Mr. Hezekiah Rudd
Huntington

Oct.
1828

# THE
# AMERICAN JOURNAL
# OF
# SCIENCE AND ARTS.

CONDUCTED BY

BENJAMIN SILLIMAN, M. D. LL. D.

Professor of Chemistry, Mineralogy, &c. in Yale College; Corresponding Member of
the Society of Arts, Manufactures, and Commerce, and Foreign Member of
the Geological Society, of London; Member of the Royal Mineralogical
Society of Dresden; of the Imperial Agricultural Society of Moscow; Honorary Member of the Linnæan Society of Paris;
of the Natural History Society of Belfast; and
Member of various Literary and Scientific Societies in America.

VOL. XV.—No. 1.—OCTOBER, 1828.

FOR JULY, AUGUST, AND SEPTEMBER, 1828.

NEW HAVEN:

Published and Sold by HEZEKIAH HOWE and A. H. MALTBY.
*Philadelphia*, E. LITTELL.—*New York*, G. & C. CARVILL.
*Boston*, HILLIARD, GRAY, LITTLE & WILKINS.
*London*, JOHN MILLER, 40 Pall Mall.

PRINTED BY HEZEKIAH HOWE.

A.H.MALTBY

HAS FOR SALE A VALUABLE ASSORTMENT OF

**BOOKS:**

*—AMONG WHICH ARE—*

DONNEGAN'S New Greek and English Lexicon. 1 vol. 8vo.

Vanderhooght's Hebrew Bible. 1 vol. 8vo. Bound.

Robinson's Greek and English Lexicon of the New Testament. 1 vol. 8vo.

Jahn's Biblical Archæology, new edition. 1 vol. 8vo.

Jahn's Introduction to the Old Testament. 1 vol. 8vo.

Schleusner's Lexicon of the New Testament. By Dr. Carey. 1 vol. 8vo.

Aikin's British Poets. 1 vol. 8vo.

Ewing's Greek and English Lexicon. 1 vol. 8vo.

Miller's Letters on Clerical Manners and Habits. 1 vol. 12mo.

Hawes' Lectures to Young Men. 1 vol. 12mo.

Irving's Life and Voyages of Columbus. 3 vols. 8vo.

Doddridge's Family Expositor; or a Paraphrase and Version of the New Testament; with critical notes and a practical improvement of each section.

Horne's Introduction to the Critical Study of the Scriptures. 4 vols. 8vo.

Fischer's Elements of Natural Philosophy. 1 vol. 8vo.

Cambridge Mathematics. 2 vols. 8vo.

Day's Mathematics. 8vo

Stewart's Philosophy of the Human Mind. 3 vols. 8vo.

Kirby and Spence's Entomology. 4 vols. 8vo.

Buffon's Natural History. 2 vols. 8vo.

Murray's Materia Medica, a new edition, just published, from the last Edinburgh edition. 1 vol. 8vo.

Pascal's Provincial Letters, containing an Exposure of the Reasoning and Morals of the Jesuits; to which is added, a View of the History of the Jesuits, and the late Bull for the Revival of the Order in Europe. 1 vol. 12mo.

"The Bishop of Lucon, son of the celebrated Bussy, told me, that, asking one day the Bishop of Meaux what work he would covet most to be the author of, supposing his own performances set aside, Bossuet replied, *The Provincial Letters.*—Examples of all the species of eloquence abound in them."—*Voltaire.*

Bishop Burnet's Lives of Sir Matthew Hale and John Earl of Rochester. In 1 vol. 18mo. with portraits.

Pollock's Course of Time—third edition, with an Index. 1 vol. 12mo.

Dewar's Elements of Moral Philosophy and of Christian Ethics. 2 vols. 8vo.

Remains of the Rev. Carlos Wilcox, with a Memoir of his Life. 1 vol. 8vo.

Notions of the Americans, picked up by a Travelling Bachelor. 2 vols. 12mo.

Philosophy in Sport. 3 vols. 12mo.

Jamieson's Universal Science, or the Cabinet of Nature and Art. 2 vols. 12mo.

Sermons, by the late Rev. Edward Payson, D. D., Pastor of the Second Church in Portland. 1 vol. 8vo.

Upham's Elements of Intellectual Philosophy, designed as a Text-Book. 1 vol. 8vo. Second edition, much improved.

Rush's Medical Inquiries and Observations upon the Diseases of the Mind. 1 vol. 8vo.

Sale's Koran, commonly called the Alcoran of Mohammed, translated into English immediately from the original Arabic; with Explanatory Notes, taken from the most approved commentators. 2 vols. 8vo.

The Philosophy of the Human Voice; embracing its Physical History; together with a System of Principles by which Criticism in the Art of Elocution may be rendered intelligible, and instruction definite and comprehensive: to which is added a brief Analysis of Song and Recitative, by James Rush, M. D. 1 vol. 8vo.

Smith's Cabinet-Makers' and Upholsterers' Guide, Drawing Book and Repository of new and original designs, for Household Furniture and Interior Decoration, in the most approved and modern taste; including specimens of the Egyptian, Grecian, Gothic, Arabesque, French, English, and other schools of the art; in 12 numbers, 4to.

Wilson's American Ornithology; or, the Natural History of the Birds of the United States. Illustrated with Plates engraved and colored from original drawings taken from nature. 9 vols. royal 4to.

Travels of Anacharsis the Younger in Greece, during the middle of the fourth century before the Christian Æra. Translated from the French. In six volumes; and a seventh, in quarto, containing Maps, Plans, Views, and Coins, illustrative of the Geography of Ancient Greece.

Brown's Lectures on the Philosophy of the Human Mind. 2 vols. 8vo.

Milton's Treatise on Christian Doctrine, compiled from the Holy Scriptures alone. 2 vols. 8vo.

Southey's Book of the Church. 2 vols. 8vo.

Robinson's Catalogue of Minerals. 1 vol. 8vo.

Flint's Travels and Residence in Mississippi. 1 vol. 8vo.

Thatcher's Military Journal during the American Revolutionary War, from 1775 to 1783. 2d edition. 1 vol. 8vo.

The Works of the British Poets, with Lives of the Authors. 50 vols. 18mo.

Stuart's Commentary on the Hebrews. 2 vols. 8vo.

Storr and Flatt's Elementary Course of Biblical Theology. 2 vols. 8vo.

Cruden's Concordance to the Holy Scriptures of the Old and New Testament. 1 vol. royal 8vo.

Sermons, by Timothy Dwight, D. D., LL. D., late President of Yale College. 2 vols. 8vo.

Prince's Chronological History of New-England. 1 vol. 8vo.

The Works of the Right Honorable Edmund Burke. 14 vols. 8vo.

Biography of the Signers to the Declaration of Independence; by John Sanderson. 9 vols. 8vo.

Schlegel's Lectures on the History of Literature, ancient and modern. 2 vols. 8vo.

Denmark Delineated; or, Sketches of the Present State of that Country, illustrated with portraits, views, and other engravings, from drawings by eminent Danish Artists. 8vo.

Pitkin's Political and Civil History of the United States of America, from the year 1763 to the close of the Administration of President Washington, in March, 1797: Including a Summary View of the Political and Civil State of the North American Colonies, prior to that period. 2 vols. 8vo.

Lingard's History of England from the first invasion by the Romans. 10 vols. 8vo.

Roscoe's Life and Pontificate of Leo the Tenth. 4 vols. 8vo.

Memoirs of Cardinal De Retz; containing the particulars of his own life, with the most secret transactions of the French Court and the Civil Wars. 3 vols. 8vo.

Bigelow's American Botany; being a Collection of the Native Medicinal Plants of the United States, containing their botanical history and chemical analysis, and properties and uses in medicine, diet, and the arts, with colored engravings. 3 vols. 8vo.

Say's Treatise on Political Economy; or the Production, Distribution and Consumption of Wealth. 1 vol. 8vo.

Aristotle's Ethics and Politics, comprising his Practical Philosophy, translated from the Greek, &c. By John Gillies. 2 vols. 8vo.

Gibbon's History of the Decline and Fall of the Roman Empire. 4 vols. 8vo.

Clarendon's History of the Rebellion and Civil Wars in England; to which is added, an Historical View of the Affairs of Ireland. With the Suppressed Passages. 6 vols. 8vo.

Goldsmith's History of the Earth, and Animated Nature. Illustrated with Engravings. 5 vols. 8vo.

Hallam's View of the State of Europe during the Middle Ages. 4 vols. 8vo.

Holmes's American Annals; or a Chronological History of America from its discovery in 1492 to 1806. 2 vols. 8vo.

Holt's Public and Domestic Life of George the Third; comprising the most eventful and important period in the Annals of British History. 2 vols. 8vo.

Elmes' General and Bibliographical Dictionary of the Fine Arts. 1 vol. 8vo.

Jenning's Jewish Antiquities; or, a Course of Lectures on the first three Books of Godwin's Moses and Aaron. 1 vol. 8vo.

Dwight's Theology. 4 vols. 8vo.

Mitford's History of Greece. 8 vols. 8vo.

The Works of Samuel Johnson, LL. D. 6 vols. 8vo.

Botta's History of the War of the Independence of the United States of America. 2 vols. 8vo.

Hume, Smollett and Bissett's History of England. 9 vols. 8vo.

Hume, Smollett and Miller's History of England. 3 vols. 8vo.

Malte-Brun's Universal Geography. 4 vols. 8vo.

Mignet's History of the French Revolution from 1789 to 1814. 1 vol. 8vo.

Russell's History of Modern Europe; with an Account of the Decline and Fall of the Roman Empire. 6 vols. 8vo.

Brown's Inquiry into the Relation of Cause and Effect. 1 vol. 8vo.

Trumbull's History of Connecticut, Civil and Ecclesiastical, from the emigration of its first planters, from England, in the year 1630, to the year 1764; and to the close of the Indian Wars. 2 vols. 8vo.

Rafinesque's Medical Flora; or Manual of the Medical Botany of the United States of North America. With 52 Plates. 1 vol. 12mo.

The Divina Commedia of Dante Alighieri; consisting of the Inferno—Purgatorio—and Paradiso. Translated into English verse; with Preliminary Essays, Notes, and Illustrations; by the Rev. Henry Boyd, A. M. 3 vols. 8vo.

Jamieson's Popular Ballads and Songs, from tradition, manuscripts, and scarce editions; with translations of similar pieces from the ancient Danish language, and a few originals by the editor. 2 vols. 8vo.

Newton's Works, complete, in 4 vols. 8vo.

Shakspeare, a variety of editions.

Rollin's Ancient History. 8 vols. 12mo.

Whiston's Works of Flavius Josephus. 6 vols. 12mo.

Mosheim's Ecclesiastical History, ancient and modern, from the birth of Christ to the beginning of the present century. 4 vols. 8vo.

The History of Rome, by Titus Livius; translated from the original. With Notes and Illustrations, by George Baker, A. M. 6 vols. 8vo.

Shuckford's Sacred and Profane History of the World connected, from the Creation of the World to the Destruction of the Assyrian Empire at the death of Sardanapalus, &c. 4 vols. 8vo.

Prideaux's Old and New Testaments connected in the History of the Jews and Neighboring Nations, from the declensions of the kingdoms of Israel and Judah to the time of Christ. 3 vols. 8vo.

Globes, 3 inch, 9 inch, and 13 inch. Maps of the United States, Europe, Asia, Turkey in Europe, and of the World. Pocket Maps of the several States. Arrowsmith, Morse, Finley, Malte-Brun, Dr Butler, and Lavoisne's Atlasses.

NEW-HAVEN, OCTOBER, 1828.

# HEZEKIAH HOWE,

## *HAS FOR SALE, A VARIETY OF*

# BOOKS,

### IN THE DIFFERENT DEPARTMENTS OF SCIENCE, AMONG WHICH ARE THE FOLLOWING, VIZ.

Barton's Flora of North America, illustrated by colored figures drawn from Nature on 70 plates, 3 vols. 4to. half bound. $13,50.

Barton's Vegetable Materia Medica of the United States, or Medical Botany, illustrated by colored engravings, made after drawings from Nature, on 50 copper plates, 2 vols. 4to half bound. $12.

Bélidor. La Science des Ingénieurs dans la conduite des travaux de fortification et d'architecture civile, 4to. $5,50.

Bigelow's Florula Bostoniensis, or Plants of Boston and its vicinity, 8vo. boards. $2,50

Biot. Recherches Expérimentales et Mathématiques, sur les mouvemens des molécules de la lumière autour de leur centre de gravité, 4to. $3.

Brande's Descriptive Catalogue of the Geological Specimens deposited in the Geological collections of the Royal Institution, 8vo. $1,87 1-2.

Brande's Tables in illustration of the theory of definite proportionals; shewing the prime equivalent numbers of the elementary substances, and the volumes and weights in which they combine, 8vo. boards. $2,62 1-2.

Buckland's Reliquiæ Diluvianæ; or Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel and on other Geological Phenomena, attesting the action of an Universal Deluge, 4to. boards. $10.

Burrows' Elements of Conchology, illustrated with 28 plates, 8vo. boards. $5.

Cheyne. Fluxionum methodus inversa sive quantitatum fluentium leges generaliores, 4to. boards. $1.

Clairaut. Théorie de la figure de la Terre, tirée des principes de l'Hydrostatique, 8vo. $1,50.

Classes and Orders of the Linnæan System of Botany, illustrated by select specimens of foreign and indigenous Plants on 250 copper plates, 3 vols. 8vo. boards. $13,50.

Conchologist's Companion, comprising the instincts and constructions of Testaceous Animals, &c., 12mo. boards. $1,62 1-2.

Crabb's Universal Technological Dictionary, or familiar explanation of the terms used in all arts and sciences, 2 vols. 4to. $27.

Daniell's Meteorological Essays and Observations, parts I. and II., 2 vols. 8vo. boards. $7.

Daubeny's Tabular View of Volcanic Phenomena, comprising a list of the burning mountains that have been noticed at any time since the commencement of historical records, or which appear to have existed at antecedent periods, together with the dates of their respective eruptions, and of the principal earthquakes connected with them. $2,50.

Davies' Elements of Descriptive Geometry, 8vo. boards. $2,50.

Decandolle. Prodromus systematis naturalis Regni Vegetabilis; sive enumeratio contracta ordinum, generum specierumque plantarum, huc usque cognitarum, juxta methodi naturalis normas digesta, 3 vols. 8vo. $14.

Delambre. Methodes Analytiques pour la detérmination d'un Arc du Méridien, 4to. $2.

De Luc. Recherches sur les modifications de l'atmosphere, 4 vols. 8vo. $5.

Elements of the Philosophy of Plants, by Decandolle and Sprengel, 8vo. boards. $5.

Elliott's Botany of South Carolina and Georgia, 2 vols. 8vo. $7,50.

Faraday's Chemical Manipulations, being instructions to students in Chemistry, on the methods of performing experiments of demonstrations or of research, with accuracy and success, 8vo. boards. $5,50.

Godman's American Natural History, illustrated with plates, 3 vols. 8vo. boards. $10,50.

Greenough's Critical Examination of the first principles of Geology, 8vo. boards. $2,87 1-2.

Gregory's Economy of Nature, explained and illustrated on the principles of modern Philosophy, 3 vols. 8vo. boards. $4.

Henry's Elements of Experimental Chemistry, tenth edition, comprehending all the recent discoveries, illustrated with ten copperplates, and several engravings on wood, 2 vols. 8vo. boards. $10,50.

Humboldt's Geognostical Essay on the superposition of Rocks in both hemispheres, 8vo. boards. $4,25.

Jaume St. Hilaire. Exposition des Familles Naturelles et de la germination des plantes, 2 vols. royal 8vo.

Kirby and Spence's Introduction to Entomology, or Elements of the Natural History of Insects, with plates, 4 vols. 8vo. boards. $20.

Kunth. Synopsis plantarum, quas in itinere ad plagam æquinoctialem orbis novi, collegerunt Al. de Humboldt et Am. Bonpland, 4 vols. 8vo.

La Lande. Astronomie, 4 vols. 4to. $20.

La Place. Mécanique Céleste, 4 vols. 4to. $15.

Letters on Entomology, intended for the amusement and instruction of young persons, and to facilitate their acquiring a knowledge of the Natural History of Insects, 12mo. boards. $1,50.

Macculloch's Geological Classification of Rocks, with descriptive synopses of their species and varieties, comprising the elements of practical Geology, 8vo. boards. $6,25.

Memoires de l'Institut Nationale des Sciences et Arts—Sciences Mathematiques et Physiques, tome 1 à 6. 6 vols. 4to. boards. $18.

Mohs' Treatise on Mineralogy, or the Natural History of the mineral kingdom; translated from the German, with considerable additions, by W. Haidinger, 3 vols. 8vo. $8,50.

Monge. Application de l'analyse a la Géométrie a l'usage de l'école impériale polytechnique, 4to. $2,50.

Muhlenburg. Descriptio Graminum et Plantarum Calamariarum Americæ Septentrionalis, Indigenarum et Cicurum, 8vo. 75 cts.

Newtoni, Lectiones Opticæ, 4to. $2,50.

Newtoni, Philosophiæ Naturalis principia Mathematica, perpetuis commentariis illustrata, communi studio P. P. Thomæ Le Seur et Francisci Jacquier, 4 vols. royal 8vo. boards. $13,50.

Newton's Mathematical principles of Natural Philosophy, translated by Motte, with Newton's System of the World, Emerson's Commentary and defence of the Principia, Machin on the Laws of the Moon's motion, &c. 3 vols. 8vo. $10,75.

Nuttall's Introduction to systematic and physiological Botany, 12mo. boards. $2.

Parkes' Chemical Essays, principally relating to the Arts and Manufactures of the British Dominions, 2 vols. 8vo. boards. $10,50.

Parkinson's Introduction to the Study of Fossil Organic Remains, 8vo. bds. $3,75.

Philosophical Transactions of the Royal Society of London from 1665 to 1800, abridged, with notes and biographical illustrations, by Charles Hutton, George Shaw, and Richard Pearson, 18 vols. To which are added 9 volumes of the Transactions at large, of the Royal Society from 1801 to 1809, inclusive, the whole comprised in 27 vols. 4to. calf—nearly new—$108.

Pursh's Flora, or a systematic arrangement and description of the Plants of North America, with 24 colored engravings, 2 vols. 8vo. bds. $14,50.

Robinson's Catalogue of American Minerals, with their localities, including all that are known to exist in the United States and British Provinces, &c. &c. 8vo. bds. $1,50.

Scrope's Considerations on Volcanos, the probable causes of their phenomena, the laws which determine their march, the disposition of their products, &c. &c. 8vo. bds. $3,62 1-2.

Smith's Grammar of Botany, illustrative of artificial as well as natural classification, &c. &c. 8vo. bds. $2.

Thompson's Attempt to establish the First Principles of Chemistry by experiment, 2 vols. 8vo. bds. $9.

Torrey's Flora of the Northern and Middle Sections of the United States; or a Systematic Arrangement and Description of the Plants hitherto discovered in the United States, north of Virginia, vol. 1, in three parts, sewed, $4.

Torrey's Compendium of the Flora of the Northern and Middle States, 12mo. $1 12 1-2.

Williams' Natural History of the Mineral Kingdom, relative to the Strata of Coal, Mineral Veins, and the prevailing Strata of the Globe, 2 vols. 8vo. bds. $5.

Withering's Arrangement of British Plants, according to the latest improvements of the Linnæan System, with an easy introduction to Botany; illustrated by copper-plates, 4 vols. 8vo. bds. $11.

NEW-HAVEN, OCTOBER, 1828.

# *BAKEWELL'S GEOLOGY.*

## HEZEKIAH HOWE,

HAS in press, BAKEWELL'S INTRODUCTION TO GEOLOGY, from the third London edition, which came from the hands of the Author in March last, "entirely recomposed and greatly enlarged, with new plates, a colored map and cuts," in one volume 8vo.

This edition will be published under the superintendence of Professor SILLIMAN, who will annex, for the use of students, a full outline of his own course of lectures on Geology.

# CONTENTS.

## INTELLIGENCE AND MISCELLANIES.

### I. FOREIGN.

## II. Domestic.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

◆

## Art. I.—*On the Muriate of Soda, or Common Salt, with an account of the Salt Springs in the United States; by* George W. Carpenter, of Philadelphia.

There is perhaps no individual article more important or indispensable for the support of the animal creation than common salt; and, the Creator, in his arrangements for the comfort, happiness, and sustenance of man, has placed, in the most systematic and best adapted order—in situations easily accessible, and in astonishing profusion, the substances most essential to the support and comfort of human life; hence we find salt, iron, coal, limestone, &c. to be almost universally distributed over the surface of the globe in large quantities, and in the most accessible situations; whilst the less useful bodies, as gold, silver, diamonds, &c. exist in minute quantities, and often in places not to be explored without great labor and expense. Salt, as before observed, exists in immense masses or beds, either at the surface of the earth, or at a great depth below the soil. It has been found in regions much elevated above the sea, and in some instances it constitutes whole mountains of very considerable altitude. The ocean however is the greatest depository of salt; nearly one-thirtieth part of the whole weight of the waters of the ocean is muriate of soda. Other salts, viz. the muriates both of lime and magnesia, and the sulphate of soda, exist in the waters of the ocean. According to La Place, the average depth of the ocean is ten miles; were the water evaporated, the salt would form a bed of seven hundred feet in thickness, a mass sufficient to cover all the present dry land with salt to the depth of two thousand feet; and as the ocean has once covered our present continents, we need not be surprised at the quantity of rock salt found in various parts of the globe.[*] The proportion of salt contained in the water is, with few exceptions, nearly the same in all latitudes. The Baltic is much less salt than the ocean, and contains, when an easterly wind prevails, only $\frac{1}{108}$ part of saline matter. The Dead Sea of Palestine is an exception of the opposite kind. According to Gay Lussac, one hundred parts of this water contain muriate of magnesia 15·3, muriate of soda 6·9, muriate of lime 4·0.[†] It is stated in the first volume of Romé de l'Isle's Crystallography, page 375, that the salt water in the Baltic sea contains $\frac{1}{64}$ part of its weight of salt; that of the sea between England and Flanders contains $\frac{1}{32}$ part; and that of the coast of Spain one ounce in the pound; and that between the tropics one ounce and a half or even two ounces, viz. one-eighth of the whole. From this may be seen the great advantage of separating the brine of the sea water in cold climates by freezing before it is set over the fire for evaporation.

Rock salt is found very high above the level of the sea, as in the Cordilleras of America, and also in Savoy, where it exists at an elevation equal to that of perpetual snow.

Salt fountains are very common in various parts of Europe and elsewhere, so that hardly any kingdom is absolutely without salt either in mines or springs. Salt springs are found in Lorraine, Alsatia, Franche-Compté and Gascony, provinces of France, in the Palatinate of the Rhine, Spire, Hesse, and Luneburg, in Germany; Halle in Saxony, in Ostrogothland, Westmanland, &c. &c.[‡] From the salt springs at Droitwitch, in Worcestershire, sixteen thousand tons of salt are annually procured, and one hundred and fifty-six thousand tons of rock salt are annually raised from the great deposit near Northwitch, in Cheshire. In France there are many salt springs, but no known deposit of solid salt. Sweden and Norway are without salt. It is abundantly diffused through many countries of Asia, Africa, and America.

The most celebrated salt mines in Europe are at Cardona in Spain, and in Poland. The former appears to be an enormous mass of salt that probably once formed the bottom of the lake. Through this mass the water has excavated a valley, leaving several detached mountains of salt, that were

---

[*] Bakewell's Mineralogy, page 637. [†] Cleaveland's Mineralogy, page 128.
[‡] Cronsted's Mineralogy, Vol. 1, p. 361.

probably harder than the other parts. There is an extensive formation of rock salt on each side of the Carpathian mountains for six hundred miles, from Weleiska in Poland to Rimmie in Moldavia. Rock salt and salt springs most generally occur near the feet of extensive mountain ranges, which adds probability to the opinion that these ranges were once boundaries of extensive lakes of salt water. In some parts of Africa there are salt lakes which rest on beds of solid rock salt: these beds were probably formed by fresh depositions of salt as the water evaporates. Near Algiers the salt lakes are dried up in summer, and leave immense masses of rock salt at the bottom.

The lake Yelta, beyond the river Volga, supplies all Russia with salt.*

Muriate of soda is most generally associated with beds of clay, which frequently alternate with those of the salt; sand, sandstone, and compact, fetid and bituminous limestone usually accompany the deposits of salt. But the most intimate connexion exists between this salt and the sulphate of lime or gypsum, over which the beds are usually placed, or sometimes they even alternate with it. The constant occurrence of the muriatic and sulphuric acids in the same situations is an interesting fact, which, in a more advanced state of chemical and geological science may serve to elucidate the formation of gypsum and rock salt.

In the *United States*, salt springs are very numerous. They sometimes flow naturally, but are generally formed by sinking wells in those places where salt is known to exist, as in certain marshes, salt licks, &c.

The country on the Arkansas river furnishes some salt; it differs, however, from most other places in the United States, by existing in pools, and forming incrustations on the soil of plains and prairies. There is no salt obtained in Arkansas by boring, the usual mode of procuring it in other localities.

There are many salt springs in Missouri; the working of many of them, however, has been suspended or entirely relinquished, in consequence of the reduced price of the salt. The principal one now in operation is at Boon's Lick.

There are no salt works in operation on the Wabash. There is one manufactory in operation at Tohota, on a trib-

---

* Philosophical Transactions, Vol. 77, and Foster's Introduction to Mineralogy, page 32.

utary of the Wabash. Salt springs are worked at Sciota; the quantity yielded, however, is comparatively small. There are no salt works on the Tennessee river, but on the Holston, a tributary to the Tennessee river, are extensive salt springs, situated near Abingdon, Virginia, known by the name of King's and Preston's salt works. These springs yield a considerable quantity of salt, which sells at the works, at one dollar per bushel. King's wells have produced on a lease of five years, an annual rent of $60,000, or $300,000 for the term of five years. Preston's works have been rendered much less valuable by being diluted with fresh water, caused by a spring of fresh water flowing in the midst of the salt.

Kentucky furnishes numerous salt works. On the Big and Little Sandy rivers are salt works in operation; they afford, however, a weak brine, and are on the decline, in consequence of the reduced price of salt, which sells at fifty cents per bushel. Green river furnishes numerous salt works, which are very productive: these works are all flourishing, and under favorable prospects of increasing. They are the most extensive in the state: the price of salt at the works is fifty cents per bushel. On Goose creek, also, a tributary to the Kentucky river, are very extensive works; these, and the springs on Green river, might support works affording inexhaustible quantities of salt; the price at the works is fifty cents per bushel.

In Ohio many salt works exist; they are, however, on the decline, in consequence of the reduced price of salt. The principal ones now in operation are on the Sciota, Muskingum, and Yellow creek; the price of salt at these works is fifty cents per bushel.

In Illinois, on Saline river, near Shawneetown, are extensive salt works, formerly owned by the United States: they are now the property of the state. The price of salt at the works is fifty cents per bushel.

In Virginia, on the Great Kanawha, are very extensive salt works. The quantity furnished is about one million bushels* per annum, and may be increased to almost any

---

* It is stated in the last edition of Professor Cleaveland's Mineralogy, that the whole amount of salt obtained in the United States, is one million bushels per annum. This must be very far short of the present annual product, as the Kanawha works alone furnish this amount.

amount. The brine at the Kanawha works, as appears from careful experiments made by Dr. Putney, is very strong,—sixty-five to seventy gallons yielding one bushel of salt. The price at the works is from twenty to twenty-five cents per bushel, according to the quantity purchased. It is obtained by boring to a depth of from three to five hundred feet. Large quantities of inflammable gas are sometimes disengaged, with considerable noise and violence, preventing operations for several days. The salt works at Kanawha, and those on the Holston near Abingdon, are the only two in Virginia worked to any extent. These works, and those of the Kiskiminicus, one of the waters of the Alleghany river, furnish the principal part of that used in the western states.

Pennsylvania. On the Kiskiminicus, near Pittsburg, are the most extensive works in the state. The price of salt at the works is from twenty to twenty-five cents per bushel. There are several other works in the neighbourhood of Pittsburg; they are, however, all comparatively small. The brine of the Kanawha and Pittsburg works is evaporated by coal: all the other works in the United States employ wood, which operates in diminishing the profits by increasing the expenses every year. This, with many other causes, produces the suspension of operation in many salt works, particularly in places where a competition exists, and some of the competitors enjoy the above named advantages. Hence it is, that although the price of salt at Kanawha and Kiskiminicus is only from twenty to twenty-five cents, the manufacture is conducted with profit, whilst other establishments, where salt brings fifty cents and upwards, are rapidly declining, in consequence of the reduction of price, which formerly was one dollar to one dollar and twenty-five cents per bushel. Their brine being weak, and laboring under other disadvantages, they cannot afford to work the springs for salt at that price, and the manufacture is consequently on the decline.

There are numerous salt springs in the state of New-York, some of which are very productive. The best springs are near the canal which connects the Hudson with Lake Erie. The salt is obtained by the spontaneous evaporation of the brine exposed in vats to the influence of the sun, aided by steam conducted through tubes immersed in the brine.

There are also salt works in Alabama. Being recently discovered, they are at present of moderate extent. They will no doubt be extended and enlarged in a short time.

Considerable quantities of salt are obtained in North Carolina from a neck of the sea, by digging pits near the shore, which are filled by the tide; it is then carried by trenches to a distance, where it is evaporated by the sun; and being situated near extensive fisheries, is employed to great advantage and profit in putting up fish for exportation.*

Nearly all the salt furnished in the United States is obtained by boring, and the brine is evaporated by heat; the mother water, or bittern, as it is termed, is thrown away. It is a strong solution of muriate of lime, and magnesia. As this article is produced in considerable quantities, Epsom salt and magnesia might be advantageously manufactured from it. It is stated that the bittern has proved very deleterious to animals; horses, cows, &c. have been killed by taking small portions of it, which frequently happens, as it forms on evaporation, incrustations which are mistaken for salt.

## ART. II.—*Notice of the Salt Springs and Manufacture of Salt at Salina, Syracuse, &c. N. Y. made at the request of the Editor; by* STEPHEN SMITH, Superintendent at Salina.

IN the town of Salina, and state of New-York, nearly equidistant from Albany on the river Hudson, and Buffalo at the north-eastern extremity of Lake Erie, are situated the works, the most extensive in the United States, for the manufacture of salt from natural brine. The indications of that substance along the margin of Onondaga lake, were similar, as is be-

---

* The following method is adopted for extracting salt from sea water by spontaneous evaporation in hot climates: Several parcels of flat ground, under the mark of the high tides, and properly surrounded by dikes, are disposed near the sea, into many compartments, the last of which are well lined with clay, and properly beaten in an even horizontal surface; so that when the sea water is allowed to run into these, after it has partly evaporated in the former ones, the heat of the sun, in a few hours, evaporates it enough to crystalize the salt, which falls to the bottom, and is drawn out with a flat piece of board at the end of a pole, &c.

But in cold climates, much labor and fuel may be spared by letting the sea water stand to freeze, and after separating the ice, which is formed only of the watery particles, the remaining brine contains a much larger quantity of salt, which may be very soon evaporated by fire. This method is stated by General Baur to have been practised with great success in Russia, and perhaps is also now used in various other parts of the north.—*Cronstedt, Vol. I. p. 360.*

lieved, to those found at the salt licks so common in the interior of this country; and the knowledge of their existence was derived, by the travellers or white settlers who first visited this region, from the aborigines, to whom, we may presume, they must have been known for ages anterior to the discovery of the American continent by Columbus.

One of the earliest settlers in the county of Onondaga has informed the writer that, to procure salt for his family, about forty years since, he, with an Indian guide in a canoe, descended a small river, that discharges into the lake at its south-eastern termination, along the shore of which he passed a short distance to the right, and, ascending a rivulet (now Mud creek) a few rods, arrived at the spring or natural discharge of salt water, which was obtained by lowering to the bottom, then four or five feet beneath the surface of the fresh water of the lake, an iron vessel, which, filling instantly with the heavier fluid, was drawn up, and the brine poured out. In this way, he got enough to make on the spot, by boiling, and without any separation of the earthy impurities that were held with the salt in solution, a small quantity of brownish colored and very impure salt. Since that time other springs have been discovered, at various and almost opposite points on the shores of the lake, and many wells have been sunk to procure brine for the manufactories at the villages of Liverpool, Salina, Syracuse, and Geddesburgh. The wells did not exceed eighteen feet in depth, and in the strength of the water which they respectively afforded there was great difference, which varied veıy much with the seasons, with this remarkable circumstance, that it sometimes diminished fifteen to twenty per cent., and in some instances one-third, as the adjoining lands, on the advance of summer, became drained; and the lake, which in the spring overflowed the wells, had subsided six or eight feet.

Until the close of the summer of 1822, the salt water had been pumped principally by men, who were then superseded by hydraulic machinery, capable of elevating to a height of seventy feet between fifteen and twenty thousand gallons per hour. Its operation produced a more rapid influx of the brine, with an increase of strength from twenty to twenty-five per cent., standing at 13° on the hydrometer of Beaumé, of which the point of saturation was 22°, and has continued at that degree, with very little change, to the present time.

In the course of the last eight years, a manufacturer at Salina, under a law of the state for the encouragement of the undertaking, has made several unsuccessful attempts, by boring in different places, to discover rock salt: and, within eighteen months, the same operation has been performed, with partial success, to obtain brine of increased strength and quantity. At one place, in Syracuse, the boring was two hundred and fifty feet, eighty feet lower than the deepest places in Onondaga lake, and principally through indurated clay, but the adventurers, meeting with very hard rock, supposed to be granite, the work was discontinued without the discovery of any vein of salt or even fresh water. At another place, salt water of inferior strength appeared at the commencement, but at the depth of fifty feet the boring was abandoned, owing to the difficulty of forcing down the tube, of sheet iron, through a bed of rounded smooth stones, which were of every size from common coarse gravel to that of a man's head, and of a variety of colors and texture.

About a mile from the south end of the lake, and on the border of Onondaga creek, (the small river before mentioned,) among stones resembling those just described, a well had been sunk thirty feet, and the work suspended three years; but last summer a tube was driven down, in the centre of the well, fifty feet further, into a stratum, the thickness of which is undetermined, of clean washed gravel: ten feet from the surface of the ground the saltness of the water was first perceptible, increasing with the descent of the well, and afterwards of the tube, till the boring ceased at the depth of eighty feet, where it was found to contain twenty-two ounces of salt and impurities in the gallon. When the water of the well is lowered eight feet by pumping, the quantity discharged from the tube, which has the upper part cut off at that depth, is one hundred gallons per minute, and, when the pumps are stopped, it rises to the surface of the earth and discharges in a small stream.

At Geddesburgh and Green Point, places on opposite shores of the lake, there has been boring to considerable depths, not over eighty feet, and other veins have been opened of salt water which is extensively used at the former place and Liverpool.

Three large metallic pumps, moved by the surplus water of the Erie canal, and one, worked by a small steam engine, raise the brine from the wells to the reservoirs, from which it is conveyed, by means of wooden pipes, to every manufactory.

A great number of plans and experiments, *called improvements*, have been or are still in operation, but the works erected for the making of salt, and now principally used, are denominated Blocks, Solar Works, and Steam Works.

The Blocks, constructed with potash kettles, containing from eighty to one hundred and twenty gallons each, are of the greatest extent,—the kettles are placed in masonry, in two parallel lines, having from eight to twenty in each line, (of course from sixteen to forty in a block,) under which there are separate passages for the heat with fire places or *arches* at one end, and a flue or chimney, common to both, at the other end of the block. The fuel is exclusively wood, of the kinds most common in the forests of this part of the country, such as beach, maple, elm, hemlock, bass wood, &c. of which the prices, for the last six years, have been from seventy-five cents to one dollar and fifty cents per cord, delivered at the works.

In the boiling down of the water to saturation, a portion of the impurities, sulphate and carbonate of lime stained with iron, is deposited in ladles and taken out, and the *vaporization* of the brine is continued until but a small quantity remains; when the salt which has been made, and which is, even at first, beautifully white and of fine grain, is taken out into baskets, drained, and removed; and the kettles are again filled with salt water, and the operation repeated. The inner surface of the kettles soon becomes firmly incrusted with a compound of the earthy substances and salt, which require frequent removal to prevent injury from overheating and cracking the metal.

Next in extent, or more properly in production, are the erections adjoining the Erie canal for evaporation by solar heat: they are vats of wood, resting horizontally upon a great number of small posts driven into the ground, according to the inequalities of the surface over which they are built, touching it in some places, and at a height of ten feet in others; but the most convenient height is between eighteen and thirty-six inches from the ground. Their width is eighteen and a half feet, depth from six to fifteen inches, and length from eighty to six hundred and forty feet; and they have roofs in divisions of sixteen feet each, sustained by rollers which travel on level supporters, and are moved on and off by the strength of one man. The water from the reservoirs is received first into the deepest vats, in which is deposited much of the iron or coloring matter, which appears in the form of a pellicle as soon as the temperature (at the wells it is 50°) is increased by the action of the sun or warm atmosphere. From those it is passed by means of pipes into vats of less depth, not exceeding six inches, and at a lower level, in which it remains till, by the evaporation and consequent concentration of the brine, and the precipitation of sulphate and carbonate of lime, it is sufficiently depurated for the crystalization of the salt which will then begin to appear on the surface. The brine, leaving behind the substances that have been separated, is again drawn off into vats of a level still lower, which are kept clean, and in which the salt is made with greater or less rapidity, according to the altitude of the sun, the clearness of the atmosphere from clouds and moisture, and the strength of the wind. As the brine, by the formation of the salt in the last vats, diminishes, and as it is necessary that it be preserved of a proper depth, which seldom exceeds five inches, and should always cover the salt at the bottom, further supplies are drawn occasionally, and as they are needed, from the second gradation or tier.

The removal of the salt from the vats is without any regularity as to time or quantity, and is dependant upon the convenience of the manufacturer, who sometimes leaves it till there is an accumulation of three or four inches, or takes it out when there is barely enough to cover the bottom. It is shovelled into tubs, holding about one hundred pounds, in which it is drained for a few minutes, and, without further drying, is conveyed in carts to the storehouses.

The measured bushel will weigh from seventy-four to eighty-five pounds—the product of the slowest evaporation being the heaviest. When the weather has been clear and calm, and the salt water free from agitation, the surface has often been heated to 106°, while that in contact with or near the bottom of the vat was 122°, and, by the hydrometer, was ascertained to be specifically lighter than the upper portions.

The mother-water (remaining after the extraction of the salt) is a solution of the muriates of lime and magnesia, possessing a pungent taste, unlike the bitter in that from the ocean, and probably containing very little magnesia.*

---

* According to my experiments, there is, in that which I examined scarcely a trace of magnesia. See also Mr. Chilton's results, Vol. VII. p. 344, of this Journal.—Ed.

It is estimated that the solar establishments at Syracuse, including the land necessary for the roofs and passages, occupy one hundred and ten acres; that the aggregate length of the vats is thirteen miles, and their superficial surface one million two hundred and fifty thousand square feet, of which the annual product is about three thousand five hundred tons.

