were very severe, but they entirely ceased in about eight minutes. The motion, as described by Mr. Douglas, was horizontal, and similar to that of a ship going before a high, regular swell; from three to five shocks being felt in a minute; and the direction being from N.E. to S.W. Forest-trees nearly touched the soil in these directions; and a pocket compass placed level on the ground vibrated, during the violent shocks, two points to westward, but only half a point to eastward; and during the minor shocks the needle pointed north. At Calbuco, a village on the mainland opposite the northern extremity of Chiloe, as well as at Valdivia, between Chiloe and Concepcion, the earthquake was much less severely felt; and near Mellipulli, in the Cordilleras (not far from Calbuco), not at all. The volcano of Villareca, near Valdivia, which is said to be more frequently in irruption than almost any other in the chain, was not the least affected; though the volcanos of central Chili are stated by Mr. Caldcleugh to have been seen, some days afterwards, in great activity. Several of the culminating points of the Cordillera in front of the island of Chiloe, exhibited increased energy during the earthquake, and immediately after it. During the shocks, Osorno, which had been in activity for at least forty-eight hours previously, threw up a thick column of dark blue smoke; and directly it had passed away, a large crater was seen forming in the S.S.E. side of the mountain; Minchinmadiva also, which had been in its usual state of moderate activity, commenced a fresh period of

* Phil. Trans., 1836; Part I. p. 21.

violence. At the time of the principal shock, the Corcovado was quiet; but when the summit of the mountain was visible a week afterwards, the snow had disappeared from the north-west crater. On Yntales, to the south of the Corcovado, three black patches, resembling craters, were observed above the snow-line after the earthquake, though they had not been noticed previously to it. During the remainder of the year, the whole of the volcanic chain, from Osorno to Yntales, a range of 150 miles, exhibited, at times, unusual activity. On the night of the 11th of November, Osorno and Corcovado threw up stones to a great height; and on the same day, Talcahuano, the port of Concepcion, 400 miles distant, was shaken by a very severe earthquake; and on the 5th of December the whole summit of Osorno fell in.

After these details of more particular phænomena, Mr. Darwin alluded to the great areas over which earthquakes have been simultaneously felt; but he added, it is impossible even to guess through how wide an extent, in the subterranean regions, actual changes may have taken place. In order to enable the reader, who may be more familiar with European than South American geography, to comprehend the vast surface which was affected by the earthquake of February 1835, he stated, that it had a north and south range, equal in extent to the distance between the North Sea and the Mediterranean: that we must imagine the eastern coast of England to be permanently raised; and a train of volcanos to become active in the southern extremity of Norway; also that a submarine volcano burst forth near the northern extremity of Ireland; and that the long dormant volcanos of the Cantal and Auvergne, each sent up a column of smoke.

The contemplation of volcanic phænomena in South America, has induced the author to infer, that the crust of the globe in Chili rests on a lake of molten stone, undergoing some slow but great change; for if this inference be denied, he says, the only alternative is, that channels from the various points of eruption must unite in some very deeply-seated focus. This conclusion, however, he doubts, on account of the union of the different trains of volcanos on the one line of the Cordillera, and more especially as many hundred square miles of surface in Chili, have been elevated during the same earthquake. Moreover, these elevations have acted within a period geologically recent, throughout the whole, or at least the greater part, of Chili and Peru, and have upraised the land several hundred feet. He is further of opinion, that the shocks coming from a given point of the compass, and the overthrow of the walls, according to their position with respect to this point, prove that the vibrations do not travel from a profound depth, but are due to the rending of the strata not far below the surface of the earth.

In a geological point of view, the author conceives, the three classes of phænomena exhibited during this earthquake of February 1835, viz. a submarine outburst—renewed volcanic activity, simultaneously at distant localities—and a permanent elevation of the land, to be of the greatest importance, as forming parts of one great action, and being the effects of one great cause, modified only by local circumstances. Mr. Darwin further observed, that, as the volcanos near Chiloe commenced, at the moment of the shock, a period of renewed activity, which lasted throughout the following year, the motive power of these volcanos (as well as of the submarine outburst near Juan Fernandez) must be of a similar nature with that, which, at the same instant, permanently raised another part of the coast; and he therefore concluded, that no theory of the cause of volcanos, which is not applicable to continental elevations, can be considered as well-grounded.

Mr. Darwin then offered some remarks on the two tables published by Humboldt, of the great earthquakes which affected, in 1797 and 1811, so large portions of America; and he is of opinion, that a repetition of the coincidences can alone determine how far the increased activity of the subterranean powers, at such remote points, was the effect of some general law, or of accident. He likewise disbelieves that periodical eruptions, as those of Coseguina, in 1709 and 1809, or of earthquakes, as the shocks felt at Lima on the 17th of June 1578, and the 17th of June 1678, are more than accidental agreements. He also gave a table of the volcanic phænomena in South America in 1835; and concluded, that it is probable that the subterranean forces manifest, for a period, their action, beneath a large portion of the South American continent, in the same intermittent manner as they do beneath isolated volcanos. In the latter table, Mr. Darwin pointed out the case of Osorno, Aconcagua, and Coseguina, (the first and last being 2700 miles apart,) which burst into sudden activity early on the morning of June 20th, 1835; but he hesitated to assent to there being any necessary connexion between them. He further remarked, that if such simultaneous outbursts had been observed in Hecla and Ætna, points unconnected by any uniformity of physical structure, it would be doubtful how far they would have been worthy of consideration; but in South America, where the volcanic orifices fall on one line of uniform, physical structure, and where the whole country presents proofs of the action of subterranean forces, he conceives it ceases to be improbable, to any excessive degree, that the action of the volcanos should sometimes be absolutely simultaneous.

The author then briefly described the groups into which the volcanic vents of the Cordilleras have been divided. The most southern extends from Yntales to the volcanos of central Chili, a distance of nearly 800 geographical miles; the second, from Arequipa to Patas, rather more than 600 miles; the third, from Riobamba to Popayan, a distance of about 300 miles; and to the northward, there are in Guatimala, Mexico, and California, three groups of volcanos separated from each other a few hundred miles. That the vents in each of these groups are connected, the author has little doubt; but that the groups are united in one system, there are less satisfactory means of proving.

Mr. Darwin next considered the nature of the earthquakes which occur at irregular intervals on the South American coast. He is perfectly convinced, from the numerous points of analogy which exist between these phænomena and simple eruptions, that they belong to the same class of events; but he makes this distinction, that earthquakes, unaccompanied by eruptions at the chief point of disturbance, are followed by a vast number of minor shocks. These, he believes, indicate a repeated rending of the strata beneath the surface; whereas, in an ordinary eruption, a channel is formed during the first outburst.

Among other phænomena belonging to earthquakes, Mr. Darwin alluded to their affecting elongated areas. Thus the shock in Syria, in 1837, was felt on a line 500 miles in length by 90 in breadth; and those in South America are felt along 800 and 1000 miles of coast, but are on no occasion transmitted across the Cordillera to a nearly equal distance; and, as a consequence, the inland towns are much less affected than those near the coast. He does not conceive, however, that the disturbances proceed from one point, but many ranged in a band, otherwise the linear extension of earthquakes would be unintelligible. For instance, in 1835, the island of Chiloe, the neighbourhood of Concepcion and Juan Fernandez were all violently affected at the same time.

The last consideration which Mr. Darwin entered upon indicating the cause of earthquakes, is, that in South America they have been generally accompanied by elevation of the land; though it is not a necessary concomitant, at least to a perceptible amount. But he especially observed, that, as at Concepcion, during the few days succeeding the great shock, several hundred earthquakes, of no inconsiderable violence, were experienced, whilst the level of the ground in that part of the coast certainly was not raised by them (but after the interval of a few weeks, it stood lower,), there is a clear indication of some cause of disturbance, independent of the uplifting of the land in mass.

In summing up the evidence of phænomena accompanying earthquakes, the author is of opinion that the following conclusions may be drawn:—

1st. That the primary shock of an earthquake is caused by a violent rending of the strata, which, on the coast of Chili and Peru, seems generally to occur at the bottom of the neighbouring sea.

2ndly. That this is followed by many minor fractures, which, though extending upwards, do not, except in submarine volcanos, actually reach the surface.

3dly. That the area thus fissured extends parallel, or approximately so, to the neighbouring coast mountains.

Lastly. That the earthquake relieves the subterranean force, precisely in the same manner as an eruption through an ordinary volcano.

The author afterwards discussed the nature and phænomena of mountain chains; and stated his belief, that the injection, when in a fluid state, of the great mass of crystalline matter, of which the axis is generally composed, would relieve the subterranean pressure in the same manner as an ejection of lava or scoria; and that the dislocation of the strata would produce horizontal vibrations through the surrounding country. In drawing this parallel, he also stated his belief, that the earthquake of Concepcion marked one step in the elevation of a mountain chain; and he adduced, in support of this opinion, the fact observed by Capt. Fitzroy, that the island of Santa Maria, situated 35 miles to the south-west of that city, was elevated to three times the height of the upraised coast near Concepcion; or at the southern extremity of the island, eight feet; in the middle, nine feet; and at the northern extremity, upwards of ten feet; and that at Tubal, to the south-east of Santa Maria, the land was raised six feet*; this unequal change of level indicating, in his opinion, an axis of elevation in the bottom of the sea, off the northern end of Santa Maria.

Mr. Darwin then alluded to Mr. Hopkins's Researches in Physical Geology, where it is demonstrated, that if an elongated area were elevated uniformly, it would crack or yield parallel to its longer axis; and that if the force acted unequally, transverse cracks or fissures would be produced, and that the masses, thus unequally disturbed, would represent the irregular outline of a mountain-chain. He further added, that if the force should act unequally beneath the area simultaneously affected, various fissures would be formed in different parts, having different directions, and thus give rise, at the same moment, to as many local earthquakes. The author believes, that this view will more readily explain intermediate districts being little disturbed (as Valdivia in 1835, and in cases alluded to by Humboldt,) than the supposed inertness of intermediary rock in conveying the vibrations from a deeply-seated focus.

If the preceding theory of the cause of earthquakes be true, Mr. Darwin said, we might expect to find, that the many parallel ridges of which the Cordillera is composed, were of successive ages. In Central Chili, the only portion examined by him, this is the case, even with regard to the two main ridges; and some of the exterior lines of mountains appear, likewise, to be of subsequent dates to the central ones. The contemplation of these phænomena led him, while in South America, to infer, that mountain-chains are only subsidiary, and attendant operations on continental elevations.

The conclusion, that mountain-chains are formed by a long succession of small movements, the author conceived may be arrived at by theoretical reasoning. The first effect of disturbing agents, Mr. Hopkins has shown, is to arch the crust of the earth, and to traverse it by a system of parallel but vertical fissures; and that subsequent elevations and subsidences of the disjointed masses would produce anticlinal and synclinal lines. In the Cordillera, the strata in the central parts, are inclined at an angle commonly exceeding 45°, and are very often absolutely vertical, the axis being composed of granitic masses, which, from the number of dikes branching from them, must have been fluid when propelled against the lower beds. How then,

* Journal of the Royal Geographical Society, vol. vi. p. 327.

he asked, could the strata have been placed in a highly inclined and often vertical position, by the action of the fluid rock beneath, without the very bowels of the earth gushing out? If, on the other hand, it be supposed that mountain-chains were formed by a succession of shocks similar to those which elevated Concepcion, and after long intervals, time would be allowed for the injected rock to become solid, as well as the upper part of the great central mass. Thus, by a succession of movements, the strata might be placed in any position; and the crystalline nucleus gradually thickening, would prevent the surface of the surrounding country, being inundated with molten matter.

In crossing the Andes, Mr. Darwin was surprised at finding, not one great anticlinal line, but eight, or more; and that the rocks composing the axes were seldom visible, except in denuded patches in the vallies. This circumstance, he conceives, must be due to the thickness of the up-heaved strata being equal, or nearly so, to the average distance of the anticlinal from the synclinal lines. For in that case, the masses of strata, when placed vertically, would occupy, or rest on, as great an horizontal extent, as they did before they were disturbed.

In the central ridges of the Cordillera, there are masses of compact, unstratified rocks, half again as lofty as Ætna; and these, he believes, for the reasons before stated, were formed by the gradual cooling of the subjacent fluid mass; afterwards slowly elevated to the present position, by the injection of molten matter at nearly as slow a rate, as we must suppose the innumerable layers of volcanic products, of which the Sicilian mountain is formed, have been ejected.

In conclusion, Mr. Darwin repeated the argument, that mountain-chains and volcanos are due to the same cause, and may be considered as mere subsidiary phænomena, attendant on continental elevations;—that continental elevations, and the action of volcanos, are phænomena now in progress, caused by some slow but great change in the interior of the earth; and, therefore, that it might be anticipated, that the formation of mountain-chains is likewise in progress; and at a rate which may be judged of, by either actions, but most clearly by the growth of volcanos.

March 21st.—Richard Henry King, M.D., of Reigate; John Warden Robberds, Esq., of Norwich; Edmund Lloyd, Esq., of Bloomsbury-square; and Lieut. Tremenheere, of the Bengal Engineers; were elected Fellows of this Society.

A paper was first read, on the Dislocation of the Tail, at a certain point, observable in the skeletons of many Ichthyosauri, by Richard Owen, Esq., F.G.S., Hunterian Professor to the Royal College of Surgeons, London.

Mr. Owen commences his observations by referring to the skeleton of the existing cetacea, and pointing out how slight is the indication afforded by the caudal vertebræ of the large terminal fin, which forms, in that class, so important an organ of locomotion; and the improbability that its presence would have been suspected, had the cetacea been known only by their fossil remains, in consequence of the fin having consisted entirely of decomposable and unossified material.

He states, that the flattened shape of the terminal vertebræ, which gives the only indication of the horizontal fin—and which character is not present in all the cetacea—is not recognisable in the skeletons of the Ichthyosauri and Plesiosauri; but he proceeds to describe a condition of the tail in the skeletons of the Ichthyosauri, which, he conceives, affords an indication of a structure in the extinct animal, analogous to the tegumentary fin of the cetacea, and which has not been suspected by the authors of the conjecturally-restored figures of the Ichthyosauri, already published. The condition alluded to, is described as an abrupt bend of the tail about one-third of its whole length distant from the end; and at the thirtieth caudal vertebra in the *Ichthyosaurus communis*; the broken portion continuing, beyond the dislocation, as straight as in the part which precedes it. As there is no appearance of a modification of structure in the dislocated vertebræ, indicative of the tail having possessed more mobility at that point than at any other; and as the dislocation has taken place at the same point in seven specimens examined by the author, he conceives that it must be due to some cause operating in a peculiar manner on the dead carcase of the Ichthyosaurus, in consequence of some peculiarity of external form, while it floated on the surface of the sea.

A broad tegumentary fin, composed of dense but decomposable material, might have been attached to the terminal portion of the tail; and such a fin, either by its weight, or by presenting an extended surface to the beating of the waves, or by attracting predatory animals of strength sufficient to tug at, without tearing it off, would occasion, when decomposition of the connecting ligaments had sufficiently far advanced, a dislocation of the vertebræ immediately proximate of its point of attachment. The two portions of the tail, with the rest of the skeleton, would continue to be held together by the dense exterior integument, until the rupture of the parietes of the abdomen, at some yielding point, had set free the gases generated by putrefaction; and the skeleton, having undergone certain partial dislocations, from the decomposition of the more yielding ligaments, would subside to the bottom, and become imbedded in the sedimentary deposits, exhibiting the fracture of the tail alluded to.

With respect to the relative position of this conjectured, caudal, tegumentary fin of the Ichthyosaurus, Mr. Owen cannot perceive any indication of its horizontality in the forms of the vertebræ, which he supposes to have supported it; and he regards the superaddition of posterior paddles in these air-breathing marine animals, as a compensation for the absence of that form of fin, which is so essential in the cetacea, for the purpose of bringing the head to the surface of the sea to inhale the air. On the other hand, a vertical caudal fin seems especially required by the short-necked and stiff-necked *Ichthyosauri*, in order to produce, with sufficient rapidity, the lateral movements of the head, which were needed by those predatory inhabitants of the ancient deep; while, in the *Plesiosaurus*, such a fin would be unnecessary, in consequence of the length and mobility of the neck; and Mr. Owen concludes, by stating, that in those skeletons of *Plesiosauri* in which the tail is perfect, it is straight, and presents no indication of the partial fracture or bend, which is so common in the tails of *Ichthyosauri*.

Figures of the tails of five specimens of *Ichthyosauri*, now in London, accompanied the Note; the subject of which was also illustrated by a sixth skeleton of an *Ichthyosaurus* on the Table, the property of Sir John Mordaunt, Bart.

A paper was commenced, on the Primary Formations of England, by the Rev. Adam Sedgwick, V.P.G.S.; Woodwardian Professor in the University of Cambridge, &c.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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April 4.—Thomas William Maltby, Esq., M.A., of Turnham Green, Middlesex; William Taylor, Esq., B.A., late of Queen's College, Cambridge, now of New Ormond Street; Mr. Isaiah Deck, of Cambridge; and Dr. Ainsworth, late Naturalist of Col. Chesney's Expedition; were elected Fellows of this Society.

A paper was read, entitled, "A Description of Viscount Cole's specimen of *Plesiosaurus macrocephalus* (Conybeare)," by Richard Owen, Esq., F.G.S., Hunterian Professor in the College of Surgeons, London.

The author premises his description of the *Plesiosaurus macrocephalus*, by pointing out the characters of a species of Plesiosaurus, which he regards as distinct from the *Plesiosaurus dolichodeirus* of Mr. Conybeare; and which, from the completeness of its skeleton in the British Museum and other collections, he selects for a more immediate comparison with the *Plesiosaurus macrocephalus*.

He proposes to call the species thus selected, as a term of comparison, *Plesiosaurus Hawkinsii*, in honour of the gentleman to whose remarkable skill and indefatigable labour, the beautiful and perfect skeletons of it are exclusively due. The chief points in which the *Plesiosaurus Hawkinsii* differs from the *Pl. dolichodeirus* are,—that the neck is a little longer than the trunk, instead of being fully equal to the body and tail united;—that it contains twenty-nine cervical vertebræ, bearing hatched-shaped ribs, instead of thirty-five; and that the length of the head is equal to one-tenth part of the total length of the skeleton, instead of one-thirteenth part as in the *Dolichodeirus*. The *Pl. Hawkinsii* differs also in the relative shortness and form of the ulna and fibula, and in some other minor points.

Having defined the species selected to illustrate the specific peculiarities of the *Pl. macrocephalus*, Mr. Owen next offers some new views respecting the elementary composition of a vertebra in the abstract, suggested principally by a study of the vertebral column in the *Plesiosauri*; for having observed that the vertebral ribs, or the elements termed by Geoffroy St. Hilaire *paraaux*, or *para-vertebral elements*, are not bent down in the caudal region to form the protecting laminæ of the vascular trunks beneath the tail, but are continued as shorter rib-like processes through a great part of the tail, co-existing with the inferior laminæ (also called *paraaux* by Geoffroy), he proposes to call these latter or inferior elements (which remain united in the *Plesiosauri*) '*hæmapophyses*', in allusion to their physiological relations with the great blood vessels. The superior laminæ he denominates on the same principle '*neurapophyses*', from their being developed to protect the great nervous trunk. The author further observes that the parts or processes of a complicated vertebra are of two distinct kinds; some being developed independently in separate cartilages, while others are mere projections from these independent constituents.

As examples of the first, or autogenous elements, Mr. Owen instances the *centrum*, or body of the vertebræ; the *neurapophyses* and *superior spine*; the *hæmapophyses* and *inferior spine*; and the *ribs*, or costal processes. The transverse and oblique processes are instances of the second, or exogenous parts of a vertebra.

The vertebræ of the *Plesiosaurus* are then described according to the preceding views, and the varying relations of the different vertebral elements in different regions of the spine are pointed out.