The steam-works are similar in their construction to the blocks, the kettles of which are covered, to save the steam produced in the boiling of the water to saturation, and, by condensation in its passage through metallic pipes, immersed in the brine which is in deep wooden vats, the heat is applied a second time to the crystallizing of the salt.

Some of the earliest laws for the regulation of the manufacture were passed by the state of New-York in 1797, anterior to which year the business was in its commencement, but has since been gradually extending; and last year, in the town of Salina, the quantity made was about thirty thousand tons, one million two hundred thousand bushels, of which the average price at the works, exclusive of the state duty, was twelve and a half cents per bushel of fifty-six pounds. It is commonly packed, for sale, in barrels that contain five bushels, and is inspected and branded before it can be removed.

"An account of the Salt Springs at Salina, by Lewis C. Beck, M. D." published in the "New-York Medical and Physical Journal, No. 18," contains analyses of the brine, salt, and impurities, with geological and other information.

In regard to the saltness of the water at the bottom of Onondaga lake, (very commonly called *Salt* lake,) it is apprehended that Dr. B. was misinformed, as an experiment with a bottle, let down in the way that he mentions, in the deepest places, about one hundred and fifty feet, brought up cold fresh water only. The following is his analysis of the brine, in which there is an omission of the iron, which evidently exists in the salt water of every spring yet discovered in this vicinity.

| | |
|---|---|
| Carbonate of lime, | 1.79 |
| Sulphate of do. | 4.20 |
| Muriate of do. | 3.48 |
| Muriate of magnesia, | 2.57 |
| Muriate of soda, | 143.50 |
| | 155.54 |

The weight of the dry residuum from a like quantity of water was 156.

Water has been repeatedly taken from the different wells, as it flowed in from the earth, and where it could not possibly have been in contact with the iron of any part of the pumping machinery, and, on scraping into it some nutgall, with a piece of broken glass, there has been observed, in a short time, a change from limpid transparency to a purple color, which soon became green, and finally of a reddish brown; and, after standing two or three weeks, there was a dark brown deposit that covered the bottoms of the tumblers in which the experiments were made.

Bubbles of carbonic acid are continually escaping, and frequently in great quantity, from the brine of the springs.

As one of the plants that frequent salt marshes on the sea shore was observed growing abundantly at Salina, Mr. Smith was requested to examine it for iodine—which substance did not appear on the addition of sulphuric acid and solution of starch to the fluid bittern, or the solid residuum which it afforded by evaporation. The following is Mr. Smith's remark in a P. S. to his communication.—Ed.

I have made, and repeated, the experiment requested by you, when here, with the samphire, of which the quantity employed yielded half a peck of ashes. The product was principally muriate of soda, without any appearance of iodine.

---

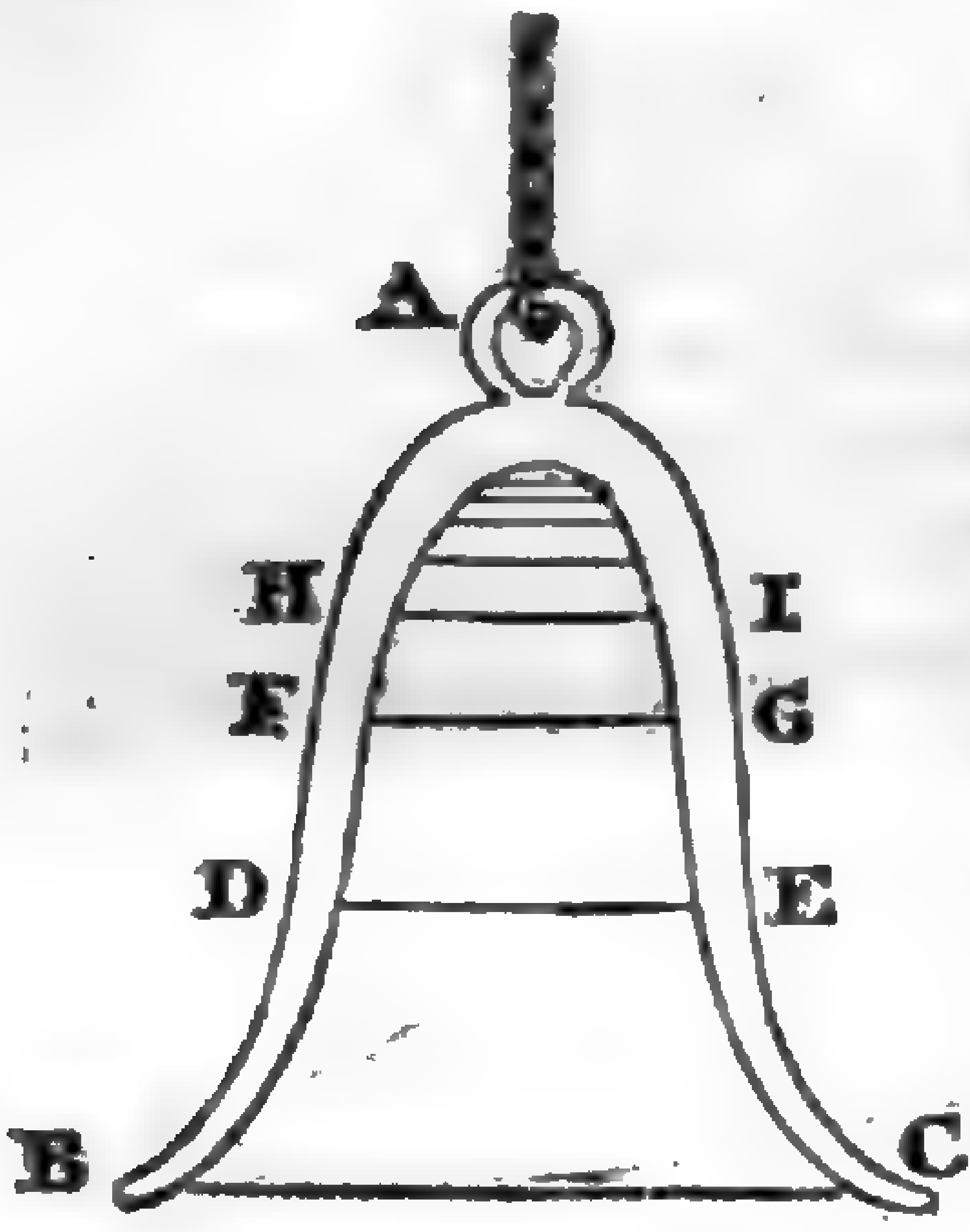
## Art. III.—*Hypothesis on Volcanos and Earthquakes; by* Joseph Du Commun, *of the Military Academy at West-Point.*

The air of the atmosphere at the surface of the earth, will support, in barometer tubes, mercury at 30 inches,
fresh water at 33 feet,
and sea water at about 32 feet.

It is eight hundred and twenty-eight times lighter than fresh water, or - - - - - : : 0,00120 : 1.

And because fresh water is to sea water as 1000 is to 1029, so air is eight hundred and fifty-three times lighter than sea water, or - - - - - - - : : 0,00118 : 1.

But for reasons to be explained in the course of this article, we will assume that the air is only eight hundred times lighter than sea water, or - - - : : 0,00125 : 1.



This being granted: let us suppose that a bell A B C, suspended by a metallic chain, and full of atmospheric air, is plunged into the ocean; the air contained in it will be compressed more and more as it descends, and consequently its density will be increased in proportion to the depth it penetrates. This condensation is here represented, at first by the line BC, at the moment of its immersion, then by the lines DE, FG, HI, &c.

The following table will show the ratio of the condensation compared with the depth of the immersion.

| Goemetrical ratio of the compression represented by the number of Atmospheres. | Weight of the Atmosphere equal to 32 feet of sea water. | Immersion of the Bell in the sea expressed in feet. | Total pressure of the air in the bell expressed in feet of sea water. | Increasing density of the air in the bell compared with unity as the density of sea water. |
|---:|---:|---:|---:|---:|
| 1 | 32 | 0 | 32 | 0,00125 |
| 2 | 32 | 32 | 64 | 0,00250 |
| 4 | 32 | 96 | 128 | 0,00500 |
| 8 | 32 | 224 | 256 | 0,01000 |
| 16 | 32 | 480 | 512 | 0,02000 |
| 32 | 32 | 992 | 1,024 | 0,04000 |
| 64 | 32 | 2,016 | 2,048 | 0,08000 |
| 128 | 32 | 4,064 | 4,096 | 0,16000 |
| 256 | 32 | 8,160 | 8,192 | 0,32000 |
| 512 | 32 | 16,352 | 16,384 | 0,64000 |
| 1024 | 32 | 32,736 | 32,768 | 1,28000 |

From this table it appears that the point at which the density of the atmospheric air would be exactly equal to 1, or equal to the density of sea water, is to be found between 16,352 and 32,736 feet immersion in the sea. And if we wish to determine by calculation the depth at which that precise point is obtained, we shall find twenty-five thousand six hundred feet, or about four miles and seven-eighths, equal to the pressure of eight hundred atmospheres.

Thence it follows, that at the depth of four miles and seven-eighths the air would be compressed in the bell to the same density with the sea water.

But now, when arrived at this point, if we plunge the bell more and more into the sea, the density will still increase, and will soon exceed that of the surrounding water; at that moment what will become of the bubble of air contained in the bell, if even we suppose it to be upset?

Will it come up and break at the surface? It cannot, for by the supposition, it is heavier than its own volume of water; on the contrary, it must descend to the bottom, with an increased velocity; for its density will increase as it sinks, and it must remain at the bottom of the sea, just as a stone itself would do.

I request the reader to stop here, and reflect one moment; the novelty of the assertion, that a bubble of air is precipitated to the bottom of the sea, instead of rising to its surface, merits to be examined with attention before it is admitted; if it can be destroyed, either by argument or experiment, the remainder of this article becomes useless, for all that follows is in the form of corollaries from this first principle; but if, after a close and severe examination, the reader, as well as myself, is convinced of its truth, let us then proceed together.

If a series of bells, similar to the one just described, were constantly in operation through the whole extent of the ocean, there would soon be, under the water of the sea, a layer of compressed air of its whole extent. But has nature provided for such an apparatus? Yes, she has, with the simplicity, ease, grandeur, and efficacy that she shows in all her operations; let us merely study her laws, and we shall soon discover it.

Let us take a glass of water from a running spring; let us expose it for some time to the light and heat of the sun; we shall soon observe bubbles rising from every part of the water, collecting at the surface, and breaking the one after the other. Let us put some of the same water into a convenient vessel by the fire, and we shall again observe a rising of bubbles before the moment of ebullition; and, still better, let us put some of it into a glass under the receiver of an air-pump, and produce a vacuum, when the bubbles will rise with great celerity; let us collect the air thus disengaged, and we shall find its quantity a little above four per cent. in bulk of the water under experiment.

The water of the sea, always under full atmospheric pressure, is constantly agitated by the wind, and, being divided, at its surface into waves and breakers, it so multiplies its points of contact with the atmospheric air, that it, of course, absorbs all that its affinity for it, under these circumstances, allows. Moreover, all rain water being divided into drops, the most favorable condition for its combination, brings down water perfectly saturated with air, and the whole quantity of rain that falls on the globe goes ultimately to the sea, whether it falls directly into it, or whether it is carried to it by rivers flowing down and renewing constantly their surfaces, all which circumstances unite to supply the sea with a new and perpetual addition of combined atmospheric air; it may then be admitted that the sea water is completely saturated with this fluid.

We have seen, in one of the preceding paragraphs, that the affinity of the air for water is very weak. Is it a chemical combination, or merely an affinity of cohesion? It matters not which opinion we form in that respect, for true it is, that the least change in the temperature, or in the relative densities, destroys their union. We have just seen that in spring water, by the mere subtraction of the atmospheric pressure, the air resumes its gaseous form, and then, from its relative levity, separates from the water, and ascends and breaks into bubbles at its surface. Now, below the depth of twenty-five thousand six hundred feet, the air is denser than the water; and if a density different from that of the water in *minus* has been sufficient to operate their disunion, a similar difference in *plus* must produce the same effect. A bubble of air, under the pressure of eight hundred atmospheres, small as we may conceive it, is still a bubble of air, and its density being superior to that of the medium in which it is placed, it must plunge to the bottom, performing exactly what we have ascertained to be the case with the bell. I conceive that these bubbles collect together in sinking, just as they do in rising, making a constant shower at the bottom of the sea, to supply the constant consumption of it, as we shall soon have occasion to state.

Until this moment we have called the air absorbed by water atmospheric air; which, according to the multiplied experiments made on it, appears to be a compound of 24 oxygen, 75 azote, and 1 carbonic acid gas; total 100. Whereas, the air absorbed by water, although a compound of the three same gases, contains them in different proportions. The analysis of the air contained in spring water has been made at different times, in different places, and by different persons, and, consequently, the results are all different and uncertain. The analysis of the air contained in rain water, river water, and particularly sea water, should be the object of our immediate researches, as going more directly to our purpose; but I could not find any publication on this subject. To arrive at any positive result would require no small trouble, and meet with many difficulties, as the analysis should be performed at sea, in different latitudes, and upon water taken at various depths. It is probable, however, from what information we can collect, that the relative proportion of the three gases is altered; that the absorbed air contains more carbonic acid, less azote, and the same relative quantity of oxygen, which alteration must increase its density. These considerations have induced us, in the foregoing table, to represent the density of the air and water by the numbers 800 and 1, instead of 853 and 1. This is the explanation we have promised to give.

The depth of the sea water is not a variable, it is an absolute quantity; a measure which will be determined to a foot by calculation as soon as we have exactly the relation of the three gases it contains. By our computation, which is, however, not far from the truth, we found it twenty-five thousand six hundred feet, or four miles and seven-eighths; but whatever be the depth, at the point of contact, the air must be exactly of the same density with the water. It cannot be more or less; for, if it were less, it would rise to the surface; if it were more, a new quantity of it would shower again through the water.

Air compressed under such an immense weight must have a tremendous force of elasticity. It is superior to any thing we have as yet produced in our most powerful engines, not excepting Perkins' high pressure steam artillery; so that, if we conceive a tube of sufficient length and resistance to open a communication through the sea between that immense reservoir of compressed air and our atmosphere, the projectiles placed in this tube would acquire a velocity several times greater than that of a cannon ball; this air then must penetrate, under ground at four miles and seven-eighths below the surface of the earth, through the crevices of the rocks, and in all the subterranean vacuities which communicate with each other, or with the general reservoir of air. And if it meets there, or rather, when it meets there combustible substances, as bitumen, sulphur, coal, &c. a conflagration must ensue, which is constantly supplied with a new quantity of blowing air, forced by the pressure of the sea, as if by a permanent forge bellows. The air, after having supported combustion, rarefied by the heat, opens its way, and issues by apertures at the summit of volcanic mountains, which we have called craters, as it does in common chimnies at the top of the flues. Such is our conception of these subterranean fires called volcanoes, considered in their quiet and peaceful operation.

It would be difficult to conceive how combustion should be constantly supported under ground without a constant supply of air; and we do not perceive how that air would be brought into those subterranean cavities, except by the means just suggested; we see no hole or opening which might be considered as a draught for the passage of air; on the contrary, all the apertures observed emit gases that may be considered as the result of the conflagration of combustible bodies, and decomposition of water by fire. We see smoke ascending from the top of volcanic mountains, and all these phenomena seem to speak in favour of our hypothesis.

We do not think it necessary to enlarge on the various products of these subterranean fires; a great deal has been said and published on this subject; the formation of carbonic acid; its emission in its natural gaseous state; its combination with lime, magnesia, metallic oxides, &c.; its abundance in mineral waters; the flowing of hot water springs, either simple or sulphurous; the rushing out of hydrogen gas, sulphuretted or carburetted: these results are the natural effects of these permanent fires, considered in their quiet state.

Now, it is time to present our readers with the complement of the theory by the spectacle of an eruption. A large volcano may be considered as a whole coalery on fire, several miles and perhaps several hundred miles in extent, five miles under ground, that is to say, under the inferior level of the sea water; coals, bitumen, sulphur, &c. are constantly burning; minerals, sand, and stones are melting, vitrifying, and running at the bottom of the cavern in the shape of lava, of which it forms a permanent lake in fusion, just as melted iron is collected at the bottom of a casting furnace. These things being in this situation, if a sudden vacuum is produced, what will happen? But I may be stopped here, and be asked, how can a sudden vacuum be produced? I see many causes why it may, but the most simple and natural, and consequently the least objectionable one, is, that after a certain time, a number of years that cannot be foreseen, for it is not periodical, a layer of the coal being burnt, reduced to ashes, the mineral to lava, the ground above, no longer supported, crumbles down, with a rumbling noise; a new surface of cold ground is put in contact with the overheated air and vapours, and a sudden condensation is produced; a partial vacuum follows: it is so sudden, that it communicates a tremor to the surrounding ground, which is felt as the first shock of an earthquake. This vacuum produces in its turn a violent aspiration, that brings down the water of the sea itself, and of all the streams that may communicate with that furnace. Then, a reverse effect is produced; water coming in contact with the melted lava and the burning coals, is acted upon in two different ways; a part is vaporised, and another part decomposed; steam and hydrogen gas are produced in immense abundance; these fluids must open their passage; water is repulsed back into the sea, which rises above its natural level, under the appearance of a huge tide or wave; another part may be thrown off through the gaping ground, and even may issue mixed with the flames of the mountains. In the meanwhile, new shocks are felt, until the weakest point has yielded to the combined powers of the steam and gases, actuated by the heat and a pressure of eight hundred atmospheres. Generally, the former crater, filled in part with loose stones, lava, and ashes of the preceding eruption, is the weakest point; all is thrown up; a column of fire, produced by the burning hydrogen, is raised to the clouds; ashes, the result perhaps of twenty years' combustion, in sufficient quantity to bury villages and cities, and stones of all sizes, loosened, are projected to an immense distance; and, finally, the lava, swept away by the steam, gases, and blowing air, is raised up to the summit of the crater, or runs on one side of the mountain, after having broken open a passage by its enormous mass and weight. When the steam and gases are exhausted, when the lava has flowed out for some time, the eruption decreases, and finally is stopped, because the column of lava in the crater, being of a density superior to the water of the sea, chokes the passage, and the volcano must then resume its quiet operation.

But, why should I endeavour to describe what *must* happen? Let us rather ascertain what *has* happened, and see whether the facts recorded agree with the theory here presented.

One of the first historians who gives an account of Vesuvius, is, I believe, Pliny the younger. We read in his Epist. xx. lib. vi. these remarkable words:

> "Preterea mare in se resorberi et tremore terræ quasi repelli videbamus. Certè processerat littus, multa animalia maris siccis arenis detinebat. Ab altero latere nubes atra et horrenda ignei spiritûs tortis vibratisque discursibus rupta, in longas flammarum figuras dehiscebat; fulgoribus illæ et similes et majores erant."

The retreat of the sea, and its sudden return by the effect of the elasticity of the fluids, seems to be one of the best ascertained facts.

### *Eruption of Vesuvius,* 1730, *by Nicholas Cyrillus, Phil. Trans. vol.* 37.

> "March 8th. Vesuvius sends forth a great smoke and stream of fire, with hollow rumbling. 9th. The following night Vesuvius thundered as it were twice. 10th, 11th, 12th. The clouds hide the smoke and fire. 13th. Smoke lessened. 14th. In the evening, after eight o'clock, the fire arose to a vast height...... Pumice stones, red hot, of two or more ounces weight, were driven several miles like a shower of hail."

The blazing flame, hollow rumbling, throwing up of smoke, ashes, and stone, are but the natural results already anticipated.

### *Collection of various papers concerning Earthquakes felt in England in* 1750. *Phil. Trans. vol.* 46.

"The mighty concussion was felt precisely at the same instant of time, being about half an hour after twelve at noon. Let us reflect on the vast extent of this trembling, one hundred miles in length, and forty in breadth, which amount to four thousand square miles in surface. That this should be put into such an agitation in one moment, is such a prodigy, as we would never believe, did we not know it to be a fact, from our own senses."

The astonishment of the writer of this paragraph would have ceased, if he had conceived, as ourselves, that the vacuum produced in a receiver is almost instantaneous in all its parts, whatever be its extent, or is filled as instantaneously, because steam and gases rush into a vacuum at the rate of thirteen hundred and five feet in a second of time, under the pressure of one atmosphere: what then must it be under eight hundred? The following extracts will come again in support of this assertion.

*Account of an Earthquake at Lisbon, Nov. 1st, 1755. Dr. Wolfal. Phil. Tr. vol. 49.*

"Soon after the shock, (forty minutes past nine,) which was near high water, the tide rose forty feet higher, in an instant, than was ever known, and as suddenly subsided."

*The same at Oporto, in Portugal, Nov. 1st, 1755. Phil. Tr. vol. 49.*

"It began about half an hour past nine....and soon saw the river in some places open, and throw out a vast deal of wind, which was very terrifying......"

*The same at Cadiz, Nov. 1st, 1755. Benjamin Bewick. Phil. Tr. vol. 49.*

"Just before ten, the whole town was shaken with a violent earthquake......they saw rolling towards the city a tide of the sea, which passed over the parapet of sixty feet above the ordinary level of the water......the waves came in this manner four or five times, but with less force each time."

*The same in Barbary, Nov. 1st, 1755. General Fowke, Governor of Gibraltar. Phil. Tr. vol. 49.*

*At Tetuan*, "the earthquake began at ten in the morning...."

*At Tangier*, "it began about the same time......the sea came up to the very walls, a thing never seen before, and went down with the same rapidity. These commotions of the sea were repeated eighteen times, though not with the same violence as at the first time......The fountains were dried up, so that there was no water to be had till night."

*At Arzila*, "it happened about the same time."

*The same in the Island of Madeira, Nov. 1st, 1755. Dr. Thomas Heberden. Phil. Tr. vol. 49.*

"At half an hour past nine o'clock in the morning was felt a shock of an earthquake......In the northern part of the island, the inundation has been more violent; the sea there retiring at first above one hundred paces, and suddenly returning overflowed the shore......"

*The same at Neufchatel, in Switzerland, Nov. 1st, 1755. Mr. Pantrovers.*

"The dreadful earthquake has been perceived even in this country; it swelled our lake to the height of near two feet above its natural level......"

*The same at Lyons, in France, Nov. 1st, 1755. Mr. Trembley. Phil. Tr. vol. 49.*

"It is said that the waters retired for some moments at the end of the lake of Geneva, and that a motion was observed in those of the lake of Zurich......"

*Agitation of the Waters. Nov. 1st, 1755. John Pringle. Phil. Tr. vol. 49.*

"About ten o'clock of the forenoon, at a seaport on the Frith of Forth, about seven miles higher up than Leith, the water was observed to rise very suddenly, and return again with the same motion; and this continued for three or four minutes, it being then calm; but after the second and third rush of water, it was always less."

We have expatiated with some details upon the dreadful earthquake which was so fatal to Lisbon in 1755, destroyed whole cities in Europe and in Africa, cost the lives perhaps of one hundred thousand human beings, and was felt upon a surface of more than one million square miles at the same moment. We have taken into consideration particularly its effects upon the water of the sea. The detonation took place under ground, or rather under the sea, in that space which we suppose filled with condensed air, below its inferior level. If we should wish to locate precisely the centre of concussion, judging from its intensity and direction, it seems to be, between the Azores, Madeira, and the continent. The sea was swelled at the same moment from the thirtieth degree of latitude to the fiftieth, that is to say, on the coast of Africa from Morocco up to Tangier, on the coasts of Spain and

Portugal, France, Hamburg, the coast of England, and even to the north of Scotland. However, a fact observed by Captain Affleck, of the Advice man-of-war, then at Antigua, and recorded in the Philoso. Transactions, vol. 49, surpasses in wonder even all this:

> "On the first of November last, you had a remarkable flux and reflux of the sea at Portsmouth, and other parts of the coast, which was agitated in like manner, AT THE SAME TIME, on the coast of America, and all these islands."

If by the words "same time" is meant the same hour, it is in fact three hours later, on account of the difference of longitude, and the distance between the point of explosion across the Atlantic to the Antilles, being about four thousand miles, and will give a velocity of two thousand and forty feet in a second of time. This velocity cannot be that of a wave of water; it must be, it can be, but a velocity of percussion in an elastic fluid or gas of a greater density than atmospheric air. This fact, and similar ones, will enable us one day to give not only a mathematical demonstration of the existence of such a fluid under the sea, but also to calculate exactly its density.

Let us proceed in our investigation.

### *Earthquake in Calabria*, 1638.

In Goldsmith's History of the Earth, is an account of that great convulsion of nature, translated from the celebrated Father Kircher, from which we extract the two following observations:

> "The Gulph of Charybdis, which we approached, seemed whirled round in such a manner as to form a vast hollow, verging to a point in the centre."

And afterwards:

> "The sea itself seemed to wear a very unusual appearance. Those who have seen a lake in a violent shower of rain, covered all over with bubbles, will conceive some idea of its agitation; my surprise was still increased by the calmness and serenity of the weather; not a breeze, not a cloud......"

The rushing of the sea into a subterranean abyss cannot be better demonstrated than by the first observation, and the ejection of gases through its water, than by the second.

*Earthquake in Sicily*, 1692. *Schenchzer. Phil. Tr. vol.* 33.

"Just at the time of the second shock, the sea retired from the land, all along the coast, leaving its bottom dry for a considerable distance, and in a few minutes it returned again with great fury, and overflowed the shores. In many places the earth gaped prodigiously......Out of all these openings sprung forth a great quantity of water, which drowned the neighbouring places. This last (shake) was stupendous beyond imagination, the fiery eruption of the burning Ætna throwing out a prodigious quantity of flames, stones and ashes, &c."

*Earthquakes in the two Calabrias, Messina, &c.* 1783. *By Sir Wm. Hamilton. Phil. Tr. vol.* 73.

"A shock had raised and agitated the sea so violently, that the wave went furiously three miles inland, and swept off in its return two thousand four hundred and seventy-three of the inhabitants of Scilla, &c.

"At the moment of the earthquake the river disappeared, and returning soon after, overflowed, &c.

"The officer who commanded in the citadel (Messina) assured me that on the fifth of February, and the three following days, the sea, about a quarter of a mile from that fortress, rose and boiled with a most horrid noise, &c."

*The same.* 1783. *Count Francesco Ippolito. From the Italian.*

"Flames were seen to issue from the ground, &c.

"Out of many of these apertures a great quantity of water spouted during several hours; from one of them, about a mile from the sea, there came out a large quantity of salt water. Warm water likewise issued from the apertures made in the plain, &c."

*Molucca Islands.* 1693. *In a letter to Nicholas Wetsen, of Amsterdam. Phil. Tr. vol.* 19.

"The mountain (———) has cast out so many stone, and some near six feet long, that the adjacent sea, which has been forty or fifty fathoms deep, is not only filled up there, but become many fathoms higher than the water."

*Eruption of Mount Vesuvius, June* 12*th*, 1794. *Sir William Hamilton. Phil. Tr. vol.* —.

"The classical accounts of the eruption of Vesuvius, which destroyed Herculaneum and Pompei, and many of the existing printed accounts of its great eruption in 1631, might pass for an account of the late eruption, by only changing the date, and omitting the circumstance of the retreat of the sea from the shore, which happened in both those great eruptions, and not in this, &c."

The water of the sea not retiring from the coast in this eruption seems to be an anomaly. Whether the suction or aspiration was performed too slowly, or too far from the shore to be observed, or whether it did not take place at all from the sea, still we are in no apprehension of seeing an eruption without the presence of water; for, in the same relation, a few lines lower, we read:

> "The water at the great fountain at Torre del Greco began to decrease some days before the eruption......It was necessary in all the other wells of the town and its neighbourhood to lengthen the ropes daily to reach the water, and some of the wells became quite dry......"
>
> "Subterranean noises were heard at Resina for two days before the eruption. Soon after the beginning of it, ashes fell thick at the foot of the mountain....and though there were not at that time any clouds in the air, the ashes were wet, accompanied with large drops of water, which were to the taste very salt......
>
> "After some time, the lava ran in abundance, freely and with great velocity......The frequent falling of the huge stones and scoriæ, which were thrown up to an incredible height, from some of the new mouths, one of which, having been since measured, was ten feet high, and thirty-five in circumference, &c.
>
> "It is impossible that any description can give an idea of this fiery scene, or of the horrid noises that attended this great operation of nature. It was a mixture of the loudest thunder with incessant reports, like those from a numerous heavy artillery, accompanied by a continual hollow murmur, like that of the roaring of the ocean during a violent storm; and, added to these, was another blowing noise, which brought to my mind that noise which is produced by the action of enormous bellows at the furnace of the Carron iron foundery in Scotland, and which it perfectly resembled, &c."

If this last paragraph had been written with the direct intention of supporting our theory, could Sir Wm. Hamilton have made use of other expressions?

We will here recapitulate in a few words the whole of the hypothesis. We have endeavored to establish—that the surface of the earth, as deep as four miles and seven-eighths, is the domain of water; that it cannot penetrate deeper, as it there meets with a fluid denser than itself; that either in the open sea, or between the crevices of the rocks and ground at that depth, is its inferior level; that at the surface of the earth, fresh water ascends higher than the superior level of the sea, in proportion to its relative levity, and the depth at which they come in contact. This is what we have particularly tried to demonstrate in a former communication, (vol. xiv. p. 174); that below four miles and seven-eighths is condensed air which supports the combustion of inflammable bodies, and keeps in activity those subterranean fires, the immediate cause of earthquakes and volcanos; that it ceases to be problematical how these fires under ground are not smothered for want of oxygen, and how those under the sea are not extinguished by its water; that we now may account for volcanic islands suddenly rising or disappearing; that it also explains why earthquakes, without any outward explosion, extend to a greater distance, and are more destructive, than those breaking out in a volcanic eruption, &c. &c.

But it is high time to close this article, not because the subject is exhausted, for it seems to extend in proportion as we proceed, but because the limits granted to a publication are perhaps already outreached. We will hereafter present our readers with some new considerations derived from the same principle.

JOSEPH DU COMMUN.

*West Point, April 16th*, 1828.

---

## *Objections to the above Theory.*[*]

1st. The experiments of Perkins[†] prove that air, and those of Mr. Faraday,[‡] that many gases, and from analogy, (grounded on so many established cases,) we may infer that *all* gases, under extreme compression, especially when aided by cold, lose their elastic form, and become fluid.

2d. This being the fact, all reasonings respecting the condition of air under extreme pressure, must contemplate it as a fluid—(truly such while the pressure exists)—and resuming its elastic character, by diminution or removal of pressure.

3d. Whether it would form a stratum, distinct from water, must depend upon the existence or absence of affinity

---

[*] Forwarded to the author in a letter from the Editor.

[†] Jones' Mechanics' Mag. IV. 2.

[‡] Phil. Transac. London, 1823.

between the two fluids, and upon their relative specific gravity.

4th. That any particular effect of pressure upon air may take place, deep in the ocean, must of course depend upon the fact that air is conveyed to the region supposed.

5th. No cause is obvious, that can produce such an effect; the extensive contact of air and water, however often repeated, can do no more than saturate water with air, at the particular temperature and pressure.

6th. In this condition, and upon the surface of the globe, the water and the air form, apparently, a homogeneous fluid, and should this fluid descend to the greatest depth, and be subjected to ever so many miles of pressure, it is not perceived that the air and water would probably separate, or undergo any other change than a diminution of volume, as proved by Mr. Perkins' experiment on the compressibility of water.

7th. Could air be forced down through and beneath a superincumbent ocean, of the depth supposed, then it would be in a suitable condition to receive the effect of the pressure; but air, already united to water at or near the surface, has already become a fluid by the union, (or a constituent of a fluid,) and will probably undergo no other change than a mere fluid undergoes.

8th. Is it physically possible, that any aerial body should be subjected to such a pressure, as to acquire a specific gravity greater than that of water, and still retain its aerial form? Would not the supposed approximation of its particles necessarily cause it to become a fluid; and is it not physically possible that by increased pressure it may become even a solid?

### *Answer to the Objections.*

No. 1 and 2. Experiments made in Paris, prove that air may be condensed above the density of water, without losing its elastic or gaseous properties; the point at which it is condensed into a liquid being beyond that density.

No. 3. Why should it not form a stratum under water, its density being greater, and the two fluids having combined as far as their affinity goes?

No. 4 and 5. True, that the air should be conveyed to the lowest regions of the ocean, is a consequence of its whole mass being saturated with it.

No. 6 and 7. That the air should separate from water saturated and compressed, is deduced by analogy, from what happens at the surface, as is explained in the article itself.

No. 8. The best answer to this last, and perhaps to all the other objections, is to copy here an extract of the PHILOSOPHICAL TRANSACTIONS, 1826. On Compression of Atmospheric Air, by Perkins. "In the course of my experiments on the compression of atmospheric air, I observed a curious fact, which induced me to extend the experiment; viz: that of the air beginning to disappear at a pressure of five hundred atmospheres, evidently by a partial liquefaction, which is indicated by the quicksilver not settling down to a level with its surface. At an increased pressure of six hundred atmospheres, the quicksilver was suspended about one-eighth of the volume up the tube or gasometer. At eight hundred atmospheres it remained about one-third up the tube; at one thousand atmospheres, two-thirds up the tube, and small globules of liquid began to form about the top of it; at twelve hundred atmospheres the quicksilver remained three-quarters up the tube, and a beautiful transparent liquid was seen on the surface of the quicksilver, in quantity about $\frac{1}{2000}$ part of the column of air."

From these experiments, it follows as a fact, that under the pressure of eight hundred atmospheres, two-thirds of the air is still under an aerial form, although its density is then equal to that of water; and even at twelve hundred, when it is much denser, one-third of it is not liquefied. This is sufficient for us to maintain that under the pressure of the sea a layer of air may produce the effects we have endeavored to describe.

N. B. We regret that the beautiful experiments of Mr. Perkins on the compressibility of water have not been performed upon water at forty degrees of temperature, its greatest natural condensation, instead of fifty degrees, and upon water entirely deprived of air; this would be a still greater proof that water itself is condensed, and not the air it contains, or not that the caloric, which dilates it, is repelled by compression. By similar reasons, the compression of air should have been performed on air perfectly dry, that it might not be objected that some water has been liquefied; and the experiment performed also on oxygen and azote separately, to show, whether these gases liquefy each at the same pressure when they are not combined as in the atmospheric air.

## ART. IV.—*Descriptive Arrangement of Volcanic Rocks; by* G. POULETT SCROPE, Esq., M. G. S.

[Communicated by the Author, to the English Journal of Science, &c. No. 42, for July, 1826.]

IN the course of a series of investigations of the geology of volcanic districts, the writer of this paper has met with great inconvenience from the want of a fixed nomenclature and mineralogical classification of this family of rocks.

MM. Cordier and Fleurian de Bellevue, in two well known memoirs,[*] proposed a systematic arrangement of volcanic rocks on mineralogical principles; which, however, has not as yet got into general use, owing perhaps to some obvious imperfections in the mode of arrangement.

M. D'Aubuisson followed these writers in classing the pyrogenous rocks into two main families, trachyte and basalt; according to the prevalence of felspar or augite in their composition, and these terms have since been generally adopted on the continent.

But of late great confusion has been introduced into the subject by the determination of M. de Beaudant,[†] and after him of M. de Humboldt,[‡] to confine the terms Trachyte and Basalt to rocks of a particular age and position in the geological series. The attempt has originated in an unfortunate mistake of these distinguished geologists, who have been led by their observations to presume, that rocks of the mineral character of trachyte never occur superposed to their own conglomerates, or to tertiary strata. That this notion is false in fact, may be proved by numerous examples from the Mont Dor, Cantal, and Italy. But, had it been true, still it is by no means allowable to employ the mineralogical title of a rock to designate its place in a geological series. This is the more strange in the latter author, because he talks of granites of different ages, of syenites and porphyries of primitive and transition formations, &c.; and because he ever expresses himself in these positive words; "There are trachytes, phonolites, basalts, obsidians, and perlites, of *different ages*, just as there are different formations of granite,

---

[*] Cordier. Essai sur les Roches Pyrogenes de tous les Ages.—*Journal de Physique*. Fleurian de Bellvue.—*Journal de Physique*, tom. lxxxiv.

[†] Beudant. *Hongrie*, tom. iii.

[‡] Humboldt. *Essai Geoligique.*

gneiss, mica-schist, limestone, grey-wacke, syenite, and porphyry." How then, after this, could the same author confine the term trachyte, basalt, and phonolite, to rocks of a particular epoch, and vaguely unite all the rocks mineralogically identical with them, but bearing appearances of a later date, under the undescriptive, undistinctive term "Lavas." How much more simple, after such a confession of the different ages of the same rocks, to name them geologically by means of epithets superadded to their primary mineralogical designation, in the same manner as the other rocks are treated. We should then have secondary trachytes, tertiary trachytes; or, if it was preferred, trachytes of the new red sandstone, trachytes of the greensand, recent trachytes, &c.

It is so obvious that the determination of the mineral characters of a rock must precede any attempt to find its place in a geological system, since it is *only* by these characters that it can be distinguished from the other rocks with which it is associated, that it is difficult to believe any person would dispute the propriety, not to say the necessity, of a mineralogical nomenclature being made use of for the *primary* terms of a geological classification. In fact, such a classification is a Tabular History of Rocks, or of the globe's surface, and requires a great deal of previous description and comparison of all these rocks according to their mineral nature. It is also founded on hypothetical views, since it is a mere hypothesis, and perhaps a false one, more particularly with respect to the elevated strata, and, above all, the unstratified rocks, that *superposition* is any proof of a posterior origin. The arrangement of rocks on such a basis must necessarily be dubious, insecure, and often erroneous. Whereas no error can be committed in a nomenclature which is merely descriptive, and founded on oryctognostical principles. The character inferred by the name must always be true of the rock to which it has been applied; all speculative ideas as to age or origin are kept out of view; at the same time that this arrangement displays the various rocks known in a clear, concise, and ready manner, for the purpose of any ulterior classification upon geognostical or geological principles that may be preferred.*

---

* The utter absurdity of making the primary or only name of a rock indicative, not of its mineral nature, but its geological connexions, is instantly seen, by supposing that this principle were acted on, not in one or two, but in all

These considerations will perhaps evince the propriety and utility of generally adopting some such descriptive nomenclature for all classes of rocks, as that which is here proposed for those of unquestionable volcanic origin, or the *pyrogenous rocks.* The end which the writer has had in view is to offer concise and comprehensive definitions of the principal oryctognostical characters of this family of rocks, by the use of which any one of its members may be distinctly described by an observer in a manner intelligible to all geologists.

The *primary* characters by which alone the nature of a rock or mineral mass, simple or compound, can be identified, are those of its mineral composition, texture, the relative disposition of its component minerals, if a compound rock, its internal structure, and natural divisions.

The colour, lustre, fracture, hardness, fusibility, and specific gravity of rocks are obviously determined by their qualities of mineral composition or texture, and must vary with them; these therefore are secondary characters, not characteristics. Of the primary qualities, that of mineral composition is obviously by far the most important towards identifying the rock. All the other characteristics are probably accidental modifications determined by the mineral composition, under the influence of external circumstances; whereas it is difficult to conceive this latter character to be in any way influenced by the others, under any circumstances.

Hence the *mineral composition* of the rocks under review at present has been taken as the basis of their systematic arrangement into genera and species; the sub-species and va-

---

cases; the consequence of which would be, that we should have no names whatever; for to say that granite is a rock determined by its underlying gneiss; gneiss characterized by its underlying mica-schist, and this by its bearing the same relation to clayslate; and so on, would be to pursue the most vicious of all circles, since we can have no means of distinguishing an over from an underlying rock, but by their distinctions of mineral character: these must therefore be determined, and the mineralogical characteristics of each rock defined, (which cannot be done without applying some name to it,) *before* their relations of position can become a question. To force the *primary* name of a rock to denote its supposed place in a geological series, would be as inconvenient and irrational as to confine the name of a simple mineral to one found in a particular locality, so that, when met with in another, a new name must be invented for it; or to give, for instance, the name of felspar to this mineral only when in company with mica, and refuse it the appellation when associated with quartz. Hence arises a *general rule*, that when a rock possesses but *one name*, it is significative of its mineralogical character.

rieties being distinguished, according to the remaining primary characters, under the separate heads of—

| | |
|---|---|
| 1. Texture. | 3. Internal structure. |
| 2. Mineral disposition. | 4. Natural division. |

There is, however, one previous distinction which it is incumbent to draw between the rocks of the trap family, and which is rather of a geological than mineralogical nature; viz., their division into the two *classes* of *lithoidal* or *massive*, and *fragmentary* rocks; according as they are composed of minerals intimately united by the force of crystalline aggregation; or merely of separate parcels of matter, incoherent, or enveloped in a cement, whether crystalline or earthy, but evidently of later origin than the fragmented portion it encloses.

The second step is to arrange the lithoidal rocks into genera, according to their broad general characters of mineral constitution. Now it has been ascertained that all the rocks of this family, with very few exceptions, are principally composed of felspar and augite in varying proportions. The felspar is sometimes partially or wholly replaced by leucite, melilite, olivine, or hauyne; and this substitution is observed only to occur when the proportion of augite in the rock is very considerable. The augite appears in the same manner, occasionally replaced to a greater or less extent by mica; and this occurs only when the felspar is greatly in excess. The augite is either pyroxene or hornblende, the one seeming to replace the other in proportion to the abundance of felspar. Titaniferous iron and sphene are subordinate but very general ingredients in these rocks; the former is often in considerable quantity, and abounds most in the augitic species. Quartz occurs very rarely in crystals or grains; garnet, spinelle, sapphire, and other still rarer minerals can only be reckoned as accidents.

It is seen then that these rocks naturally group themselves into two principal orders; viz.—1. That in which felspar predominates exceedingly. 2. That in which augite or the ferruginous minerals are in excess; or at least so abundant as to stamp their character on the rock. This is, in fact, the division which has been generally made by the continental geologists, who have called the former order *trachyte*, the latter *basalt*.

But the shades of mineral composition amongst the compound rocks of this family are so varied in nature, and graduate so imperceptibly into one another, that two genera alone can hardly be reckoned sufficient.

A very numerous tribe of rocks is to be met with, in which the proportions of felspar and augite are such, that it is impossible to tell which predominates, while, in their general characters, the rocks are so unlike the extremes of either genus, that it is scarcely allowable to rank them together. It appears from these reasons expedient to institute an intermediate class of rocks, for the reception of those members which cannot, without difficulty, be referred to either of the two extremes. The name which I conceive most appropriate to them, as having been applied to such rocks already by Werner and other mineralogists, and as susceptible of little misconception, is greystone, (graustein,) their color being universally of some tint of grey, generally lead-grey, greenish, iron, purplish, or slate-grey, with the exception only of their vitrified varieties, some of which have assumed a black color, which, however, passes away under the blowpipe, and is succeeded by the usual grey tint.*

The genera of the volcanic, or trap family of rocks, will then consist of—

I. TRACHYTE.
II. GREYSTONE.
III. BASALT.

It may, perhaps, be objected to the basis of this arrangement, that these subjects frequently appear homogeneous, and hence their constituent minerals are undiscoverable. This is, however, far from the case. There are very few rocks of this family, indeed, in which a good lens, or at furthest, a microscope, will not discover a granitoidal mixture of the constituent minerals in a crystalline form. The method of mechanical analysis, first proposed by M. Cordier, will determine this with accuracy and certainty. But, for ordinary purposes, examination with a lens will be sufficient, and even the color may be generally depended on as an accurate criterion, unless the rock is passing to a resinous or vitreous

---

* Greystone corresponds in part to the class of volcanic rocks called tephrine, by M. de la Metherie. It comprehends also the majority of clinkstones.

state, under which circumstances the lightest colored felspar rocks sometimes assume a blackish hue.*

Speaking generally, the colour of the mass is deeper in proportion to the quantity of augitic matter in its composition, the felspar being always of a light colour, the augite a darkish green or black, and the iron a dark-brown or black. The proportion of felspar, or its substitutes, which exists in trachyte, may be reckoned at, or above, ninety per cent., the remainder being composed of augite, or the ferruginous minerals. In greystone, felspar or its substitutes composes more than seventy-five per cent.; when these minerals are in less proportion than seventy-five per cent., the rock should be classed as basalt.

Another auxiliary test, in which greater confidence may be reposed, is the specific gravity of the substance when reduced to powder. In fact, the specific gravity of the augitic and ferruginous minerals is so greatly superior to that of felspar, that an observation of this nature will indicate the general proportion of these two classes of minerals in any volcanic rock. In general, the specific gravity of trachyte will be found not to exceed 2.7, that of greystone 3.0, while basalt occasionally reaches 3.50, which is much above the specific gravity of augite alone, and caused by the presence of a quantity of iron in a metallic state.

A third test consists in the colour of the glass, produced by fusion of the mineral before the blowpipe. That resulting from trachyte is light coloured, and nearly transparent. The glass of greystone is darker, and spotted with numerous green or black specks, often of a green colour, bearing a constant ratio to the proportion of ferruginous minerals in the rock. Basalt melts into a dark green, or black enamel. Observations which have often been made on these rocks, and which, without being insisted on as infallible criteria, will yet often assist in distinguishing them, are—

1. That leucite has not been found to occur in any trachyte, only making its appearance when the proportion of the heavier minerals is considerable; rarely in greystone, oftener in basalt.

---

* Apparently derived from the bitumen, which appears, from chemical analysis, to be present in this condition of the rock, and which is volatilized on exposure to the blowpipe.

2. Olivin never has been met with as yet but in basalt; it appears to replace the felspar, in part or altogether, only when augite is in excess.

The specific divisions of these genera should be drawn from minor modifications of mineral constitution: a tabular view of the principal species is subjoined:

### Genus I.—Trachyte, characterized as above.

Species A. Compound trachyte with mica, hornblende, or augite, sometimes both, and grains of titaniferous iron.
“ B. Simple T., without any visible ingredient but felspar.
“ C. Quartziferous T., when containing numerous crystals of quartz.
“ D. Siliceous T., when there appears to have been introduced a great deal of silex into its composition.

### Genus II.—Greystone.

“ A. Common greystone, consisting of felspar, augite, or hornblende and iron.
“ B. Leucitic greystone, when leucite supplants the felspar.
“ C. Melilitic greystone, when melilite is substituted for that mineral, &c.

### Genus III.—Basalt, characters as above.

“ A. Common basalt, composed of felspar, augite, and iron.
“ B. Leucitic B., when leucite replaces the felspar.
“ C. Basalt, with olivin in lieu of felspar.
“ D. Basalt, with hauÿne in lieu of felspar.
“ E. Ferruginous basalt, when iron is the predominant ingredient.
“ F. Augitic basalt, when pyroxene or hornblende composes nearly the whole of the rock.

The character which ranks next in importance, towards the descriptive qualification of a volcanic rock, is its *texture*, and by this character the sub-species may be, with propriety, distinguished.

All lithoidal volcanic rocks, with the exception only of those which have partly, or wholly, passed by complete fusion into the state of glass, consist of an aggregation of more or less imperfect crystals of one or more minerals.

The average size of these crystals, or integrant particles, determines the *grain* of the rock, which is one of the elements of its texture. When the average size of the crystals is so large as to strike the eye by its crystalline structure at a distance, as in granites, the texture is called *granitic;* when of such size as to be discerned only by close inspection, *granular;* and when so minute as to require a lens to ascertain its crystalline texture, or the assistance of the mechanical analysis, *compact.* When the rock appears to be passing to the state of a glass or enamel, assuming a pearly, waxy, or resinous lustre, its texture is called *resinous*, or *semi-vitreous;* and lastly, the finest texture of all is the *vitreous*, or *glassy*.

But, besides the size of the crystalline particles, another character influences the *texture* of the rock, viz., their more or less intimate aggregation, which may be *loose* and incoherent, giving an *earthy* aspect to the rock; or *close* and compact, producing the effect of *hardness* and solidity. Another and still more important characteristic is, the regular or irregular *disposition* of its component crystalline particles, which are sometimes aggregated in a confused and disorderly manner, without any determined method, so as to give an irregular fracture to the rock, as in granite, claystone, &c.; at others, they are arranged so that their longest plane surfaces preserve a more or less perfect parallelism to one another, through a considerable space, by which a *foliated*, or *scaly* texture is given to the rock, and a splintery or slaty fracture, as well as a lamellar or schistose structure, on a large scale. This remarkable difference in the diposition of the crystalline particles is always found to pervade the whole mass of rock, and, in fact, forms the only distinction between granite and gneiss, claystone and clinkstone.

Hence, according to the arrangement proposed here, the sub-species of the volcanic rocks should be distinguished by epithets significative of their peculiar texture, viz.

A. Granitic
B. Granular
C. Compact
D. Resinous
E. Vitreous

*a* Massive, or granitoidal.
*b* Scaly, or foliated.

Loose α.
Close β.

The texture is also either, 1. *Uniform*, which needs no explanation, or, 2. *Varied*, when consisting of parts of different texture. Epithets may be also made use of to describe the general form and disposition of these parts, as, 1. Nodular. 2. Lenticular. 3. Zoned. 4. Brecciated.

These varieties of texture in the same mass are generally connected with, and in all probability owing to, an unequal distribution of the different minerals composing the substance, which forms another very characteristic distinction amongst this family of rocks, and may with propriety be assumed as the basis of their division into *varieties*. The principal modes of mineral distribution are—

1. *Uniform*, when the minerals are generally intermixed throughout the mass, as in granites, syenites, &c.

2. *Porphyritic*, when large crystals, or grains, of one or more minerals are dispersed throughout a base of very fine texture, and uniform disposition, so as to strike the eye by their prominence, as in porphyries.

3. *Globular concretionary*, when some minerals have more or less completely separated themselves from the remaining mixture, and agglomerated into globular nuclei, as in pearlstone, variolite, orbicular granite, &c.

4. *Nodular concretionary*, when some minerals have separated in the form of irregular knots, as in the masegna of the Euganean hills, in many granites and porphyries, or like the flints in chalk.

5. *Lenticular concretionary*, when the figure of the segregated parts is much elongated in any one direction.

6. *Zoned concretionary*, when they are elongated still more into alternate stripes.

7. *Veined*, when one or more species of minerals appear to have occupied cracks in the rock.

8. *Amygdaloidal*, when one or more minerals have occupied vesicular cells in it.

The next head under which it has been thought right to class the characteristic qualities of these rocks, is their *internal structure*, which comprehends the following varieties:—

1. Massive, or compact.
2. Porous, as are all loose-textured, earthy, and bibulous rocks.
3. Cellular, when the cavities are visible to the eye, but irregular and angular.
4. Vesicular, when the cells are more or less spheroidal.
5. Cavernous, when the blisters or air-cells are of a very large size, and very numerous.
6. Spumous, when the air-cells are so numerous as to give a lightness and frothy appearance to the rock, as in some varieties of pumice and scoria.
7. Filamentous, when composed of twisted thread-like fibres.

The last head to be noticed in the description of this class of rocks is their *divisionary structure ;* by which is meant the figures or the parts into which the rock is divided by seams or natural clefts. Frequently there are no such separations of continuity, and the rock is then pronounced *amorphous.* The varieties of divisionary structure may be classed as—

1. The bedded structure, when divided into massive beds.
2. Stratified, when the beds are less bulky, from the greater frequency of the seams.
3. Tabular, when the separate divisions are still thinner, flat, and of no great longitudinal extent.
4. Laminar, when still thinner.
5. Schistose, lamellar, or slaty ; a well known structure.
6. Columnar, when the divisions are regular many-sided prisms of considerable length.
7. Prismatic, when the form of the prisms is less regular, and the transverse joints more frequent.
8. Rhomboidal, when there exists a double system of parallel seams, dividing the mass into portions approaching in figure to cubes or rhomboids.
9. Conchoido-prismatic, when the boundaries of these portions are curvilinear.
10. The *globiform*, when the rock is divided into globular masses of a large size. These are often subdivided into concentric laminæ, less frequently into radiating prisms, or even columns.
11. The globular, when the spherical concretions are very small.

12. The angulo-globular, when the rock separates into small angular divisions rudely approaching to a globular form. It resembles the conchoido-prismatic structure on a very small scale.

The *secondary* characters of these rocks are often of service towards ascertaining with greater precision their primary qualities, and thus accurately *defining* the rock. They consist chiefly of—

1. The *lustre* and *fracture;* both of which depend upon, and consequently disclose, the *texture* of the rock.
2. *Hardness*, which indicates the mineral composition.
3. *Solidity*, or the coherence of its integrant parts, which depends upon texture.
4. *Fusibility*, which varies somewhat with the size of the grain; the smallest grain melting most readily *cæteris paribus;* but it depends chiefly on the mineral composition of the rock, of which it becomes a serviceable test.
5. *Colour* usually indicates the mineral nature of the rock, unless it is stained by metallic oxides, or other accidental modifications, which are in general easily distinguishable from the genuine tint of the component minerals.

Each of the three genera of lithoidal volcanic rocks possesses their conglomerates, which may be referred to any of them, according to the mineral nature of the composing fragments. They thus are divided into—

1. Trachytic conglomerates. 2. Greystone ditto. 3. Basaltic ditto.

The primary characters of these conglomerates, by which they are most distinctly recognized and described, consist of—

1. The average size of the fragments; which may be called,

A. Coarse, when of a considerable size.
B. Gravelly, when of a medium size.
C. Sandy, or arenaceous.
D. Fine.
E. Argillaceous.
F. Mixed, when fragments of one size or more are imbedded in a base or cement of finer materials. The cement is occasionally of crystalline texture.

2. The form of the fragments must also be noticed. This is either,

α. angular, β. water-worn, γ. rolled.

3. The fragments should be referred, if possible, to some mineral species of lithoidal rocks, and their varieties, if any, taken notice of; as well as the occurrence of isolated crystals, rare minerals, shells, wood, &c.

4. The solidity of the conglomerate rock; which may be,

A. incoherent, or earthy, B. indurated.

5. The divisionary structure, which is occasionally met with in conglomerate as well as in lithoidal rocks, and is subject to the same varieties of form.

The volcanic rocks, both lithoidal and conglomerate, are sometimes found in an altered state, from having been exposed to the decomposing influence either,

1. Of proximate emanations of aqueous vapours charged with sulphuric and muriatic acids; or,

2. Of the ordinary atmospheric agents.

In the first case, the alumine and potass of the felspar and augite are taken up by the sulphuric acid, and deposited by the agency of water, as sulphat of alumine (alumstone,) in the cavities aud fissures of the rock, and in neighbouring hollows; leaving the remainder of the rock, composed almost solely of silex, in a carious state, but often filled up with other infiltrated matters as well as alum, and stained with ferruginous oxides, from the union of its iron with the oxygen of the acids. In the second case, the decomposition of the augite and felspar, sometimes of one, at others of both, produces a variety of argillaceous earths or *boles*, giving to the rock, which is then often called *wacke*, a more or less argillaceous aspect, proportionate to the degree of decomposition, and sufficient to render it occasionally difficult to recognise its original mineral composition. These boles are sometimes conveyed by aqueous infiltrations into the cellular and other cavities of the rock, giving occasion to the amygdaloidal composition.

The object proposed in the foregoing remarks is to endeavour to establish a fixed nomenclature for the principal characteristics of the volcanic rocks, so as to enable any observer to define or describe all their varieties accurately and distinctly, for the ulterior purposes of geology. Names may be subsequently given by geologists to any of these varieties, for the sake of avoiding a redundancy of words, or not.

as convenience may dictate. A number of appellations have indeed been given, and confirmed by general use, to particular varieties; some of which it may be as well to specify in this place. Thus the granular, massive, and earthy subspecies of trachyte has been called in England *claystone;* in France, *domite; necrolite,* by Brocchi. Compact and close-grained trachyte has received the name of compact felspar, and perhaps of hornstone; the laminar sub-species of the same rock, clinkstone, (phonolite;) and this name being appropriated to a peculiarity of texture, is given as well to greystone and basalt, as to trachyte, when possessed of that character.

*Resinous* trachyte is generally known by the name of pitchstone; *vitreous* by that of obsidian; and the same when formed into globular concretions, perlite or pearlstone; and the same vitreous basalt has been called gallinace by the French geologists.

Spumous and filamentous trachytes are called *pumice.* Spumous greystone and basalt, *scoria.*

When porphyritic, many of these varieties have been called porphyries; as claystone porphyry, pitchstone porphyry, &c. Large grained or granitic basalt has the title of *greenstone* (dolerite.) Very coarse grained trachytes have, perhaps, often been described as syenites.

With regard to the conglomerates, the sandy and fine-grained varieties of trachytic conglomerate are generally called tufa, sometimes trass; the coarse and incoherent, lapillo. Those of greystone also usually bear the same appellations. The basaltic conglomerates are occasionally styled peperino, or trap-tuff; but when fine, or sandy and incoherent, puzzolana. Some fine tufas, indurated by water, and, with a lamellar structure, have been made use of and described as tripoli. Basaltic conglomerates, when much decomposed, have been designated by the term wacke, as well as the congenerous lithoidal rock when in a similar condition.

# Art. V.—*The Report of* J. L. Tiarks, *Astronomer on the part of his Britannic Majesty under the sixth and seventh Articles of the Treaty of Ghent: on his Astronomical Observations for ascertaining the most northwestern point of the Lake of the Woods.*

(Communicated by Prof. Renwick, for insertion in this Journal.)

In order to explain the operations by which I have endeavoured to ascertain the most northwestern point of the Lake of the Woods, it will be necessary that I should give a definition of the term "most northwestern," and explain the property, which a point of a lake must possess, in order to entitle it to the appellation the "most northwestern." In so doing, I hope I shall not overstep the province of the astronomer, who is supposed to be qualified to give definitions of terms connected with his science. If there should be a difference of opinion on the meaning of the words "most northwestern," I shall humbly offer that definition which appears to me to be the true one, with due deference to the judgment of the Honorable Board of Commissioners, in order to render intelligible the operations which I have performed, and the conclusions at which I have arrived, on this subject.

The most northwestern point of a Lake appears to me to be the point which has the following property, viz: that if a loxodromic line be drawn from it, intersecting every meridian in the direction from southwest to northeast, at an angle of forty-five, and such loxodromic line be continued, both ways if necessary, to its intersection with the meridian of the extreme eastern and western points of the lake, this line shall touch no other water of the lake. It is well known, that on Mercator's projection, all loxodromic lines become straight lines, and the solution of the problem conformably to the definition here given, becomes, therefore, more simple by projecting the lake, the most northwestern point of which is to be ascertained, in this manner, on a plain surface. On such a projection, that point of the lake from which a northeast and southwest course can be drawn, without touching or intersecting any other point of the lake, is the most northwestern one; and in order to ascertain which of two given points is the more northwest, it will be sufficient to connect the two points by a straight line on the map, (projected according to Mercator.) If the angle formed by this line, and one of the parallels of the map, be more than an angle of 45°, the northern point is the more northwest; if less, the southern is the more northwest; if 45° exactly, the two points are equally northwest. It will be easily seen, that if through the southern one of the two points, which are thus to be compared, a parallel of latitude be drawn, and through the northern one a meridian, and those lines be continued until their intersection, a right angled triangle will be formed, the hypothenuse of which is the straight line, connecting the two points in question, or the course from the one to the other, and the two cathetes the difference of longitude and the difference of latitude of the two points on the map. The angle formed by the connecting line of the two points with the parallel is exactly 45°, if the difference of longitude on the map is equal to the difference of latitude; it is $\left\{\begin{matrix}\text{more}\\ \text{less}\end{matrix}\right\}$ than 45°, if the difference of latitude be $\left\{\begin{matrix}\text{more}\\ \text{less}\end{matrix}\right\}$ than the difference of longitude, both being measured on a map projected on Mercator's principles. If therefore the differences of latitude and longitude be expressed in figures, in the same manner, for example in minutes of a degree, on the principle of Mercator's projection, these numbers will immediately show which is the more northwestern one of the two points. The degrees of longitude are all equal on Mercator's projection, and may be easily expressed in any manner required. The degrees of latitude increase from the Equator to the Pole: the expression of the length of a meridian from the Equator to the latitude L., in minutes of a degree, is $= 7915' \, 7044674$ log. tangt. $(45° + \frac{1}{2} L)$. The numbers resulting from this formula for the different degrees and minutes of latitude are contained in the common books of navigation, under the head of "meridional parts." From all this, it will appear, that in order to ascertain which is the more northwestern one of two points, the longitude and latitude of which are given, it will be necessary to find by the above formula the numbers corresponding to the two latitudes, and to take the difference of the same; and likewise to take the difference of longitude of the two points, and express it in minutes of a degree, (which numbers thus express by a common measure the difference of longitude and latitude on Mercator's projection,) and if the former number is $\begin{Bmatrix}\text{greater}\\ \text{less}\end{Bmatrix}$ than the latter, the $\begin{Bmatrix}\text{northern}\\ \text{southern}\end{Bmatrix}$ point is the more northwestern one.

The map of the Lake of the Woods, which Mr. Thompson has constructed from his surveys, proves, that there are two points on this lake which are more northwest than all other points of the lake, and so nearly equally northwest as to require a more accurate comparison, in order to pronounce with certainty which of them is, according to the principles above explained, the most northwestern point of the Lake of the Woods. These two points are: 1. the most northwest point of a deep bay, on which Mr. Thompson has placed his monument No. 1, (in latitude 46° 23′ nearly.) 2. The most northwest point of the bay on which the beginning of the Rat Portage is situated, (in latitude 49° 46′ nearly.) The accuracy with which Mr. Thompson has laid down the relative position of these two points, considering the manner in which this survey was necessarily conducted, which will appear from comparing his maps with the results of my astronomical observations, is a proof that the conclusions which have been drawn from the map with regard to the situation of the intermediate points, are perfectly just, and that all these points are less northwest than the one above mentioned. With a view, therefore, of comparing the situation of those points, I have endeavoured accurately to ascertain their difference of longitude, and their latitude, for which purposes the following observations were made. I have used an excellent sextant, of nine inches radius, made by Mr. Troughton, and two pocket chronometers, one made by Arnold, (No. 2111,) and the other by Morice, (No. 201.)

The most northwest point in the neighbourhood of Mr. Thompson's monument, No. 1, having no camping ground near it, I thought best to make my observations at the monument itself, and to connect this point with the other by actual measurement.

## Mr. Thompson's Monument No. 1.

*Circummeridian Observations of the Sun's Altitude for determining the Latitude.* { Index error — 7″ 5 Thermometer 75°

| Time by Arnold 2111. | Double Alt. of Sun's U. L. | Time by Arnold 2111. | Double Alt. of Sun's L. L. |
|---|---|---|---|
| July 27. 0h 0′ 40″2 | 120° 7′ 30″ | July 27. 0h 6′ 58″2 | 119° 6′ 30″ |
| 1 29 | 8 15 | 7 6 2 | 6 35 |
| 2 15 2 | 8 50 | 8 16 2 | 6 15 |
| 4 2 3 | 9 25 | 10 27 3 | 5 15 |
| 14 33 | 4 45 | 11 12 3 | 4 50 |
| 17 12 4 | 0 50 | 12 17 | 4 5 |
| 18 11 3 | 119 58 40 | 13 3 3 | 3 10 |
| 19 6 4 | 56 50 | | |

| | | |
|---|---|---|
| Result: | Zenith distance of Sun's centre at noon, | 30° 10′ 52″ 70 |
| | Refraction less parallax, - - - | 27 90 |
| | Sun's declination, - - - | 19 11 43 00 |
| | Latitude of Thompson's Monument No. 1, | 49 23 3 60 |

I arrived at Mr. T.'s monument near noon; it was cloudy the whole afternoon, and consequently no observations for determining the time were made this day, (July 27.)

---

## Mr. Thompson's Monument No. 1.

*Circummeridian Observations of the Sun for determining the Latitude.* { Index error + 2″½ Thermometer 75°

| Time by Arnold 2111. | Double Alt. of Sun's U. L. | Time by Arnold 2111. | Double Alt. of Sun's L. L. |
|---|---|---|---|
| July27. 23h 58′ 25″ | 119° 37′ 25″ | July 28. 0h 4′ 26″ | 118° 38′ 25″ |
| 59 0 | 38 10 | 5 6 | 38 50 |
| 59 31 | 39 0 | 6 18 | 38 55 |
| 59 57 | 39 20 | 6 46 | 38 50 |
| 28. 0 1 34 | 40 0 | 7 25 | 38 40 |
| 2 32 | 40 40 | 8 4 | 38 30 |
| 3 13 | 41 10 | 8 32 | 38 10 |
| 9 51 | 41 10 | 9 12 | 37 50 |
| 10 20 | 41 0 | | |
| 11 4 | 40 20 | | |
| 11 41 | 39 50 | | |
| 12 37 | 38 40 | | |
| 13 27 | 37 50 | | |
| 15 37 | 34 50 | | |
| 16 11 | 34 15 | | |
| 16 45 | 33 43 | | |
| 17 32 | 31 50 | | |
| 17 59 | 31 20 | | |
| 19 5 | 28 40 | | |
| 20 18 | 26 50 | | |
| 20 52 | 25 0 | | |

| | | |
|---|---|---|
| Result: | Zenith distance of Sun's centre at noon, | 30° 24′ 45″ 80 |
| | Refraction less parallax, - | 28 22 |
| | Sun's declination, - - | 18 57 55 22 |
| | Latitude of Mr. Thompson's Monument No. 1, | 49 23 9 24 |

### MR. THOMPSON'S MONUMENT NO. 1.

*Equal Altitudes of the Sun for ascertaining the time.*

| Double Altitude of Sun's U. L. | Times before noon. | Times after noon. | By Arnold 2111. |
|---|---|---|---|
| 96° 0 | July27. 21h 39′ 15″ | July 28. 2h 33′ 17″ | |
| 20 | 40 28 | 32 5 | |
| 30 | 41 8 | 31 27 | |
| 97 40 | 45 25 | 27 8 | |
| 50 | 46 3 | 26 31 | |
| 98 0 | 46 39 | 25 54 | |
| 10 | 47 17 | 25 16 | |
| 20 | 47 53 | 24 38 | |
| 30 | 48 31 | 24 1 | |
| 40 | 49 10 | 23 23 | |
| 50 | 49 46 | 22 45 | |
| 99 20 | 51 40 | 20 51 | |
| 30 | 52 19 | 20 14 | |
| 40 | 52 58 | 19 35 | |
| 50 | 53 35 | 18 56 | |
| 100 0 | 54 15 | 18 9 | |

| | |
|---|---|
| Results: Uncorrected noon by the mean of all observations, - - - | 0h 6′ 16″ 31 |
| Correction, - - - - | 8 43 |
| Apparent noon, - - | 0 6 24 74 |
| Mean time at the apparent noon, - | 1 6 6 38 |
| Arnold 2111 fast of the mean time of Mr. Thompson's Monument No. 1, on July 28, at noon, - | 0 18 36 |

---

### STATION NEAR THE RAT PORTAGE.

*Altitudes of the Sun for ascertaining the Time.* { Index error + 2″ ½ | Thermom. 74°

| Time by Arnold 2111. | Double Altitude of Sun's U. L. | Time by Arnold 2111. | Double Altitude of Sun's L. L. |
|---|---|---|---|
| J'ly29. 20h 54′ 14″5 | 82° 41′ 40″ | July29. 20h 57′ 39″ | 82° 39′ 30′ |
| 54 59 | 55 15 | 58 30 | 54 25 |
| 55 54 | 83 12 0 | 59 14 | 83 7 30 |
| 56 29 | 22 10 | 59 47 | 17 40 |
| 57 2 | 31 30 | 21 0 22 | 27 50 |

| | |
|---|---|
| Result of the observations of the Sun's Upper Limb: Arnold slow 2′ 9″ 89 | Result of the observations of the Sun's Lower Limb: Arnold slow 2′ 9″ 52 |

*Mean Result of all Observations.*

| | |
|---|---|
| Arnold 2111. Slow of the mean of the Rat Portage station, July 29, - | 20h 59′ 33″ M. T. |
| | 2 9 70 |

It was cloudy the whole afternoon of the 30th July, and I obtained no corresponding altitudes to a numerous set of altitudes, which I had taken in the morning.

## STATION NEAR THE RAT PORTAGE.

*Circummeridian Observations of the Sun for determining the Latitude.*
Index error + 2″ 5
Thermom. 76°

| Time by Arnold 2111. | Double Altitude of Sun's U. L. | Time by Arnold 2111. | Double Altitude of Sun's L. L. |
|---|---|---|---|
| J'ly29. 23h 49′ 41″ | 117° 44′ 20″ | J'ly29. 23h 55′ 26″ | 116° 50′ 40″ |
| 50 40 5 | 46 15 | 56 6 | 51 50 |
| 51 16 | 47 45 | 56 45 | 52 20 |
| 52 04 | 49 20 | 57 22 | 53 10 |
| 53 4 5 | 51 0 | 58 1 | 53 55 |
| 53 43 | 51 50 | 59 24 5 | 54 50 |
| 30. 0 13 9 | 52 40 | 30. 0 0 31 | 55 0 |
| 14 24 5 | 50 40 | 1 2 | 55 30 |
| 19 23 5 | 41 0 | 1 86 | 55 40 |
| | | 2 23 5 | 55 40 |
| | | 4 44 | 55 50 |
| | | 6 2 | 55 45 |
| | | 7 22 5 | 55 20 |
| | | 8 54 5 | 54 20 |
| | | 11 1 | 52 0 |
| | | 11 31 | 51 30 |
| | | 12 35 | 50 15 |

| | |
|---|---|
| **Result**: Zenith distance of the Sun's centre at noon, | 31° 16′ 0″ 97 |
| Refraction less parallax, - - - | 29 23 |
| Sun's declination, - - - - | 18 29 25 90 |
| Latitude of the station near the Rat Portage, | 49 45 56 10 |

---

## MR. THOMPSON'S MONUMENT No. 1.

*Altitudes of the Sun for ascertaining the Time.*
Index error + 2″ 5
Thermom. 69°

| Time by Arnold 2111. | Double Altitude of Sun's U. L. | Time by Arnold 2111. | Double Altitude of Sun's L. L. |
|---|---|---|---|
| July 31. 4h 46′ 58″ | 53° 36′ 10″ | July 31. 4h 53′ 1″ | 50° 54′ 30″ |
| 47 82 | 24 40 | 53 49 | 18 50 |
| 48 16 | 10 25 | 54 48 | 0 20 |
| 48 56 | 52 57 30 | 55 50 | 49 39 30 |
| 49 30 | 46 20 | 56 50 5 | 20 5 |
| Result of the observations of the Sun's Upper Limb: Arnold 2111 fast 0′ 5″ 58 | | Result of the observations of the Sun's Lower Limb: Arnold 2111 fast 0′ 5″ 54 | |

### *Mean Result of all Observations.*

Arnold 2111, fast of the mean time of Mr. Thompson's Monument No. 1, on July 31st, 4h 51′ M. T. - 0′ 5″ 57

### Station near the Rat Portage.

*Equal Altitudes of the Sun for ascertaining the Time.*

| Double Altitude of Sun's U. L. | Times before midnight. | Times after midnight. | By Arnold 2111. |
|---|---|---|---|
| 30° 10′ | Aug. 1. 5h 56′ 11″ | Aug. 1. 18h 11′ 31″ | |
| 0 | 56 42 | 10 58 5 | |
| 29 50 | 57 14 | 10 26 5 | |
| 40 | 57 45 | 9 55 | |
| 30 | 58 18 | 9 23 5 | |
| 20 | 58 49 5 | 8 51 5 | |
| 10 | 59 20 5 | 8 21 | |
| 0 | 59 53 | 7 47 5 | |
| 28 50 | 6 0 24 | 7 18 | |
| 40 | 0 56 | 6 45 5 | |
| Double Altitude of Sun's L. L. | | | |
| 27 10 | 2 21 | 5 20 | |
| 0 | 2 53 | 4 47 5 | |
| 26 50 | 3 24 5 | 4 16 | |
| 40 | 3 56 | 3 43 | |
| 30 | 4 28 | 3 12 | |
| 20 | 4 59 | 2 41 | |
| 10 | 5 31 | 2 8 | |
| 0 | 6 3 5 | 1 37 5 | |

| | |
|---|---|
| Result: Uncorrected midnight by the mean of all observations of the Upper Limb, | 12h 3′ 50″ 55 |
| Correction, | — 18 29 |
| Apparent midnight by Sun's U. L. | 12 3 32 26 |
| Uncorrected midnight by the mean of all observations of the Lower Limb, | 12 3 50 13 |
| Correction, - | — 17 99 |
| Apparent midnight by Sun's L. L. - | 12 3 32 14 |
| " " " U. L. - | 12 3 32 26 |
| Apparent midnight by the mean of all observations, - - - - | 12 3 32 20 |
| Mean time at the apparent midnight, | 12 5 54 75 |
| Arnold 2111, slow of the Rat Portage mean time on the 1st of August, 12h 6′. | 2 22 55 |

### STATION NEAR THE RAT PORTAGE.

*Circummeridian Observations of the Sun for determining the Latitude.* { Index error + 2″ 5
Thermom. 74°

| Time by Arnold 2111. | Double Altitude of Sun's U. L. | Time by Arnold 2111. | Double Altitude of Sun's L. L. |
|---|---|---|---|
| Aug.1. 23h 50′ 11″5 | 116° 16′ 20″ | Aug.1. 23h 55′ 0″ | 115° 21′ 5″ |
| 51 16 | 18 40 | 55 41 | 21 30 |
| 51 51 | 19 50 | 56 12 | 22 10 |
| 52 30 | 20 40 | 56 43 5 | 22 40 |
| 52 59 5 | 21 50 | 57 14 | 23 10 |
| 53 33 | 22 35 | 57 47 | 23 30 |
| 54 10 | 23 30 | 58 34 | 24 20 |
| Aug.2. 0 2 34 | 29 50 | 59 19 | 25 0 |
| 3 52 | 29 55 | Aug. 2. 0 0 6 | 25 20 |
| 4 35 | 29 50 | 1 23 | 25 50 |
| 5 14 | 29 30 | | |
| 5 51 | 29 10 | | |
| 6 21 | 28 50 | | |
| 6 53 | 28 35 | | |
| 7 32 5 | 28 0 | | |
| 7 56 5 | 27 40 | | |
| 8 30 5 | 27 30 | | |
| 9 5 | 27 15 | | |
| 9 49 5 | 26 35 | | |
| 10 29 | 25 50 | | |
| 16 32 5 | 16 20 | | |

| | |
|---|---|
| Result: Zenith distance of Sun's centre at noon, | 32° 1′ 2″ 86 |
| Refraction less parallax, - - - - | 30 11 |
| Sun's declination, - - - - | 17 44 23 96 |
| Latitude of the Station near the Rat Portage, | 49 45 56 93 |

### MR. THOMPSON'S MONUMENT No. 1.

*Equal Altitudes of the Sun for ascertaining the Time.*

| Double Altitude of Sun's U. L. | Time before noon. | Time after noon. | By Arnold 2111. |
|---|---|---|---|
| 101° 20′ | Aug.3. 22h 10′ 50″5 | Aug.4. 1h 59′ 56″ | |
| 30 | 11 33 | 59 14 | |
| 40 | 12 17 | 58 32 | |
| 50 | 13 0 | 57 45 5 | |
| Double Altitude of Sun's L. L. | | | |
| 101° 0′ | 13 59 | 56 49 5 | |
| 10 | 14 42 | 56 5 5 | |
| 20 | 15 26 5 | 55 22 5 | |
| 30 | 16 10 | 54 39 | |

| | |
|---|---|
| Result: Uncorrected noon by the mean of all observations, - - - - | 0h 5′ 24″ 00 |
| Correction, - - - - - - | + 9 56 |
| Apparent noon, - - - - - | 0 5 33 56 |
| Mean time at the apparent noon, - | 0 5 43 12 |
| Arnold slow of the mean time of Mr. Thompson's Monument No. 1, Aug. 4th, 0h 5′ 7″ M. T. | 0 9 56 |

---

### MR. THOMPSON'S MONUMENT No. 1.

*Circummeridian Observations for determining the Latitude.* { Index error + 2″ 5
Thermom. 75°½

| Time by Arnold 2111. | Double Altitude of Sun's U. L. | Time by Arnold 2111. | Double Altitude of Sun's L. L. |
|---|---|---|---|
| Aug. 4. 4′ 3″ | 116° 12′ 10″ | Aug. 4. 0h 16′ 30″5 | 114° 59′ 50″ |
| 4 34 | 12 35 | 18 51 | 54 50 |
| 14 40 | 6 10 | 21 42 | 48 50 |
| 15 14 | 5 0 | | |
| 15 32 | 4 20 | | |
| 15 58 5 | 3 50 | | |

| | |
|---|---|
| Result: Zenith distance of the Sun's centre at noon, | 32° 9′ 38″ 93 |
| Refraction less parallax, - - - | 30 30 |
| Sun's declination, - - - - | 17 12 53 14 |
| Latitude of Mr. Thompson's Monument No. 1. | 49 23 2 37 |

---

*Latitude of the two Stations.*

From the mean of all observations made at the same station, the following results have been deduced:

| | |
|---|---|
| Latitude of Mr. Thompson's Monument No. 1, | 49° 23′ 6″ 48 |
| Latitude of the Station near the Rat Portage, | 49 45 56 54 |

### *Comparisons of the two Chronometers on the days on which Observations have been taken.*

| Days of Comparison. | Time the Chronometers showed in the same instant. | |
|---|---|---|
| | Arnold 2111. | Morice 201. |
| July 28 | 5h 0′ 0″ | 5h 1′ 5″ |
| 29 | 0 42 0 | 0 43 16 |
| 30 | 0 35 0 | 0 36 30 7 |
| 31 | 5 28 0 | 5 29 48 |
| Aug. 1 | 6 8 0 | 6 10 3 |
| 1 | 18 17 0 | 18 19 11 5 |
| 3 | 9 53 0 | 9 55 33 3 |
| — | 20 10 0 | 20 12 38 6 |
| — | 22 18 0 | 22 20 40 |
| 4 | 2 3 0 | 2 5 41 7 |

From these comparisons, and the differences of Arnold 2111 from the mean time of the two stations resulting from the preceding observations, the differences of Morice No. 201 from the mean time of the same places, can be easily deduced, and we obtain the following results:

### Differences of the two Chronometers from the mean time of the two Stations at the moments of observations.

### *Differences from the Mean Time of Mr. Thompson's Monument No. 1.*

| Day & fraction. | Arnold 2111. | Daily Rate. | Morice 201. | Daily Rate. |
|---|---|---|---|---|
| July28. 004 | + 18″ 36 | | + 1′ 20″ 63 | |
| 31. 202 | + 5 57 | – 3″ 99 | 1 53 54 | + 10″ 29 |
| Aug. 4. 004 | – 9 56 | – 3 . 98 | 2 31 28 | + 9 93 |

### *Differences from the Mean Time of the Station near the Rat Portage.*

| Day & fraction. | Arnold 2111. | Daily Rate. | Morice 201. | Daily Rate. |
|---|---|---|---|---|
| July29. 875 | – 2′ 9″ 70 | | – 41″ 21 | |
| Aug. 1. 504 | – 2 22 53 | – 4″ 89 | – 15 41 | – 9″ 81 |

By interpolating between two successive moments at which the difference from the mean time of the one place is known, we can now find the difference from the mean time of that place in the same moment in which the difference of the Chronometer from the mean time of the other place was ascertained by actual observation, and thus determine the difference of longitude between the two places. In this manner we find by the three combinations of which the observations admit, the following results.

| | | DIFFERENCE OF LONGITUDE. | | |
|---|---|---|---|---|
| | | True Intervals in mean time. | Between the two Stations. | |
| | | | Arnold 2111. | Morice 201. |
| MEAN TIME OF | | Days. | | |
| Mr. Thompson's Monument No. 1, July 28, | 004 | | | |
| | | 1.869 | | |
| Station near the Rat Portage, July 29, | 875 | | 2′ 20″ 59 | 2′ 21″ 07 |
| | | 1.329 | | |
| Mr. Thompson's Monument No. 1, July 31, | 202 | | | |
| MEAN TIME OF | | | | |
| Station near the Rat Portage, July 29, | 875 | | | |
| | | 1.329 | | |
| Mr. Thompson's Monument No. 1, July 31, | 202 | | 2 21 77 | 2 21 71 |
| | | 1.300 | | |
| Station near the Rat Portage, Aug. 1, | 504 | | | |
| MEAN TIME OF | | | | |
| Mr. Thompson's Monument No. 1, July 31, | 202 | | | |
| | | 1.300 | | |
| Station near the Rat Portage, Aug. 1, | 504 | | 2 22 95 | 2 21 85 |
| | | 2.502 | | |
| Mr. Thompson's Monument No. 1, Aug. 4, | 004 | | | |
| Mean Result of each Chronometer, - | | | 2 21 77 | 2 21 54 |
| Mean of all Results. | | | | |

Difference of Longitude between Mr. Thompson's Monument and the Station near the Rat Portage, — 2′ 21″ 65

Mr. Thompson's Monument No. 1 is not the most northwest point in that vicinity. The bay on which it is placed extends about a mile farther, and terminates in a small pond which is free from rushes, and not fed by any considerable brook. Beyond this point, there is a swamp, which no doubt is part of the lake in the spring and fall of the year; but I have considered as the termination of the lake, in the northwest direction, the extreme northwest point of the pond, which we reached by paddling, without any difficulty, in the loaded canoe.