The dorsal vertebræ having been determined in previous descriptions of the skeletons of this genus by their usual anatomical character of affording articular surfaces to ribs, much difficulty has been experienced in defining the precise number of the cervical vertebræ, in consequence of the gradual change of the cervical ribs (hitherto considered as transverse processes), from the form of an expanded hatchet to that of an elongated style. The author, however, regarding the lateral appendages of the spinal column throughout its whole extent as modifications of one and the same vertebral element, proposes to distinguish the cervical and dorsal regions of the spine by the position of the articular surface supporting that lateral element, or rib: thus he would call cervical all those anterior vertebræ in which the body affords the whole or any part of the costal articular surface; and the dorsal series would commence at that vertebra where the costal surface had first passed upon the neurapophysis. The author finds in the *Plesiosaurus Hawkinsii* that the costal processes of the two vertebræ which are articulated to the ilium, and which are consequently to be regarded as sacral, begin again to slide down from the neurapophysis upon the centrum; and that in the *Pl. macrocephalus*, where the costal appendages are lost, the bodies of the first two vertebræ which again begin to exhibit a portion of the costal pit, correspond, in their relative situation to the ilia, with the sacral vertebræ in the more perfect skeletons of the *Pl. Hawkinsii*. In the vertebræ which succeed the sacral ones, the ribs rapidly descend from the neurapophyses upon the centrum; but the bodies of the caudal vertebræ so characterized may be distinguished from those of the cervical by the absence of a longitudinal groove which traverses the costal pits in the cervical region; and also by the presence of the articular surfaces for the hæmapophyses. The determination of characters in the body or central element of a vertebra which point out the region of the spine to which it belongs, is the more valuable in the skeletons of the *Enaliosauri*, because in these cold-blooded reptiles ossification is tardy in its progress, and anchylosis of the autogenous elements of a vertebra rarely takes place; and hence the bodies are often found separated and detached from their peripheral appendages.

After concluding his observations on the structure of the vertebræ in the *Plesiosauri* generally, the author next proceeds to point out the specific peculiarities of the cervical, dorsal, sacral, and caudal vertebræ of the *Plesiosaurus macrocephalus*.

The bodies of the cervical vertebræ of this species may be distinguished from those of the *Pl. Hawkinsii* and *Pl. dolichodeirus* by the close proximity of the costal to the neurapophyseal depressions: in this respect, indeed, the anterior cervical vertebræ of the *Pl. Macrocephalus* differ from those of every *Plesiosaurus* which the author has examined. Other minor distinctive characters are also pointed out. The number of cervical vertebræ in the *Pl. Macrocephalus* is twenty-nine, that of *Pl. Hawkinsii* thirty-one; the length of the neck is twice that of the head; in *Pl. Hawkinsii* it is three times the length of the head.

The dorsal vertebræ of the *Pl. macrocephalus* differ from those of the *Pl. Hawkinsii* and *Pl. dolichodeirus* in being more flattened in the antero-posterior direction, and more concave at the sides; true transverse processes are developed from the neurapophyses to support the ribs, as in other *Plesiosauri*.

In the sacral vertebræ the medullary canal presents a slight enlargement as compared with that in the neck.

The terminal caudal vertebræ in the specimen described, are wanting, but in those of a perfect skeleton of the *Pl. Hawkinsii* in the British Museum, the author discovered an interesting modification of the surfaces by which the bodies are joined to one another. They are hollowed out like the vertebræ of the *Ichthyosaurus*, so as to join by double concave surfaces; he conceives this to be, as in the Batrachian reptiles, the original structure of all the vertebræ, and that it is permanent in those which are most remotely situated from the centre and source of vital energy: but Mr. Owen observes, that this arrest of development is obviously designed, to give to the tail of the Plesiosaurus the same combination of elasticity with flexibility, which characterizes that of fishes.

After describing the vertebral and sternal ribs of the abdominal region, the author next compares the bones of the pectoral and pelvic extremities with those of other species of *Plesiosauri*. In the *Macrocephalus* the ulna is relatively longer and broader, and presents a more complete reniform figure than in the *Hawkinsii* or *Dolichodeirus*. These characters are still more marked in the fibula; the femur is longer than the humerus. There are eight ossicles in the carpus, and six ossicles in the tarsus; these latter are so arranged as to allow of greater freedom of inflection forwards, and to give a compound motion to the stroke of the hinder paddle.

The author concludes with a detailed account of the structure of the cranium, which he compares, at each step, with that of the two principal modifications of the Saurian type, as exemplified in the Crocodilian and Lacertine species; and he points out many particulars in which the *Plesiosaurus* deviates from the Loricate, and corresponds with the Lacertine or Squamate group. Amongst these may be noticed, the predominance of the elongated form in the cranial bones, extending from point to point with wide interspaces, and giving to the osseous fabric of the head the appearance of a scaffolding; the posterior bifurcation, mesial crista, and foramen of the parietal bone; the form and relative position of the posterior frontals, and especially the absence of the ridge which, in the Crocodile, extends like a second zygoma longitudinally across the zygomatic cavity. Mr. Owen further dwelt upon the form and position of the zygomatic portion of the temporal bone, the bony interspace of the external nostrils, the structure of the lower jaw, and particularly on the existence of a wide space on each side of the posterior region of the skull, bounded above by the arch formed by the bifurcate processes of the parietal and the tympanic bones, and opening into the temporal fossæ, as evidences of the affinity of the *Plesiosaurus* to the Lacertine Sauria. The correspondence of the cranial organization of the *Plesiosaurus* to those of the Crocodile, was noticed in the strength of the maxillary apparatus, the general form and structure of the upper jaw, and in the nature and alveolar lodgement of the teeth. The peculiarities of structure referable to the special exigencies of the extinct form of Saurian under consideration, were also dwelt upon, and, lastly, those which characterized the species described, and which illustrate its more immediate affinities.

April 25.—Egerton V. Vernon Harcourt, Esq., M.A., of Nuneham, Oxfordshire; George Crane, Esq., Ynyscedwyn Iron Works, near Swansea; Mr. James Tennant, Strand; C. W. Grant, Esq., Capt. Bombay Engineers; and B. F. Outram, M.D., Hanover Square, were elected Fellows of the Society.

A paper was first read, entitled, "Notes on a small patch of Silurian Rocks to the west of Abergele, on the north coast of Denbighshire;" by J. C. Bowman, Esq., and communicated by R. I. Murchison, Esq., V.P.G.S.

The author's attention was first directed to these strata by Mr. John Price, of New College, Bristol. They occur immediately south of the narrow belt of carboniferous limestone, which skirts the coast from the Great Ormes Head, eastward, to the Point of Air and the Estuary of the Dee. The belt of limestone is here not above a mile broad, and the strata dip N. or N.E. At the base of the limestone precipices at Craig y Forwyn, is a seam of impure coal about a foot thick, and a thinner layer of bituminous shale with carbonized impressions of Lepidodendra? and a leaf-like Poacites. The beds constituting the following section are successively displayed between Llandulas and Garthewin, a distance of nearly six miles:—

1. Immediately under the limestone is a conglomerate, the basis consisting of "light loam," and the rounded pebbles of greenish, slightly micaceous sandstone, containing a few bivalves and joints of encrinites. This stratum the author has also seen between Llandeilo Bay and Colwyn on the Holy-

head road, but the pebbles are there sometimes a foot in diameter.

2. Thin bed of the same sandstone.
3. A thick deposit of red marl, containing numerous angular and water-worn pebbles, interspersed thickly with shells apparently belonging to the Ludlow rocks. This marl forms a considerable part of Ffernant Dingle; but it alternates with a compact marl, and is sometimes speckled green or yellow. The beds dip at a high angle to the north. Similar pebbles are found on the top of the limestone precipices, and beyond them on the beach.
4. Compact, hard, arenaceous conglomerate, composed of pebbles more or less rounded, of liver-coloured and green micaceous shelly sandstone, also of pebbles of quartz, and the reddish subjacent limestone.
5. Thin beds of compact reddish limestone containing few organic remains. It passes occasionally into a calcareous sandstone.
6. Near the lower end of the dingle, the limestone rests on a bed of very fine blue clay.
7. Blue clay-slate, finely grained, slightly micaceous, and containing occasionally a layer of small shells. It sometimes presents obscure indications of vertical cleavage. This rock constitutes the whole of the southern portion of the dingle, and in one place is traversed by a fault.

The rill in Ffernant dingle flows into Melin y Person brook. The red marly conglomerate is there succeeded, on the south, by alluvium containing slate pebbles. Above the village of Bettws Abergele the slate rocks occur, but are greatly contorted; and on the height a little further south, and to the east of the road, is a hard finely grained rock inclosing joints of small encrinites. Still further south this rock alternates with beds of breccia, containing encrinital and other organic remains, the imbedded angular fragments consisting of glossy clay-slate. A little south of this quarry, towards Garthewin, the non-fissile blue slate again occurs, and the author found in it abundance of small fragments of encrinites, with univalves and bivalves. These fossils occurred apparently in layers, but were much decomposed. Similar remains were noticed, by Mr. Bowman, in the debris of the lead mines at the Bronhaylog, to the north-east of Garthewin.

The paper was accompanied by a list of fossils prepared by Mr. James de Carle Sowerby, including the following species which have been found by Mr. Murchison in the Ludlow Rocks elsewhere: *Leptæna lata, Terebratula nucula, T. pulchra, T. navicula, Conularia quadrisulcata, Atrypa affinis, Orthis orbicularis, Cypricardia cymbæformis*, var., *Nucula ovalis, Euomphalus funatus, Orthoceras striatum, Avicula retroflexa*, and *Pleurotoma corallii.*

A notice "On the Occurrence of Wealden strata at Linksfield, near Elgin; on the Remains of Fishes in the Old Red Sandstone of that neighbourhood; and on raised beaches along the adjacent coast;" by J. Malcolmson, Esq., F.G.S., was then read.

The country around Elgin is composed of sandstones, conglomerates, and concretionary limestones, belonging to the old red sandstone; but at Linksfield, one mile south of Elgin, that formation is overlaid, unconformably, by a series of beds, which Mr. Malcolmson has ascertained, by their organic remains, to represent the Wealden strata of England, though they have been usually considered to be lias.

The following section gives the principal beds in descending order, the average thickness of the whole series being from 20 to 30 feet:

1. Blue clay, containing thin bands of limestone, the lower being shelly.
2. Thin bands of limestone and clay.
3. Blackish shale, not bituminous, 1 to 2 feet.
4. Compact grey limestone, without shells, in layers separated by clay, 4 feet.
5. Laminated green clay, with a network of fibrous carbonate of lime.
6. Red, sandy, calcareous marl, abounding with rolled pebbles of granite, gneiss, &c., also angular fragments of the fine-grained yellow and grey sandstone forming the hills to the west, but the geological position of which is not yet ascertained.

Cornstone of the old red sandstone in unconformable position.

The fossils are principally found in the lower bands of the top bed. They are rarely well preserved, and cannot be separated from the rock. The species are few in number, but abundant in individuals; and one species of *Cyclas* is undistinguishable from the *C. media* of Sussex, found also by Prof. Sedgwick and Mr. Murchison in the Isle of Skye: there is likewise an *Avicula*, which agrees with one found in the Purbeck strata at Swanwich. Mr. Malcolmson procured also fragments of an *Astarte* and a *Venus*, and a microscopic univalve. The clay below this shelly limestone is full of the valves of a new, round species of *Cypris*. The author also obtained teeth and scales of fishes; and the Rev. G. Gordon has found a Saurian bone.

Fossils of the same description have been recently discovered by that gentleman at Lhanbryde, three miles to the east of Linksfield; and in a micaceous white sandstone, he has procured a large *Pinna*, which Mr. James Sowerby has identified with a species found in the Portland sand of England. In April, 1832, Mr. Gordon communicated to the Society a notice of the discovery in a dark clay*, penetrated while draining the Lake of Spynie, of the *Turritella muricata* of the Coral Rag. Mr. Malcolmson, therefore, hopes that many members of the series above the old red sandstone, not yet known to exist south of the Murray Frith, will be discovered by the practical geologists resident in that district.

Mr. Martin, of the Anderson Institution, has recently discovered in a bed of calciferous conglomerate, near Elgin, and supposed by Mr. Gordon to represent the old red sandstone of Clasbennie in

* Proceedings, vol. i. p. 391.

Perthshire, scales, teeth, and bones of fishes; and, by comparing these remains with a magnificent specimen of a fish from Clasbennie, in Mr. Murchison's possession, Mr. Malcolmson has ascertained this supposition to be correct. A doubt, therefore, which formerly existed respecting the age of the conglomerate, is now removed.

The paper concluded with an account of eleven ancient beaches on the coast, rising above each other, and from one of which, 15 feet above high-water mark, and cut through in draining Loch Spynie, Mr. Malcolmson procured twelve species of existing marine testacea.

A paper, "On the Origin of the Limestones of Devonshire," by Robert Alfred Cloyne Austen, Esq., F.G.S., was afterwards read.

The object of the paper is not to account for the origin of calcareous matter, or the means by which marine animals derive it from the surrounding medium, but to show how far the limestones of South Devonshire may have been produced by polypi.

These limestones are stated by the author to occur, in nearly every instance, in the immediate vicinity of volcanic disturbances, and to be partly included in the slates and sandstones, and partly to rest upon them. To the former belong the broad band extending from Staple Hill to Dean Prior, the minor bands in the neighbourhood of Hempstone and Totness, and all those which occur beyond the Dart; also the limestones of Newton and Torbay. They are said to be less pure and more slaty than the overlying limestones, and to be frequently separated by seams of shale. Transverse sections of these bands show, that the strata in some cases become thinner as they descend, and that the partings of shale increase, as near Staverton in the valley of the Dart, and at Staple Hill; but that in other instances, as between Newton and Totness, the strata instead of fining off end abruptly upon the slate, and are covered in the direction of the dip by similar slates. The strata are always inclined, but they invariably form a table-land at the surface. This inclined position the author conceives is not due to dislocation, but to the beds having been deposited at the angle which they now present; and he illustrated his opinion, by a section between three and four miles in length, through the parishes of Pegwell, Denbury, and Abbots Kerswell, a remarkably level country. The bands of limestone dip 40°, but are nowhere more than 150 feet thick, and they all contain the same description of organic remains. If the bands were deposited horizontally, and the most recent nearly at a level with the surface of the ancient ocean, then the lower beds, the author says, would have been placed at a depth of nearly three miles, although the organic remains prove that all the beds were formed under precisely similar conditions.

In the structure of the Devonshire limestones, however, Mr. Austen considers that he has discovered evidences of an origin similar to that of modern coral reefs, and which will explain their inclined position. At Ogwell Park the limestone forms a horizontal capping to the inclined strata; and at Bradley rests conformably against a ridge of slate, the basset edge of each bed rising to the level of the crest of the ridge. This structure, Mr. Austen states, agrees with that of the coral reefs in the Southern Ocean, where the polypi raise their habitations on the flat summits or sides of submarine hills, to a level with the surface of the water. The stratified arrangement of the calcareous masses he considers may be explained by the occasional deposition of sedimentary matter, which might interrupt, for a time, the labours of the polypus; and thus a series of beds would be produced varying in thickness according to the recurrence, at shorter or longer intervals, of interfering agents, each bed rising successively to the surface level of the water. If the deposition of sedimentary matter were great, then the polypi would be destroyed, and the reef would become encased in a mechanical accumulation. In further proof of the limestone of Devonshire having been coral reefs, Mr. Austen adduced the great abundance of zoophytes found on the surface of the lower strata, imbedded in the layers of sand which separate the beds; and, he added, that their absence in other parts, especially in the interior of the bands, is no objection to his view of the origin of the limestone, because, in recent reefs, all traces of organic structure are frequently obliterated.

May 9.—Joseph Skilbeck, Esq., of Highbury Place, London; the Rev. John Hymers, Fellow and Tutor of St. John's College, Cambridge; and the Rev. Walter Davenport Bromley, of Wootton Hall, Staffordshire, were elected Fellows of this Society.

A communication by Dr. Black, F.G.S., was first read, "On a fossil stem of a Tree recently discovered near Bolton-le-Moor."

The rock in which this fossil was found, occurs in the middle of the coal-measures, about 50 yards beneath a six-feet bed of coal, and it rests upon another bed four feet thick. It consists of three strata of argillaceous sandstone dipping from 15° to 18° to the south-west, and amounting in all to about 40 feet in thickness. The upper portion of the fossil stem was discovered about thirty feet beneath the surface of the rock, and the lower end extended to within 5 or 10 feet of the subjacent bed of coal. It was inclined 18° to north-east, or in an opposite direction to the sandstone strata; and, when first laid open, it appears to have been about 30 feet in length, but at the time it was examined by Dr. Black only 12 feet remained *in situ*. The upper end of this portion was 15 inches in diameter, and the lower 9 inches. The whole of the exterior of the stem was singularly striated, and irregularly furrowed, as if by compression; and it was coated with a layer of coal, which evidently occupied the place of the bark. The interior of the stem is stated to be composed of a dark, hard, argillo-ferruginous sandstone, having a specific gravity of 2·9. A Sternbergia, about an inch in diameter, extended along the whole length of the stem, and in some parts appeared to be half imbedded in a groove in it. This connexion of the two plants was Dr. Black's principal object in making the communication to the Society, not having previously observed a similar occurrence, nor having heard that it had been noticed elsewhere by other collectors. He is of opinion that the Sternbergia was not accidentally allocated with the larger stem, but that it was, while living, a parasite, and in this respect resembled the mighty creepers of the existing tropical regions.

A paper was next read, "On the Distribution of Organic Remains in part of the Oolitic Series on the coast of Yorkshire;" by Mr. Williamson, Curator of the Natural History Society of Manchester.

In former communications* Mr. Williamson explained the vertical range of organic remains in the Lias of inferior and great oolites, and in this he showed their distribution in the upper sandstone and shale, the cornbrash, the Kelloway Rock, and the Oxford Clay.

The upper sandstones and shales vary considerably in their characters, but they consist of three principal divisions, the highest and lowest being composed of sandstones sometimes ferruginous, and the middle one of clays and shales. The principal localities for the fossils are on the north side of Scalby Beck, near Scarborough, and Burniston Bay. The most characteristic plants are *Pecopteris Murrayana, Cyclopteris digitata,* and *Otopteris obtusa*; but remains of Cycadeæ and Equiseta also occur. The list of plants is much smaller than that generally given, in consequence of Mr. Williamson having removed to the great oolite, a bed generally considered as belonging to the upper sandstones.

Cornbrash.—This formation seldom exceeds five feet in thickness, and in Cayton Bay consists of the following strata in descending order:

Fissile oolite	6 inches.
Softer rock, sometimes ironshot..	2 feet.
Hard ironshot rock............	2 feet.
Blue clay, from	3 inches to 4 feet.

The fossils contained in the fissile upper bed, are chiefly *Terebratula ovoides, T. obsoleta, Ostrea edulina,* and *O. Marshii.* The greater portion of the organic remains are found towards the middle of the deposit, the following being the most abundant: *Ammonites Herveyi, Ostrea Marshii, Plagiostoma rigidulum, P. interstinctum, Trigonia clavata, T. costata, Cardium citrinoideum, Unio peregrinus, Amphidesma decurtatum, A. securiforme, Mya literata,* and *Clypeus orbicularis.* Twenty other species also occur, but less numerously. In the bed of clay, remains of a small *Astacus* (?) are obtained, also a shell resembling an *Unio,* and an undescribed Belemnite. Thirteen of the species found in the cornbrash are stated to exist also in the great oolite of Yorkshire, and nine in the coralline or Oxford oolite.

Kelloway Rock.—This deposit consists of soft sandstones, sometimes calcareous, but towards the top it is occasionally very ferruginous; and it varies in thickness from 35 to 70 feet. The fossils are numerous and highly characteristic, particularly the Ammonites. The ferruginous bed is full of organic remains, consisting chiefly of

* Proceedings, vol. ii., pp. 82, 429. Geol. Trans., vol. v. Part I., p. 223, *et seq.*

Belemnites abbreviatus, B. tornatilis, Ammonites Calloviencis, A. sublævis, A. Königi, A. Sutherlandeæ, Ostrea Marshii, Gryphea dilatata, β. The most abundant species in the sandstones are, *Ammonites flexicostatus, A. sublævis, A. gemmatus, A. Calloviencis, A. perarmatus, A. ichthyodorsus* (W.), *A. gamma* (W.), *A. rotifer* (W.), *A. oblisus* (W.), *Belemnites abbreviatus, B. tornatilis, Turbo sulcostomus, Terebratula ornithocephala, T. socialis, Gryphæa dilatata, Ostrea Marshii, Avicula Braamburiensis, A. expansa, Lucina lirata, Amphidesma recurvum* : 18 other species of testacea occur, though less abundantly. Five species are stated to be common to the Kelloway rock and the cornbrash, and ten to the Kelloway rock and the coralline oolite. Remains of fishes and of Ichthyosauri and Plesiosauri also occur in the deposit.