The courses from Mr. Thompson's Monument No. 1 are as follow:

1. N. 56° W. 1565½ feet.
2. N. 6° W. 861½ feet.
3. N. 28° W. 615.4 feet.
4. N. 27° 10′ W. 595.4 feet.
5. N. 5° 10′ E. 1322½ feet.
6. N. 7° 45′ W. 493 feet.

From these courses and distances I find, supposing the variation of the needle to be 12° east, that this point is

0″ 90 (time) west and } of Mr. Thompson's Monument
48 33 (arc.) north } No. 1.

The latitude of this point is therefore - 49° 23′ 54″ 81
And its longitude west of the Rat Portage station, in time, - - - - - - 2 22 55
or 35″ 38″ 25 = 35′ 6375.

### *Meridional Parts for various Latitudes, near those of the Stations.*

| Latitudes. | | | Meridional Parts. | Latitudes. | | | Meridional Parts. |
|---|---|---|---|---|---|---|---|
| 49° | 22′ | 50″ | 3417.′019 | 49° | 45′ | 40″ | 3452.′230 |
| | 23 | 0 | 3417. 275 | | | 50 | 3452. 488 |
| | | 10 | 3417. 532 | | 46 | 0 | 3452. 745 |
| | | 20 | 3417. 788 | | | 10 | 3453. 003 |
| | | 30 | 3418. 043 | | | 20 | 3453. 261 |
| | | 40 | 3418. 300 | | | 30 | 3453. 519 |
| | 24 | 50 | 3418. 555 | | | 40 | 3453. 778 |
| | | 0 | 3418. 812 | | | 50 | 3454. 036 |
| | | 10 | 3419. 068 | | 47 | 0 | 3454. 293 |
| | | 20 | 3419. 324 | | | | |

### *Meridional Parts of the Latitudes of the Stations.*

Meridional part for the latitude of Mr. Thompson's Monument No. 1, - - - - = 3417′ 441

Meridional part for the latitude of the most northwest point of the Lake of the Woods in the vicinity of Mr. Thompson's Monument No. 1, - - - - - - = 3418 679

Meridional part for the station near the Rat Portage, - - - - - - 3452 656

### *Comparison of the different Stations.*

Rat Portage Station and Thompson's Monument No. 1.

| *Difference of meridional parts.* | *Difference of longitude.* |
|---|---|
| 35′ 215 | 35′ 4125 |

Rat Portage Station, and most northwest point of the Lake of the Woods, in the vicinity of Mr. Thompson's Monument No. 1.

| *Difference of meridional parts.* | *Difference of longitude.* |
|---|---|
| 33′ 977 | 35′ 6375 |

It is therefore evident, that, according to the observations, Mr. Thompson's Monument No. 1, is a little more northwest than the station near the Rat Portage; but the most northwestern point of the lake in the vicinity of Mr. Thompson's Monument No. 1, is considerably more northwest than the station near the Rat Portage, and is, therefore, agreeably to the principles explained in this report, the most northwestern point of the Lake of the Woods.

With regard to the accuracy of the observations, I beg to remark—1. That the angles by which the latitudes are determined are all read off on the same, or nearly the same, divisions of the sextant, and that, consequently, all errors, which the sextant may have, are common to both latitudes, and do not affect the difference of latitude on which the result chiefly depends. 2. The difference of longitude being correct, it would require an error of more than one minute in one of the latitudes, or an error of more than thirty seconds and of contrary sign in each, to change the result derived from the observations. 3. The agreement of the two chronometers shows, that the difference of longitude cannot be far from the truth. 4. If there should be any doubt respecting the observations for time depending on single altitudes, on account of the possible errors of the instrument, it is to be observed that these errors would be too small to affect the result, and that nearly the same difference of longitude may be derived from the equal altitudes only which are not liable to the same objection.

The sun's declination, and the equation of time, have been calculated from the Nautical Almanack, on the supposition of the longitude of the station near the Rat Portage being 94° 39′ west of the Royal Observatory at Greenwich, which would give the longitude of the most northwestern point of the Lake of the Woods, in the vicinity of Mr. Thompson's Monument No. 1, 95° 14′ 38″ west of the same place.

*Note.*—Mr. Tiarks made oath in New-York, Nov. 18th, 1825, before Judge Irving, to the truth and correctness (to the best of his knowledge) of the above report.

## Art. VI.—*On the Vitality of Matter.*

(Communicated for this Journal.)

The mystery of life, or the cause of sensation and voluntary motion, has been a subject of the deepest interest in all ages of the world. The curious and the learned have instituted the most diligent inquiries to discover whether the hidden principle is an emanation from the divinity, or a supernatural gift; or whether it resides in the organized structure, by some particular disposition and consent of parts; or whether each particle possesses inherent powers of life in its separate state, and thus spontaneously arises from decaying forms to engage in new scenes of activity.

Within a few years, from some investigations with the microscope, a theory has arisen, which maintains that this mysterious principle is inherent in the elementary forms of matter, and that they assume new shapes, and revive in their primitive activity, whenever death changes their aspects.

These doctrines, adopted in their full extent, restore the dogmas of the metempsychosis, and the chances of Democritus, and, by vulgar induction, end in atheism. Without the dignity of that system of which Epicurus, Lucretius, Pliny and Lucian were disciples, they fall into the materialism of Leibnitz, who considers "each monad or atom possessed of perception and appetite. This appetency produces an internal principle of alteration—hence the sympathies and affinities, the combinations and the forms of bodies."

The Epicurean theory, although it deemed matter eternal and insensate, and that its particles, by jostling forever, had at length adhered in masses, ultimately forming the world itself, inhabited by animals, and clothed with vegetation; yet, it taught that it was operated upon by an immaterial divinity, and that life was imparted by a divine invisible power, who ruled over all.

In later times, Sir Isaac Newton built a noble superstructure upon the principle asserted in the Mosaic account of the creation—that all things were made by an omnipotent, immaterial, intelligent being; that he established those immutable laws by which the universe is regulated and governed; and that he imparted animation to creatures by bestowing upon them the breath of life.

But Dr. H. M. Edwards, an English physician in Paris, and Dumas, Dutrochet, Prevost and others, have ascertained to their own satisfaction, by some elaborate discoveries with the microscope, that the elementary, organic, constituent parts of animal and vegetable bodies, inherently and independently possess the vital principle; that spirit of life, which has hitherto been veiled in mystery. Edwards describes the animal body as "built of animalcules, as a pyramid is built of bricks," being a congeries of countless millions of organized units, "each capable of living in a separate state, and perhaps exercising the functions of individual life, while incorporated in one being. He teaches that these monads or globules, being of the $\frac{1}{8000}$ part of an inch in diameter, by one arrangement form the various tissues and fibres of the animal structure; and by another arrangement, spring up in the glowing colours and varieties of vegetable life, and that when death passes upon them, and decomposition separates the parts, elements which were before parts of some animal, become vegetables, or if it so may chance, vegetable atoms awake to life as animals.

These inferences rest on the following experiments.

Dr. Edwards examined a piece of animal substance macerated in water, and immediately perceived a number of white vesicles moving about with great rapidity. These he considered to be animalcules of the tribe monades. He observed that these monads lost all power of motion when the water evaporated. "If water were added *immediately* after the cessation of motion, they again began to move, but if allowed to remain dry for a short time, they never recovered the faculty of locomotion." He also observed, that "whenever they adhered to the sides of the glass, they exhibited every appearance of vegetable life."*

The same experimenter macerated a leaf of the horse-chesnut, and "as soon as the particles became detached from the margin of the leaf, they were seen to put themselves in motion;" thus showing that when the tissue of plants is decomposed in water, its component organic parts possess independent life, and spontaneous motion.

Another example, though not included in those mentioned by Dr. Edwards, is still more surprising, as it would suggest that the degree of heat which destroys life in visible objects, had the effect, while life was in its invisible state, to aid in its development. "A potatoe was boiled in water until it

---

* Westminster Review, No. 13, Jan. 1827.

became of a mealy consistence. It was closely covered in a glass vessel, and a drop of the water was examined twenty-four hours after, when it exhibited innumerable animalcules in great activity."

From these examples, they conclude that sensation and voluntary motion reside in matter; that however minutely the parts are dissociated, they still possess a principle of vitality; "that death does not destroy their susceptibility; and that life and matter are coexistent, and from everlasting to everlasting."

These data, and the inferences deduced from them, being at variance with those visible facts, and those unerring, invariably recurring rules called the laws of nature, an inquiry respecting them is justified—

I. Whether there is not a fallacy in those appearances which are assumed as first principles?
II. Whether life exists in brute matter? And
III. Whether inert matter, or particles specifically animal or vegetable, can spring to life, in natures remote from, and opposite to, their own origin?

I. *Is there not a fallacy in those appearances which are assumed as first principles?*

Microscopic discoveries are peculiarly liable to error. They require great acuteness and accuracy of sight, and the contradictory conclusions made by the most exact observers with the microscope, render it of doubtful validity. As it would be unfortunate to build a principle in physiology upon an optical illusion, those appearances which have been adduced should be received with great caution, because, if the first point is wrong, every succeeding step must be erroneous, and all further reasoning upon it would be confirming the deception.

A fallacy may therefore be suspected in those appearances which were considered as voluntary motions. It is worthy of remark, that the monads were viewed through the refracting medium of water, and that many of the fibres retained their thread shaped forms, while others, still farther divided, were reduced to points or globules. Being so attenuated as to be scarcely visible, the progress of decomposition producing a further separation of parts, and moving them by chemical action, might easily cheat the senses with the appearance of animation. While the motions accompanying a chemical process are visible to our unassisted sight, they excite no surprise. A piece of sugar rises and falls in a glass of water, bubbles agitate the mass with motions which appear to be inherent, but these phenomena are not suspected of bearing any relation to life. The motions of the eye stone in a plate of vinegar have been attributed to animal life, but as it is a calcareous stone, the motions are obviously referable to the action of the acid upon it, which disengaging a gas, impels it mechanically from side to side. Gaseous particles, disengaged or acquired at the precise point of time when those macerated materials were under examination, by effecting a moving impulse upon them, aided by the refraction of the water, and the minuteness of the particles, might produce a resemblance to life, although by no means a demonstration that they possess vitality. Further proof is unattainable, as the subject eludes further inspection.

We are therefore warranted in doubting the correctness of the inference, that the motions discovered by the microscope were attributable to animal life: and we are justified in believing that the senses were deluded by appearances resembling life which were not life; inasmuch as the circumstances under which they were detected, render the evidence of the senses imperfect; and as the conclusions drawn from the analysis are unsupported by analogy throughout the visible creation.

But if no doubt rested upon the fidelity or capacity of the human senses in this inquiry, and if it were granted that man with his excellent perfections, and the oak with its duration and grandeur, are composed of the identical particles which form the ignoble reptile, and the poisonous weed; yet we are assailed at this point of the inquiry with the

II.'d question, *Whether life exists in brute matter?*

If animation were inherent in matter, and the presence of water were to awaken the principle, why should it leave the monads as soon as it is withdrawn? and why do they not revive on its reapplication? Mr. Edwards expressly states that "they never recover the faculty of locomotion, unless the water, after evaporation, is immediately restored." It is a contradiction to say, *that life is inherent in matter*, when, by changing its circumstances, it becomes deprived of it, and *cannot regain it.* What is that but death in its common acceptation? The term death implies a change from the power of acting to total inactivity. It implies an utter and irrecoverable extinguishment of sensation, and the faculty of motion. Inertness expresses the state of matter without life, and without any innate principle of revivification.

If the water were not withdrawn, would those particles of matter remain stationary, or would they increase in dimensions; or would they change into other living beings; or form other and unknown combinations? Whatever their shape or location, whether they remain units forever, or experience transformation, *if they are indued with an inherent living spirit*, they must be immortal. A thing possessing an innate principle of vitality cannot be dispossessed of it, unless it is annihilated. If annihilation can dispossess a material monad of existence, the same principle may apply to masses of matter, and the balance of the globe be destroyed by its operation. The order being disturbed which rules the planets in their spheres, and establishes the symmetry of the universe, the whole might rush into chaos, or evanish into nonentity.

But to return to the vitality of material elements. Animal and vegetable matter having been interred in the earth, or decomposed upon its surface, for nearly six thousand years, if the particles were immortal in the animalcular form, the grave would not secure them, and the earth by their accumulation would be heaving and rolling under our feet. There is abundant evidence, however, that bodies continue in the grave long after their inhumation. A single instance is sufficient for the argument. The remains of Charles I. of England were discovered a few years since, after having been interred two hundred years. They were found in their natural state, so far as to be readily identified, and exhibited every appearance of inert matter, resolved and resolving into elementary dust.

The microscopic theorists having conducted us to the lowest gradation of existence, remark that "physiologists can carry analysis no farther, except to convert the substance into gases by distillation." If so, where is the vital principle then? Can distillation extinguish that principle which resisted death and all the previous stages of decomposition? If "life and matter are coexistent, and from everlasting to everlasting," it is absurd to say that distillation, or any other material agency, can separate them, or destroy that life; and there appears no other alternative but to presume it to be still existing invisible among those aerial vapours to which it was driven by this mode of analysis, waiting for some casual chance to be united to a new shape, and enabled to pursue some new career of being.

From these premises the conclusion is irresistible, that after experiencing the changes of death and decomposition, material atoms, possessing inherent vitality, *are transformed into some unknown shape of moving life,* which establishes the doctrine of the metempsychosis without qualification. Those who affirm that when a living being dies, it only changes its form, will easily believe that men may arise unseen from their sepulchres to people the fields and forests;* or, indulging the poetry of feeling, they may fancy their departed friends returning among them as singing birds or blooming flowers, or as waving trees overshadowing their dwellings.†

But our later philosophers are not as courteous as Pythagoras and Ovid, nor as pious as Plato and Epicurus. They make us descend to the most degraded state, and from the decomposing remains of our animal nature they see clouds of loathsome insects floating on the air, winged with pestilence and death. They do not indulge in the fine imaginings of those heathen; the former of whom maintained that the spirits of human beings who led virtuous lives were changed into seraphs, fairies, and heroes; trees, flowers, and fountains: or with the latter, that the gift of life was *bestowed* by a divine almighty power; or with Plato, that it remigrates to the divinity from whence it originated, after leaving its transitory abode in this world.

In assuming that "life and matter are coexistent," identified, indivisible, and eternal, it is also asserted, "that it is perpetually living, dying, reviving, and recombining in new shapes and modes of existence."‡ If so, then is not the boast of the atheist established, and accountability and moral obligation destroyed?

Based upon this hypothesis is the theory of the Gordius Aquaticus, or horse hair snake; and as this is the boldest example, in illustration of this system of physiology, it is selected as a test for the

---

* Pythagoras. † Ovid. ‡ Mason Good.

III.'d inquiry, *Whether inert particles of matter spring to life in forms and natures remote from, and opposite to, their own previous state of existence?*

It is imagined that myriads of monads congregate upon a hair immersed in water; that having in itself a vital principle, it assimilates with these extraneous visitants, and they with each other, until this admixture of fortuitous materials becomes a living being; that gradually "a complete animal is developed, the root of the hair assuming the shape and character of the head, with eyes and mouth." It is not difficult to conceive that a hair, by being placed in water, an element where millions of ephemera occasionally reside, should be covered with them so as to make an entire surface, and that from its elasticity their motions should impart sinuosity through its whole length, and that it should be found writhing and turning like an organized, animated being, although no more endowed with animal life than the limb of a tree, which sways backward or forward, in compliance with the impulse of a boy upon its branches. But for a mass so heterogeneous, and so far removed from all the habits and laws which are invariable concomitants of animal life in every known instance, to obtain a head to guide its voluntary motions; a mouth whereby to receive its sustenance; itself affording aliment to a congeries of insects, creatures of a distinct and separate genus; to become identified with them, and spring to independent existence, and be itself the individual in which they lose their identity; is too monstrous and absurd to admit of belief. It is confounding the distinctions which divide animals from each other, and from brute matter to affirm, that an integral part of a quadruped, having been reduced to utter inertness, should revivify itself, acquiring a head with its curious and complex organization to control its movements, and from the identity of a land animal to become a water serpent. If it be possible for one quadruped to produce snakes, another may; and, if snakes, why not other and more monstrous forms of existence?

Pursuing the analogy, why are not cemeteries and fields of battle overgrown with night-shade and hellebore, and peopled with gorgons and hydras? But it is argued that a butterfly arising from a worm is analagous to the presumed metamorphosis of the gordius aquaticus. The example is not a parallel one. The butterfly preserves its identity through all its changes; it is the same specific and entire being; and its race is continued subject to the same invariable laws. It is not a casual association of atoms, at one time part of a horse, at another, part of a serpent. If the chrysalis were attached to the side of a piece of tortoise shell, or other substance similar to hair, and on bursting its cerements, the shell should become its head or its painted wings, then the case would be parallel to the horse-hair snake.

It is further stated, as will be kept in mind, that vegetables after death arise with the locomotion of animals. Also that the monads of animal remains revive in vegetables, or animals, as chances occur. The atoms of a chesnut leaf were animals while in the water, but upon being dried upon the sides of the glass, became vegetables, with appropriate forms and colours: and finally, that a drop of water in which a vegetable (potatoe) had been *boiled*, discovered innumerable atoms in great activity. This is an anomaly in the experience of the whole world, boiling heat being destructive of life; but in this instance the vital principle is stated to have triumphed over its vegetable origin—over death—over the destruction of fire—and, surpassing even the fabled Phenix, to have awaked to life and animation.

The examination of this subject has been extended far beyond my original design; but on a review of the whole argument it appears that the following are undeniable positions:

1st. That life is not inherent in matter, because it is in proof that the material elements of animal and vegetable remains continue insensate for ages after death—that the presumed fact of their revivification rests upon the slender evidence of microscopic observations—that the phenomena adduced to establish it were probably optical illusions, occasioned by chemical action and disturbance—or were owing to some other cause than material innate vitality.

2d. That the order which prevails throughout the visible creation proves that all things are governed by immutable laws, which have been the same from the beginning, and which forbid the revolting idea that inert matter springs to life in odious and degraded shapes, remote from its generic origin; and that animals cannot change to vegetables, nor vegetables to animals; nor animals to others of opposite genera; else

> "Man himself might spring from ocean,
> Prone down the skies the bellowing herds might bound,
> Or from promiscuous earth the finny race and feathery tribes ascend."[*]

If these inferences are correct, it follows, that in all the complicated series of existence, and in all the changes which chemical and other agents produce upon matter, the hidden principle of life has never been revealed.

Even galvanism, which has almost imposed upon the credulity of science a suspicion that it possesses the power of restoring the vital principle after it has left the clay, has been found to exert only a mechanical action upon the inanimate subject; while it electrifies the muscles and limbs, and produces motion resembling life, yet life is not there, and the hideous distortions it occasions, as if in mockery of human wisdom, leave the body an example of the insufficiency of matter to revivify itself, or to furnish any clue to the mystery of its animation.

Vegetable life is equally hidden from human sight. A grain of sand cannot become a tree, though with other grains and other combinations it sustains the tree in verdure and beauty. If men could obtain a knowledge of the mystery of life, they might restore it when taken away—the fabulous systems of the poets might return as realities—groves might wave in sudden luxuriance over the dreariest deserts—and multitudes arise, as if by the magician's impulse, where solitude and silence have hitherto held undisputed dominion.[†]

## Art. VII.—*On the Zodiacal Light.*

(Communicated by David Leslie, New-York, March, 1828.)

The Zodiacal light, generally ascribed to the sun's atmosphere, is nothing more than those beams of light, seen at times to issue from the sun through the interstices of dense

---

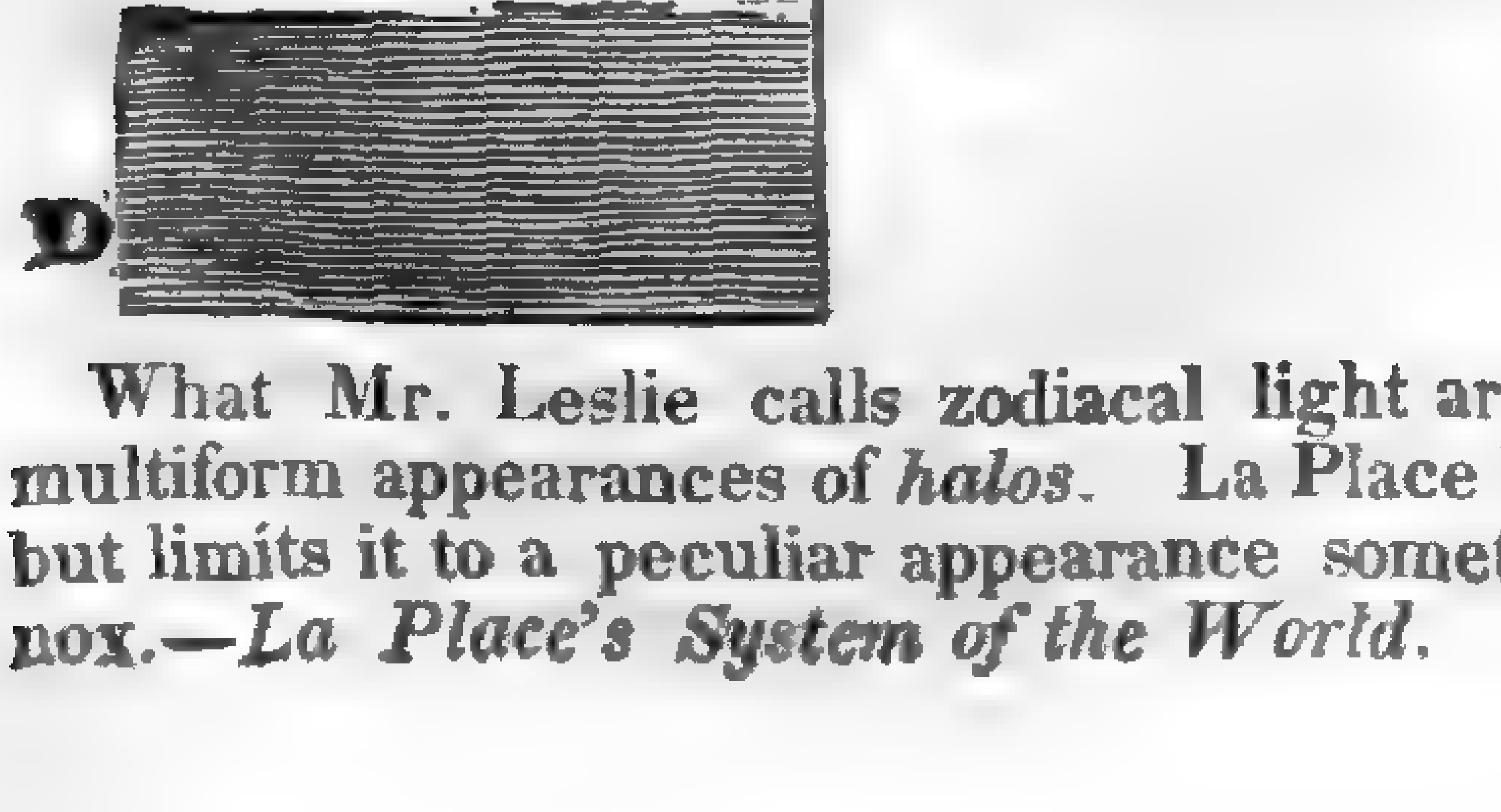
[*] Lucretius.

[†] The author appears not to have adverted to the fact that innumerable animalculae are discovered by the microscope in and upon almost every thing, and that therefore the apparent animation of inert matter may arise from the adherence of these animalcules, whose origin is doubtless by the regular although singular processes of life.—*Ed.*

clouds, when that luminary is near the horizon, and are called by seamen, *shrouds* and *backstays*, from their resemblance to those appurtenances of ships. These beams, which by the laws of perspective, appear to diverge from the sun, are, in fact, parallel, and when seen of considerable length, they of course appear arcs of great circles. When the sun is in, or a little below the horizon, they are often seen to converge to a point diametrically opposite to the sun, and have no relation to the sun's equator. The beams are seldom seen far from the vanishing point. I have seen them almost every day, in certain places, within the tropics. They are however often very faint, and can be seen only by a practiced eye, and as in looking at a celestial nebula or the tail of a comet, are best seen with the eyes partly closed, or by looking a little to one side of the object. These beams are produced in the same manner as those in a room where there is smoke or dust, and the sun shining in through the window. The vanishing point of the solar beams is seen in the sea, when transparent and smooth, and the sun shining at least 60° or 70° above the horizon. Then by looking over a vessel's side, opposite to the sun, the spectator will see around the shadow of his *own* head, only a kind of corona.[*] The same phenomenon may likewise be seen in a stratum of fog when the sun and observer are in certain positions, as when seen

---

[*] This has been called the *Apotheosis* of travellers. (V. Malte Brun.) The appearance is caused either by rain, fog, or spray, on the same principles as the common rainbow. A line drawn from the centre of the sun passing through the eye of the spectator who has his back to the sun, passes through the centre of the bow. Consequently, if the spectator be elevated above the horizon, as when on a high mountain, he may see the entire bow encircling the head of his shadow.



Let A be a spectator standing on the brow of a high mountain; let B represent the sun; then C will be the bow, both parts of which will be visible to the spectator; and being projected on the subjacent plain, or upon the clouds, along with his shadow, it will appear to encircle his head like a corona.

What Mr. Leslie calls zodiacal light are phenomena included under the multiform appearances of *halos*. La Place has an article on "Zodiacal light," but limits it to a peculiar appearance sometimes from about the vernal equinox.—*La Place's System of the World.*

by the Spanish Mathematicians while triangulating the Andes. It has also been seen by some Aeronauts of late years. I do not remember to have seen the Zodiacal light in high latitudes, but I think that Parry states that he saw something of the kind at Melville Island, in the point of the heavens opposite to the sun, before he reappeared above the horizon, in the spring.

While on optical phenomena, I must mention the following as noted in my journal in the Pacific.

"Ship Jupiter, July 13th, 1824, Lat. 14° North, Lon. 139° W. This afternoon I was gratified with a most beautiful and unusual sight, viz. part of four distinct concentric rainbows, all united to each other. The principal or outer bow made the usual angle with the sun, and was the broadest; the others diminished in size and brightness, but the prismatic colors were distinctly seen in each, and were all in the same order. The secondary bow, often seen at a distance from the primary, with colors reversed, was not seen. The bow was complete to the horizon, but the compound part was not above 20° in length. The compound part did not appear to be broader than that which was single. The sun was about 12° above the western horizon, shining through the interstices of a very dense broken cloud; each aperture appeared almost as bright as a sun,* and which I supposed produced the different bows. The wind was from the direction of the bows, and in a few minutes afterwards a shower of very fine rain fell, and the bows disappeared."

P. S. General Humphreys told me that on a morning of a 4th of July, in Connecticut, about sunrising, he saw to the westward, and opposite to the sun, beams of light radiating from a point, and those who had never seen or heard of such a thing before, considered its appearance on that day as ominous. This was no doubt the Zodiacal light.

## Art. VIII.—*Remarks upon Bleaching.*

Communicated for this Journal.

The improvements made in the art of Bleaching during the last half century, have in some measure conquered the

---

* These I think must be the mock suns mentioned in the books,—I have never seen any other.

prejudices inseperable from long established habits, and practical men though strongly wedded to their own methods of working, and sufficiently jealous of projected improvements, have yielded reluctantly to a conviction of their utility. It is presumed that the usual method of chemical bleaching as now practised both in Europe, and the United States of America is too well known, to require a particular description. In that method, there appears to me to be a fundamental error in the alternate use of hot and cold liquors. It is evident that a heated solution of alkali opens and expands the fibres of linen submitted to its action, and thus affords an opportunity for the alkali to act upon its coloring matter, and to increase its solubility. But the second step in the ordinary process of bleaching, counteracts the first. The linen is taken *hot* from the bucking tub, and immediately thrown into *cold water*, for the purpose of being washed. The fibres of linen collapse; the coloring matter is condensed, and its affinity for the linen is restored, which is manifestly the reverse of the object intended to be gained by the process.—If the rinsing water be of the same temperature as the alkaline liquor, this re-action is prevented.

2dly. From this washing in cold water, the linen, after having been bucked a sufficient number of times, and exposed for months to the air in the fields, comes, in due course of time, to its second stage of operation.

The linen in large quantities, is immersed in vats of cold chloride of lime, in a quiescent state, and the bleaching properties of the liquor act upon it imperfectly and unequally, in consequence of the dense mass of linen, and the frigidity of the medium through which it has to act.

If the linen were put into the bleaching liquor moderately warmed, confined so as to prevent the escape of gaseous vapours, and then set into regular and constant motion, these objections would be obviated; the effect of the warm liquor would be uniform and active, which can never be the fact while it is cold, and in a state of rest.

What I have remarked concerning the manner of using alkaline and chloruretted liquors, applies with equal truth to the use of acidulated water in the third stage of bleaching.

3dly. The third most important point to be considered in the process of bleaching, is the degree of heat to which the linen is subjected.

Bleachers are generally sensible of the advantages of heat, and various contrivances have been adopted to apply *steam heat* to the purposes of bleaching. But I am not aware that any one has attempted to bring his goods into *action* in steam heat *under pressure.* Nor do I know that there has ever been any mechanical invention brought into practice, by which it could be done, until my machine was constructed. The French Bleachers have taken much pains to use an alkaline solution at a temperature above boiling heat, but without success. They seem to have a correct idea of the probable effect of increments of heat above that degree, but failed in their attempts to reach it, through the imperfection of their mechanical inventions.* But I can find no evidence of their ever having conceived an idea of the advantages likely to result from the combined action of *heat* and motion.

Unless the steam is brought to act *under pressure* it is evident that no material benefit is gained by steaming instead of boiling—often the reverse, because the heat will never exceed, and the moment it is exposed to the atmospheric air will fall below 212° Fahrenheit or boiling heat. But if the steam is *confined*, it is easy to raise its heat to 230° and then the effect upon the linen shows, in the most unequivocal manner, the advantages of augmented heat in bleaching. This effect is not only more strikingly obvious, but is singularly beautiful, when the goods are put in motion, and the degree of bleaching is rendered perfectly uniform.

There can be no danger, as some have apprehended, of injuring the linen by excessive steam heat, because the scorching heat of steam is 520° Fah.—a pressure of fifty atmospheres or seven hundred and thirty five pounds upon a square inch —a pressure which no ordinary steam apparatus will resist.

Steam heat at 350°. thermometical measurement, will so far soften soldering as to cause it to yield to the pressure, and the steam pipes will burst. These are facts which I state as the result of my own repeated experiments, in which I cannot be materially mistaken, and therefore I feel justified in saying, that it is not possible with any ordinary working apparatus, to carry steam to so high a temperature as to injure any goods submitted to its action. By giving motion to the linen, under the reciprocal action of steam heat, under pressure, and alkaline liquor, the effect is not only more powerful, than it can be by bucking, but, as already hinted,

---

* Vide Berthollet on Dying.

it is more uniform. Every part of the cloth is equally exposed to the operation, and the coloring matter detached from the cloth, floats in the liquor below.

This appears to me to determine the question which some have raised, whether the coloring matter of linen is actually detached from the cloth, or is bleached upon it without being detached? When we find that the loss of weight, in the various methods of bleaching ranges from twenty to thirty per cent.—and when we find the coloring matter suspended in the liquor, and reducible by evaporation to a mucus, it seems to me that there can be no doubt that the coloring matter is removed—at any rate a large proportion of it. The repeated experiments which I have made upon a considerable scale in bleaching, clearly demonstrate the utility of combining heat and motion. The action is direct, immediate, and uniform. The strong affinity which unites the coloring, the glutinous and the oleaginous matter to the fibres of the linen is weakened and rapidly overcome, and no opportunity is afforded for their subsequent combination.

By this method I have bleached Scotch drills in twelve hours, and Manchester cotton shirtings in four.* There will be no occasion to croft cotton goods, but linens receive a clearer and more brilliant white by exposure upon the grass for a few days.

JUNIUS SMITH.

*Liverpool*, *Jan.* 15*th*, 1828.

P. S. I have omitted to notice, that the saving in alkali by this method of bleaching, compared with the usual consumption by the English, Scotch and Irish Bleachers, is about twenty-five per cent.

## ART. IX.—*Biographical Notice of Alexander Volta.*

(Translated for this Journal by Prof. John Griscom.)

BEFORE the great discovery which bears his name, and which has immortalized him, Volta had devoted himself to Electricity, and Chemistry. The researches of Muschenbroeck, greatly interested him, and it was not long after this, that his memoir on the attractive force of the electric fluid, appeared. At a later period, he applied himself to perfecting the philosophical instruments for measuring electricity,

---

* Specimens of these articles perfectly bleached by Mr. Smith's process are in our hands.—ED.

and to the invention of new ones; the Electroscopes of Cavallo, and of De Saussure, obtained in his hands, the greatest exactness; the Electrophorus, and the condenser, owed their origin to him. This last apparatus, especially, founded on the true principles of electricity, of which it is the consequence, is to that science, what the microscope is to natural history, in permitting us to appreciate the quantities of electricity, which by their feeble effects, would have entirely escaped the means formerly known.

The condenser was to shew, at a later period the important part, which the electric agent held in nature and the great number of phenomena which produce it, and finally it was to become, to Volta himself, the basis of his grand discovery, the means of shewing that there is a development of electricity on the contact of two metals.

It was in electricity that Volta found an explanation of the greater number of meteorological phenomena.

His hypothesis of the formation of hail, is ingenious, and his observations upon the periodical return of clouds, are not without interest; but in general, we must distinguish throughout this subject, the theories of the author, from the numerous, and curious facts, with which he has enriched the science of meteorology, still so imperfect.

Let us turn our attention, for a moment to the labours of Volta, relative to chemistry; labours, which are worthy of our attention, from their results, and from the progress of invention which distinguished them. It was he who discovered the inflammable gas of marshes, and who furnished an explanation, the consequence of the former, of the wandering fires, and of those igneous phenomena, which are sometimes produced upon the surface of the ground. He has shewn that they result from the combustion of this gas, by means of electricity.

It was on the occasion of the discovery of an inflammable spring, which was observed to issue from a fountain in 1776, that he suspected the true cause of this phenomenon and of some other similar ones and which he attributed, not to a circumstance purely local, but to the formation of a gas by the fermentation of vegetable and animal substances in contact with water.

Thus he shewed that wherever there was muddy ground or stagnant water, on stirring the bottom, bubbles of this gas would arise; which gas was proto-carburetted hydrogen.

He explained in the same manner, the cause of the burning soils of Barigazin, of the burning fountain of Dauphiny, of the igneous phenomena of Petramala, of Villeja, &c.; the inspection of places every where proved the correctness of his explanation, which had besides the positive merit of pointing out the imperfectly known cause of these wandering fires, and the advantage of shewing that this phenomenon was not owing, as was supposed, to the presence of petroleum or bitumen, in the places where it was manifested.