Oxford Clay.—This great argillaceous formation is about 130 feet thick, and consists chiefly of fissile shales, but towards the upper part it becomes sandy. Fossils are comparatively rare in it, and are confined to the lower part, the only shell discovered in the upper by Mr. Williamson being *Pinna lanceolata.* The characteristic fossils are *Ammonites Vernoni, A. cristatus, A. athleta, A. occulatus, Belemnites gracilis, Nucula nuda, N. elliptica, Pinna mitis, Astarte lurida, A. carinata, Avicula expansa.* The bed resting on the Kelloway rock is characterised by *Belemnites abbreviatus* and *Gryphæa bullata.*

In future communications, the author purposes to illustrate the distribution of organic remains in the higher oolitic strata of the Yorkshire coast.

A paper was afterwards read, "On the State in which Animal Matter is usually found in Fossils;" by Mr. Alfred Smee, Student of King's College, London, and communicated by Prof. Royle, M.D., F.G.S.

The author first describes briefly, the composition of those parts of recent animals capable of being preserved in a fossil state; and then proceeds to detail his investigations into the composition of fossil organic remains.

For the sake of arrangement, he divides fossils into two great classes, one in which animal matter is present in various states, the other in which it has been removed. The first class he further subdivides into three cases: 1. comprehending those fossils in which animal matter retains its original condition; 2. those in which it has been partially changed; 3. those in which only the carbon of the animal matter remains.

1. The following examples were given of the first case.

Small portions of the tooth of a horse, of an ox, and a stag, from the chalk rubble at Brighton, were submitted to the action of diluted muriatic acid; and after the earthy portions had been removed the animal matter retained the shape of the bone, was white, and of the consistence of cartilage. Fragments of a tooth of a mammoth from Norfolk, and of a rib of a mastodon from Big-bone-lick in Ohio, when similarly treated, gave the same results. A thin slice of the rib exhibited under the microscope the structure of recent bone. Fragments of a stag's rib and horn, of an ox's head, and the tusk of a boar found near the Bank of England, associated with Roman implements, retained their animal matter unaltered. Small portions of a Terebratula and of two species of Productæ, from the Silurian rocks of Malvern, were placed in very diluted muriatic acid, and when the earthy portions had been removed, small flocculi of animal matter, resembling the recent membrane of a shell, floated in the solution. A minute fragment of *Asaphus caudatus* yielded little shreds of animal matter. The experiments on the shells were repeated several times with the same results. Under the microscope these fossils exhibited also the structure of recent shells.

2. The second case in which animal matter has been partially changed, was illustrated by the following experiments. Portions of a stag's jaw from the Brighton chalk rubble, of a fish-bone, and a shark's tooth from the London clay, when dissolved in diluted muriatic acid, gave only a brown powder; and the animal matter of a fragment of the humerus of a mastodon from Big-bone-lick exhibited but little flexibility, and was easily torn, particularly in the longitudinal direction. It was found impossible to make sections of the jaw-bone of the stag or the humerus of the mastodon for microscopic observation. Part of a human parietal bone found upon the site of the cathedral of Old Sarum, and human bones obtained from the church-yard of St. Christophe le Stocks, on part of which the Bank of England stands, were ascertained to have had their animal matter reduced to the same state as that of the stag's jaw. A fossil oyster from the Isle of Wight, when placed under the microscope, showed black spots over its surface, and the structure of the shell was apparently destroyed. A fragment of a Pecten from the lias also exhibited opaque spots. Part of an ammonite when dissolved left a substance resembling Sepia.

3. The third case, where only the carbon of the animal matter remains, was explained by two series of experiments, one of which proved it to be associated with bitumen, and the other that it existed by itself. The scales of *Dapedium politum* and other fishes from Lyme Regis, when acted upon by acid, left carbon undissolved; and when heated under a test-tube gave a considerable quantity of bitumen.

Portions of the bones of the Ichthyosaurus and Plesiosaurus from the lias, yielded a black residuum, which deflagrated with red hot nitre, and the resulting mass gave a precipitate with chloride of calcium. To prove that the carbon was a portion of the bone and not an adventitious ingredient, a section was made, and the greatest quantity of carbon was found in the thickest part; and an analysis showed that the proportion of carbon was about the same as in the animal matter of a similar mass of recent bone. A still further proof was adduced, in no gelatine having been detected after 36 hours boiling of a fragment of the fossil. A section of recent bone displayed, when carbonized by heat and charged with crystals of alum or a composition of whitening, a similar appearance in the arrangement of the carbon as in the fossil bone. No bitumen was given off, when fragments of these bones were acted upon by heat under a test-tube.

With respect to the second great class in which the animal matter has been removed, the following cases were mentioned :—Portion of the external and internal parts of a mammoth tusk from Siberia, did not blacken by heat, and dissolved completely in muriatic acid. The internal part of a tusk from Ohio gave the same results, but the external part was found to contain a considerable proportion of animal matter. In bones from the crag, the animal matter had been abstracted. Human bones which had been long buried were found to be in the same state.

The paper concluded with the following remarks. As the different states, in which animal matter is found in fossils, pass insensibly into each other, and as many of the changes occur in church-yard and other bones, it follows, that no extraordinary circumstances are requisite to produce these alterations; but that they may be effected by the ordinary processes of putrefaction. Even the carbonization of animal matter may be accomplished by similar processes without the aid of heat, as bones become black by being macerated too long. It is also to be observed, that the parts of animals preserved in the fossil state, are those which longest resist putrefaction. It having been likewise shown that the degree of change does not depend upon the age of the bed in which the fossil occurs, it is a curious subject of inquiry for the geologist to ascertain how far the conditions necessary to putrefactive air, a certain temperature and moisture, were present in those strata, in which the change has been great; how far they were absent in those, in which the change has been small.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1838. No. 58.

May 23.—A memoir entitled, a Synopsis of the English series of stratified rocks inferior to the old red sandstone—with an attempt to determine the successive natural groups and formations. By the Rev. Adam Sedgwick, *Woodwardian Professor in the University of Cambridge*, commenced on the 21st March, was concluded.

Introduction.—The author, after stating what was now offered to the Society to be only a first approximation, involving many questions of difficulty and doubt, pointed out the principles on which he had undertaken the task. There are two elements of classification applicable to stratified rocks of all ages, viz., physical structure and order of superposition; one giving the mineralogical unity of a group of rocks, the other their relative age. In addition to the two former, are classifications founded on the organic remains in the several groups. In the commencement of geology the last method was only subsidiary to the two former. But after observations had been multiplied, laws respecting the distribution of organic types were discovered, which not merely superseded, in many large formations, all classifications founded on mineral structure; but often, through wide regions, gave indications of succession which were unsupported by the direct evidence of sections. As, however, the (so called) laws respecting the distribution of organic types, are mere general results grounded on actual observation, it is obvious that they can never upset conclusions drawn from the clear and unambiguous evidence of sections. The two methods may be used independently, and conspire to the same end; but in their nature cannot come into permanent collision.

The author then points out some examples in which these principles had been violated. (1) The attempt formerly made by some geologists to arrange the Stonesfield slate in a tertiary group, merely from the presence of certain fossils of a class not commonly found in secondary rocks. (2) Some of the doctrines put forth in the papers of M. Deshayes, which if pushed to their utmost extent would make the evidence of sections of no value; whereas without sections fossils could never have led to any general laws of succession. (3) The recent discussions respecting the age of the culm plants of North Devon. The plants were assumed to be of the age of the greywacké, from the mineral structure of the rocks in which they were imbedded; or the rocks were assumed to be of the carboniferous period by the species of the imbedded plants: whereas true geological reasoning required that, anterior to either of the preceding conclusions, the true position of the culm measures should be determined by actual sections.

The author then goes on to point out the difficulty of classifying the vast series of schistose rocks below the old red sandstone —from the great resemblance of their mineral type—from the absence of well-defined beds of organic remains in many large regions—and from their entire disappearance in the last members of the descending series. The Silurian system is almost the only exception to this remark; and even this system is developed in many parts of England without any distinct succession of natural groups. The mineral type is on the whole much more uniform in the great series under notice than in the secondary system of England; but the frequent absence of organic remains, and of any succession of distinct groups, is compensated by the enormous scale of development, as shown in the natural sections: and the author concludes, that it is not by hypothetical views and analogies, or by maintaining one part of geological evidence at the expense of another; but by applying every kind of evidence in its proper place, and above all by actual surveys and detailed sections, that we can ever hope to bring into coordination the complicated phænomena of which he is only attempting to give a brief synopsis.

TWO CLASSES OF OLD STRATIFIED ROCKS, &c.

The author first notices the older stratified series of Scotland, and divides it into two classes.

(1.) The primary class (composed of gneiss, mica slate, quartz rock, &c. &c.,) is largely developed in the Highlands.

(2.) The second class (greywacké, greywacké slate, &c. &c.,) is also largely developed in the Lammermuir hills, and in the whole chain extending in the south of Scotland from St. Abb's Head to the Mull of Galloway. It is shown, partly on mineralogical characters, and partly on the evidence of sections, that the rocks of the former class are inferior to those of the latter. For a zone of slate rocks (the *roches chloriteuses et quartzeuses* of Dr. Boué) is superior to the crystalline slates of the Grampians, and is (at least provisionally) placed on the same parallel with the earthy and mechanical slates of Lammermuir chain. Both the preceding classes are shown to be inferior, and generally unconformable, to the old red sandstone; which in the northern part of Scotland was once grouped with the primary class; but in the geological map of Scotland is now put in its true place.

After giving a series of sections to connect the structure of the Lammermuir chain with the adjacent parts of the north of England, he then proceeds to describe, in general terms, the expansion of the rocks of the second class through various mountainous tracts of South Britain. The frontier chain of Scotland—the slaty series of the Cumbrian mountains—of North and South Wales—and of the whole region between the eastern side of Devon and the western end of Cornwall—as well as the slate rocks of some smaller unconnected tracts, are all referred to one great class, the highest group of which passes into the old red sandstone, while the lowest (where the development is complete) rests on the crystalline system of the first class. Independently of the direct evidence from detailed sections, the several regions are shown to be related; 1st, by a common physical structure; 2ndly, by organic remains; 3dly, by common lines of *strike*; tending to show that several disconnected tracts of wide extent, having partaken of the same accidents, were once probably connected and continuous deposits in a deep sea.

In illustration of these views he shows that the prevailing strike of the beds (as well as the prevailing direction of the anticlinal and synclinal lines) in the Lammermuir system, in the Cumbrian system, and in the system of all the highest chains of North Wales, is nearly N.E. and S.W. and he further shows that the actual impress was given to all these regions before the period of the old red sandstone. In Cornwall the average strike is about W.N.W., but gradually bends round to the E. and W., in which prevailing direction the rocks cross Devonshire. In the southern parts of the slate regions of South Wales the beds also have an east and west strike; and these parallel dislocations of Devonshire and South Wales are posterior to the carboniferous series and probably contemporaneous with one another. Where the two preceding systems of strike meet, the beds are thrown into inextricable confusion; and on the outskirts of Wales, and in the counties where the Silurian system has been most largely developed, the dislocations are too irregular and complicated to be reduced to any law. Lastly, he notices a system of dislocations that have brought up a portion of the older rocks (of the class here described) at Dudley, on both sides of the Warwickshire coal field, and in Charnwood forest. At all these localities the strike is the same, and the lines of greatest movement are nearly parallel—all being about N.N.W. and S.S.E.; and all these movements belong to one epoch, having been completed *after* the deposition of the lower red sandstone, and *before* the period of the upper and gypseous marls. Hence we have three great systems of elevation, each marked by parallel lines of strike, and the three systems of strike indicating three distinct periods of elevation.

The author then points out the importance of such facts to the broad speculations of geology, as well as the limitations under which they are to be applied. The dynamical powers of elevation appear to have been employed in three principal forms. 1st. In gradually raising up ridges through large spaces of the earth's crust. These will explain the correspondence of strike through very extensive regions; and such elevations if continued beyond a certain limit must have produced longitudinal fissures and lines of volcanic vent. 2ndly. In the long-continued protrusion and eruption of igneous rocks along such lines of vent. 3dly. In local and partial eruptions and protrusions, producing valleys of elevation, local derangements, and other phænomena that terminate in ordinary volcanic action. Elevatory forces, when considered in this general way, explain the phænomena of strike—the parallelism of great contemporaneous elevations—as well as the exceptions to the rule of parallelism.

GROUPS OF THE CUMBRIAN SECTION, &c.

The author then commences the separation of the whole series of rocks of the *second class* into natural groups, founded on sections exhibited in the several districts above noticed; and after shortly discussing two sections connecting the Cheviot hills with the formations in the basin of the Tweed, he describes in some detail a transverse section through the whole system of the Cumbrian mountains, which exhibits the following groups in ascending order.

(1.) The group of Skiddaw Forest, &c., the lower part of which rests on the granite, and passes into a system of crystalline strata resembling the rocks of the first class; the upper part abounds in a fine dark glossy clay slate, interrupted here and there by beds of more mechanical structure. The whole is of great thickness, almost without calcareous matter, and without any trace of organic remains, and forms the mineral axis of the Cumbrian mountains.

(2.) A group essentially composed of quartzose and chloritic roofing slates alternating with mechanical beds of coarser structure, and also with innumerable igneous rocks (compact felspar, felspar porphyry, brecciated porphyries, &c. &c.,) which partake of all the accidents of the slates. It is of enormous thickness, and rises into the highest mountains of the country; and though chiefly developed on the south side of the preceding group (No. 1), it also appears extensively on the north side of the lower group, which thus forms a mineral axis —a fact not yet noticed in any of the published geological maps. Though abounding in calcareous matter, it has no organic remains. (*Lower Cambrian system*).

(3.) A great series, expanded through Westmoreland and parts of Lancashire and Yorkshire. It is based on calcareous slates, passing into limestone, and full of organic remains, and in its lower division are fine roofing slates, but less crystalline than those of the preceding group. Its upper division (not however separable by any very distinct zoological or mineralogical characters from the lower) abounds in arenaceous flagstone, coarse quartzose greywacké, coarse slates with imperfect cleavage, and not fit for use, and the series is incomplete, being cut off by the unconformable deposits of old red sandstone and carboniferous limestone. Distinct beds of limestone are almost wanting in this upper division, and organic remains are very rare, but they appear here and there in very thin bands among the coarse siliceous slates. Provisionally, the lower division is placed in the *Upper Cambrian system*, and the upper division in the *Silurian* system; but without being separable into any further clear subdivisions. This great group (No. 3.) does not appear on the north side of the mineral axis of Cumberland, as was represented in the early geological maps.

SECTIONS OF NORTH WALES, &c.

The author next discusses a series of sections illustrating the structure of North Wales. One is drawn from the Menai Straits, in a direction about E.S.E., so as to cross the Berwyn chain and end in the carboniferous series near Oswestry. The others are drawn from the Berwyn chain to different parts of the carboniferous limestone range on the north side of Denbighshire. The greater portion of the first section crosses the older beds (the *Cambrian System*) which strike towards the N.E. The other sections intersect the upper series (*Silurian System*) which strike towards the N.W., passing (in some places unconformably) round the beds of the older system. From a consideration of the whole evidence the rocks are grouped in the ascending order as follows.

(1.) Chlorite slate, quartz rock, and mica slate of Anglesea and Caernarvonshire. These are placed on the parallel of the first class; and nothing is discovered in the section that is perfectly analogous with the Skiddaw slate, or first Cumbrian group, above described.

(2.) The old slate series of Caernarvonshire and Merionethshire, alternating indefinitely with bands of porphyry and felspar rock; many parts absolutely identical in structure with the second Cumbrian group above-described. It is of enormous but unknown thickness, and is bent into great undulations, the anticlinal and synclinal lines of which are parallel to the strike of the chain. Through wide tracts of country it is without fossils; but at Snowdon and Glider Fawr, encrinites, corals, and one or two species of bivalves have been discovered in it. It ends with the calcareous beds which range from Bala to the neighbourhood of Dinas Mowddy. This is called the *Lower Cambrian System*.

(3.) The next group (the *Upper Cambrian System*) commences with the fossiliferous beds of Bala, includes all the higher portion of the Berwyns, and all the slate rocks of South Wales which are below the Silurian System. Its slate beds are less crystalline, and its general structure is more mechanical, than the preceding group, and it contains incomparably more fossils, which (though there are many extensive portions of the group without fossils) are disseminated through the more calcareous beds in great abundance. Many of the fossils are identical in species with those of the lower division of the *Silurian System*, nor have the true distinctive zoological characters of the group been well ascertained.

In many parts of South Wales it is separated from the *Silurian System* by great faults and derangements of the strata, marked by a broad band of rotten non-fossiliferous schist. At the north end of the Berwyn chain it appears to pass by insensible gradations into the lower division of the Upper System (the *Caradoc Sandstone*).

(4.) The last natural group (the *Silurian System*). For all details respecting this system the author refers to the abstracts of Mr. Murchison's papers, and to his forthcoming work. He then describes the sections:

(1.) East of the Berwyns, in which the Caradoc Sandstone is finely developed; containing the *Llandeilo flagstone* and other characteristic calcareous and shelly bands.

(2.) The sections north of the Berwyns, connecting Montgomeryshire with Denbighshire. The ascending series is described as follows:—

(1.) A series of beds several thousand feet in thickness, and apparently forming a passage between the Upper Cambrian and lowest portion of the Silurian System.

(2.) Bands of calcareous slate with numerous organic remains of the "*Caradoc Sandstone.*"

(3.) Series of flagstones, more or less calcareous, with many orthoceratites and two species of cardiola, overlaid by, and associated with, irregular masses of roofing slate with a transverse cleavage.

(4.) Flagstones and rotten slates, many parts in an imperfect state of induration, and the whole surmounted by the Carboniferous Limestone.—Of the preceding section the lower part of No. 3. is identical with the series of Long Mountain in the Silurian sections of Mr. Murchison; but No. 4. is mineralogically unlike any thing he has described, although it has been found to contain some of the fossils of the *Upper Ludlow Rock.* It appears from these details that the Silurian System, although its subdivisions are obscure from the absence of the Wenlock and Ludlow limestones, is more fully developed than in the group (No. 3.) of the great Cumbrian section above described.

The author then briefly notices the slate rocks of Charnwood Forest, which he refers provisionally to the Upper Cambrian System; but from the imperfection of the sections and the absence of organic remains, their exact place is not determined.

SECTION FROM THE NORTH TO THE SOUTH COAST OF DEVONSHIRE.

I. *North Devon section.*—For details the author refers to a paper by Mr. Murchison and himself, but enumerates the successive groups for the purpose of adding some remarks, and of connecting the system of Devon with that of Cornwall*. The ascending order is as follows:

(1.) A series of coarse arenaceous slates, not noticed in the former paper.

(2.) The calcareous slates of the river Lyn.

(3.) The coarse red flagstones, &c., of Exmoor Forest, and of the coast to the east of Combe Martin.

(4.) The calcareous slates and limestone bands of Ilfracombe.

(5.) The contorted slate zone south of Ilfracombe.

(6.) The calcareous slates and irregular masses of limestone between the preceding group and the culm measures.

The whole of the preceding series is placed in the Upper Cambrian System with the exception of the upper portion of No. 6., which is

* See Proceedings, p. 556 et seq.

considered, both from its structure and its fossils, as near the doubtful limit between the Upper Cambrian and Lower Silurian Systems.

II. *Culm measures.*—This series is described (as in a former paper) to occupy a great trough, which ranges across the country in a direction bearing nearly east and west; on its north side overlying the preceding group (No. 6. of the North Devon section), and on its south side rising up to the granite of Dartmoor, or overlying the older slate system of Devonshire and Cornwall*. Its subdivisions are enumerated as in the former paper; and the author adds, that during the summer of 1837 he ascertained that the lower beds of the culm measures rest unconformably on a portion of the slate rocks in the north of Cornwall, near Launceston. On the contrary, in the cliffs near Barnstaple, the lower culm measures seem to graduate almost insensibly into the formation on which it rests. Hence (independently of all other evidence) it is clear that slate rocks in the north of Cornwall are of an older epoch than the upper group of the North Devon section.

The author then considers the classification of the culm series, and states his opinion that the base of it is lower than the base of the ordinary English carboniferous series. The base line (in the former paper) was intentionally left in an ambiguous position; and the difficulty of the subject has been subsequently increased by the supposed discovery of some true carboniferous plants in the highest group (No. 6.) of the North Devon section. In the upper part of the culm measures all the fossil plants have been described as identical in species with plants of the carboniferous series; and hence (unless some conflicting evidence be discovered) the culm measures and common coal measures must continue to be placed on the same parallel.

Lastly, he states that, independently of any question of classification, the former paper by Mr. Murchison and himself first pointed out the following facts in the general structure of the county:—

(1.) That the Wavellite rock and culm limestone (of Barnstaple, &c.) were in position, structure, and fossils distinct from all the other calcareous groups of Devon.