Volta was led by the observations to which we have just alluded, to the discovery of the electrical pistol, in which, by means of an electric spark, the sudden combustion of hydrogen, produces a loud explosion. It is this property of electricity, of setting fire to inflammable gases, which, combined with another discovery of Volta, that of the electrophorus, gave birth to the hydrogen gas lamp. It is also to the same property, that we are indebted for the most exact mode of analyzing gases, particularly the eudiometer, invented by Volta himself. This instrument, the use of which, is to shew the proportion of oxygen contained in a certain quantity of atmospheric air, depends on different principles, all of which proceed from chemical affinities. The mode proposed by Volta, and which has been acknowledged by Humbolt and Gay Lussac, to be preferable to all others, consists in mingling with the given quantity of atmospheric air, a quantity of hydrogen more than double the quantity of oxygen, which is known to exist in the purest air, to determine afterwards, by an electric spark, the combination of the two gases, and consequently the formation of water, and to take one third of the total diminution of the mixture, which is found to be the expression of the given quantity of oxygen sought.

It remains for us to speak of that discovery of Volta, which has contributed most to his fame, viz. the new method of producing electricity, which is called by his name, and which will always remain a monument of the genius of this learned man, to whom it owes its origin.

Galvani, being engaged in some anatomical experiments, perceived that two heterogeneous metals, connected by the intervention of a frog, suitably prepared, produced in the muscles of this animal, a sudden commotion, similar to an electric shock. This learned gentleman and some other philosophers, struck with this phenomenon, endeavored to explain it by a fluid sui generis, which they called animal electricity, and which they supposed to be put in action in the experiment just named. Volta's opinion was widely different from that of the authors of this hypothesis. He advanced the idea, that this fluid was nothing more than common electricity developed by the contact of two metals, and that the frog only acted the part of a conductor and electroscope. This simple and natural explanation met with many objections. Galvani and the other philosophers alleged that it was not necessary to make use of two different metals, and that the contact of two similar metals, or even that of the muscles and nerves of the frog, was sufficent to produce the shock, which, it is true was much weaker. Volta replied that these results proceeded from this, that the metals were not perfectly the same, and that the nerves and muscles might also, as heterogeneous substances, produce electricity by their contact. Volta must be admired for the indefatigable perseverance with which he endeavored to prove the truth of his explanation, and of the general principle, that two heterogeneous bodies in contact are in two different electrical states; he was not discouraged either by difficulty of execution, or by the ceaseless attacks which were directed against him by philosophers rendered jealous by not having been able to discover a truth which was directly before their eyes. He succeeded in producing electricity simply by the contact of two metals, without the aid of a frog; he shewed by means of his condenser, that the agent produced in this manner, possessed all the properties of common electricity; he replied victoriously to his adversaries, who dared no longer to oppose him, in making to the scientific world the invaluable gift of the apparatus known by the name of the voltaic pile.

Volta was led to the construction of his pile by the distinction which he established, between electro-motive bodies, such as the metals, and bodies, which are not electromotive, or only in a very low degree, but which serve only as conductors, such as fluids.

Having discovered that the contact of two different metals, called a pair or a voltaic element, produces a certain quantity of electricity, he was enabled to increase this quantity, by the union of several of these elements to one another, by means of one of those conductors such as water holding in solution a salt or an acid.

It is the union of all these couples, which is called the voltaic pile, and which forms an apparatus capable of producing electricity with a force to which no one has been able to find a limit, since there is none in the size and number of the elements which can be thus brought together.

Volta's theory of the pile, in which he attributes the electricity produced, solely to the contact; regarding liquids as acting no other part than conductors, has been strongly attacked, particularly by the English chemists. We will not say with the author of the notice, that it may be rigorously demonstrated that the oxidation occasioned by the liquid, is only the effect, and not the cause of the electrical agent; we believe on the contrary, that if it is true, as Volta has proved it, that the contact of the metals is necessary for the production of this electricity, it is not less true also, that the chemical action of the acids, or of the saline solutions upon the metallic plates contributes much to the effect. But we must also admit that the theory of the pile is far from being perfect, and that we cannot hope to have a more satisfactory one until the numerous and various effects of this admirable instrument are better understood.

Volta has shewn, as we have said before, that the agent produced by the contact of two different bodies, possesses all the properties of electricity, he shewed also, that this agent accumulated in a much greater quantity at the two poles or extremities of the pile, may produce all the effects of the electricity of machines, such as attraction and repulsion, charging a Leyden bottle, &c. and in a word, it is known that the accumulation at one of the poles is called *negative*, from negative or resinous electricity, and at the other pole, it is called *positive*, from positive or vitreous electricity.

The discovery of the pile is important, not only because it offers to us a new class of phenomena, and because it furnishes a new mode of producing electricity;—it is especially important because it presents electricity to us under a form until then unknown, and which renders this agent capable of producing effects, some of which could not before be obtained by the aid of common machines, and others were not so strong and were always instantaneous, or not continual. We allude to the phenomena which the pile presents, in uniting the two poles by a conductor, and permitting the two accumulated electricities to reunite, and form a current, which is found to be continual, on account of the faculty which the apparatus possesses, of producing the electrical agent as fast as it is expended.

It may seem to be a departure from the subject of this article to describe these phenomena, but we think with the Italian author, that to become duly sensible of the value of the great discovery of Volta, it will be necessary to present some of the consequences which flow from it, and to show how fruitful in important results it has been in the hands of philosophers. It is not an exposition, nor even a complete enumeration of the effects of the pile that we pretend here to make; it is only some of the more conspicuous facts which owe their origin to this apparatus, which we wish to dwell upon.

In following the author of the biographical notice, we shall recall the curious experiments of Erman, on the property which certain bodies possess, of conducting only one or the other of the electricities of the pile, and the distinction which it draws between unipolar and bipolar conductors; the different forms given to the voltaic apparatus by Volta himself, by Wollaston,* Pepys, Children, Accum, &c.; the dry piles made by De Luc and Zamboni; the wet piles constructed by Davy with other substances besides metals, &c. All these details belong more properly to the theory than to the effects of the pile; as we shall partly complete them by citing with the author, the labors of Marianini relative to the electromotive faculty of certain substances, and to the influence of temperature and other circumstances, either upon this faculty or upon conductibility; and lastly in adverting to the researches of Prof. A. De La Rive upon the electric currents disseminated in fluids, and the experiments in which he has laid hold of several remarkable analogies between electricity in this state, and the properties of light and of radiant caloric.

The services which the discovery of the pile has rendered to philosophy, are neither less important, nor less rich in consequences than those which it has rendered to chemistry. Not only has voltaic electricity furnished a new and much more powerful mode of producing heat and light, than the ancient, but it has given birth to a new class of phenomena, of a kind, then quite unknown to science.

Philosophers remarked not long after Volta had put the pile into their hands, that conductors placed between the

---

* Dr. Hare is certainly entitled to be mentioned in this list.—Ed.

poles, would be very strongly heated, particularly metallic wire, and even platina wire would melt and burn. The most conspicuous characteristic of this kind of ignition, independent of its intensity, is, that it is continual, and has no resemblance to combustion, since it acts in a vacuum, or in gases which are not supporters of combustion, such as azote, and carbonic acid, as well as in air. In vain have philosophers every where sought to study these effects in varying and reproducing them under a thousand forms; as yet, no satisfactory explanation has been given. They have only increased the number of experiments, and here we ought not to forget to mention that of Davy, one of the most remarkable in experimental philosophy; we mean the brilliant jet of light that this able chemist has produced between two pieces of carbon, in connecting them with each pole of the pile.

Ever since the earliest enquiries into the nature of electricity and magnetism, philosophers have suspected that an analogy existed between these two agents, but this, until 1820, had been purely hypothetical.

It was reserved for the voltaic apparatus to show by facts the truth of this analogy; it is to Oersted that we are indebted for having known how to prove this experimentally; he discovered the action which a conductor, uniting the two poles of the pile, exercises upon a magnetic needle.

If we have thus far adopted the order of ideas traced by the Italian author, without however subjecting ourselves to the necessity of following him step by step, and omitting nothing which he has said, or adding nothing to his exposition, we are now obliged to abandon him entirely. In fact, after having claimed the honor of the experiment of Oersted in favor of two of his fellow citizens, Mojon and Romagnesi, he satisfies himself with recalling the determination by Biot and Savart, of the law which governs the new action, and the very remarkable fact discovered by M. Arago, of the magnetism given to needles of steel by an exterior electric current. But by a forgetfulness which we cannot account for, the author does not mention the name of M. Ampere, of that philosopher, who may be justly called the creator of a new branch of physics, called electro dynamics; the history of the labors of this philosopher is the best homage that we can render to the memory of Volta, since they show of what great theoretical and experimental discoveries the pile has been the origin.

M. Ampere had for a long time meditated on this subject, and he appeared only to wait for a favorable opportunity, to give vent to the results of his meditations, when the discovery of Oersted suddenly appeared, he immediately availed himself of it, and by his labors, laid the foundation of a new science. Whatever may be the present and future opinion relative to the ingenious theory which this philosopher has sought to establish, the numerous facts by which he has enriched science, will always remain a monument of the services which he has rendered, and if some difficult minds should find his explanations insufficient, his hypotheses a little too bold, let them not forget a least, that abstractly from their intrinsic merit, it is these explanations, these suppositions which have given birth to numerous experimental discoveries.

The first step that M. Ampere made on electro-dynamics, was to discover, that, independently of the influence which the electric currents exercise upon the magnetic needle, they exert also an action upon one another, the law of which, he determined. He soon went farther; instead of imputing, as all other philosophers at first did, the influence which a conductor of voltaic electricity exercises upon a magnet, to a magnetism impressed into this conductor, by the current, he shewed with much sagacity that the magnet itself is nothing more than a union of electric currents, and that the action discovered by Oersted is only a more complicated case of the simple action of two currents upon one another. As a proof of the identity which he established between magnetism and electricity, M. Ampere shows that all phenomena relative to the action of magnets and currents, even the singular movements of continual rotation discovered by Mr. Faraday, with the action of magnets upon one another may be explained, by supposing that the latter are formed by an assemblage of electric currents disposed agreeably to a certain order which he was enabled to imitate, so as to obtain a real magnet, only by means of electricity.

Lastly, he has gone still farther, in shewing that an electric current possesses, like the compass needle, the property of assuming a constant direction by the action of the terrestrial globe. He has subjected this action of the globe, both upon the moveable current and upon the magnet, to that which an assemblage of electric currents would exercise when directed from east to west, towards the equator. Now every thing conspires to prove the correctness of this supposition. Davy has discovered by means of the piles, that all bodies which we call earthy, are metallic oxides; it is, then probable that below the oxidized crust of our globe, there are metals in a pure state, which are continually acted upon by the surrounding agents, such as water, and we have thus an active source of electric currents, on which the earth's rotation tends to impress a determined direction.

What an admirable connexion does the explanation of M. Ampere, which we have just presented, exhibit. It is the pile which teaches us that an electric current is under the influence of the earth; it is the pile which teaches us that all the substances of which the earth is composed, are metallic oxides; these two facts which at first view, have no other relation to each other, than that of arising from the same source, are found, by an ingenious theory, to have an intimate application to each other.

If we were to enumerate all the services which the pile has rendered to science, we should be obliged to surpass the bounds within which this article must necessarily be limited. We regret that we cannot enlarge upon the important labours of Mr. Becquerel, upon the recent researches of Mr. Savary relative to the very remarkable phenomena which he has discovered in the magnetism of steel by electric discharges, and that we cannot dwell upon other numerous experiments made by philosophers of various countries. The foregoing account is sufficient, we think, to shew what an inexhaustible mine of rich discoveries Volta has put into the hands of experimenters, in giving them the pile, and consequently, what legitimate claims he has upon their gratitude and their regrets.

It was our wish in terminating this article, to give some details relative to the life of Volta; but the journal from which we derived the article which has served as a text to the developments we have just given, gives us very little information on that subject.

We only observe that Volta was born at Como, in 1745, that in 1771 he was appointed professor of philosophy at Pavia, and that in that city, during twenty five years, he taught the true principles of electricity, and ornamented this science by his most valuable discoveries. In 1782 he made several journies in Europe with his illustrious colleague

Scarpa, and received from the Royal Society of London a gold medal for the discovery of his condenser. In 1801 he was at Paris, where he explained his pile; the Institute decreed to him a gold medal as a testimony of its admiration, and he was placed among the number of the eight foreign associates of that learned body. Advantageous offers were afterwards made to draw him to the great capitals, but he preferred his country to the brilliant prospects which were presented to him; he was no less, on this account, the European savant, so true it is, that true genius has no need of a large theatre, to be known and appreciated to its just extent.

Volta, aged and weary, retired to Como, where he continued to occupy himself with philosophy, and particularly with meteorology. A slow fever which had for a long time been weakening him, carried him off on the 5th of March last, at the age of eighty two years.

This is all we learn from the Italian journal relative to the life of this great philosopher of whom science is now deprived. We cannot help deploring on this occasion another loss which science sustained in the same year. By a sad coincidence, the same month, and even the same day which terminated the life of Volta, were the month and the day which witnessed the death of Laplace. A singular concurrence between two of the greatest geniuses of the age, so different otherwise, in the paths which they followed in the pursuit of science! If one by his inventive genius, has opened a new career to the sagacity of the human mind, the other, by a force of conception which raised him to the most sublime generalizations, has traced a route which no person, perhaps, will attempt to follow. The theory of the world begun by Newton can expect no future Laplace; that of electricity which owes its great progress to Volta, has a right to ask a Laplace.—*A. D. L. R. Bib. Univ. Juillet*, 1827.

---

## ART. X.—*Double Stars and the Order of the Starry Firmament.*

(Translated for this Journal by Prof. John Griscom.)

In the year 1824 the observatory of Dorpat in Livonia, was furnished with the grand achromatic Telescope of Fraunhofer, the most remarkable instrument of the kind ever constructed. Four observatories, completely furnished with Instruments, have been founded in Russia within the last twenty years.

F. G. W. Struve, Director of the observatory at Dorpat, an able and excellent astronomer, has turned to an important account, the superiority of this new Instrument, in a more extended and accurate examination of double stars than has been effected by any preceding astronomer. The following are extracts from an analysis of his report on this subject by A. Gautier.

The new measures executed in England and at Dorpat, already surpass in precision those of the great astronomer to whom we owe the discovery of Uranus, on account of the perfection of micrometers. But the achromatic telescopes, hitherto employed have been greatly inferior, in their optical powers, to the reflecting telescopes of Herschell. A telescope, therefore which would bear a comparison with them, in those relations, and which had a decided superiority in its micrometrical apparatus, was very fit for obtaining interesting confirmation and giving greater extension to preceding discoveries. That which appears to me the most important (says Prof. Struve) was to undertake with the telescope of Fraunhofer, a review of all the stars of a certain brightness, in that portion of the sky, visible to me, in order to ascertain which among them is double. I entertained the hope of obtaining more positive knowledge on the manner of distinguishing stars physically and optically double, in order to be able to deduce some general views of the manner in which these stars are distributed over the celestial vault.

It is only under the equator that the whole sky can be perceived, by the earth's rotation, while at each pole, but one half is visible. In the latitude of Dorpat 121½° of the sky can be seen, viz. from the pole to 31½° south of the equator. But the southern stars rise too little above the horizon, to be successfully examined even by the most powerful instruments, for at those small altitudes the inferior strata of the atmosphere, produce a trembling in the image. I resolved in consequence to extend my review only to 105° from the pole, or 15° south of the equator. In this space the lowest stars were still 16¼° above the horizon at their meridian passage. I divided this interval into twelve zones, according to the distances from the celestial poles and made my examination by zones. All the stars extending to those of the eighth magnitude and even the most brilliant of the ninth, which could be detected by the finder of the instruments, were brought successively into the field of view, in order to examine which among them were double. As soon as a star was discovered to be double, its position was determined by reading the index of the two circles of the instrument, as well as by the clock adjusted to sidereal-time; and a short description of the star according to its class and magnitude was inscribed in the register. When the power of two hundred and fourteen times, commonly employed, induced a suspicion that a star was double, by exhibiting it of an elongated form, a higher power extending if necessary to six hundred was substituted in order to decide the case.

The number of stars thus passed in review may be estimated at one hundred and twenty thousand. I then included in a catalogue the stars thus found to be double, comprehending those already known. This catalogue includes three thousand and sixty three double stars of the first four classes, of which three hundred and forty are found in the catalogues of Herschell, and four hundred and forty in my catalogue of double stars known in 1820. The following table shows the increase of our knowledge relative to the double stars of these four classes, and of each of them in particular.

| Number of double Stars. | 1st to 4th class. | 1st class. | 2d class. | 3d class. | 4th class. |
|---|---|---|---|---|---|
| In the new catalogue, | 3,063 | 987 | 675 | 650 | 736 |
| In the catalogue of Herschell, | 340 | 76 | 76 | 82 | 106 |
| In the catalogue of 1820, | 441 | 96 | 112 | 111 | 122 |

The number of double stars is therefore nine times greater in this than in Herschell's catalogue, and those of the first class thirteen times greater.

I have constructed a chart of the double stars now known, situated in the northern hemisphere and to the fifth degree south of the equator, which will be published as an addition to the catalogue, and by which an estimate may be formed of the distribution of double stars over the celestial vault. This chart will show that double stars are to be found in every region of the heavens; but that their number, is less, in general in those where there are the fewest stars; and accordingly in the Great Bear, in a part of the Dragon, and in the Hounds, constellations most distant from the milky way, there is the smaller proportion of them.

From this region, the number of double stars increases as we approach the Galaxy, that is to say as the number of stars increase. There are however in the milky way, regions that are not more rich in double stars than the Great Bear, such as Cepheus, and Cassiopœ, and still farther south the region about the constellation Pegasus, and the anterior part of Andromeda. The richest regions are in Lyra, the north of the milky way, the Goose, the Fox and the Arrow. In Perseus also and to the north of the milky way, there is a great accumulation of double stars, while the Galaxy itself is not as well furnished as the Rams, the Triangle, the Fly, and a part of the Bull situated in the south. Finally, the constellation Orion, that region of the sky so surprisingly rich, on the south of the milky way contains a surprising number of double stars, while the parts of the milky way itself which follow it, such as the Unicorn, &c. are very barren of them. At a greater distance from the milky way on the north, in the Twins, and in the Lynx, and the Telescope, generally poor in brilliant stars, we find as many double stars as in those parts of the milky way south of these regions.

Since, of one hundred and twenty thousand stars that have been examined, more than three thousand have been ascertained to be double, it may be stated that the latter are about one to forty; but this ratio changes with the splendor of the stars. Flamstead determined more than a century ago, in the portion of the sky that we have reviewed, the place of two thousand three hundred and seventy-four stars; which are mostly of the first to the sixth magnitude. All these were examined by Herschell who found one hundred and sixty-seven, of the first four classes, double, and to them sixty-three have been since added. Thus of two thousand three hundred and seventy-four, as far as the sixth magnitude, there are two hundred and thirty double, viz. one to eleven.

The great catalogue of Piazza contains five thousand seven hundred and sixty-two stars. Deducting those of Flamstead, there remain three thousand three hundred and eighty eight, mostly smaller, among which one hundred and thirty four are double, which is one to twenty-five. As to the stars which are much smaller, whose position has more recently been determined, the proportion is about one to forty-two.

A reason for such a diversity in the ratios, cannot be given on the hypothesis of stars optically double. This diversity therefore furnishes a new proof of our preceding assertion; and we may explain the reason of the small stars appearing more rarely double, from the difficulty of seeing, at an immense distance the satellite star, often much more faint than the primary.

It is remarkable that among the double stars, newly discovered, there are several whose proper motion is already known. I will here mention only the brilliant star γ of the Whale, composed of a star of the third magnitude and one of the seventh; No. 42 in Berenice's Hair, composed of two stars of the sixth magnitude, remarkably near each other; and γ of the Crown, which, on account of the great proximity of the principal star of the fourth magnitude to its companion of the seventh, is one of the most difficult to observe. Our catalogue presents a considerable number of double stars of this description, a part of which had probably escaped former observers by the difficulty of distinguishing them. η of Hercules, and γ of the Crown may be considered, in this respect, as real touch stones of the perfection of telescopes, and they may serve to compare the power of these instruments, with that of the great telescope of Fraunhofer. I have examined with this instrument, the double stars of Herschell, a portion of which, such as ζ of Hercules, and δ of the Swan had become single according to his own observations, and another portion were no longer double according to later observers, because the power of their telescopes was less. I have discovered that they were double and have even proved the circular motion of the companions of the two stars above named, thus disproving the conjecture that the companion of one of them had disappeared. The star τ of the Serpent, is the only one seen to be double by Sir W. Herschell, which the instrument of Fraunhofer shows to be single. The low altitude of the star may have diminished the power of our instrument. I propose to observe it frequently; for the moment will surely arrive in which the companion will remove from the star whose brilliancy obscures it. The extraordinary force of our instrument accounts also for our seeing many stars triple, which were before only regarded as double. Thus Sir W. Herschell saw the star No. 7 of Taurus, as a double star of the fourth class, and all subsequent observers have so regarded it, the primary being of the sixth and the companion of about the tenth magnitude. But our telescope has proved that the primary itself is a double star of the first class, composed of two single stars of the seventh magnitude. Also according to Herschell as well as the observations previously made at Dorpat, and those of Messrs. Herschell, the son, and South, the star ψ of Cassiopœ was regarded as double. But our Fraunhofer has shown that the primary is composed of two very proximate stars of the ninth magnitude. All astronomers provided with good instruments have observed a trapezium of four stars, of various brightness, in the midst of the nebulæ of Orion. The two Herschells, and Schröter in particular, have examined this curious object. Our instrument however shows a fifth star, remarked by no preceding observer. Mr. Herschell has since observed it with his twenty feet reflector.

Our Sun is decidedly a single fixed star. If it formed a double star with some other, the latter must from its proximity, be distinguished from all others by its magnitude, much beyond that of Sirius itself, and its change of position in the heavens would characterize it still more clearly. Suppose for example, that the time of its revolution was equal to that of the companion of ρ Serpentarius, we should then observe in it a movement of more than seven degrees annually, and even if its revolution were a hundred times longer, its proper motion must be fifty times greater than that of 61 of the Swan, which is the most considerable hitherto observed.

Another question which arises from the consideration of this subject is, whether there does not exist between two stars of the first magnitude, some mutual relation, analogous to that of double stars, and which on account of their greater proximity to us, we do not at first discover. If we find any remarkable approach between stars of the first magnitude, such a relation would acquire some probability. Now there are in the northern hemisphere, three hundred and six stars of the first to the fourth magnitude, and three hundred and seventeen in the southern hemisphere, viz.

| | 1st | 2d | 3d | 4th |
|---|---|---|---|---|
| Northern hemisphere, | 9 stars, | 26, | 76, | 195. |
| Southern do. | 9, | 26, | 101, | 181. |

The smaller number of stars of the third magnitude, in the northern, being compensated by a greater number of the fourth. A calculation founded on those numbers, and compared with that which really exists, proves that there are not in the heavens, two stars of the first magnitude, sufficiently near each other to render it probable that their distance ought to be considered as fortuitous. In return the magnitude which we find in the first, presents us with examples of remarkable proximity. Who is not acquainted with the three brilliant stars of the second magnitude, in the belt of Orion, the two exterior of which are distant from the middle one, the one, only twenty-six, and the other eighteen minutes? Calculation proves that there are one thousand four hundred to one against the probability that this nearness is accidental. The constellation of the southern cross is still more remarkable. We there find, within the space of fifteen degrees square, (which does not comprehend the two thousand seven hundredth part of the celestial vault,) one star of the first magnitude, two of the second, one of the third, and one of the fourth; and the doctrine of probabilities shows twenty thousand to one against an accidental combination of this nature. We have good reason therefore to presume that these stars are dependent one upon another.

These conjectures are confirmed when we examine the stars to the sixth and seventh magnitudes, relative to their distribution in the celestial vault. According to a calculation of probabilities, founded on the number of these stars which are found in the catalogue of Harding, the case in which two among them should be distant from thirty-two seconds to a minute, ought not to exist more than once and a half, while we are in fact acquainted with fifteen examples. There ought not to be more than six or seven couples from the first to the seventh magnitude, in which the two stars forming the couple, should be distant from one to two minutes, and there are fifteen already known. If we wish to calculate on greater distances for stars of the sixth magnitude, we shall find that there ought not to be more than seven or eight couples distant from two to five minutes, while in fact there are eighteen. From five to ten minutes, probabilities give us twenty-seven or twenty-eight couple, and we are acquainted with thirty-six. We find more than calculation would grant, even at ten or fifteen minutes, namely twenty-five instead of twenty-two. We may then regard with great probability a considerable number of pairs of stars from the first to the sixth magnitude, in which the two stars are distant from each other from one to fifteen minutes, as belonging to a system of stars, stars really double, visible to the naked eye; and which are consequently, the more brilliant, and the nearest to us. Such as e. g. Nos. 16 and 17 and the two ν in the Dragon, Nos. 4 and 5 in the Lyre, the two α of the Balance, ζ of the Great Bear, and the well known star d'alcor, &c. We find a remarkable confirmation of this opinion in the circumstance already observed by Bessel that some of these pairs have a common and peculiar movement; such for example, are No. 36 of the Serpent and 30 of the Scorpion, and the two stars above mentioned in the tail of the Great Bear. It is also well worthy of remark that it frequently happens that sometimes one of the stars of these couples, sometimes, both are themselves double in the strictest acceptation of the word.

We meet also much more frequently three stars so near each other as to render it probable that they were not distributed at random. Among the one thousand three hundred and eighty-six stars of the first to the fifth magnitude which are in the charts of Harding, the cases in which there would be three within a circle of one degree in diameter are only one fourth of a time, that is, not at all, while it does in reality occur seven times, or twenty-five times oftener than if the distribution were fortuitous. Agreeably to these statements, we may therefore hazard the conjecture that the stars situated like the three δ in the Bull, the three ψ in the Water Bearer are stars physically triple which may be recognized by the naked eye.

Our review has afforded the means of discovering many nebulæ before unknown.

[The scientific world will doubtless review with interest and gratitude the remarkable performance, the general results of which are given in the preceding report. Every one may appreciate the toil which the execution of this task, in a climate so rigorous as that of Livonia, must have cost its indefatigable author; and must cherish the desire that Mr. Struve may continue for a long time to pursue his important researches with the fine instrument which he employs with so much advantage.]—*A. Gautier, Bib. Univ. Oct.* 1827.

## Art. XI.—*Account of the Tracks of Foot-Marks of Animals found impressed in Sandstone in the Quarry of Corncockle Muir, Dumfries-shire;** *by the* Rev. Henry Duncan, D.D. Minister at Ruthwell. Communicated by the Author.

The sandstone quarry of Corncockle Muir is situated between the rivers Annan and the Kinnel, about a mile and a half above their confluence, and not quite three miles from Lochmaben. It is near the top of a low round-backed hill, which stretches about half a mile in a westerly direction, almost in the line of the rivers.

The sandstone of which the quarry is composed is like most other sandstone in the county, of a reddish brown color, and is believed to be what is called in Britain the new red sandstone. Its texture is friable, and its strata of very unequal thickness. It lies in the direction of the greater part of the sandstone of the district, which is from west north-west to east south-east, with its dip southerly, inclining at an angle of 38.°

The remarkable phenomenon I am about to describe, as existing in this quarry, is that of numerous impressions, frequently distinct and well-defined, of the foot-prints of quadrupeds, which have been found by the workmen on the surface of certain strata, when the superincumbent layers have been removed in the process of quarrying. This fact, so extraordinary, and I believe *unique*, has not hitherto been noticed in any scientific work, though it is fifteen or sixteen years since the discovery was first made. It is not easy to convey an accurate idea of the nature of these impressions in words; but out of a considerable variety which have been observed, differing in magnitude from the size of a hare's paw to that of the hoof of a pony, I shall give some account of one remarkable track impressed on a slab, formerly in the possession of Mr. Carruthers of Dormont, (who procured it from the quarry some years ago,) and now forming part of the wall of a summer-house in the garden belonging to the manse of Ruthwell. On this slab, which is five feet two

---

* The Editor has been indebted to Dr. Duncan for this abridgement of his very interesting and valuable paper, which was read at the Royal Society of Edinburgh on the eighth of January last, and which will appear in vol. xi. part i. of their Transactions, now in the press.

inches in length, there are twenty-four impressions, which make twelve of the right feet, and as many of the left, being of course six repetitions of the mark of each foot. The marks of the fore feet are a little more than two inches in diameter, both from claw to heel and across, and those made by the hind feet are of much the same size, but somewhat differently shaped. The appearance of five claws is discernible in each fore paw, the three in front being particularly distinct. The three front claws of the hind paws may also be plainly traced, and are placed nearer to each other than those of the fore feet. There has obviously been no division in the sole of the foot, as is the case in the canine and feline species; but a gentle concavity of surface may be observed, especially in the fore paws, occasioned partly perhaps by the act of sinking in the wet sand. The depth of the strongest impressions is about half an inch; and it is observable that the fore feet have made somewhat deeper marks than those behind,—a fact which may either indicate a considerable length in the animal's neck, or the more than ordinary weight of its head and shoulders; for, had it not been for one or other of these circumstances, the chief pressure would have been thrown on its hinder paws, as is the case in some other specimens, because the surface up which it was moving, was of considerable steepness. The distance from the claw of the hind foot, to the heel of nearest impression of the fore foot on the same side, varies from an inch to an inch and a half. This, however, merely marks the position of the two feet when the hinder one was brought forward in moving; and if we would ascertain the animal's step—or rather the distance between the hind and fore paw, when the former was thrown back and the latter advanced—we must measure from the hind foot forward, to the second impression of the fore foot on the same side. Now, this gives a distance of between thirteen and fourteen inches, which is considerably more, however, than would have been the case if the animal had not been moving. If we compare this with the distance between the line of the right and left feet (which is, as to the fore-paws, nearly 6½ inches, and as to the hind paws something more than 7½ inches,) we shall see that an extraordinary thickness of the animal's body, in proportion to its length, is clearly indicated.

This description may be considered as applying, in its general features, to a considerable number of the impressions—I mean those of animals in the act of ascending. Not many tracks, however, have been found, of which the prints are so well defined, and several of them belong evidently to animals of different species. I am myself acquainted with five or six varieties which are clearly distinguishable—the largest of them indicating a quadruped of such considerable magnitude, that the distance between the impression of the hind foot and that of the corresponding fore foot, is more, if I am not greatly mistaken, than a yard and a half.

But there is another class of impressions which must be referred to the tracks of animals in the act of decending the steep face of the stratum. These are not less numerous than the other, but, for an obvious reason, they are not so easily recognized to be the prints of feet. The steep face of the stratum has caused the animals to slide in their descent, so that in most instances nothing is observable but the rut made by the heels of their fore paws, and sometimes also a slight mark of their hind paws, which must have rested lightly on the surface, while the animals were sliding their fore paws alternately downward, and sinking them in the sand to secure their footing.

Of both of those kinds of impressions, traces may at this moment be observed in the uncovered strata of the quarry, though there are none of a very striking character which have not been removed. The best specimins I have seen are in the summer-house at Ruthwell.

With regard to the species of animals whose tracks have been so wonderfully preserved, I am happy that as to three of them I can give the conjectures of a much more competent judge than myself, one of the first geologists of the age, Professor Buckland, with whom I have been in correspondence, having favored me with his opinion on the subject. That eminent individual, supposing the sandstone to have been deposited at an era when according to the received opinion, no animals existed on our earth of a higher order than reptiles, was induced to look to our present crocodiles or tortoises as the species most nearly resembling those of whose footsteps I sent him casts; and on making experiments with some live tortoises which he has in his possession, he has come to the conclusion, that to animals of this species the tracts belong. With regard to the sliding impressions in particular, he says that he fully adopts my theory of their origin, his tortoises, in going down a declivity over wet sand, having made "almost exactly the same impressions."

There are some curious facts connected with this phenomenon which have not yet been mentioned, and which the limits I must prescribe to myself will not allow me to do more than enumerate:—

*1st*, In most instances the counter impressions are distinctly marked in relief on the under surface of the layer covering the foot prints, these projections corresponding to the cavities below as exactly as a cast to its mould.

*2d*, The impressions never occur but on what the workmen call a clay face, by which is meant a stratum, the outer coat of which has a slight admixture of clay, rendering it harder than the rest of the rock, accompanied sometimes with a thin layer of soft clay in the seam between the under and upper stratum.

*3d*, All the tracks are constantly in a direction either up or down, sometimes inclining a very little either to the right or left, but never running across the slope in any great degree.

*4th*, In most of the impressions there are marks of the matter being displaced by the foot-marks, and wherever such an appearance occurs, the matter is found to have been carried directly downwards, with reference to the present inclination of the quarry.

These two last circumstances, as well as that of the sliding tracks, prove that the strata must have been very much inclined, while in a soft state, and while in the act of forming though this is contrary to the received opinion as to the formation of sandstone.

*5th*, The sand must have possessed very considerable tenacity, and have even been sometimes skinned over with a stiff coat, for in one of the specimens preserved at Ruthwell, the claws of the animal had evidently broken through the outer coat at every step, and in two others, where the hind paws have rested on the matter just displaced by the fore paws, their pressure, instead of obliterating the appearance of superadded matter, has merely caused an indentation of the part rested on.

*6th*, There are continuous strata of sandstone resting on those in which the impressions are found, for the distance of not less than a quarter of a mile, all of which must have been deposited subsequently to the period in which the tracks were left on the surface of the sand.

*7th*, As far down as the quarry has yet been worked, which is not less than forty-five feet perpendicularly from the top of the rock, similar impressions have been found, and these equally distinct and well defined with such as are nearer the surface.

*8th*, The impressions are not confined to a single stratum, but have been found on many successive strata. Since the foot-marks were first discovered, about forty yards of sandstone have been removed in a direction perpendicular to the line of strata, and throughout the whole of that extent, impressions have, at frequently recurring intervals, been uncovered, particularly in one part of the quarry, and still continue to be uncovered.

Hence it must be inferred that the process, whatever it may have been, by which the impressions were buried in the sand, that of drifting by storms for instance, has not been occasioned by any sudden or isolated convulsion of nature but has been carried on through many successive years or rather ages. Nor has it been the result of tides on the shore of the sea, which can scarcely be supposed to have flowed to the height of between forty and fifty feet; and even if they had done so, would certainly have swept away or filled up any impressions which animals might have made at low water, by moving over the surface of the sands they were depositing.

In the midst of so much difficulty, it is not easy to form even a plausible conjecture as to the manner in which the sand composing the rock was originally accumulated. It might, however, be perhaps worth while to inquire whether or not this successive accumulation could be the effect of the drifting occasioned by violent winds from the south-west. Supposing a sand-hill to be thus formed, a period of rainy weather following the stormy season would soften and diffuse the particles of clay, which may easily be believed to have mingled with the sand-drift, and would not only prevent the sand from being again moved by the wind, but would form it into a substance of some tenacity, resembling mortar, well fitted for preserving any impression which it might receive. If, during or immediately after the rainy season, animals were to traverse a hill thus formed, their tracks would be either altogether obliterated, or partially filled up, of which latter state many traces are to be found in the quarry; but when the surface had begun to dry, the foot-marks impressed on it would remain a considerable time quite distinct and well defined. Now, supposing the stormy monsoon again to commence, the neighbouring sands, which had not yet been fixed by any mixture of clay, and which happened, from their situation, to be easily dried by a few days of favorable weather, would be suddenly drifted on the hill in question, forming a layer which may easily have covered over the half-indurated surface, without being incorporated with it, and without in any way injuring the form of the footsteps imprinted on it. Let the monsoon be now supposed to continue during the whole course of a dry summer: Fresh layers of sand would be drifted, pure at first, but mingled again towards the close of the season with the clayey dust swept from an arid soil, which mixture would form the materials of what the quarry-men know in its present state by the name of a *clay-face*, and would once more, when subjected to the operation of the returning period of rain, both fix the sand, and prepare it for the reception of permanent impressions of the tracks of wandering animals. Thus from year to year the same round would be continued, and the same appearances would take place, till, after the revolution of many ages, what was originally sand would be converted, by a common process of nature, into sandstone and being exposed, in common with the rest of our globe, to those mighty but mysterious convulsions of which there are every where such incontrovertible proofs, would at last, by the submersion of the universal deluge, be buried under its present covering of soil.—*Dr. Brewster's Jour. for April*, 1828.

---

The following jeu d'esprit from Newton's Journal for April 1828, may amuse our readers, without invalidating the very interesting discovery to which it alludes.—*Ed. of this Journal.*

*Fossil Remains.*—It will be remembered that the Rev. Mr. Buckland distinguished himself a few years ago, by discovering a cave at Kirkdale, which he proved to be the dining room of antediluvian hyenas, that had in this retreat feasted upon elephants and water-rats, and left nothing but the teeth of these tit-bits, just as records of their good living, and bones of contention for future naturalists and cosmogonists. The same ingenious gentleman has lately had the good fortune to find a piece of red sand stone, bearing on it the traces of an antediluvian tortoise's foot steps. The whole geological world has been in raptures at this discovery; and in order to make sure of the fact, that the steps traced in the stone were the steps of a tortoise, a meeting of the Society was held, and some soft chalk was prepared, on which a modern tortoise might make his mark, and thus authenticate as it were, the signature of his ancestor. Every thing being ready for the demonstration, and the interest of the scientific company wound up to the highest pitch, the tortoise was placed on the chalk, and, first of all, he flatly refused to stir a step. The members, upon this very properly waxed impatient, got in a rage, and began kicking and banging him about, and maledicting him in an extremely moving manner. They had much better, however, have refrained from these stimulants, for when the tortoise was at last prevailed on to walk, he insisted on walking as straight as an arrow; whereas the antediluvian tortoise's march was as crooked as a ram's horn. The Society were aghast at the discrepancy. Various arguments however, were used to console them. It was suggested, that the tortoise might have forgotten the true manner of walking while confined in the ark; and that owing to this circumstance, the proper step might have been lost by its descendants. Or it might be, that chastened by the deluge, his slow race had returned to the path of rectitude, which they had, in the universal degeneracy, wilfully deserted for devious ways. Or, perhaps they had one way of walking on red sand stone, and another on soft chalk: one manner in private, and another before scientific beholders.[*]

### Art. XII.—*Observations concerning Fossil Organic Remains; by* J. E. Doornik, M. D. &c. Communicated for this Journal, by the author, in French MS. and translated by Charles U. Shepard.

### *Remarks upon M. Cuvier's method of explaining the importance of organic remains in geology.*[†]

The study of fossil remains is, without doubt, one of the

---

[*] The learned Society here alluded to, will we are persuaded excuse the harmless raillery of our anonymous correspondent. Subjects that have formed the pursuit of a Cuvier and a Buckland, can never be of themselves ridiculous, it is only when they fall into the hands of dilletanti philosophers, that they can be stigmatized as puerile.

[†] G. Cuvier, sur les ossemens fossiles, &c. Paris, vol. 3. edit. 1825, 1. vol. p. 29.

principal branches of Geology: one of the best established means in the explanation of the most important phenomena connected with the natural history of our earth. It is, therefore of the utmost importance that we should be familiar with the whole series of organic remains, before we form our ideas upon the subject in its full extent, and before we allow ourselves to undertake an explanation of the apparent labyrinth.

Notwithstanding my conviction of the great utility of a thorough knowledge of organic remains, as connected with the genera and species to which they belong; the various localities where they are found, and the situations which they occupy in the different strata—belonging to epochs so remote: still, I cannot subscribe to the views of M. Cuvier, when he speaks of the high importance of organic remains.

"Why—do we not perceive, that to *fossil remains alone*, is due the origin of the theory of the earth; and, that without them, we should possibly have never dreamed, that there had been in the formation of the globe, *successive epochs*, and a *series of different operations?*"

This is, truly, a position which allows of infinitely more in its principles than could have been granted by any logical deduction. If it is solely *to fossil remains that the origin of the theory of the earth is due*, then every other consideration for such a theory is excluded. According to the position of M. Cuvier, there exists but one cause from which the theory of the earth has taken its origin; and that is, the study of *fossil bones.*

Such a position it seems to me proves too much, and therefore nothing, decidedly.

After having read and meditated much upon it, I take the liberty to ask M. Cuvier if the knowledge we possess concerning the various rock formations,—the manifest differences in their constituent parts; in the succession, alternation and regular recurrence of their strata; that relating also, to the obvious order which reigns in the superposition of rocks, and the striking instances of conformity, of indentity, of equivalence and parallelism in these superpositions,—proved by the researches of the most able geologists, and found true in countries the most remote from each other: I would ask, if such knowledge is not sufficient to afford some positive data in a theory of the earth—and whether we should not add to it whatever may be derived from the study of fossil remains, so that they may mutually assist each other, and become two inseparable sources from whence we may derive the materials of a theory of the earth?

According to the views of M. Cuvier, then, a theory of the earth should be the result of a knowledge, which is partial; whilst it ought to be on the contrary, the result of a knowledge which is general, and which embraces every thing belonging to the science of GEOLOGY. The discovery of fossil remains; the observation of differences among their genera and species; their diversified appearance when in different strata, and the epochs to which they may be supposed to belong,—are so many materials for framing a theory of the earth; but they are not the only materials: they merely cooperate with other branches of knowledge to form a complete system.

Therefore I maintain, *that the origin of the theory of the earth cannot be attributed, exclusively, to organic remains.*

The arguments which I have cited, prove, if I mistake not, that we, already, had collected many materials for the commencement of a theory of the earth, previous to any progress in the study of fossil remains, and their scientific classification, founded upon comparative anatomy; for which, we are indebted to M. Cuvier as the original author.

I take it for granted that M. Cuvier in advancing this position forgot for the moment, that he was accusing the great WERNER of not having given sufficient attention to the study of organic remains. Nevertheless, Werner had erected a geological system, which has rendered the name of this distinguished philosopher immortal, although according to the opinion of M. Cuvier, he did not sufficiently occupy himself with what he maintains to have been, and to be, the only foundation for a theory of the earth. Every one will maintain with me, I think, that Werner has laid the foundation of Geology. His labors have brought to light materials, which are, and must always remain of the highest value in the formation of a theory of the earth; although connected with a class of knowledge different from that, which is derived from the study of organic remains.

Finally, let us suppose for a moment, that we were ignorant of all that is at present known concerning organic remains; and that our geological knowledge was limited to what we know of those formations called primitive, transition, secondary and tertiary, gathered from their conformation, structure, position, and mutual relations—information purely geological; that our knowledge was confined to what has been observed concerning the summits of mountains; their planes and bases; concerning lakes and valleys; and to the removal of immense masses of rock, to great distances; is it probable that there could be a philosopher found, who would maintain that this amount of knowledge does not, or could not contribute to furnish the materials for a theory of the earth? I cannot believe it, or ever persuade myself that M. Cuvier seriously meant to maintain such a proposition. His vast erudition in every thing which relates to physical science, forbids my believing it; and I choose to think that the passages which have been cited are, so to speak, slips of the lively pen, of this justly celebrated author.

A little farther on we read, "It is only by analogy that we have extended to primitive formations the conclusion, which organic remains furnish, *directly* for the secondary formations; and if there had only existed formations without fossil remains, *no one could have maintained that these formations had not been simultaneous.*"

Here I must commence with the same remark that I have just made upon the first position, which is, that M. Cuvier, assumes infinitely more than sound logic will sustain him in doing. I allude more particularly to the latter part of the above quotation, where he says "and if there had only existed formations without fossil remains, &c."

Truly, when this point shall be yielded to M. Cuvier, geology will lose very much of its dignity; for the science must then acknowledge that it owes every thing to our knowledge of organic remains. But how shall we make a position of this sort agree with what we know concerning the constituent parts of rocks of different composition—information derived entirely from chemical analysis? How shall we then dispose of our discoveries relating to the different structure of formations, which are so geologically distinct, that they have based upon this circumstance the characters for distinguishing the formations?—Is not all we know concerning succession in the primitive formations, directly the result of observations purely geological? Are we not able to distinguish successive formations in strata, which do not belong to the primitive? Should we confound the formation of chalk with that of the *calcaire grossier*, if deprived of the aid of their imbedded fossils, when there exists the formation of plastic clay, of *molasse* and conglomerates of various kinds, intermediate between these strata? In every formation, from the lowest to that which is uppermost, we perceive a repetition of rocks and strata, whose chemical composition is similar; that is, siliceous, argillaceous or calcareous. But the difference in structure is most obvious. The lower formations are crystallized and firm; whilst the upper are earthy and loose. The intermediate formations differ from these, as well as from each other, in a manner no less remarkable. A striking character of the transition formation, and which separates it from the primitive and secondary (more properly "tertiary") is seen in the alternation of a series of rocks, in which there is a regular recurrence of similar beds, rendering perfectly obvious, likewise, the limits of this extensive class of rocks. Another characteristic of the same formation exists in the three great formations which hold nearly the same rank in different parts of the globe; They are, 1st, talcose granular limestone, graywacke with anthracite and mica slate; 2dly, syenite and porphyry with crystals of hornblende, and occasionally quartz; 3dly, clay-slate, graywacke and black limestone.

The mica slate with anthracite and clay slate serves as the connecting points of the transition with the primitive; whilst on the other hand, the fine grained graywackes and porphyries, abounding in the crystals of quartz cause it to approximate to the secondary.

The different ages of these formations are likewise indicated by their position. For example, the porphyries of Guanaxuato repose upon a bituminous clay-slate, those of Hungary upon a transition mica slate, whilst those of the Andes, of Quito are situated upon primitive rocks; large masses of graywacke are to be seen in the oldest slate rocks of the transition class; whilst extensive beds of graywacke are met with, whose origin is more recent. In fine the transition class of rocks is distinguishable both by structure and age from the primitive,—the limits of the latter are in general simple; while those of the former are more complex.

When we observe the highly uniform and decidedly crystalline structure in the primitive rocks; when we view this character much less distinctly in the transition; still less in the secondary; and not at all in the tertiary; is it probable that a geologist could be found, who would maintain that they were, nevertheless, all formed at the same epoch?

It is well known, that over an extent of some thousand square leagues, (in Thuringia and all the northern part of Germany,) nine of the upper formations, viz. the transition limestone, the graywacke, the red sandstone, the zechstein with bituminous shale, the muriatiferous gypsum, the oolitic limestone, the gypsum in clay, the muschelkalk, the white sandstone, and the quadersandstein, have been distinguished from each other without the aid of zoological characters.*

M. Cuvier in his theory of the earth after having done justice to the high reputation of Werner observes, that neither M. Werner or M. de Saussure—the geological historian of the Alps, *have described the species of the organic remains in each of the strata, with that accuracy which has now become necessary, since the number of animals already known is so great.*

It is true Werner was not so well versed in comparative anatomy as M. Cuvier, who in this branch surpasses all his predecessors, and probably his contemporaries also; yet I will venture to say to M. Cuvier, that it appears to me he is not acquainted with the merits of Werner in contributing to the promotion of the natural history of organic remains. Far from confining himself to the mere science of mineralogy, in forming his theory of the earth, Werner from the first occupied himself with the study of the different relations of all the classes of organic remains. A genius like his must naturally have perceived that a complete knowledge of these relations was absolutely necessary to a geologist, and accordingly, with such a conviction, he informed himself of all that was known of petrifactions. During his lectures, he often called the attention of his auditors to the importance of forming collections, which besides a complete series of rocks and minerals, to illustrate the formation of our globe, he insisted, ought also to embrace an extensive collection of organic remains, both of vegetables and animals. Neither did he neglect, at the same time, to make mention of the numerous researches and discoveries, relating to those caverns which contained large quantities of animal remains.

Werner also insisted much upon the observation, made, if I mistake not, by M. Lister, more than one hundred and fifty years ago, that the different formations were capable of being distinguished by means of the fossil remains they con-

---

* See Humboldt on the superposition of rocks.

tained; and also, that these relics were first apparent in the transition class, though in a very small proportion; and belonged only to the class of zoophites and testaceous animals. Thus he explained, most decidedly, the antiquity of the marine and terrestrial animals; maintaining that the first possessed the most ancient origin.

It was, when pursuing these investigations, and engaged in the study of the genera and species of organic remains, that, with his customary sagacity, he remarked, how widely those species differ which are the products of more ancient rocks, from such as exist at the present day; and on the contrary, how closely those species which occur in the most recent formations, approach to existing animals.

To conclude, here is another observation of Werner, by which it is proved, beyond a doubt, that he attached a high importance to these studies. He insisted upon the observation that many fossil species are limited to particular rocks, while others, on the contrary, possess a wider distribution; these last appearing to have enjoyed an organization which enabled them to live during a variety of changes, which exterminated those found only in particular rocks.*

My profound veneration for the high merits of Werner has occasioned the foregoing remarks, and which, I trust, have been made with propriety.

### *Geological question proposed by M. Brongniart.*

(Descrip. geolog. des environs de Paris, p. 92.)

"When we have in two formations remote from each other, a difference of structure, but the same organic remains; ought we to refer them to different series, or in consequence of the general and easily ascertained resemblance of the imbedded fossil remains, to consider them as belonging to the same formation, when not opposed to any fact connected with the superposition of rocks elsewhere?"

### *Reply of M. Brongniart.*

"We should not forget that one of the principal objects of geology is to determine the different epochs which have succeeded each other in the formation of the globe, and to ascertain the particular strata which were formed at these epochs.

---

* See Prof. Jameson's notes to Cuvier.

"But we will admit that strata widely differing from each other may be formed at the same moment, not only in different parts of the globe, but even in the same place.

"We cannot deny a conclusion drawn from facts immediately under our eyes; for whatever takes place upon the surface of the globe, belongs to the same geological epoch, and which commenced at the moment when our continents took their actual form: and although this epoch may have a character of stability or repose, in the geological phenomena it presents, which does not permit, except in a few cases, the formation of new rocks; nevertheless, it produces still a few of these for our observation; for example, the lavas of Vesuvius and other volcanos, the calcareous tufas formed in many of our streams, and the siliceous sinters in those of Iceland; all of which, are, mineralogically, quite distinct from each other; but the organic remains they enclose have all the common character of belonging to a creation formed since the commencement of this epoch. To desire a greater number of examples, and of course, proofs of a similar truth, would prolong, unnecessarily, an argument already somewhat extended.

"It is not the same with generations of organized beings; they can be, it is true, destroyed in an instant; but a long time is requisite to create them anew, in order that they may present the number and the varieties of development which they now exhibit. This development requires a long series of ages; or at least of years, which establishes a true geological epoch; during which, all organized beings which inhabit, either the whole surface of the globe, or at least a very large part of it, have assumed a peculiar character of family or of epoch, which, though it cannot be defined, cannot be mistaken.

"I consider then, those characters relating to the epochs of formations, which are taken from organic remains, as of the first value in geology, and as superior to all others, however valuable they may appear: thus, even when characters drawn from the nature of the rocks, (and these are very weak,) such as the height of the strata, the hollowing out of vallies, likewise the inclination and contrasted stratification of beds,—are found in opposition with such as are furnished us by organic remains, I shall allow to the latter the preponderance: for all these effects may be the result of a revolution, or of a sudden formation, which does not form in geology a special epoch. Without delaying to prove this principle by farther arguments, it shall suffice me to cite a single fact. The strata at Calabria have been these thirty-eight years, the scene of the most frightful disorder; horizontal beds have become vertical; entire strata have been transported to a distance and deposited upon those which are different; yet no geologist has proposed to regard these facts as proofs of a different geological epoch. For a change in organized species, circumstances of a very different nature, and catastrophes much more general and of a longer duration would be requisite: in a few days the strata of Calabria have shown us derangements similar to those we witness among the Alps; whilst, five or six thousand years have not given rise to any appreciable difference in the forms, and other characters of organized species.

"I do not however mean to assert that characters taken from the relative situation of strata, (but not from their *evident superposition*,) from their very nature, ought not to be employed with confidence by the geologist in the determination of the different epochs of formations. Alone, or united to those we draw from the nature of fossil remains, they are of the highest value; but I merely contend, and I think I have given reasons sufficiently weighty for my belief, that when these characters are in opposition to those we obtain from the presence of organic remains, the last ought to have the precedence.

"Nor do I conceal that it is necessary to bring the greatest circumspection to the use of these characters; I am aware that it is necessary to know how to distinguish and calculate the influence of distance and of climate upon the different species; that it is necessary to be able to appreciate the apparent and sometimes real resemblances which occur in formations evidently quite distinct, and to recognize some species which have enjoyed the rare privilege of surviving the destruction of their contemporaries, and of constantly remaining the same, amidst all those catastrophes which have taken place around them.

"I am not ignorant either that it is also necessary to know how to distinguish those individuals which have been detached from other strata, and brought by some cause or other into those which are more recent, and how to separate them from those which have lived in places, and at epochs, which the species to which they belong ought to characterize. I under-stand all these difficulties, and am upon the watch against such causes of deception, that introduce into geology those uncertainties which we find in all the sciences, and which require of the geologist, constant attention and labor, in order to select those species from which he ought to draw his characters, and to attach to them their due importance."

### *Remarks upon this reply.*

Upon the reply of M. Brongniart to the question proposed by himself, I observe in general; and in the first place, that it appears to me he does not make a distinction between the words *period* and *epoch;* yet the difference between the ideas which these two words imply is too great to be confounded. *Epoch*, in my opinion, is distinguished from *period* under the relation of duration of a greater or less extent, and also that of consequences which flow from it. *Period* is a progressive succession for a given time, during which many acts succeed each other, or many developments take place at different times and remote from one another. In consequence of this distinction, we say that some facts though very different from each other, as regards their nature and their mode of existence, have taken place in the same *period;* but we could not say or maintain that these different facts took place at the same *time:* they have occurred progressively, at different *times*, though in the same *period;* or in other words, they have taken place at different *epochs* in the same *period.*

By neglecting this logical distinction, we make events contemporaneous, which have occurred at *epochs* quite distinct, and therefore introduce a degree of confusion into the science which is calculated to impair the accuracy of our observations.

We can say that various formations may have been formed in the same *period*, but we cannot say that these same formations were formed at the same *epoch:* such an error would undermine the foundations of the science as relates to the superposition of rocks; a subject which has been so elegantly elucidated by M. de Humboldt.

"But we will admit that strata widely differing from each other, may be formed at the same moment, not only in different parts of the globe, but even in the same place."

I frankly avow my dissent from M. Brongniart, in the opinion here expressed. I cannot imagine how different rocks can be formed at the same time and in the same place. Geology has made us acquainted with a series of formations of quite a different nature, and whose characters are sufficiently distinct to prove to us that they belong to epochs decidedly different.

The mica-slate, the alpine limestone, the sandstones with lignite are rocks whose nature is very different, and I cannot believe that any one would wish to defend the idea that these rocks could have been formed in the same moment and in the same place, whilst every thing announces to us, that they belong not only to *epochs* but to *periods* widely remote. Truly, by admitting such a doctrine, we run the hazard of confounding geological phenomena in such a manner, as, that finally we shall lose the path which alone can conduct us to the true knowledge of things.

M. Brongniart informs us, that whatever has taken place upon the surface of the earth, belongs to the same *epoch* or *period.* I cannot allow, it belongs to the same period with that in which the earth was, when it recovered itself after the last great catastrophe: a *period* continues, but this period is divisible into many *epochs* which are truly distinct from each other. It is true that the organic remains contained in the newer formations, possess all those characters which are common to the tribes now occupying the face of the earth; but it does not follow from thence, that since the organic remains possess a similar character, that different strata ought to be regarded as belonging to the same *epoch* of formation. I allow they may belong to the same *period*, but not to the same *epoch.* Many active volcanos, belong to the *period* in which we live, but not to the *epoch;* and that they do not, is obvious from their ejected matters. For it is ascertained that lavas of the same volcanos, differ at different *epochs;* and we can easily conceive that volcanic products, evolved during a period of thousands of years would differ from each other, and that they would evince by this difference, the distance of the epochs which separate them. The differences, then among volcanic products, are so many proofs that they were formed at different epochs. Organic remains may possess a common character, as well as rocks which are the result of different formations and epochs widely remote. Since the period, successive to the last great catastrophe, the earth has certainly undergone partial derangements, but which have not interfered with the existence of genera of plants and animals. Thus we find, although in formations of different epochs, organic remains, that bear the common character of the *period*. That which is true of the *period*, in which we exist, may not be true of the preceding periods; and totally different formations, belonging to periods widely separated, together with differences among fossil remains, which relate both to their genera and species, prove abundantly, that the opinion of M. Brongniart, is not correct. All that we can safely infer with regard to the past, is, that events have transpired as we observe them taking place now. That is to say, that species of animals have continued to exist, notwithstanding those great changes which the earth has undergone; and that therefore, we find similar organic remains, in strata belonging to different formations, and to different epochs. But we shall continually fall into error, if we admit, from the similarity of these remains, that the rocks which contain them, are contemporaneous and belong to the same formation: such a consequence embraces much more than the ground of the similarity in fossil remains will justify.

I cannot therefore, with M. Brongniart consider those characters connected with the epochs of formations which are derived from the agreement of organic remains as of the first value in geology; and much less, that they ought to have the preference among all other characters how important soever they may be.

Well marked differences, both in different formations and in separate periods and epochs, are, and will continue to be of so high a value in geology that they can never give way to those derived from the similarity of organic remains without introducing perplexity into the science, and neglecting its true principles. But to pursue the remarks of M. Brongniart.

"Thus then" (he continues) "when the characters taken from the nature of the strata, &c. are found to be in opposition to those which we obtain from their imbedded remains, I shall still allow to these the preponderance." It is not at all necessary that the former characters should be in opposition to those derived from zoology: the formations may be of a different nature, and separated by different epochs whilst the organic remains may possess a similar character. The pachydermata, the palæotheria, the anoplotheria, &c. appear to have been destroyed at a period entirely distinct from that, in which our mammoths, rhinoceroses, hippopotamuses, &c. were entombed. The rocks which contain the first may belong to different formations as well as epochs, notwithstanding there exist a resemblance and similar characters among the pachydermata; but we can never deduce (according to the established principles of geology) from such an analogy in the organic remains of this period, that these formations are contemporaneous.

The instance of the confusion in the strata at Calabria mentioned by M. Brongniart, does not prove what this philosopher wishes to deduce from it. "Horizontal strata have become vertical,—entire masses of the formations have been transported and deposited in contrasted stratification, upon other strata." Very well! Let us suppose we had lost all historical trace of this disaster at Calabria, no geologist would regard these masses, as belonging to a distant geological epoch (or period.) In order to shun such an error he would compare the masses which had been displaced and the strata upon which they had been deposited, and from these observations he would be able to explain why they do not belong to a *period* geologically different, though happening at an *epoch* in the course of this *period*, and different from other *epochs* of the same *period*. But, besides, a fact of this kind, isolated, local and confined to so small a portion of the earth, could not compare with those great changes which have taken place at different periods and upon an infinitely larger scale.

To conclude these remarks I subjoin the following observation, concerning the conformity of position among rocks. "There may exist *an identity of structure*, (that is to say of mineralogical composition,) and a *diversity of organic remains*, or *diversity of composition* and *identity of organic remains*. The rocks $\beta$, and $\beta$, situated at remote horizontal distances, between two identical formations $\alpha$ and $\gamma$ either belong to the same, or to parallel formations. In the first case, their composition is similar; but on account of their distances from each other and the effects of climate, the organic remains they contain may differ from each other. In the second case, the mineralogical composition is different, but the organic remains may be similar. We are to regard the words "*identical formations*," "*partial formations*," as indicative of conformity, or of non conformity of mineralogical composition: but they cannot enable us to decide *a priori* as to the identity of the fossils. It is sufficiently probable that the deposits $\beta$ and $\beta$ situated at great horizontal distances, from each other, placed between the same rocks $\alpha$ and $\gamma$ are formed at the same *epoch*, because they contain the same organic remains, and possess the same composition; it is not on that account, equally probable that the epochs of their formation are very distant from each other, when the fossils are dissimilar. We conceive that in the same zone, in a country of small extent that the generations of animals have succeeded each other, and characterized as it were, by peculiar types the epochs of their formations; but beings of various forms at great horizontal distances, may have occupied at the same time, in different climates, the surface of the globe, or the basin of the sea. We may observe farther, that the position of $\beta$ between $\alpha$ and $\gamma$ proves that it is anterior to the formation $\gamma$ and posterior to that of $\alpha$; but there is nothing which, enables us to measure the interval of time which elapsed between the deposition of the strata; and the different isolated deposits of $\beta$ may not be simultaneous."

I have taken my last remarks from the essay of the celebrated M. de Humboldt *upon the superposition of rocks*, because they appeared to me to be connected with those observations which I have taken the liberty to offer M. Brongniart, with that respectful consideration, which I entertain for the merits of so distinguished a philosopher.

## *Observations upon the situation in which Organic Remains are found.*

Among the observations which have been made upon the position of organic remains, this certainly is a highly important one; that different strata belonging to distinct rock formations, or to the same formation, as is sometimes the case, are distinguishable by means of vegetable and animal remains, which appear to be peculiar to these strata, or at least, are but rarely noticed in others. Thus we find in the great coal formation, a large number of vegetable fossils peculiar to this formation, and very unlike existing plants. They are referable to the arundinaceæ, of which, some approach to the genera of the present day; but a greater number belong to an order quite peculiar, and distinguishable by the cortical part, which is covered entirely with regular impressions arising from the petioles of the leaves. This discription of plants is supposed to have an affinity to the order of palmaceæ, and to an anomolous division, constituting an intermediate order between the palms and the conifères. Among the vegetable fossils of this formation, we find the very curious *Phytolithus palmatus*, of Sheinhauer, belonging to the *Lepidodendra*. To which succeed the *Syrengodendra*, and a plant, different from all the rest, described by M. Steinhauer, the *Phytolithus transversus*. But among all these vegetable remains, which occur in the coal formation, there are none which present themselves in such abundance, as those which are allied to the *Conferve*. Another characteristic trait of this formation, in relation to the organic remains it contains, is, that we find in it, a small quantity of animal remains, belonging to the *Testaceous* tribe. We find in it, no remains of animals belonging to a higher order, but in ascending to the strata of bituminous slate, above the coal formation, we begin to meet with those of quadrupeds, and reptiles of the lizard family.

We find, also, nearly in the middle of the Derbyshire Coal formation, in the ninth stratum (counting in an ascending order,) a stratum of a ferriferous rock (iron-stone,) which is filled with different species of *mytile*, which is distinguished by the name of *bande à mouler*. The shells are univalves and bivalves.

The existence of such a stratum, with such organic remains, gives rise to the following question, which I think is is sufficiently important, to be introduced in this place. Do these testaceous remains, among which are *Ammonites*, *Orthoceræ*, and *Terabratulæ*, *Mytilus crassus*, and three species of *Unio*, belong to marine, or fluviatile shells?

Undoubtedly, the *Ammonites*, the *Orthoceræ*, and *Terabratulæ*, belong to the marine class; but we are accustomed to regard the *Unio* as fluviatile, and the *Mytilus crassus*, as fluviatile, also, and belonging to the genus *Anadonta*. Along with Conybeare and Phillips, I doubt myself, if we are not in an error upon this point. I am aware, that conchologists admit the genus *Unio*, as separating the fluviatile from the marine shells: but we ought not to neglect, at the same time, the circumstance that the form of the hinge—admitted as a distinctive character, is common to different species found in the fossil state, and in situations, which render it certain that they belong to the marine class: thus we find in many of the oolites, in the lias, shells, called in consequence of their hinge, *Unio*; occuring accompanied by others, which are indubitably marine; for the reason, that they exist in too great abundance, and too constantly in the same strata, to have been fluviatile, and accidentally introduced. Now some of these *Unios*, so called, which are also found in the oolite, and the lias, are also found in the coal formation; and as it is so probable that the shells of the oolite are marine, we have, I think, very slender grounds for calling those found in the coal formation, fluviatile.

The formation of chalk is characterized by the family of *Echinites*. The quantity of fossil remains of this family alone, is certainly equal to that of all the other species found in it. Thus also the *Ostrea deltoidea* is the most characteristic shell in the oolite formation; whilst in the red marl, we never find a single fossil remain, and, whilst the gypsum, *le gypse à ossemens*, in the vicinity of Paris, owes its name to the quantity of organic remains it contains. I might multiply examples, if I did not suppose, I had already cited a sufficient number. We will then turn our attention to another question which I deem of considerable importance. Is there any constant connexion between the antiquity of strata, and the similarity or dissimilarity of their contained fossils, compared with existing animals?

The more ancient are any strata, that is, the more ancient the formation with which they are connected, the greater will be the dissimilarity of the fossil remains they contain, to existing animals. This observation is generally true, as relates to vegetables, to zoophytes, to vertebrate and invertebrate animals, as well as to quadrupeds, both oviparous and viviparous. And on the contrary, the more recent is any formation, the greater is the resemblance of its contained fossils to living beings. Of this we may satisfy ourselves, by consulting the distribution of organic remains in the different rock formations, and the enumeration of fossil animals according to the epochs of their appearance upon the earth.

The primitive formation of the GRANITE; not yet alternating with gneiss; complete in its constituent parts; unstratified; abounding in quartz; fine grained; destitute of minerals which are foreign to its primitive composition; without subordinate beds of primitive limestone;—the primitive formations immediately succeeding the granite—gneiss, gneissoid granite, granite intermediary between gneiss and mica slate; mica slate, clay slate, &c. forming along with the primitive granite, the great frame-work of the earth at that period,—are destitute of every trace of fossil remains. This is the distinguishing trait of the rocks of this period, and widely separates them from those which succeed.

The period succeeding that of the primitive, less ancient, yet very remote, begins to present us with fossil remains; vegetables, zoophytes, molluscous and crustaceous animals —entirely different from the species we now see, though possessing some analogy to our genera.

If we advance in this enquiry concerning the traces of life, and compare for example, the vegetable remains of different strata—the *Arundinaceæ*, the *Filices*, &c. of the coal formation; the *Exogenites*, the *Endogenites*, the *Calmites*, the *Lycopodites*, the *Phyllites*, of the calcaire grossier, we shall perceive that they all belong to a former world.

Among the animals, the *Ichthiosauri*, the *Pleisiosauri*, the *Palaeotheria*, the *Anoplotheria*, of a more recent period, are so many incontestible proofs of this difference, and therefore of their dissimilarity with the beings of our own time. However, a greater resemblance is visible, in those epochs which approach the period in which our globe has undergone that disastrous catastrophe, commonly denominated the Deluge. Among the animals existing at that epoch, and those of the present day, there is a much greater analogy. Then, the organized world was composed of beings whose resemblance to the genera at present existing, is more distinct: and on this account, it is reasonable to expect a much greater conformity between living beings, and those fossil remains which are found in diluvian deposits, and in such as had their origin nearly at the same epoch.

*As constant as is the relation between the antiquity of strata, and the similarity and dissimilarity of fossil remains with living beings, so much the less, or not at all, does there exist a similarity of climate, between these fossils and those of the living beings which they most resemble.* Those which show this resemblance to existing animals, among the herbiferous pachydermata, are the elephants, the rhinoceroses, the hippopotamuses, &c.; and among the carnivorous, the hyenas; all of which exist at present in warm climates. We are then embarrassed by a singular phenomenon, since the remains of these animals are so widely dispersed, both in the old, and in the new world. Their great number, and the circumstances under which they are found, seem to indicate clearly, that they must have lived in the places where their remains are deposited. But this phenomenon is directly opposed to what we see at the present day; for no one of these animals lives in the northern hemisphere, but on the contrary, in the midst of the torrid zone. It seems therefore, that all connexion with climate, is inapplicable to our present subject. Nor are we able to escape the embarrassment of these opposing facts, by admitting a change of temperature at that period: for we find the Russian mammoth provided with a covering perfectly adapted to a severe climate. All that it is permitted for us to say here, is, that these animals have been able to exist in the different countries where we have found their remains. This compels us to suppose that during the existence of these animals upon the earth, there was a climate very different from ours; more uniform, in which they could live and propagate as other animals in their native country.

In admitting this as the most probable reason, it follows as a necessary consequence, that we are not obliged in order to explain the occurrence of these remains in the northern hemisphere, to suppose that they were transported thither by great currents of water; nor have we occasion to calculate the epochs of their transportation; from whence it follows also, we have no farther occasion to go in pursuit of proofs of epochs, drawn from the strata, which, it has been supposed, contain the evidence of them.

Whatever is true in relation to animal remains, must be so likewise with regard to vegetables, of which similar genera live at present, only in warm climates.

Such a proposition, which appears to me very probable, gives a new aspect to the notions which have been formed, respecting this early period, and invites us to enquire into the most probable causes, which might have operated to bring about the phenomena, to which we have just recalled the attention of geologists. More extended researches, and more complete discoveries will place us in a condition to form a comparative fossil physiology, to be added to the comparative anatomy of a similar nature; for which we are indebted to the modern Pliny of France. It is therefore much to be desired that another Cuvier should appear to fulfil a task so important in the natural history of the earth.

## *Desiderata in Geology.*

That some geologist will prepare with care, a systematic description, by means of which we can determine the genera and species to which fossil remains, both vegetable and animal, belong. The materials for such a work exist; but are distributed through a great variety of works; as those of Cuvier and Brongniart, of Parkinson, of Sternberg, of Steinhauer, of Schlottheim and others. As far as I am acquainted, there does not exist a systematic catalogue of this nature; by which we can obtain an exact determination of the species, or by which we should be conducted to a knowledge of their resemblance to the animals and plants of the present day. Such a system would teach us also, which of the classes, orders, and families of organic bodies, present the greatest number of analogies with living beings; and in what proportion the number of the genera and species augment, as the deposits in which they are contained, become more recent.

The author of such a work, should be equally well versed in geology, as in botany and comparative anatomy; for without such an union of knowledge, his work would always be defective in those scientific details and general conclusions, which ought to belong to it.

With the necessary knowledge, he would be enabled to make a just comparison of fossil remains among each other, and with those at present existing in our lakes, rivers, and seas; from which would result the complete determination of the similarity and dissimilarity, which may and ought to exist in relation to this subject.

From his geological knowledge he would be able to distinguish precisely to what extent, the order observed in the superposition of transition, secondary and tertiary formations, is in harmony with those analogies with which the types of the formations present him. By these researches he would perceive if these types succeed each other in a regular manner:—after the graywacke passing through the black limestone of the transition, the sandstone of the coal formation, the alpine limestone, the chalk; from thence to the tertiary gypsum, lacustrine formation; and finally from the diluvial deposits, to those of the alluvion: he would be in a condition to demonstrate whether these types succeed each other in the order which has been adopted in the systems of natural history; in fine, he would be able to classify its different beings according to their structure, which would become a more difficult task, as other systems of organs were added to those already observed.

Such researches, directed by a skillful hand, by a philosophical mind, and a judgment quick, clear and correct, would lead to a solution of the great problem, whether the distribution of organic remains in different strata of the different formations separated by periods, indicates a progressive development of vegetable and animal life upon our globe.

I also hope that such an undertaking may not omit also, the attempt to explain the subject of climates, their relative distribution, in particular, before the catastrophe of the Deluge.

I trust moreover, that the two following questions may be definitely resolved.

1. Ought we to separate a formation, the unity of which has been acknowledged from the relative position, and identity of the beds which are interposed equally through the superior and inferior strata, for the single reason, that the former contain (supposed) fresh water shells, and the latter salt water shells?

2. Is the total absence of organic bodies in certain masses of the secondary and tertiary formation a sufficient reason for regarding these masses as distinct formations, where other geological facts do not justify this separation?

---

## Art. XIII.—*Analysis of an "Essai sur la temperature de l'interieur de la Terre, par M. Cordier, 4to, pp. 84. Lu à l'Academie des Sciences, 4 Juin, et 9 et 13 Juillet, 1827;" With observations; by* Thomas Cooper, M. D. &c., President of the College of South Carolina.

The supposition of a central fire is of long standing: it is found in the ancient mythological notions of Pyroplegeton and Hephastos. No wonder. In the early times of the present surface of the earth, volcanos, eruptions of lava, earthquakes, cataclysms, debacles, deluges, were events of frequent occurrence; more so than in our days, when near two hundred volcanos, in a state of activity, serve as safety-pipes to give vent to the gases and vapors generated in the igneous mass below.

"This opinion of a central fire slept, till it became obscurely revived by Des Cartes, Halley, Mairan, Buffon, and others; to whom it was suggested by some or all of the following considerations:

"The figure of the earth; a globe flattened at the poles; pointing to an originally fluid state as necessary to produce it by revolutionary motion.

"Certain astronomical phenomena.

"The mobility of the central mass, producing magnetic action.

"The difference of temperature at the surface and at small depths.

"Experiments on the cooling of incandescent bodies.

"These considerations, however, failed to produce general conviction; and the aqueous fluidity of the globe, a theory advanced by Pallas, Dessaussure, Werner and his disciples, obtained the ascendancy in public opinion. This theory supposes the aqueous liquidity of the whole matter composing the globe of the earth, and its gradual solidification, one stratum after another, from the centre to the surface, by crystallization in water; volcanos being nothing more than the accidental results of peculiar localities.

"This (Neptunian) theory of Werner, has been losing ground from the close of the last century to the present time. It may now be considered as universally abandoned."

It has been found, especially, that the substances ranked by Werner under the denomination of floetz-trap, have so strong an analogy in their appearance, their composition, mechanical and chemical, their position covering indiscriminately all kind of strata, and other circumstances, with known ejections from volcanos, that their igneous formation hardly admits of doubt. That these layers, strata and irregular masses formed over rocks of every age and formation, are often traceable to manifest craters of extinct volcanos; and have, in other cases, so many analogies with known volcanic ejections, that the conclusions as to their igneous nature are nearly irresistible.

"In aid of this last and modern theory, (the Plutonian,) come the experiments on the radiation of caloric into atmospheric space; the communication of caloric from molecule to molecule; and certain mathematical considerations of a general nature; as well as the small distance to which solar heat penetrates into the surface of the earth; and the depth where a fixed temperature has been constantly observed. Late experiments also have shewn, that the temperature of mines and deep cavities uniformly increases as the depth from the surface increases; in proportions somewhat varying, indeed, but calculated on an average at about one degree of the centigrade thermometer for each thirty or forty metres, (ninety-one, to one hundred and thirty-one English feet.)

"Hence, the conclusion has gradually prevailed that the earth possesses a central heat of its own, and an internal igneous fluidity that takes date from the very commencement of the existence of our globe: that the crust of the earth has gradually been hardened by radiation and molecular communication of caloric from stratum to stratum."

How long it has taken to produce this gradual coolness and consolidation of the present crust of the earth, we have not the means of conjecturing in the present state of our knowledge.

"La Grange and Dolomieu were the first who returned to the old theory of central heat. Hutton, and his commentator, Playfair, followed. Lately, M Fourier, in his Researches respecting the general theory of heat, was led the same way. The subject was also taken up by the much lamented M. de la Place."

The publication of M. Faujas de la Fond on the extinct volcanos of Viverais and Velay, the account of central France by M. Giraud de la Soulavie, and the elements of geology by M. Breislak, have added strength to the modern theory. In England, Mr. Kirwan and Professor Jameson adopted Werner's theory; but Hutton and Playfair, Gregory Watt and Sir James Hall, the disciples of Hutton, Sir George M'Kenzie, Dr. M'Culloch, Mr. Conybeare, and Mr. Scrope, have greatly contributed to change the geological opinions of the British public in this respect. At present the igneous fluidity of the central mass of our earth, and the igneous origin of floetz trap, may be regarded as the settled theories both of the British and continental geologists. Werner seems to have suspected the untenable character of his own opinion as to the aqueous origin of the floetz trap formation, when, being at Paris, he refused the pressing invitations to visit Auvergne.

"If the proofs hitherto adduced in favor of central fusion be sufficient, we ought to consider this theory as fully established: if not, further experiments ought to be instituted that shall set the question beyond reasonable doubt.

"One of the elements of this problem, that which seems to needs further investigation most, is the permanent increase of temperature in descending from the surface towards the centre of the earth. It may be asked, are the experiments, already made, sufficiently exact? Have they been sufficiently examined and criticised as to the manner of conducting them? Are the consequences deduced from them, legitimate and conclusive of the question? Let us therefore, in the first place, examine the experiments which have already been made with this view; secondly, let us give an account of the experiments which we have instituted ourselves for the same purpose; thirdly, let us designate the results and conclusions they afford.

"*On the experiments hitherto made as to subterraneous temperature.*—These relate, to the temperature of natural springs.

"The temperature of natural and artificial excavations: these have been pushed as far as four or five hundred metres, (one thousand six hundred and forty English feet.)

"In France, we possess observations on the temperature of the cave under the Observatory of Paris, during one hundred and fifty years; lately brought to perfection by M. Arago. Those made by M. Gensanne, in the mines of Girmagny, about the middle of the last century; the experiments of M. D'Aubuisson, in the mines of Brittany, in 1806.

"In Switzerland, we have the experiments made by De Saussure, about forty years ago, in the salt mines of Bex.

"In Saxony, we have those of M. M. Friesleben and Humboldt, collected in 1791; those of M. D'Aubuisson, in 1802, and especially those of M. Trebra, in 1805, 6, 7 and 15.

"In Great Britain, we have a great number, from 1815 to the present time; by Messrs. M'Lean, Reed, and W. Fox, in Cornwall and Devonshire; and by Messrs. Bald, Dunn, and Fenwick, in the coal mines of the north of England.

"Nor ought we to omit those made by Humboldt, in the mines of Peru and Mexico, at a former period."*

---

* These experiments may all require to be further considered, before the conclusion is permanently established: therefore the authorities cited by Cordier, are inserted here.—*Reviewer.*

Experiments made *in France.* See Dissertation sur la Glace par Mairan. Paris, 1749, in 12mo, p. 60, et suiv. Journal des Mines, tom. 21, p. 119.

*In Switzerland.* De Saussure, Voyages dans les Alps, 1088.

*In Saxony.* Ann. de Chim. et de Phys. tom. 25, p. 210. Description des mines de Freyberg, tom. 3, pp. 151, 186, 200. Journal des Mines, tom. 11, p. 517; tom. 13, p. 113. Annales des Mines, tom. 1, p. 377; tom. 3, p. 59.