(2.) That the same group was repeated over again with a reversed dip on the north side of Dartmoor, and entirely distinct from the calcareous slates of Cornwall, with which it had no analogy in structure or fossils.

(3.) That the Holcombe Rogus limestone was a part of the culm series.

(4.) That the culmiferous system was superior to all the slate rocks of Devonshire and Cornwall, and was overlaid by no older rock than the new red sandstone. Whereas before, the portion of the culm series near the granite had, from its metamorphic structure, been confounded with the oldest rocks of Devonshire and Cornwall; and the position of whole series among the Devonian groups had been misapprehended.

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* See Proceedings, p. 561.

III. *South Devon section.*—This section, in conformity with the scheme given in the former paper, is as follows, in the ascending order*:—

(1.) A series of slate rocks subdivided into two groups,—the lower containing a few calcareous bands, the upper group more calcareous and ending with the Plymouth limestone. The two are considered as one formation; and the name, *Ashburton bands*, which had been given to the calcareous beds of the lower division, is now withdrawn, as the position of the Ashburton lime rock is considered ambiguous. The name of *Ugborough bands* is not liable to the same objection.

(2.) A great group of coarse red flagstone and slate, identical in its structure with No. 3. of the North Devon section, and containing some corals that do not appear in the mountain limestone, but are found both in the Cambrian and Silurian systems. This group is provisionally identified with No. 3. of the North Devon section.

(3.) A great group of slate rocks without beds of limestone, and very rarely with any traces of organic remains. By the suppression of No. 4., this group is considered as the equivalent of No. 5. of the North Devon section.

(4.) Mica and chlorite slate, anomalous in structure and position, and forming no part of the ascending series.

The preceding identifications are only provisional, and many desiderata are enumerated; but it is considered certain that the South Devon section belongs, on the whole, to a lower series than the North Devon. Neither of them are, however, supposed to descend lower than the Upper Cambrian, or the higher part of the Lower Cambrian, group. To place the South Devon section above the North Devon, would be to violate all the analogies of structure derived from other parts of England; and would not, the author believes, be supported by any specific evidence derived from fossils.

CLASSIFICATION OF THE ROCKS OF CORNWALL.

The author states, that the Plymouth limestone, in its range westwards, gradually thins off, and comes to an edge about the middle of Whitesand bay. The strike of the beds and the trending of the coast prevent this limestone and all the upper groups of the *South Devon section* from appearing again on the south-eastern side of Cornwall.

The inferior portion of the first group (No. 1.) of the South Devon section passes into Cornwall in a broad zone, gradually acquires the strike of the Cornish rocks, and so runs along the S.E. coast; and finally passes from Falmouth bay to Mounts bay; rising on its north side towards the granite, and on its south side dipping under the serpentine of the Lizard district. As in Devonshire, the group contains beds more or less calcareous, and, rarely, thin beds of limestone.

In the same way, though not with the same clear evidence, the calcareous slates rising from beneath the culm-measures near Launceston, double round the granitic promontory of Rough-Tor, and

* See Proceedings, p. 562.

are thence expanded (though with considerable irregularities of strike and modifications of structure) as far as St. Ives' Bay.

The granitic ridge of the county is supposed to represent an interrupted mineral axis, on the N.E. and S.W. sides of which are slaty groups of the same geological period. In all cases near the granite the slaty groups change their structure; but this change of structure cannot be assumed as the ground of a classification dependent on the age of the deposit; as it is shown by a series of sections, that in several places the fossiliferous slates on the coast are of the same date with the indurated metalliferous slates that rise to the granite. Hence the crystalline and metalliferous slates of Cornwall are considered as metamorphic, and in that respect agree with the bottom culm series that touches on the Dartmoor granite.

Of the rocks of Cornwall the newest are the granites; next come the serpentine and other trappean rocks; and the oldest are the slate rocks. These slate rocks (including all the killas of Cornwall of whatever structure) appear to be an actual prolongation of the lowest group of the *South Devon section,* and therefore, agreeably to what is stated above, are provisionally arranged near the upper portion of the *Lower Cambrian System.*

Many of these rocks were formerly considered primitive; but none of them have any pretension to that class. Numerous fossils were found by the author in the cliffs on both sides Loe bay, and on both sides of the Fowey river, and still further west in Gerrans bay. Mr. J. Conybeare found fossils many years since in the Tintagel slates; and the author in 1828 traced the fossiliferous system into the cliffs west of Padstow. During M. De la Beche's survey he had (before the author's last visit to the N.W. coast of Cornwall) found fossils innumerable in that part of the county. The Cornish fossils are generally ill preserved; but among them are some corals that are common both to the Silurian and Cambrian systems. The fossils of New Quay and South Petherwin are an exception to the remark; as many of them are well preserved. They consist of corals; encrinites; numerous specimens of the genera *Terebratula, Orthis,* and *Spirifer*; of four or five species of *Orthoceratites*; *Goniatites*; and lastly, three or four new species of a genus described by Count Munster under the name Clymene, and by Mr. Ansted under the name Endosiphonites. As they occupy a position so much lower, so, as a group, these fossils are distinct from those of the Silurian system.

Conclusion.—The author here takes a retrospect of the preceding description, and states that the classifications are founded on the details of actual sections; and that as far as such detailed sections throw light on the several questions that may arise, there is not much that remains to be done in England. Some of the generalizations are, however, founded on imperfect evidence; and to render them more complete, it is now necessary to appeal to the organic remains in the several groups. In this department little has been yet effected, excepting in the higher part of the Silurian system, where the upper divisions (at least in one part of the island) assume definite mineralogical and zoological types. Whether definite zoological groups can be made out in any lower system still remains to be seen. The rigid determination of the Devon and Cornish fossils, which are very numerous, and a rigid comparison of the Berwyn and Bala fossils with those near the base of the third group of the Cumbrian section, give the fairest promise of an answer to the question, and are pointed out as immediate *desiderata*.

The difficulty of classification by organic remains increases as we descend, and is at length insurmountable; for in the lowest stratified groups, independently of metamorphic structure, all traces of fossils gradually vanish; and the great range of certain species through numerous successive groups, and the very irregular distribution of fossils even in some of the more fossiliferous divisions, add greatly to the difficulties of establishing true definite groups even within the limits of our island. The difficulties are indefinitely increased in comparing the formations of remote continents. But these circumstances are compensated by the magnificent scale of development of the successive groups, and their wide geographical distribution. Taken together they have a great unity of character; and even in remote continents they seem to form a common base, from which we may hope to compute the whole series of secondary and tertiary deposits that surmount them.

The author then briefly touches on questions of structure and cleavage; on the indefinite alternations of trappean beds; on metamorphic structure; on the long duration of the deposits; and on their great disruptions and symmetrical dislocations, indicating a greater violence of disturbing forces than is indicated in the secondary formations of this country. Following the geological scale of deposits from top to bottom, we can trace a series of phænomena indicating the same kind of causation differing at different times in intensity and degree. The mean intensity can therefore only be collected by ascertaining the intensity during every geological period, and can never be obtained by assuming the intensity of any one epoch, past or present, as the arbitrary standard. Again, the successive organic types indicate great physical changes; and following the descending scale they at length vanish; conducting us, however, to the confines of other investigations in exact science which must prove the ultimate basis of physical geology.

Finally, the author gives a tabular arrangement of the several classes and subdivisions agreeably to the system of the preceding communication.

Class I.—*Primary stratified Groups.*

Gneiss, mica slate, &c., &c. Highlands of Scotland and the Hebrides. Crystalline slates of Anglesea and the S.W. coast of Carnarvonshire.

The series generally without organic remains; but should organic remains appear unequivocally in any parts of this class, they may be described as the *Protozoic system.*

Class 1. (*a*). The crystalline slates of central Skiddaw forest, and the upper Skiddaw slate series. The whole is inorganic and intermediate between Class I. and Class II.

Class II., or *Palæozoic series.*

This class includes all the groups of formations between Class I. and the old red sandstone; and is subdivided as follows:—

1. *Lower Cambrian System.*—All the Welsh series under the Bala limestone. The two great groups of green roofing slate and porphyry on the north and south side of the mineral axis of the Cumbrian mountains. A small part of the slates of Cornwall and South Devon. ? A part of the slate series of the Isle of Man, &c., &c.
2. *Upper Cambrian System.*—A large part of the Lammermuir chain on the south frontier of Scotland. A part of the third Cumbrian group, commencing with the calcareous slates of Coniston and Windermere. The system of the Berwyns and South Wales. The slates of Charwood forest. ? All the North Devon and a part of the South Devon series. The greater part of the Cornish series.
3. *The Silurian System.*—The upper part of the third Cumbrian group, chiefly expended in Westmoreland and Yorkshire. The flagstone series of Denbighshire. The hills on both sides of Llangollen. The region east of the Berwyn chain. The regions described in the papers of Mr. Murchison, from which the types of the system are derived. The lowest part of the culmiferous series. ?

Over all the preceding comes the *Old Red Sandstone*—divided into three great natural groups in the country bordering the Silurian types of Mr. Murchison; in the northern counties developed in a less distinct manner, chiefly in the form of great unconformable masses of conglomerate, appearing at irregular intervals between the preceding groups and the carboniferous series.

Little notice is taken in the memoir of the crystalline unstratified rocks associated with the several series. Any questions of classification, bearing on their geological epoch, can only be determined by the effects, produced by them on the stratified series, which mark the period of their first protrusion; but for the present this subject is not touched on by the author.

June 6th.—William Stark, Esq., of Norwich, was elected a Fellow of this Society.

A paper was first read, "On Spirolinites in Chalk and Chalk-flints;" by the Marquis of Northampton, F.G.S.

The fossils described in this memoir were chiefly found in the flints of Sussex; and though above two hundred specimens, more or less perfect, have been discovered by the author in that county, he has very rarely met with the genus elsewhere. They have been also found in the same county by the Rev. G. Smith and Mr. Walter Mantell. They occur more frequently in the grey than the black flints; and are sometimes accompanied by innumerable minute fragments of other organic bodies. The size of the best-preserved specimens, including the prolongation, is about one-third of an inch; and the number of chambers or divisions varies in the same species.

Of the six species described in the paper, one had been previously named, by Mr. Mantell, *Spirolinites Comptoni*, and the other five have been named by the Marquis of Northampton, *S. Murchisoni*, *S. Stokesii*, *S. Lyellii*, *S. Mantellii*, and *S. Bucklandii*; the author, however, stated that it is exceedingly difficult to determine satisfactorily specific differences, especially in such minute fossils, imbedded in flint, and exposed only by accidental fracture.