*In Great Britain.* Ann. de Chim. et de Phys. tom. 13, p. 200; tom. 16, p. 78; tom. 19, p. 438; tom. 21, p. 308. Geographical distribution of plants, by R. J. Winch, p. 51.

The number of mines subjected to these experiments are more than forty: the number of experiments amount to about three hundred. Many observations of less importance, made not expressly, but accidentally, in mines and caverns of other countries, are omitted. They generally relate to the temperature of the air, and the results are analagous to those made more carefully elsewhere.

It is necessary to examine with much care experiments in a small way, when we mean to draw conclusions from them affecting the heat of the great mass of the globe. Suppose, for instance, the error to be one degree in excess for each one hundred metres, (three hundred and twenty-eight feet,) it would cause in the calculation an error of five hundred metres too near the surface in settling the depth at which water boils.

> "With these precautions in view," says M. Cordier, "I made experiments for myself, at the mine of *Littry*, near Bayeux, Department of Calvados, where the shaft opens sixty metres above the level of the sea: at the mine of *Decise*, to the north of the town of that name, in the Department of Nievre, elevated one hundred and fifty metres above the sea: at the mine of *Carmeaux*, Department of Tarn, north of Alby, two hundred and fifty metres above the level of the sea. These experiments were made in 1822 and 1825, with a mercurial thermometer, carefully compared; and with the aid of M. M. Arago and Matthieu, the degrees were all reduced to the centigrade division of the standard at the Observatory at Paris. In the present memoir, the centigrade division has been employed throughout."

M. Cordier then enters into an elaborate investigation of the sources of error, arising from the circulation of air from the bottom of the mine toward the top; from the intermixture of the external air; from the changes produced in the air by the infiltration of water into the mine from above; from the corrections required for the effect of candles, the presence of workmen, and the heat of their bodies and their

---

*In Peru and Mexico.* Ann. de Chim. et de Phys. tom. 13, p. 207.

The British experiments may also be found in their philosophical periodicals, for these twelve or fifteen years past. Some are more, some are less exact. Most of them liable to objections, noted by Cordier, in the progress of the present memoir; but all *tending* to the same conclusion, that *the globe of our earth, under the crust forming its surface, has always been, and now is, in a state of igneous fusion.*

breath. In some mines, all these causes of error exist; in mines long abandoned, very few of them are found; but making every possible allowance, with all the accuracy that the present state of our knowledge admits, the *general fact* of the increase of heat in proportion as we descend from the surface, remains untouched.

From page 10 to page 38 of this memoir, the author is occupied in examining the defects to which former experiments are liable. He reduces many of these experiments into a tabular form; exhibiting the authors, the places, the dates of the observations, the mines, the depths, the temperature of the mine, the mean temperature of the country, and the depth corresponding to an increase of one degree of the centigrade thermometer. On these experiments he makes the following remarks:

"1. The imperfection of the thermometers; from original inaccuracy, and from inaccuracy proceeding from the effect of time on the mercury, and on the bulb. On the necessity of a previous verification of the mercurial scale.

"2. The difficulty of ascertaining the mean temperature of the place. In this, (and indeed in all other respects,) the experiments made in the abandoned quarries under the Observatory at Paris, are more free from objection than any others that have been made elsewhere; they are also more accurate, and longer continued.

"3. Doubts may arise on the absolute depths of the mines subjected to observation. The openings of mines are usually below the medium level of the country.

"4. Observations made on the temperature of springs of fresh water, of artificial fountains, of large streams sufficient to turn a mill at their first exit, may be used, provided care be taken to observe whether they are not influenced by surrounding mountainous regions, and other local circumstances.

"5. The old opinion of the effect of decomposing pyrites, is now abandoned by those who possess the modern geological information. Pyrites is not so abundant any where, even in the roofs of coal measures, as to produce any notable effect: nor is the decomposition of pyrites easily effected, unless they be broken in pieces; for their decomposition proceeds by one surface after another."

He instances this, from the pyrites in the coal mine of St. George Lavencas in Aveyron.

Cordier then proceeds to the conclusions that may reasonably be drawn from the experiments passed under review.

"1. Setting aside some of them, as being too uncertain and inaccurate to be reasoned from, all the others announce, in a greater or less degree, a notable increase of temperature on descending from the surface of the earth towards the interior: this conclusion may reasonably be allowed.

"2. The results collected at the Observatory of Paris, are the only ones which enable us with something like certainty, to express the law of this increase of temperature, viz. one degree of the centigrade thermometer for twenty-eight metres in depth. (That is, 1,8 of Fahr. for about ninety-two feet.) Hence in the locality of Paris, water will boil at the depth of two thousand five hundred and three metres, (about eight thousand two hundred and twelve feet English.)

"3. Very few of the other results furnish numerical expressions sufficiently approximative of the required law, to be of use. These expressions vary from fifty-seven to thirteen metres for one degree (cent.) of increased heat. The mean of them announces an increase more rapid than has usually been admitted. The concurrence of this testimony to the general fact, is of weight, inasmuch as they comprise the result of several series of local observations.

"4. In grouping by countries, the results admissible on whatever title; I incline to think," says Cordier, "that the results collected at the same place, depend upon, and are connected with, not merely the imperfection of the experiments made, but a real irregularity in the distribution of subterranean heat from one country to another.

"The observations hitherto published, possess therefore a real value, efficient and incontestable. But others are still wanting: and I proceed to give an account of those that I have made myself.

"*New and direct experiments on subterranean temperature*, (by M. Cordier.) I preferred coal mines: because the branching excavations are carried to a considerable distance from the shaft: because from the ease of working them, the excavations advance rapidly, and are not so liable to be affected by external circumstances: because it is easy to make speedily and with great ease, deep holes in these mines: in which the temperature can be ascertained free from opposing circumstances. The bulbs of the thermometers in these experiments were enveloped in seven folds of silk paper; so, however, as to admit the degree on the scale to be easily come at. They were kept in a tin case. They were so constructed, that being immersed in melting ice, they took but twelve minutes to descend from 15° cent. to 0°, plunged 5 decimetres in a mass of moistened sand, in a cellar they took twenty minutes to arrive at the temperature of the cellar, losing eight degrees of their initial temperature.

"The first set of experiments, were made at the coal mines of Carmeaux, September, 1825. The mine was 316 metres (1028 feet) deep, with one air shaft. There was a gallery 62 metres long, made about four months past, perfectly dry. The external air was 24°. Hardly any circulation of air took place in the gallery: at 4 decimetres from the ceiling, the air was 23° 6′. A hole was bored in the coal, in a corner of the gallery, 65 centimetres deep, and 4 in diameter, with an inclination of 15°. It took six minutes to make the hole. The thermometer was inserted, and the hole stopped with paper After an hour, it indicated 19 5′. The temperature of a well, 11,5 metres (37 3-4 feet) deep, was 13° 15′. The hole in which the thermometer was inserted, was 192 metres (630 feet) from the surface. Hence, 192 metres less 11,5 = 180 metres produced an accession of heat of 6° 35′: about one degree for 28,42 metres in depth. In another experiment at Ravin, there was an accession of 3° 95′ at 170,4 metres deep: or one degree for 43,14 metres.

"The rays of the sun do not produce any appreciable effect; for by the experiments of M. de Saussure they take six months to become sensible at ten metres (thirty-two feet) deep. Voyages dans les Alps § 1423. Annales de Chim. et de Phys. tom. 30, p. 396, by M. Arago. In the cave under the observatory at Paris, twenty-eight metres deep, (91,86 English feet,) the thermometer never varies, during the whole year, more than one-thirty-third of a degree.

"In three other experiments made at the coal mine of Decise, one gave one degree of the Cent. thermometer for 15,16 metres; another one degree for 15,52 metres; and another one degree for 14,81 metres. At Littry the accession of heat appeared to be one degree for 19,28 metres."

At Carmeaux, Cordier made ten experiments; at Littry as many; and at Decise the same number. The average accession of heat, was one degree for thirty-six metres at Carmeaux: one degree for nineteen metres at Littry: one degree for fifteen metres at Decise. Average one degree for twenty-three and one-third metres deep. Paris observatory one degree for twenty-eight metres.

M. Cordier, after these details, proceeds to draw the general conclusions which he thinks they suggest. But in this stage of our analysis of this important paper, we think it right to make two or three observations, including a notice of the circumstances which in our opinion he has not sufficiently adverted to.

1. These experiments, some more, some less carefully conducted, those of M. Cordier being the least exceptionable, all lead to the conclusion of the temperature increasing in proportion as we descend into the interior of the earth. But it is a prodigious leap, from these experiments in a small way, to the igneous liquidity of the central mass. Temperature increases one degree for each twenty-eight metres; therefore the centre of our globe is in a state of igneous fusion! Intermediate facts seem necessary before we arrive at such an immense conclusion. So far from denying, we readily admit, the igneous fusion of our planet: but Cordier's experiments on the temperature of mines are not of themselves sufficient to prove it.

Better proofs exist, in the flattening of our globe at the poles, which the latest experiments seem to fix at $\frac{1}{295}$,5: a result requiring liquidity. But the most decisive, and in our opinion incontestible proof, is, that glassy obsidian and pumice, half fused cinders, and trachytes, pearl stone, &c. are actually ejected from volcanos in a state of absolute fusion in some instances, and high incandescence in others: and that these fused and red hot ejections are not owing to coal set on fire, as Werner supposed, but are situated far below the coal formation, in the granitic crust; of which, fragments are often ejected. The mass of which these igneous and fused ejections form a part, must itself be in igneous fusion, and incandescent. But this is the central mass below the granite crust.

2. The subterranean heat will depend in some degree on the depth of the strata of which the crust of the earth consists, at the place of observation. Thus, a cavity of twenty-eight metres in the granite, will be nearer the central mass than at a coal mine, or in the surface stratum of the Paris basin, or the London gravel. What allowance ought to be made for these variations in proximity to the central mass, we have no present means of conjecturing beyond the measurements collected by Conybeare in England: but it appears to us, that it forms an element not to be neglected in resolving the problem under consideration. Captain Sabine's observations on the variation of the pendulum look the same way.

3. No allowance is made for the caloric given out at great depths, in proportion as the lower part of the column of atmospheric air is condensed by the weight and pressure of

the superincumbent column. Would not this account for much of the caloric extricated at great depths?

" *On the conclusions deducible from the preceding experiments.*

" 1. The earth possesses within itself a source of heat, not dependant on the rays of the sun: A heat which increases rapidly as we descend deeper.

" 2. The law of this increase of heat is not the same every where. It may be double or triple at one place, what it is at another.

" 3. Nor do these differences depend on latitude or longitude.

" 4. The increase of temperature is more rapid than was suspected. It may rise to one degree at thirteen metres deep in some countries. The average cannot exceed twenty-five metres.

" *Applications of these facts to the theory of the Earth.*

" 1. All the phenomena agree with the mathematical theory of heat; and with a high temperature belonging to the earth itself from its very origin. As the mass of *solid* matter in the earth is ten thousand times greater than the *liquids*, the original liquidity of our globe must have been owing to caloric, and not to water.

" 2. Suppose an increase of one degree for each twenty-five metres (eighty-two feet) in depth, the temperature of our globe at its centre would be thirty-five hundred degrees of Wedgewood's pyrometer, or two hundred and fifty thousand degrees of the centigrade thermometer.

" 3. The temperature of one hundred degrees Wedgewood, sufficient to melt all the lavas, and most of the known rocks, would be found at fifty-five leagues or five thousand metres deep at Carmeaux, at thirty leagues at Littry, and at twenty-three leagues at Decise. Numbers, which agree with 1-23, 1-42, 1-55 of the mean radius of our planet.

" 4. It is probable, therefore, that our earth is a star partially cooled, as Des Cartes and Leibnitz thought: and that the centre still preserves its original fluidity.

" 5. If we consider on one hand the generality which the observations of Dolomieu on the situation of the eruptive fires, (Rapports sur ses voyages Journ. des Mines, tom. 7, p. 385,) and our own (Cordier's) experiments on the composition of lavas, (Recherches sur differents produits volcaniques Jour. des Mines tom. 21, p. 249, tom. 23, p. 55. Memoir sur la composition des Lavas de tous les ages Journ. de Phys. tom. 83, p. 135,) have given to volcanic phenomena—and on the other hand, the great fusibility of the ejected matters of ancient and modern volcanos, we must conclude, that internal fluidity begins in many places at a less depth than where the heat rises to one hundred degrees of Wedgewood.

"6. The crust of the earth, (deducting the superficial and incomplete pellicle called secondary,) being formed by cooling, it follows that consolidation takes place from the outside toward the inside: of consequence the primitive strata, nearest to the surface, are the most ancient. In other words, the primordial formations are so much the more recent as they belong to a deeper level; which is in opposition to the notions of modern geology."

Not so: those who admit the igneous fusion of the mass under the crust of the earth, cannot but admit that consolidation must take place by successive interior layers of the fluid mass, adhering to the inside of that stratum contiguous to it, and already formed; owing to very slow and gradual radiation and molecular communication of heat. This is a consideration that geology has already contemplated, and must at once be allowed; for the formation of granite veins shooting into the gneiss and other superincumbent rocks, can no otherwise be accounted for. So, dykes must be more recent than the disrupted rocks.

"7. M. Fourier," (Remarques generales sur les temperatures du globe, et des espaces planetaires. Annales de Chim. et de Phys. tom. 27 ann. 1824, p. 326. Et resumè theorique des propriétés de la chaleur rayonnante par le meme: meme tome p. 275,) "in considering the distribution of subterranean heat at accessible depths, the temperature of the poles, and the fact of radiation toward planetary space, has demonstrated that the earth continues to cool. This cooling is not sensible at the surface, because it is compensated almost completely by the heat propagated gradually from within toward the outside; and which fact and theory are fully competent to explain. The loss of heat, therefore, has no influence but at very great depths; whence it results that the crust of the earth continues to increase interiorly by newly formed solid layers. The formation of primitive strata is constantly going on; and will only cease at some very remote period, when the operation of cooling has attained its limit."

These observations will enable us to account for elephants' bones, and fossil plants, seemingly the growth of warm climates, found in Siberia, and other northern regions. Perhaps it may incline us to doubt whether the charming letters of M. Bailly Sur l'Atlantide, are not something more than a philosophical romance.

" 8. If the crust of the earth has really been thus formed, the primitive strata, known to us, ought to be disposed nearly in the order of their fusibility. I say nearly, for it ought to have some effect on the rapid action with which the process of cooling took place at its commencement; and of the action also of chemical affinities operating on such immense masses.

" 9. Hence, the mean thickness of the crust of the earth does not exceed twenty leagues of five thousand metres, (about sixty-two miles English.) I would even say, that according to some geological data not yet followed out, and to which I shall on some future occasion return, the mean thickness is much less. Abiding by the result above mentioned, this mean thickness would not quite equal one-sixty-third part of the mean radius of the earth. It would be but the four-hundredth part of the ascertained length of a meridian."

M. Pallas somewhere calculates the thickness of the primitive formations at twenty-one miles. In travelling along the main road from Richmond to Charlottesville, in Virginia, the reviewer of this paper and Mr. Vanuxem noted, as well as we could, the distances at which the strata changed, from the granite at Richmond, to the disappearance of the primitive; and we thought the primitive strata, thus passed over, could not be less in thickness than forty miles, making the usual allowance in calculation.

" 10. It is probable that the thickness of the crust of the earth is very unequal. This seems to follow from the increase of subterranean temperature from one country to another. Difference of conducting power, is not alone sufficient to account for the fact. Several geological data tend also to the same conclusion.

" 11. The heat proper to the soil of each locality, and thence gradually disengaged, being the fundamental element of the climate of that locality (?)—and as in our opinion, (M. Cordier's) the quantity of heat disengaged is not in any constant relation between one country and another, we may conceive how, ceteris paribus, countries in the same latitude may have different climates; and how Mairan, Lambert, Mayer, and other philosophers have failed, when they sought to represent by formulæ the gradation which the mesne superficial temperatures follow, from the equator to the pole; and which they presumed to be regular. We have contributed here a new cause, in addition to those which occasion the singular inflexions exhibited by isothermal lines.

"12. Whatever may be the nature of the forces, or the astronomical events, which have anciently troubled the stability of continents, and produced that general dislocation and overturning which the crust of the earth exhibits, we may easily imagine that all the parts of this crust floating on a fluid mass, and infinitely subdivided by stratification, and above all by the innumerable contractions which cooling has produced in each layer, may have been dislocated and overturned as we actually see has been the case. These effects are inexplicable on the usual supposition of the external strata of the primitive having been last consolidated, and the globe being solid to its centre.

"13. On considering the probable fluidity of the central mass, the phenomena of earthquakes, the trifling thickness of the consolidated crust,* and, above all, the innumerable solutions of continuity which divide the crust of the earth, and which result either from stratification, or from the contraction which takes place during progressive cooling, or from the overturnings which the strata have experienced, we long ago were induced to acknowledge that the crust of the earth possessed a certain degree of flexibility. In a memoir read at the Academy in 1816, we developed the elements of this singular property: but that memoir had the misfortune to be presented at a moment when the public mind was not sufficiently prepared to attend to these kinds of speculation. This flexibility becomes now more probable than ever: we may now conceive moreover, in consequence of the fluidity of the central mass on which this crust reposes, how this flexibility may be affected without our being sensible of it. In fact, to bring about a change of figure in the spheroid capable of elevating the equator one metre, it would be sufficient in relation to the plane of the equator that each of the innumerable solutions of continuity which intersect transversely the solid crust, and which I shall suppose to be five metres separated from each other on the average, should undergo a separation equal to the 1-1276 part of a millimetre: a quantity extremely small.

"14. The probable flexibility of the crust of the earth is actually confirmed by two principal causes: the one general and continual; the other local and transitory. This last cause, considered during the last thirty centuries which have elapsed, has spared no region of the earth. Sometimes it has shaken almost at the same moment the twentieth part of the continents; or else it has produced an undulation in directions equal to the sixth or seventh part of a meridian. I allude to earthquakes. Since

---

* About the one-one-hundredth part of the semi-diameter of the globe, assuming the primitive to be forty miles deep.—*Reviewer.*

the (brief) period when history commences," (and when the diminution in the number of earthquakes at length permitted the earth to be habitable,) "we may count six hundred earthquakes remarkable for violence or extent. The second cause depends upon this, that the permanent diminution of the heat of the earth, no longer produces any sensible contraction in the subterranean regions near to the surface, while its effects still take place in the interior; either augmenting the distance between the masses which have undergone the first effects of contraction, or producing new solutions of continuity in the masses. We may add, that the slow formation of new strata in the interior must be subordinate to the general law, by which liquids contract in bulk on becoming solids.

"15. The less flexible portions of the earth's crust, are those nearest the surface; for the transverse solutions of continuity in them have long ago acquired and lost their maximum of separation. It is evident that the central forces tend to bring nearer together the elementary masses of the surface, in proportion as cooling contracts more and more the bulk of the interior. This process of approach would act uniformly if the layers of the consolidated crust were concentric; and if all the transverse solutions of continuity were found in planes perpendicular to the surface. But it is not so. The state of overthrow of the primordial crust is such, that, considered in its full extent, I can only describe it as a mass of fragments pressing sideways against each other, whose layers are all either vertical or much inclined. Since this state of things took place, the obliquity of solutions of continuity out of number, some of them of prodigious extent, forbids such an approach of elementary masses as shall be uniform, and proportionate to the central contraction. This approach has been replaced by alterations of level, slight indeed, but sufficient to affect continental surfaces of great extent. Many geological facts agree with this hypothesis. We may take for granted that the effect still subsists, although insensibly. If the secular rise of the basin of the Baltic is constant, it may be explained upon our supposition. In the same way we can account for the change of level in the Mediterranean, which we observed in company with Dolomieu, on the shores of Egypt. (See Description des ruines de Sân (Tanis des anciens) dans le grand ouvrage sur l'Egypte.) According to our notions, all that part of the continent of Africa experiences a depression equal to two or three centimetres every century."

The other facts of oceanic retrocession collected in the book entitled "Telliamed," and elsewhere, may be accounted for in the same way.

"16. M. de la Place, regarding the astronomical facts observed in the time of Hipparchus, as sufficiently exact to conclude that the duration of a day has not diminished 1-300 of a centesimal second in two thousand years, thought, that the contraction actually produced by the secular cooling of the globe was not sufficient to increase the velocity of its rotation. This opinion suggests an useful limit to the actual effect of general cooling.

"17. But if we consider the effects of contraction from the commencement of the cooling process, we must admit that some influence in this last respect has actually been exerted. On the one hand, the duration of the day has very slightly been diminished, and, on the other hand, the figure of the earth has been slightly altered in consequence of the increased velocity of its rotation; provided the flexibility of the earth's crust has been sufficient to endure this alteration of figure; which we admit. The day therefore is actually shorter, and the flattening at the poles greater than at the first origin of things. If these data be conceded, the two effects just mentioned are still going on. It remains only to find some better means of calculating this weak intensity; which is not impossible, as we shall see by and bye.

"18. Another consequence, not less probable or curious, to which we are led by the theory of the incandescence and igneous fluidity of the central mass, is this. If the flexibility of the earth's crust be such as we have supposed, the phenomena of tides take place in the crust of the earth itself. We shall not be surprised at this effect, very feeble though it be, if we pay attention to the fact that it certainly did take place at the origin of our globe, and while it was in the perfectly fluid state which *all* hypotheses admit. It would be easy to show that the highest of these ancient tides did not rise less than four or five metres.

"19. The secular refiguration, continually increasing the thickness of the earth's crust, gives room to inquire, whether the incandescent matter submitted to this action passes entirely into a state of solidity, or whether the production of gaseous substances does not accompany the process. So far from this being impossible, the daily coagulation of lavas offers a striking example. This supposition explains very naturally the origin of the first material cause of earthquakes. An excessive temperature keeps this first material cause in a gaseous state, notwithstanding the influence of immense pressure at the depth we are now considering. The capricious phenomena, earthquakes, may depend also on the great inequality of the interior surface of the crust of the earth.

"20. These data lead to a new explanation of volcanic phenomena, which, to the very few persons who have a just notion of the elements of this question, may appear more satisfactory than any heretofore suggested. These phenomena appear to us a plain and natural consequence of the cooling of the interior of the globe—a mere thermometric effect. The internal fluid mass is submitted to an increasing pressure produced by two forces of immense power; although the effects are slow, and scarcely sensible in their gradual operation. On the one hand, the solid crust of the earth contracts more and more as its temperature diminishes," (from radiation on the outside, and molecular communication internally.) "This contraction is necessarily greater than the central mass experiences at the same time. On the other hand, this envelope, in consequence of the insensible acceleration of rotatory motion, loses its interior capacity in proportion as it recedes from a spherical shape.

"The interior fluid substances are compelled to flow outward in the form of lavas by the process which we term volcanic, and with a precedent production of gaseous matters produced internally during eruptions. Let no one be surprised at this hypothesis: I can render it probable by a very simple calculation.

"At Teneriffe, in the year 1803, I took as near as possible the cubic dimensions of the ejected matters of 1705 and 1798. I did the same by two eruptions more perfectly insulated in the interior of France; in 1806 those of the volcano of Murol in Auvergne; and in 1809 those of the volcano of Cherchemus near Izarlès at Mezin. I found each eruption to have ejected less than a cubic kilometre. On these facts, and others of the same kind which I collected elsewhere, I feel authorized to consider the cubic kilometre as the extreme general term of bulk of volcanic ejections. This is very small, compared to the whole globe. Spread over its surface, it would not be one hundredth of a millimetre in thickness. In exact terms, suppose the crust of the earth to have a thickness of twenty leagues of five thousand metres each, (fifty-seven miles,) a contraction that would shorten the mean radius of the central mass 1-494 of a millimetre would suffice to produce an eruption."[*]

"Proceeding from these data, if we suppose that contraction alone will suffice to produce the phenomena, and that five eruptions annually take place over the whole surface of the earth, we find the difference between the contraction of the consolidated crust and that of the fluid mass to shorten the radius of that mass but one millimetre in a century. If there be but two eruptions annually, the same shortening will take place in two centu-

---

[*] Kilometre 109364 yards English in length. A cubic kilometre is about two and a quarter million of cubic feet English. Millimetre ,03937 cubic English inches.

ries and a half. It is clear that, in all cases, a very minute action suffices to produce the phenomena.

"It will be remarked that this action, if it be real, is necessarily connected with the whole contraction which the globe undergoes from the effect of secular cooling. It furnishes a basis for calculating the very weak influence which this total contraction exercises in accelerating the velocity of rotation.

"Nothing less than this enormous power which I have described, is required to raise lava. In the particular case where lavas come from a depth of twenty leagues, it is easy to prove from their mean specific gravity, that they would be pressed with a force equal to twenty-eight thousand atmospheres. We know moreover that they overflow after an eruption of gaseous matters, which may well be the case on my theory of the subject.

"This is not the place to develope the hypothesis purely thermometric, which I propose in explanation of volcanic phenomena; and to shew how well it applies to all their details. It will suffice to observe that it assigns a reason for the identity of the circumstances which characterize volcanic phenomena every where, of the prodigious reduction in the number of volcanos since the origin of things, of the diminution in the quantity of ejected matters at each eruption, their nearly similar composition at each geological epocha, and the small difference that appears between ejected lavas of different epochs. In short, in this hypothesis, the most usual direction of earthquakes announces the zones where the crust of the earth is thinnest; and the volcanic centers, ancient and modern, point out the thinnest and least resisting portions of this crust.

"In my preceding remarks, I have left uncalculated the gaseous matters which are produced at each eruption; for supposing them reduced to their primitive state of liquidity while in the mixture from whence they have been disengaged, they would occupy but little bulk; and the medium I have adopted, of a cubic kilometre, is much beyond the actual volume of ejected lava."

The suppositions of M. Cordier in this paragraph seem too gratuitous. We have as yet nothing that approaches to proof of the primitive formations (limestone, talcose rocks, clay slate, mica schist, hornblende rock, the gneiss to which all these seem subordinate, and the older small grained granite whereon the gneiss usually reposes,) being from forty to sixty miles thick. No accurate measure of their edges and angles has yet been taken. As yet, all is conjecture. That a lava should require for its ejection the force of twenty-eight thousand atmospheres, is neither probable from any facts known at present, or likely to be made so. There is *no* proof that the crust of the earth admits of no vacuities between itself and the fused mass. There is no proof of its being every where in contact with the fused mass. The phenomena of earthquakes and volcanos indicate continuous cavities of prodigious extent. The earthquake of Lisbon, 1755, which shook all Europe and part of Africa, took a fortnight to travel across the Atlantic, and four hours between Philadelphia and Boston, as appears by the letter of Cadwallader Colden, in Phil. Trans. for 1756. There is no accounting for this, but by means of continuous cavities between the consolidated internal crust, and the fluid mass beneath it. The rumbling noise under ground, attending earthquakes, indicates hollow places. There is no sufficiently probable evidence, beyond Cordier's peculiar notion, that the slight côntraction of the consolidating crust can act upon the whole central mass of the globes, especially if it be, as it probably is, elastic. All Cordier's most ingenious hypothesis (for theory it can hardly be denominated) *may* be true, but it wants farther proof that it is so. The action of steam, and the explosion of the gases of decomposed water, seem, to us, as yet the most probable cause of volcanic eruptions.

"21. The greater part of the substances which mineral and thermal waters contain, being analogous to the exhalations from craters during and after their eruptions, or from lava-currents during crystallization, or from solfaterras, it is reasonable to conclude that they proceed from a common source. The emissions from these waters, lessen continually the interior charge of gaseous matter. This loss, continually repaired by new subterranean products, takes place in consequence of a prodigious expansive force, and by means of very narrow fissures. The water is supplied from above, as springs usually are. The alteration of certain parts of the conducting fissures occasions the substitution of certain principles by others. In this system of explanation, we recognize easily the permanence of the springs, their nearly invariable temperature, and the singular nature of their principles. Many circumstances lead me to think that these thermal waters were more abundant anciently than now, which may be the consequence of the greater thinness of the crust of the earth formerly, and the greater activity of the process of cooling."

These observations apply to many of the warm springs in the United States, which yield sulphur, and sulphuretted hydrogen: but to very few in England, except Harrowgate, and two or three others.

"22. If we judge from the lavas, the fluidity of the incandescent matter which constitutes the interior of the earth would be very great; and its density in places distant from the center, as $\frac{42}{50}$ of the radius, would be much inferior to the mean density of the whole globe." (The density will no doubt be in a certain degree the result of superincumbent pressure.) "These two data are not in opposition to the influence which we must allow to the enormous and increasing pressure ascribable to the central forces. It must however be remembered that liquids are not easily compressed; that this compressibility must have a limit; and that excessive heat may counterbalance its effects. Moreover, lavas actually have a greater mean specific gravity than that of primitive rocks in general: whence we may conclude, independently of any other consideration, that the density of the central substances depends more on their nature, than on the compression they undergo. They have been arranged originally in the order of their specific gravities. The existence of gold and platinum proves that matters of very great specific gravity may be found at the center of the earth."

The obsidians, the pumice, the pearl stones, the volcanic cinders, the trachytes generally, do not possess a greater specific gravity than the average of the primitive rocks. Other lavas, containing a notable proportion of iron, do. We have no proof of the existence of metallic substances near the center of the earth in particular. Gold and silver are found mostly in the primitive and early transition rocks. So are tin, titanium, scheelin, and metallic iron, which could not have been deeply placed in the central mass.

"23. There is some likelihood in the hypothesis of M. Halley, which ascribes magnetic actions to the existence of an irregular mass chiefly composed of metallic iron, and having a peculiar revolving motion at the center of the earth. Two kinds of phenomena, of which Halley was ignorant, add to this probability. One is, that the rotation of Saturn's ring round that planet, may be called in as furnishing a kind of analogy: the other, that the nature of meteorolites, and the existence of meteoric iron, prove that iron in its metallic state, and alloyed with nickel, may enter abundantly into the composition of planetary masses."

The mass of Siberian iron, that in the Lyceum at New York, the mass said to exist near the Mandan village, the masses in the Pampas between Buenos Ayres and Chili, may be cited in addition. But what shall we say of the numerous masses of metallic copper in the talcose district of Lake Superior, which are partly described by Mr. Schoolcraft? Are they not also meteoric? If they be, Cordier's argument may prove too much.

"24. If Halley's hypothesis be admissible, it suggests a limit to the interior temperature of the earth. This limit is the resistance which forged iron subjected to enormous pressure opposes to fusion. We might be tempted perhaps to reduce this temperature, on considering the experiments of Newton confirmed by Barlow, which prove that iron at a white heat loses its magnetic virtue. On the other hand, we must not forget that an excessive compression of the metal is likely to retard the limit where the magnetic virtue is thus destroyed.

"25. In fine, in adopting this hypothesis, we shall be justified in examining some very feeble effects, secular, and not hitherto perceived, which the various positions and irregular figure of an interior solid mass, possessing a peculiar motion, and partly composed of metallic iron, might occasion. For instance, we should be led to doubt the perfect and absolute invariability, which we have hitherto ascribed to a plummet line in every place: this doubt would extend to countries situated far from the bands or zones without declination, and from the magnetic equator.

"Such are the principal deductions to which we are led by introducing the hypothesis of heat and central fluidity, in the midst of questions of the highest importance to geology. It would be easy to extend these inductions; and to explain for instance in a satisfactory manner the formation of primordial, unstratified rocks, those of the intermediate (transition) districts, veins, gypseous, sulphurous, saline, calcareous and magnesian strata of the secondary class. The fecundity of application is remarkable; and tends to prove the probability of the theory. This would not be the case with the Neptunian hypothesis, which has reigned so long, and which represents our globe as a mass solid even to the center, cold, inert, and formed throughout of aqueous depositions.

"This system has remained barren; and no part of it will now bear an accurate examination. It is now reduced to narrow limits, to the explanation of those superficial layers formed of consolidated sediment, conglomerated fragments, and organic remains, which form, almost entirely, the very thin covering which is called the secondary set of formations. Had not the authority of the scientific men who brought this Neptunian system into credit produced an illusion, it would long ago have been subjected to the very simple proof which it could not have resisted, viz. the comparison of the masses of water with the earthy and metallic masses which enter into the composition of our globe. It would be easy to establish that the weight of the whole mass of water, does not exceed a fifty thousandth part of the weight of the whole globe. Acuate the solvent power of this aqueous fluid as you please, it is impossible to make one kilogramme of water dissolve fifty thousand kilogrammes of earthy and metallic matter.

"We must be permitted to say, that we have not been brought back to the theory of a central fire by any spirit of system, but in opposition to system, and in spite of prejudices. The force of fact has produced this change of opinion; it results from considerations carefully reflected on, and from phenomena of a very different order. Above all we cannot believe that it is by mere accident that natural philosophy, astronomy, and geology have arrived at the same point by such different routes. We may therefore without hazard assert that an hypothesis equally necessary to all these sciences seems to put on the characters of a real and fundamental principle; and we may expect it will, by and by, have as happy an influence on the theory of the earth, as the great principle of gravitation has had on the theory of planetary motions.

"At this point of our knowledge, it should seem that the Academy ought not to remain a stranger to so great a question. Perhaps it is now time to follow up a measure proposed on the 28th November, 1825, by M. de la Place.* Perhaps it would be proper also to engage the coöperation of all our scavans by distributing the elements of the question as subjects for prize. The Academy was occupied during the whole century in determining the figure of the earth. An investigation of the principle that presides over the structure of our globe, and governs all the phenomena belonging to it, is not less worthy of the efforts of the Academy, nor beneath the means at her disposal. The end proposed is certainly among the grandest upon which hnman ingenuity can exercise itself; and success would be interesting to the whole body of science. If the earth be not that inert mass which it has long been supposed to be, if the appearance of inertia be solely ascribable to the slow development of the phe-

---

* The proposal was, to name a committee of six members, Messrs. La Place, Arago, Poisson, Thenard, Gay Lussac, and Dulong, to draw up a programme of experiments to be executed: so that the Academy might determine by exact experiments—1. The state of the magnetism of the earth. 2. The pressure and composition of the atmosphere. 3. The heat of the globe, at different depths.

nomena, and the weakness of intensity in their progress; if every thing in the interior is at work, as every thing is on the surface, we arrive at a most important result; since the remark is also applicable to the whole planetary system; and thus we obtain a proof of the most powerful kind, of the existence of the great principle of *universal instability*, which was announced or perceived by Newton and other philosophers.* A principle superior to all those great rules which we have been accustomed to regard as constituting exclusively the Laws of Nature. By the aid of this principle, we look beyond the most distant periodicities, which have hitherto been regarded as the most perfect portions of our solar system. A principle that seems to govern the universe to its minutest atom; which modifies incessantly all things; which alters and displaces them, insensibly and without return; and which forces them along with it through an immensity of ages, for new purposes which the human understanding is incompetent to fathom, but of which it may feel proud to have exhibited the necessity."

Such is the substance of M. Cordier's most interesting paper. The Neptunian hypothesis was in articulo mortis before he wrote; it is now consigned to the resting place "of all the Capulets," never to be revived.

Many difficulties remain, on Cordier's hypothesis, which he will have to account for. If the cooling of the mass began with the sienites, next to the transition series, thence to the limestone and talcose rocks, then to the clay slate, mica schist, and gneiss, why are not these rocks found composing the highest peaks and eminences, instead of the oldest granite, and porphyry? though indeed the latter is found in company with the sienite nearest the transition. The period of the conversion of steam into oceans and rivers, the average depth of the ocean hardly yet settled by astronomers, the great probability of earthquakes being either the effect of steam, or the explosion of oxygen and hydrogen from decomposed water, and many other circumstances, yet remain to be explained. When I have leisure to compare the notions of M. Cordier with those of Mr. Scrope, you may perhaps hear again from Your obedient servant,

THOMAS COOPER.

---

* The ancients entertained an opinion that all things were in a perpetual flux.—*Reviewer.*

### REMARKS.

A correspondent inquires, is it not possible that Cordier may have deduced untenable conclusions from his own experiments? By numerous trials, he seems to have shewn, that if a point be assumed at the greatest depth to which solar influence penetrates, the heat increases upwards and downwards from that point. He assumes the increase of heat to the depth of a few thousand feet as the ratio of increase to the centre of the earth. By this principle of calculation, he infers that all the interior of the earth is in a state of fusion, at a depth considerably less than one hundred miles. But if the earth was, at the beginning, highly heated throughout, would it cool in that uniform ratio assumed by Cordier; so that the remaining heat may be represented by a four-sided pyramid whose sides are isosceles triangles? Ought not the remaining heat to be represented by a four-sided pyramid whose sides are the areas of Gothic arches with sides nearly parallel towards the base? The latter would certainly be the true figure for representing the remaining heat of a red hot cannon ball, after it had been suspended by a chain, until its superficial heat should be so far reduced that it could be borne by the hand. According to this method of calculation, the increased temperature demonstrated by Cordier's experiments, would not require the greatest heat, even at the centre of the earth, to be above the red heat of iron.

## NOTICE.

Before closing this article, we deem it proper to mention, that a translation of the entire essay of M. Cordier, (in the form of a neat pocket volume,) has just been handed to us. It is from the Junior Class at the College of Amherst, who, under the direction of the able and active Professor of Chemistry, Mineralogy, &c. in that institution, have favored the American public with the whole of this singular and interesting production. As far as we have been able to observe, the translation is executed with fidelity and in good taste, and will, we trust, command the attention of those who are disposed to inquire into the physical condition of the interior of our planet.—Ed.

## Art. XIV.—*A Description of the Mineralogy and Geology of a part of Nova Scotia; by* Charles T. Jackson *and* Francis Alger.

(Continued from Vol. XIV, p. 330.)

Before describing the capes and islands of trap rocks which project into the Basin of Mines, or are scattered along its northern coast, forming the outskirts of the North Mountain range, and the limits of this interesting formation, it will be necessary to give a brief account of the situation and extent of this sheet of water. The Basin of Mines is a scalene triangular shape, and its longest side being formed by the township of Parsborough and the district of Colchester on the north is sixty miles in length. The next side, which is forty five miles long, is formed by the county of Hants; and its shortest by the county of Kings, for the distance of twenty five miles. The greatest breadth of this basin is from Windsor to Parsborough thirty miles. It communicates with the Bay of Fundy by a narrow, but deep strait called the "Gut," which passes between the majestic walls of Cape Split and Cape D'Or.

This basin will prove interesting to the traveller, not only on account of the delightful villages seated on the banks of some of the many rivers which empty their waters into it, the picturesque and imposing scenery on its borders, and the enormous tides which here rise to the height of sixty feet with fearful rapidity, but also for the remarkably fine illustrations of the geology of the country and the interesting relations of the different formations, which are here presented in an unusually distinct manner. The geologist will delight to circumnavigate the whole extent of its coast and explore the connexions of the different series of rock formations, the highly curious and important junctions of the trap with the sand stone, shale, &c. The collector of specimens in natural history will also be richly rewarded for the perils to which he may be exposed, by the acquisition of many of the rare and beautiful productions of the mineral kingdom.