A communication was next read, entitled, "A Note to accompany Specimens of Quicksilver Ore from the mine San Onofre, near the town of El Doctor, Mexico." By John Taylor, Esq., Treas. G.S.

Though quicksilver had been known for some time to exist in Mexico, yet few attempts had been made to ascertain to what extent, till the increased prices and demand induced the directors of the Real del Monte and Bolaños Mining Companies to have researches made. Ores of that metal have, in consequence, been discovered and traced in districts very remote from each other; but Mr. Taylor confined his remarks to the locality at which the specimens presented to the Society were obtained.

The ores of San Onofre are chiefly cinnabar, partly hepatic, but native quicksilver occurs, and native calomel. They are stated to exist in a regular vein, two or three yards in width, the gangue consisting of carbonate of lime, with sulphate of barytes, and a small portion of silex. It traverses a limestone hill of considerable height, and appears to have been worked in former times.

Extracts were also read from a letter addressed to John Taylor, Esq., Treas. G.S., by Mr. Frederick Edmonds, explanatory of some specimens of obsidian from the mountain of Real del Monte, Mexico, collected by Mr. Frederick Edmonds, and presented to the Society by Mr. Taylor.

About half a mile from the ancient obsidian mines is the Cerro de las Navajas, in which several passages may be observed from an earthy felspathic rock to perfect obsidian. Although no good section is exposed, the obsidian is stated to occur in irregular beds, chiefly vertical, and Mr. Edmonds is of opinion, that it has been derived from the fusion of the felspathic rock under pressure. The collection presented to the Society's museum, contained a specimen of calcareous tuff from the thermal springs of El Grande.

A notice was next read of a specimen of the Oar's Rock, nine miles south of Little Hampton, Sussex, by Roderick Impey Murchison, Esq., V.P.G.S.

The specimen consists of a calcareous grit, bearing no resemblance to the Bognor rock, or other beds above the chalk, but agrees with some of the beds in the green sands below that formation, or to the

Portland beds. Mr. Murchison's principal object in laying this notice before the Society was to point out that the Oar's Rock is between the parallels of disturbance which traverse the Wealden of Sussex on the north, and the Isle of Wight on the south, the intermediate space being also traversed by the protruded chalk-outliers of Portsdown Hill, north of Portsmouth, and High-down Hill near Worthing, described by Mr. Martin*. Mr. Murchison, therefore, inferred that the Oar's Rock may indicate the protrusion of strata at that point. He noticed likewise the earthquakes so frequently felt at Chichester, which is situated intermediate between Portsdown Hill and Highdown Hill.

A paper was then read, "On the discovery of Fossil Fishes in the Bagshot sands at Goldworth Hill, 4 miles north of Guildford;" by the Rev. William Buckland, D.D., F.G.S.

These remains were recently obtained in cutting through the summit of Goldworth Hill, on the line of the London and Southampton Railway, and their preservation is due to Mr. Sibthorpe of Guildford. The only organic bodies previously discovered in the Bagshot sand are the casts of shells found near Chobham Park, and noticed in Mr. Warburton's account of the formation.† The fossils described by Dr. Buckland, were obtained from a bed of greenish sand, the sixth from the top of the section; and they consist of a few imperfect casts of marine shells, and the remains of marine fishes. The most numerous among the latter are the teeth of sharks, and the palates and teeth of rays, similar to those which abound in the London clay. One large tooth of a saw-fish, procured from the same bed, affords the first well-authenticated example of the discovery, in England, of the genus *Pristis*. In addition to these remains, three forms of cartilaginous fishes, and a few vertebræ of bony fishes, resembling those procured in Sheppy, have been found, also three new genera of fishes. For the latter Dr. Buckland proposes the names of *Edaphodon, Passalodon,* and *Ameibodon.* In the first genus the structure of the teeth is nearly allied to that of the broad and flat palates so common in the oolitic and carboniferous limestones. There were three of these teeth in the upper jaw, and three in the lower on each side, and they were disposed so as to form a pavement, arming the interior of the mouth with powerful instruments for crushing shells. Their surface is pitted with minute depressions, disposed in nearly the same manner as in the genus *Psammodus*. The body of each tooth also, as in *Psammodus*, is composed of hollow, long, cylindrical columns, placed nearly at right angles to the working surface. The bones to which the teeth are attached, are not granulated as in cartilaginous fishes; but are cancellated after the manner of bony fishes. The mode of insertion of the teeth in both jaws offers many peculiarities, as they are placed in nearly horizontal, long sockets, and

* Geological Memoir on part of Western Sussex, p. 93, 1828.

† Geological Transactions, 2nd Series, vol. i. p. 48.

maintained by continual growth from the posterior extremity of each tooth. Details were given of the genera *Passalodon* and *Ameibodon*; and it was stated that *Edaphodon* and *Passalodon* offer combinations of the characters of cartilaginous and bony fishes. In the stratum in which these remains were found, Mr. Sibthorpe has also discovered portions of the carapace of an *Emys*, resembling that of the London clay; and Sir Philip Egerton possesses a fragment of a tooth found at Sheppy resembling the teeth of the *Edaphodon* of Goldworth Hill. From the agreement, therefore, in the fossils of that locality with those of the London clay, Mr. Lyell's opinion, that the Bagshot sand was deposited during the eocene period, has received additional support.

A notice, by Dr. Buckland, was afterwards read "On the discovery of a fossil wing of a Neuropterous Insect in the Stonesfield slate."

The elytra of several species of coleopterous insects have been, for some time, known to occur in the Stonesfield slate, but Dr. Buckland believes that this is the first discovery of any remains of *Neuroptera*. The wings of *Libellulæ* are not unfrequent at Solenhofen; and a neuropterous wing, resembling that of a *Corydalis*, has been discovered by Mr. Mantell in an ironstone nodule from Coalbrook Dale. To the notice was appended a description of the wing by Mr. Westwood, from which the following is an extract:—"I have compared the fossil insect wing with the various genera of neuropterous insects, both indigenous and exotic, but it agrees with none of them. I apprehend there can be no doubt that it belonged to a tetrapterous insect, and to the order *Neuroptera*."

Dr. Buckland proposes to call the fossil insect *Hemerobioïdes giganteus*, from its being more nearly allied to the recent genus *Hemerobius* than to any other at present known.

The last paper read was on some species of Orthocerata; by Charles Stokes Esq., F.G.S.

In Dr. Bigsby's paper on the geography and geology of Lake Huron* some *Orthocerata* of peculiar forms are described; but since the publication of that memoir, Mr. Stokes has received many other specimens, collected during the expeditions of Sir Edward Parry, Sir John Franklin, the late Capt. Lyon, and Capt. Back, and by Capt. Bayfield during his survey of the lakes and the river St. Lawrence. The object of the present communication is to describe some species indicating generic separations among the *Orthocerata*, and to call attention to certain considerations respecting the relations of the shells to the animals to which they belonged.

The first generic distinction adopted by Mr. Stokes consists in a large siphuncule, much dilated in each chamber, and contracted at the parts where the septa are attached to it. Within the siphun-

* Geological Transactions, 2nd Series, vol. i. p. 195 *et seq.* Pls. 25 and 26.

cule is a continuous tube which appears to have been capable of expansion or contraction, and is furnished with radii in verticillations, which connect the tube with the walls of the siphon. For this genus he retains the name of *Actinoceras*, given by Bronn* to figures 1—3, Pl. 25, vol. i. N.S. of the Geological Transactions. Four species have been established by Mr. Stokes; namely, *Actinoceras Lyonii* from Igloolik and Ooglit; *A. Bigsbii* from Thessalon Island, in Lake Huron; *A. Richardsonii* from Lake Winipeg; and *A. Simmsii* from Castle Espie, in the County of Down, Ireland.

The character of the second genus is a siphunculus, similar in external form to the preceding, but the inner part is divided into portions corresponding in number with the chambers, and deeply indented in the middle, where the septa of the shell are attached to them; so that one half of each division of the siphuncule is in one chamber, and the other half in the next chamber. The opening or interior passage is comparatively small, and the inner and outer walls of these divided portions, which are separated by a considerable space, are beautifully curved. From the resemblance of the siphuncule to a row of beads, Mr. Stokes proposes to call the genus Ormoceras. Three species were described, all of them obtained from Drummond Island in Lake Huron; *Ormoceras Bayfieldii*, *O. Backii*, and *O. Whitei*.

Among the fossils noticed in Dr. Bigsby's paper, were several which Mr. Stokes then considered to be corals from the internal plates, and to which he gave the generic name of *Huronia*†. He has, however, since discovered, that they do not possess the peculiar, central structure, exhibited by the greater number of the lamelliferous corals; but that they have a continuous central opening; and, from the examination of other specimens, he now considers that these bodies are the siphuncules of true *Orthocerata*. He proposes, nevertheless, to retain the generic name of *Huronia*; and has called the only species, yet found with traces of the septa, *Huronia Portlockii*.

Mr. Stokes then offered some remarks "respecting the relations of the shell to the animal to which it belonged." From the siphuncule being so often preserved without the external portion of the shell, and the latter, including the septa, being, when retained, extremely thin, he is of opinion that the shell must have been enveloped in the animal to protect it from injury. This view of the relation of the shell to the soft portions of the creature, he is of opinion, receives confirmation from his having observed only one instance of a parasitic body being attached to *Orthocerata*. In this instance, indeed, there are evidences that the parasite, a coral, must have been formed after the death of the animal of the shell (*Actinoceras Simmsii*), for the specimen exhibits in some parts, layers of earthy matter, alternating with layers of the coral; and, therefore, the growth of the latter must have been more than once interrupted by the deposition of sediment. The memoir concluded with

* *Lethæa geognostica*, vol. i. p. 98. tab. i. fig. 8. 1835.

† Geological Transactions, 2nd Series, vol. i. p. 202, Pl. 28.

some remarks on a peculiar subdivision in the septa towards the outer wall of one side of the chambers, noticed by the author in several specimens of *Ormoceras*, in an *Orthoceras* from Russia, and in *Lituites*; but he refrained from offering any opinion, whether this character is common to the family of *Orthoceratidæ*, or is confined to certain genera only.

This being the last evening of the Session, the Society adjourned to Wednesday, November the 7th.

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END OF THE SECOND VOLUME.

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