The most eligible, and only efficient mode of exploring this coast, although not free from danger, is by means of a boat, not so large as to be incapable of being rowed in case of failure of wind; for, besides the difficulty of transporting specimens, the traveller is constantly in danger of being caught, beneath the insurmountable precipices, by the rapid influx of the tides. An accident of this kind having nearly happened to ourselves in examining the geology of Cape D'Or, where we were under the necessity of making our escape by clambering up a mural precipice three hundred feet high, which was effected with great risk of falling with the detached columns on which we depended for support, we think it our duty to warn our successors of such hazards, and to recommend a boat as the ark of safety in such emergencies.

The trap rocks form the extremities of Cape Chignecto, Cape D'Or, Cape Sharp and most of the islands scattered along the northern coast of the Basin of Mines. As each of these places exhibits some interesting geological phenomena, and furnishes many specimens of minerals of remarkable beauty, we shall describe them in order, beginning at the mouth of the basin and proceeding eastwardly along its northern shore.

Cape Chignecto, although it is not situated within the basin, can be more conveniently described here than elsewhere. It is connected with Cape D'Or and projects to the west from it into the Bay of Fundy. This cape was seen only at a distance by ourselves, but the craggy precipices clearly indicated its composition to be of greenstone trap, like the adjacent cape, next to be described. This surmise has since been confirmed by the examination of its structure by our friend Dr. Benjamin Lincoln, who has kindly communicated to us many facts relating to the geology of the county of Cumberland.

The trap forming the extremity of Cape Chignecto, which is the southeastern limit of the county of Cumberland, extends back into the county nearly to Apple River, where it meets the sandstone hereafter to be described, and terminates abruptly; the sandstone coming boldly into contact with the trap, and not dipping beneath it as usually happens. The strata of this rock are nearly horizontal, and Dr. L. suggests the probability of a fault existing in the strata at this junction. This cape deserves a more attentive examination to determine if this be true, as it must have an important bearing on the theory of the origin of trap rocks, and would lead to the opinion that the weight of this superincumbent rock had caused the fragile sandstone to yield to its pressure and thus accomplished the dislocation of the strata.

The next place to be described was the subject of our own examination; and from the great variety of its productions, deserves the particular attention of the mineralogist.

Cape D'Or, situated at the mouth of the Basin of Mines, presents a mural precipice, attaining, in some places, an elevation of four hundred feet above the level of the sea; and is composed of amorphous and irregularly columnar trap, resting on amygdaloid and brecciated greenstone or trap tuff. From the yielding nature of the two last mentioned rocks, which form the base of the precipice, deep caverns and irregular arches have been formed beneath the superincumbent rock, by the beating of the angry surges against the walls, while a shelving platform of trap tuff remains below the surface of the water, and running down beneath the waves, is left exposed only by remarkably low tides. This trap tuff is a breccia composed of angular and irregularly rounded masses of compact greenstone, amygdaloid and red sandstone, united by a softer cement of the same substances. The sandstone at this place occupies but a small proportion of the breccia. The crevices in this rock are frequently occupied by irregular masses of native copper, which generally are indented by the surrounding matrix. They are rarely arborescent, and never distinctly crystallized. Where exposed to the action of the waves, the copper is always bright, and may be seen for some distance beneath the water; but, where it is beyond their reach, it is usually coated with an incrustation of the carbonate or oxide of copper. The individual pieces seldom weigh more than one or two ounces, but masses are said to have been found lying detached among the fragments of rock, one of which weighed fifteen pounds. The name of this cape doubtless originated in the supposition that this metal was gold, and was bestowed by the French emigrants, who were the first Europeans that peopled Nova Scotia. The brilliancy and unusually yellow color of this copper might easily have caused this error, as it led us to suspect it might be an alloy of that or some other metal;—but on chemical examination it was found to dissolve entirely in diluted nitric acid, and gave no precipitate when tested with muriate of soda, or when largely diluted with water, or when treated to excess of saturation with aqua ammoniæ. It does not contain, therefore, any gold, silver, antimony or iron, the only metals suspected to be present. The copper is confined, exclusively, to the brecciated and amygdaloidal trap and never occurs in the superincumbent columnar rock; hence the absurdity of excavating shallow pits into the soil, crowning the summit of the precipice formed by these rocks, in search of this metal, since it exists nearly three hundred feet beneath; this was done by the miners under the direction of an agent from a London mining company, the year before we visited the cape. Large sums of money were expended in this random method of mining, which it is not necessary to add was entirely fruitless, as must ever be the case with such processes when unaided by the light of science; and the project of mining at this place was altogether abandoned. The copper being scattered through the trap tuff, and not collected into any regular vein or bed, renders it highly probable that this metal will never be advantageously explored at this place, and as it occurs chiefly below the level of high water, the shafts would be liable to be filled at the periodical influx of the tide, if indeed the works were not entirely demolished by the violence of the currents. The sanguine expectations excited by the appearance of this metal, in a state of purity, must then be disappointed.

Masses of calcareous spar, and crystals of analcime, tinged green by the carbonate of copper, and having slender filaments of copper enclosed in them, occur in the cavities of the amygdaloid which rests on the trap tuff.

On the eastern side of Cape D'Or, the precipice assumes a concave form, and has received the characteristic appellation of Horse Shoe Cove. Here the cavities in the amygdaloid are of greater dimensions, and are frequently occupied by crystals of transparent analcime, which are grouped together, in congeries of large and small crystals.

Calcareous spar here occurs in long slender hexahedral prisms projecting into, and intersecting the cavities. They are curiously interwoven with each other, and are richly encrusted on their surfaces with small but perfect crystals of stilbite. The specimens are very prepossessing in appearance, and would, from their resemblance, be mistaken for the crystallizations of sugar, which adorn the shops of our confectioners.

The stilbite occurs, also, in radiating groups of crystals, forming beautiful stellæ, which are distributed through the enveloping masses of calcareous spar.

Many other minerals occur at Cape D'Or, but as they are such as we have already noticed as occurring at other places, we shall not here repeat the notice of them, as it is our object to describe only those which are peculiar to the place, or which possess singular beauty, or present remarkable phenomena.

Grey oxide of manganese is said to have been found here, and it is mentioned in Cleaveland's Mineralogy, p. 673, on the authority of Mr. Thayer. We were however unable to discover this substance, or any thing indicative of its presence.—Possibly, the occurrence of magnetic iron ore on this cape, may have occasioned an error in quoting it as a locality for manganese, as the inhabitants have mistaken this substance for manganese, or as they call it "*Magnus*," and formerly sent it, as that article, to the U. States for sale.

Leaving Cape D'Or, we pass Spencer's Island, which is situated about a mile from this cape. It is composed of columnar trap, and adds much to the picturesque scenery of this region, although it presents no objects of natural history worthy of a description. The altitude of this island considerably exceeds the diameter of its base, and standing alone, like a tower in the midst of the waters, it breaks in a degree, the violence of the surge, which rolls into the Basin of Mines from the Bay of Fundy.

Proceeding along the coast towards the east, up the basin we pass the more tame scenery of the sandstone and shale districts to be described hereafter, and do not observe any greenstone trap, until we arrive at Cape Sharp, which is fifteen miles from Cape D'Or. The promontory of this cape is composed of the amorphous trap which scarcely exhibits any traces of columnar arrangement. The trap forms a precipice or "bluff" which exhibits a remarkable contrast to the low sandstone hills with which it is connected; and standing between them and the sea, serves to protect them from its ravages. (See Plate I.)

This cape will not furnish the collector with any mineral specimens of interest; but as this was the first place where the junction of the sandstone, shale and trap were observed, it deserves honorable mention on account of its geological interest. The sandstone and shale, which will be particularly described hereafter, are seen at this place to dip beneath the trap, at an angle of twenty or thirty degrees, and in their passage, are observed to become singularly altered in appearance. The strata of these substances, before regular and distinctly parallel, are found altogether broken up

Pl. I

Pendletons Lithog

From nature by C. T. Jackson

CAPE SHARP

*From Partridge Island bearing North West 5 Miles.*

*1. Strata of sandstone & slate dipping beneath the trap. 2 Junction. 3 Columnar trap* and lying confusedly in various directions; the sandstone has changed to a dark red color, is more compact, and has become intimately blended with the shale, so that the eye with difficulty distinguishes the substance peculiar to each. The sharp angular fragments of the trap are next observed, and the whole becomes a distinct breccia, growing more compact as it dips beneath the superincumbent rock. That portion of the breccia in contact with the trap exhibited the small cavities of vesicular amygdaloid, as it passed into its dominion, and led us to believe that the shale and sandstone combined with the trap, and produced amygdaloid by their union. The numerous instances in which this occurred, as it did in fact at every junction of these rocks in Nova Scotia, and the absence of trap tuff and amygdaloid in places where this did not happen, or where, although the sandstone, &c. were not visible, it could fairly be inferred to exist beneath, led us irresistibly to this conclusion. That this process was attended by heat is inferred from numerous circumstances, a few of which can be mentioned here, and others in treating of the two great divisions of the country which remain to be described. The occurrence of native copper in the trap tuff and amygdaloid, may be regarded as evidence in favor of this; the conversion of claystone into fine red jasper, as it entered the superincumbent trap; the cylindrical cavities in the amygdaloid at St. Croix Cove; and even the existence of vacant spheroidal cavities may be considered as internal evidence in favor of this theory. The change of color in the sandstone from grey to red, and the compactness of the strata as it approached the trap; the absence of organic remains, and the charred state of the vegetable remains in the neighboring strata, give sufficient evidence, that, during the formation of the secondary trap in Nova Scotia, there was considerable heat. The sharp fragments of the breccia, and the breaking up of the strata, also shew, that the production of this rock, or rather its non-conformable position on the sandstone strata was effected suddenly. Whether it was ejected from the inaccessible depths of the Basin of Mines, or was thrown directly up through the strata of sandstone, we cannot determine; but the occurrence of the trap only on the borders of the basin which it almost surrounds, would lead us to the belief that this cavity was the crater, if it may be so called, from which, in former times, the trap rocks issued. The same remarks will apply to the whole North Mountain range, except that they probably originated from the unfathomable depths of the Bay of Fundy, which is completely skirted, on either side, with trap rocks.

If we were biased in favor of any theory of the earth, when exploring these formations, it was for that of Werner; and becoming satisfied of the insufficiency of the Neptunian method in accounting for the phenomena observed in the North Mountains, and the appearances assumed by the neighboring strata, we were induced to allow the superiority of the igneous theory, as taught by Hutton, Playfair, and Daubeny.

In treating of the South Mountains, we shall perceive the necessity of an amalgamation of both theories, to explain the relations of that range to the North Mountains.

Partridge Island, situated near the village of Parsborough, and six miles from Cape Sharp, is the next place to be described. In crossing the Basin of Mines, after passing the majestic Blomidon, this island is the first elevated object that meets the eye. It consists of amygdaloid and columnar greenstone, which, on its south-west side, presents a precipitous and overhanging front of about two hundred and fifty feet, rendering precarious the situation of those who may pass beneath its brow. Stationed near the verge of this precipice, the visitor beholds beneath him rugged, insulated towers rising abruptly from the sea almost to a level with his own standing, and having withstood the frequent commotions of the sea, which during the stormy winter months is thrown among them in the most frightful billows, yet remain as firm and immoveable barriers to resist the force of these repeated attacks, and prevent the more rapid decay of the island. Their summits are crowned with a thin but luxuriant soil, from which spring up a few scattered hemlocks and a low underbrush, which nearly obscures the face of the rock, but at the same time furnishes the sea bird a safe retreat beyond the reach of any invader. But at low water a scene of a different character is presented. The visitor, now on the shore beneath, beholds the stupendous objects above him. The towers and precipice seem more lofty than before; and, in addition to the wildness and picturesque beauty of the scene, the naturalist will find before him a field so richly stocked with interesting minerals that he will delight to remain on the spot and gather these objects of science. (See plate II.)

PL. 2

Pendletons Lith.

from nature by C. T. Jackson

PARTRIDGE ISLAND

*Detached Masses of trap rocks, South West extremity.*

Before alluding to these minerals, we would observe that the compact trap forming the highest parts of this island is rarely in masses which may strictly be called columnar, although they have a tendency to that form, and in a few instances, affect the pentagonal shape of basalt. We were unable, however, to discover among them any appearance of articulation in their columnar arrangement. It contains but a small proportion of iron: and consequently the exposed surfaces of the rock are very slightly altered by the oxydation of this metal, which in other places is more sensibly observed.

Of the many interesting minerals to be found at this place, stilbite associated with calcareous spar is the most abundant. This mineral, forming numerous veins in the amygdaloid near the base of the precipice, presents, in the open interstices of the rock, beautiful projecting masses composed of long fasciculated crystals of a flesh red, and sometimes straw yellow color. When crystallized, it is in elongated rectangular four-sided prisms, terminated by tetrahedral pyramids.

The calcareous spar is curiously scattered over the surfaces of stilbite in acute rhomboids, which are often hemitropic, deeply striated upon the faces of cleavage, parallel to their horizontal diagonals, and of uncommon magnitude and beauty. These crystals, usually colorless and transparent, are in a few instances of a rich honey-yellow appearance. In breaking the various masses which are scattered along the shore, it is not unusual to meet with one, which, composed of yellow stilbite externally, contains, within, numerous crystals of calcareous spar lining its walls in rhomboids, which, having their faces deeply indented by the projecting pyramids of the stilbite on which they are implanted, were obviously deposited subsequently to the formation of that mineral.

Chabasie in rhombic crystals, transparent and colorless, also of a beautiful orange yellow color, occurs at this place in the fissures of the amygdaloid. The crystals present brilliant glassy faces, and are very large, frequently measuring an inch across each rhombic plane.

Agates of various kinds, jasper and chalcedony, also botryoidal cacholong, exist in the columnar rock above the accessible base of the precipice: they may be picked up in imperfectly polished fragments among the rolled masses on the shore. A vein of magnetic oxide of iron about a foot wide was also observed entering the superincumbent trap.

But the substance for which this island has long been known by the inhabitants of the country is amethyst; which, occurring plentifully in crystals of fascinating beauty, draws hither the passing traveller, who seldom departs without something ornamental to his parlor shelf, or useful to science.

Pursuing the northern shore of the Basin of Mines, eastwardly, the next place deserving of notice is the vicinity of the Two Islands, about six miles from Partridge Island. The intermediate coast, being composed of rocks of a different character from those which it is our object at present to describe, we shall leave, to notice it more particularly when we treat of that formation.

The Two Islands consist of amygdaloid and columnar greenstone rising on all sides abruptly from the sea, and being accessible at their bases only at low water will not afford the visitor many interesting specimens. On the main land near Swan's Creek, and opposite to these islands, he will be favored with a locality of uncommon interest. At this place also we have a second, and perhaps better developed example of the conversion of shale, red sandstone, and compact trap, first into a coarse breccia, consisting of loosely united masses of these rocks, then into a more compact breccia, consisting of similar masses more closely united, though distinguishable from each other, and finally, by consecutive gradations, into a genuine, well characterized amygdaloid, in which the most critical eye would fail to distinguish separately its component ingredients. We have in our possession specimens from this place, which illustrate perfectly the changes of which we speak, and which present these three rocks tending to the production of amygdaloid. The color of this amygdaloid is obviously governed by the relative quantity of the ingredients composing it; for if the sandstone and red slate predominate, the color is then nearly of a brick red, as the appearance of the rock itself abundantly proves; but when it assumes a greenish or greyish black color, we infer that the slate and sandstone form a comparatively small proportion of the mass.

Having thus adverted to the character of this rock in particular, we shall notice more generally the appearance of the rocks at this place, and then describe the minerals before alluded to as occurring in them. The shore is fronted by a steep bank of about one hundred feet high, from the base of which a slope of dèbris, detached by the frost, inclines down into the sea. One half of this bank consists of trap and the other of red sandstone, intermixed with red shale. Upon it rests a ridge of columnar greenstone. These two rocks come boldly into contact with each other, and the sandstone and shale dipping beneath it, at an angle of forty degrees has the breccia and amygdaloid recumbent on, or more properly, inclining against it; thus presenting, when viewed from the sea, a section of the two rocks crowned with the columnar trap. The amygdaloid is vesicular, and furnishes most of the minerals which we are now to describe. They are chabasie, analcime, heulandite, calcareous spar, and siliceous sinter, all of which occur abundantly, and are often seen richly congregated in the same specimen, or included in the same cavity of the rock.

The chabasie, grouped with its associated minerals, is usually of a wine yellow or flesh red color; but in a few instances it is nearly colorless and transparent. The crystals, which are frequently three fourths of an inch in diameter, exhibit the form of the primary obtuse rhomboid, sometimes so modified, as to assume the lenticular hemitropic form represented in Phillips' Mineralogy, p. 138. At other times, from the almost innumerable faces of composition, they become indescribably complex, or at least would require, for a precise crystallographic description, the consummate skill of a Haüy, a Mohs, or a Brooke. They are slightly striated, of a glistening vitreous lustre, and often hemitropically united. This chabasie agrees in all characters excepting color and complexity of modification with that from the Scottish Islands.

The analcime is in white opaque crystals, exhibiting the passage of the primary cube into the trapesohedron, which it frequently completes, and thus forms crystals which, having twenty four equal and similar trapeziums, entirely obscure the primary planes.

Over the analcime, the heulandite is thickly implanted in small, but extremely brilliant pearly white crystals, which are transparent or translucent, and usually in the primary form, sometimes slightly modified.

The calcareous spar is crystallized in very acute rhomboids, of which scarcely two can be found possessing similar angles. The crystals are also so modified, as to assume the form of the dodecahedron composed of two scalene six sided pyramids, applied base to base. They are greatly elongated, and grouped in delicate stellae, occupying the cavities of the amygdaloid.

Delicate prismatic crystals, but not of sufficient size to determine their form, resembling the Brewsterite from Scotland, occur scattered through the cavities of the trap tuff and associated with perfect and distinct crystals of analcime, constituting interesting specimens.

The last of the minerals which we shall mention as occurring at this locality is silicoius sinter. This mineral is usually embraced in the amygdaloid, forming in its spheroidal cavities, a flaky or lamellar crust, which, enveloping their entire inner surfaces, sometimes depends in stalactitic projections, on which may be observed small crystals of common limpid quartz. Its color, which is usually snowy white, or greyish white, is in a few instances of a beautiful amethystine tint. One or two geodes of this substance were found in breccia, which, on being broken, presented internally a bright coating of amethystine sinter with numerous crystals of wine yellow chabasie implanted in, and beautifully contrasted with it.

The next places to be noticed along the northern shore of the Basin of Mines are the Five Islands, and an eminence known by the title of Tower Hill. Our description of these places will include all that remains to be said relative to the trap rocks of Nova Scotia. These islands form a group situated in a direction south east from the place last described, and about twelve miles distant. They rise abruptly from the sea, and present for the most part lofty fronts of a picturesque character. Three of the group consist entirely of trap, which from the inaccessible nature of their bases, did not admit of particular examination. If the mineralogist however, should select for his excursion a fair day when the turbulancy of the sea has subsided, he will be able to approach their bases, and without leaving the boat, to collect many specimens worthy of his visit. The remaining two are composed of sandstone and red shale, exhibiting in some places, the passage of these rocks into a reddish amygdaloid, vesicular, and zeolitic. In other places, an intermixture of the black shale is observed, which sometimes constitutes a portion of the amygdaloid, and imparts to it a corresponding color, more or less evident as it exists in a greater or less proportion, as an essential ingredient of the rock. The breccia, or trap tuff, which is a constant attendant of the amygdaloid produced by the union of the sandstone, &c. and which seems as an intermediate form necessary to the constitution of the latter, is here observed, as in all other places of similar character, superincumbent on the amygdaloid.

The Island most noted among these is that, which standing in advance of the others, is a conspicuous object to meet the eye of the mariner, in his progress up the Basin. It is composed of amorphous or indistinctly columnar trap, which resting on a softer basis of amygdaloid, presents, from the undermining action of the surges, the curious phenomena of a leaning tower, and, casting a dark, broad shade beneath it, seems as if ready to tumble into the sea from the overhanging weight of its summit.

On the southern front of Tower Hill is a precipice of about one hundred feet high, constituted of red sandstone containing red shale, and having for its summit rock, a low ridge of amorphous trap, resting immediately upon the sandstone, without the intervention of any other rock. It presents vertical veins of quartz, sometimes crystallized, but is void of the zeolites; nor were we able, during our visit at this place, to discover a single crystal belonging to that family of minerals.

This is the last place on the shore of this Basin at which trap rocks are known to occur. Still farther east, the sandstone interstratified with shale, uniformly and uninterruptedly prevails. This spot may therefore be regarded as the extreme eastern limit of the whole trap formation of Nova Scotia, and having for its opposite extremity Briar's Island, which, as may be seen on the map, is not less than one hundred and fifty miles distant, comprising within the intervening space, a field alike extensive for mineralogical and geological research, and replete with numerous objects of natural history.

Having finished our account of the trap rocks forming the North Mountains and their outskirts, which comprise a complete description of that formation, with the more important and curious mineral productions which they include, and having suggested, what appears to us the most obvious theory of their origin, which, derived from remarkable peculiarities of color, structure, and other appearances of contiguous strata, appears to account for those phenomena in a more satisfactory manner than any other, we shall now pass to the neighboring strata of sandstone and shale, forming the moderately elevated and rounded hills of the county of Cumberland, and part of the county of Hants, and part of the districts of Colchester and Pictou.

It becomes necessary to describe the formation before speaking of the South Mountains on account of its intimate connexions with the trap which we have previously alluded to, in describing the capes which project into the Basin of Mines.

The sandstone, constituting so large a portion of the province of Nova Scotia, is of various appearance, differing greatly at different places. In the immediate vicinity of the trap, as at Cape Chignecto, Cape Sharp, and Swan's Creek it is of a dark brick red color, and consists of irregularly rounded grains of quartz, usually very small, rarely exceeding the size of a pepper corn, accompained by minute spangles of mica, and united by an argillaceous cement, containing a large proportion of peroxide of iron. Where in connexion with the trap as before observed, the sandstone passes insensibly into the shale, or rather, the two form a compound in which the eye can distinguish no line of division, so completely are they blended. The shale varies greatly in color, and generally, like the sandstone, becomes red in the presence of the trap rocks, where it assumes a bright tile red color, and when exposed to the action of the waves, it becomes polished on the surface. This rock consists of thin folia of argillaceous slate, sometimes including a little mica, and is generally colored by oxide of iron. Comparatively remote from the trap, the shale assumes a grey, brown, or bluish black color: more rarely it is spotted with green.

Near Diligence River, the shale is almost black, and appears to be colored by carburet of iron. It here includes a large bed of compact limestone, a section of which has been formed by the encroachments of the waters of the Basin of Mines. A little beyond Fox River towards Cape D'Or, the sandstone of a grey color, is seen to alternate with the strata of greyish black shale, both of which are filled with relics of the vegetable kingdom of a former world. They are carbonized remains of various culmiferous plants, which are converted into a compact bituminous lignite.

Portions of ensiform leaves resembling those of the Iris, or blue flag, were here observed, lying between, and included within the strata of sandstone.

The whole northern coast of the Basin of Mines, with the exception of the capes and islands of trap before described, is composed of strata of sandstone and shale, alternating with each other, and presenting to the sea, the edges of their strata, which are finely exhibited by this natural section. They do not attain a great elevation, rarely exceeding one hundred feet, and where exposed to the waves, the strata have suffered much from their violence, and the shale is always worn away, exhibiting the bold ridges of sandstone strata, contrasted with the deep furrows occasioned by its decay. The strata of these rocks are from a foot to four feet in thickness, and are alternately stratified with each other in great regularity: no limit being found to this alternation, we are unable to say which rock is finally subordinate to the other. Near the village of Parsborough, the red shale appears to predominate, and constitutes a bed more than one hundred yards thick, which is beautifully spotted with green, and contains occasionally scattered crystals of yellow iron pyrites. East of this bed the sandstone appears in more powerful strata, and more than compensates for the thickness of the shale just mentioned. It forms a junction with the trap of Swan's Creek, where it includes numerous beds and veins of gypsum, which is of the laminated and fibrous kind. It is occasionally of a delicate flesh color, and the intersecting laminæ are more than a foot in length. The laminated and crystallized gypsum is not sought for exportation so much as the amorphous varieties, which although not so pure, exist in large beds, and are more profitably wrought, while they bear the friction and pressure of transportation without crumbling to pieces, as would inevitably happen to more friable crystalline varieties. At Tower Hill, twelve miles east of Parsborough, the sandstone again meets the trap, which forms but a small part of the precipitous summit, and has no amygdaloid in connexion with it. The united sandstone and shale however, exhibit a most singular appearance, and becoming vesicular, affect a curious imitation of amygdaloid, the place of which it occupies in relation to the trap. These rocks forming the base of the precipice, are of a fine texture, and contain a large proportion of argillaceous matter, colored with oxide of iron.

Passing beneath the trap in its immediate vicinity, it abounds with compressed and flattened spheroidal cavities, which, instead of the zeolites, are, when occupied, filled with rounded masses of gypsum, the mineral which usually occurs in this rock. These facts obviously tend to establish our theory of the origin of trap tuff and amygdaloid, and render probable the explanation of these phenomena: that the quantity of trap present was inadequate to complete the process at this locality.

Beds of gypsum, of practical worth, occur near the head of the Basin of Mines, in the vicinity of the Subenacadie River, where also occurs a large bed of limestone, containing the relics and impressions of marine shells. It is of an ash grey color, and not very compact. In one specimen, a few crystals of galena were observed, scattered through a mass of petrified shells, which resembles the lituites described in Parkinson's Outlines of Oryctology, p. 165, and portrayed in plate vi, fig. 7, of the same work. Much larger and more valuable beds of gypsum occur in the county of Hants, where first explored in the vicinity of Windsor about thirty years ago. It still continues to furnish immense quantities, the greater part of which is sent to the United States. This gypsum is of a bluish color, and is highly valued in the United States as a manure, although in its native country it does not appear to contribute in the least to the fertility of the soil; in fact, the hills entirely composed of gypsum, were not clothed with so luxuriant a crop of vegetation as those where this mineral was altogether wanting in the soil. The trap rocks by their decay furnish a far more productive soil, as exhibited in the township of Cornwallis, justly entitled, the "Garden of Acadia," and the whole extent of the base of the North Mountains.

The gypsum in the vicinity of Windsor, abounds in those conical or inverted funnel shaped cavities, supposed to have originated in the solution of rock salt, (muriate of soda,) which has been imagined once to have occupied those spaces. No salt however, or traces of its existence, were discoverable, and if any exists it is unknown to the inhabitants. In one of these caverns about ten or fifteen years since, the bones of a human being, supposed from the relics of arrows found with them, to have been those of one of the aboriginal inhabitants, were discovered in opening a gypsum quarry. It is presumed that this unfortunate individual, while pursuing his favorite occupation of the chase, was precipitated to the bottom of this frightful dungeon, and being confined by its inclined walls, was unable to reach its summit and regain the light. Thus incarcerated, he perished by hunger. His bones are preserved in the library of King's College, at Windsor, where they were politely shewed us, by the acting Vice President, Rev. Wm. King, who related to us the above story of their origin. The most extensive beds of gypsum in the county of Hants, occur in Newport. On the northeast side of the St. Croix River, which runs through this township, the gypsum forms a precipitous wall rising from the river, and extending along its course. It is extensively wrought, and furnishes more than any other locality in Nova Scotia. The sandstone in which the Newport gypsum occurs, is not of so dark a color as that on the opposite shore of the Basin, in the vicinity of the trap. It is greyish, and some of it almost white, composed principally of quartz, with a small proportion of argillaceous substance for a cement.

On the banks of a small but romantic stream which empties itself into the St. Croix, called Montague River, a remarkably beautiful precipice of siliceous breccia passing into graywacke, presents itself to the traveller. It consists of angular fragments of quartz and felspar, rarely containing a few spangles of mica, united without any apparent cement. The felspar, being of a flesh red color, and forming a principal ingredient in the rock, gives it an appearance at a distance resembling red sandstone. The precipice is about sixty feet high, and rises from a base of the same rock forming the bed of the stream, which has excavated numerous deep holes into the bottom forming beautiful reservoirs of limpid water. The direction of the strata is N.E. and S.W. and the dip 10° to the northwest, forming a declivity down which the water rushes, and falling from the broken strata, produces an agreeable effect. This place, adorned with overshadowing trees, is a favorite resort for the visitors of the Montague House, and has tempted the pencil of a noble lady to portray its beauties.

Gypsum also occurs abundantly in the county of Cumberland, at the head of Chignecto Bay. The most extensive bed is on the banks of the Maran River, where the gypsum is of a bluish color and equal to any in the province.

We shall now advert to the sandstone of Cumberland, and describe the quarries of grindstones and the coal district of this region. The sandstone where it emerges from beneath the trap at Cape D'Or, and where it comes in contact with it at Cape Chignecto, exhibits the red color noticed at other places in the vicinity of this rock, is more compact, and destitute of organic remains. Leaving its Plutonic neighbor further up Cumberland Bay, it assumes a grey color. It alternates with, and passes into a coarse conglomerate. At Apple River and the South Joggin it is quarried for grindstones and as a building material. The sandstone passes into the province of New Brunswick, and forms the extensive grindstone quarries of Meringuin and Grindstone Island; but those places are beyond our limits, and we shall content ourselves with a description of the quarries at the South Joggin and Apple River.

At the former place the best grindstones are obtained and wrought on the shore of Cumberland Bay. They are preferred, when obtained at a considerable depth from the superficial strata, and are always taken at low water as deep as possible from the surface. Two or three layers are first removed which make inferior grindstones, and then the best ones are procured. In cutting the stones, the workmen frequently meet with hard rounded nodules which they call "bulls eyes," and which always condemn the stones as useless. They differ from the surrounding matrix only in being more compact and having less of the argillaceous basis, and breaking with a conchoidal fracture. The bulls eyes differ in size from one to ten inches in diameter, and sometimes include a smaller spheroid as a nucleus within the larger.

Near the mouth of Apple River, grindstones are also quarried in a similar manner to those of the South Joggin; they are not of so good a quality, but in other respects they are like those already described. The rock of which the grindstones are made consists of irregularly rounded grains of quartz, which are transparent and colorless or slightly tinged red, green or blue, with a few spangles of mica and grains of felspar interspersed through the mass. The grains are usually minute, and not often exceeding the size of a mustard seed. They are united by an argillaceous cement, which exists in a small proportion to the whole. This rock contains numerous remains of culmiferous plants, which lie between the strata and are much compressed. They do not injure the grindstones unless many occur in the mass, which seldom happens, as they are mostly scattered diffusely through the strata. The fossils which occur in this sandstone, stamp it as a secondary rock, although it is evidently older than the trap rocks recumbent on it along the margin of the Basin of Mines.

A few miles south west from the grindstone quarries at the South Joggin, a bed of bituminous coal exists in the sandstone, accompanied by shale. The bed is about five or six feet thick, and has been wrought to a small extent, but is now abandoned, and the shaft is filled with earth and rubbish. The coal contains an abundance of pyrites, which injures its quality as an article of fuel. In the vicinity of this bed occur several smaller beds, one of which is covered by a stratum of bluish compact limestone, in the upper surface of which Dr. Lincoln observed fragments of shells resembling those of the common muscle. (*Mytilus edulis?*) Many of the vegetable fossils so common in the rocks of the coal series in other countries are found in great abundance here, imbedded in the sandstone, which dips at an angle of thirty degrees from the horizon, and includes the coal. Specimens of the phytolithus verrucosus were found by Dr. Lincoln, which exactly resemble those represented in the drawings accompanying Mr. Steinhauer's article on these fossils in the American Philosophical Transactions, New Series, Vol. I. Pl. IV. fig. 1. 2. and 4. Very good specimens of the fossil represented in Parkinson's Organic Remains, Vol. I. Pl. IX. fig. 1. were also found. Substitutes of reeds and of plants resembling bamboos and rushes are likewise abundant. Some of the reeds are three or four inches in diameter and as many feet in length. They are invariably found traversing one or more of the strata at right angles with its layers. Some, especially the larger, are cylindrical; others are flattened and are generally coated externally with a layer of coal; some are smooth, others striated longitudinally as represented in Parkinson's Organic Remains, Pl. III. fig. 3. Near the principal coal bed, Dr. Lincoln saw one segment of a trunk two feet long and twenty five inches in diameter, and another about one foot long and eighteen or twenty inches in diameter. The external appearance of this petrifaction had led the grindstone cutters to believe it to have been a hemlock tree (Pinus Canadensis.) They say that a few years ago a large part of the trunk was standing erect in the cliff, with some of its branches attached to it.

Lignites are very abundant. Some specimens appear to have been trunks of trees or succulent plants of an enormous size, and they are found, not traversing the strata of the rocks like the stony casts of the reeds, but lying between them.

The Isthmus connecting Nova Scotia with New Brunswick, situated between Cumberland Basin and Bay Verte, is but twelve or fourteen miles wide from one shore to the other, and being composed of a friable decomposed sandstone, opposes a feeble resistance to the rushing waves of Cumberland Bay, where the tides rise to the height of sixty feet; while on the shores of Bay Verte they scarcely attain the elevation of eight or ten feet. One would suppose such frail barriers would give way before the pressure and violence of the conflicting tides. It is, however, a remarkable fact, that the same waves which cause so much devastation along the rock-bound coast of the Bay of Fundy, undermining and tumbling in confusion the lofty trap rocks, roll harmless against these shores, protected by the bold promontories of Cape Chignecto and Meringuin, depositing their spoils taken from the opposing rocks, quietly on the shores of Cumberland Basin, and thus fortifying the isthmus in its weakest point. The inhabitants assist the process, securing by dykes the soil deposited on their lands, and profitably use the bounties heaped at their doors by the tumultuous sea.

From the shores of Chignecto Bay the sandstone and slate, forming the county of Cumberland, extend to the waters of the Gulf of St. Lawrence on the north, and, stretching eastwardly towards the county of Sidney, constitute a part of the districts of Colchester and Pictou. The interior of Cumberland county was not examined by ourselves, but we were credibly informed by intelligent persons residing there, of the extent of the sandstone district as represented on the geological map accompanying this essay.

Salt springs have been found in various places near the shores of the Gulf of St. Lawrence. One of the most important exists near the river Philip. The brine of this spring contains a much larger proportion of salt than the water of the ocean, and it has been economically obtained by evaporation of the water. In the year 1811 large quantities were manufactured at this spring. A spring also occurs at Pictou, which was advantageously worked for salt on an extensive scale for several years, but is now abandoned, from what cause we are not informed. No rock salt has ever been found in the vicinity of these springs, nor has the rock any perceptible salt taste. We must therefore refer the origin and the occurrence of these salt springs to such unexplained phenomena as are assigned to those in the western part of the state of New-York, so ably discussed by Prof. Eaton in his "Geological and Agricultural Survey of the District adjoining the Erie Canal." See Part I. p. 109. sqq. The existence of salt springs in this formation indicates it to be identical with the saliferous rock of Phillips and Conybeare, and allies it to the extensive deposit described by Prof. Eaton as existing in the western part of the state of New-York, in his excellent survey of the Erie Canal, and in the Amer. Journ. of Science, vol. xiv. No. 1, p. 148, as existing on the banks of the Connecticut, and as supporting the Palisades on the Hudson river.

Pursuing this formation eastwardly in the direction of its strata, we meet with occasional beds of coal, not of any practical worth, and offering no remarkable geological peculiarities. On the north bank of the West river, where the Kempt bridge crosses this stream, a bed of bituminous coal with lignites, about four or five inches wide, occurs in the cliff of sandstone, a section of which is formed by the bed of the river. At this place, which we mention on account of its vicinity to the road from Truro to Pictou, rendering it accessible to travellers, occur many of the relics of culmiferous plants before noticed at Cumberland mine.

Carriboo river, in the township of New Philadelphia, seven miles north of the flourishing town of Pictou, presents a field of great interest both to the mineralogist and the miner. On the banks of this stream, two miles from where it empties into the Gulf of St. Lawrence, occurs a bed of copper ore, included between the strata of sandstone passing into coarse conglomerate. It is associated with lignites of enormous size, which generally lie over the copper ore. The conglomerate consists of smooth rounded masses of quartz of various colors, siliceous slate, clay slate, and felspar, varying in size from that of a filbert to three or four inches in diameter; they are united by an argillaceous cement. The sandstone differs only with regard to the size of the component ingredients, which diminish until they are scarcely distinguishable by the naked eye. These rocks rise from the river to the height of fifteen or twenty feet above its level, and form banks precipitous to the stream. The direction of the strata is nearly east and west, and the dip is about ten degrees to the north. The lignites are black, and some resemble common charcoal so much as to be readily mistaken for that substance. Some are fibrous, and exhibit evident traces of the organized structure of plants; others have lost every trace of organization, are compact without any fibrous structure, break with a conchoidal fracture, and have a glossy black color. They take a good polish, and resemble the jet with which this substance is evidently identical. It occurs forming a thin layer over masses of the copper ore which sometimes forms casts of culmiferous plants resembling the stalks of Indian corn (zea mays.)

The lignite sometimes contains minute flattened crystals of red oxide of copper, which are translucent, and possess a crimson red color.

Green carbonate of copper occurs investing some of the lignites; and, filling interstices in the sandstone, it assumes a botryoidal appearance. It also occurs in delicate fibres investing the masses of *vitreous copper ore* now to be described.

This valuable ore occurs in beds from two to four inches thick, which, covered with lignites, alternate with each other, the lowest bed being the thickest and most compact. It is of an iron black color, with a slight tinge of lead grey. It possesses a metallic lustre, and breaks with a conchoidal fracture. Some specimens are of a crystalline or granular structure, breaking so as to exhibit brilliant metalloidal surfaces; others are very compact, and break with a smooth surface. The specific gravity of the most compact variety is 5.7—but the granular varieties, more open in their texture, seldom exceed 4.8 or 5. It is sectile, and readily impressed by a smooth blunt steel instrument; it therefore possesses a low degree of malleability, being extended under pressure without breaking. It receives a fine polish, and is highly splendent, resembling in lustre and color the most highly polished steel. It retains this lustre unaltered by the action of the atmosphere. It is mixed occasionally with yellowish and a lighter grey pyrites, which is much harder, and not sectile. It contains a smaller proportion of copper and more iron; but no specimen of this ore gives any traces of arsenic or antimony when examined before the blowpipe, or when dissolved in nitro-muriatic acid, and largely diluted with water.

Nor does a solution in nitric acid give any precipitate when muriate of soda is added; and sulphuric acid throws down no precipitate; hence it does not contain any silver or lead. The nitric solution, tested by aqua ammoniæ, became of a fine blue color, and, treated to excess of saturation, gave a brown precipitate of oxide of iron.

To determine the composition of the vitreous copper, similar trials were made, which discovered nothing but copper, sulphur, and iron. This ore was called by the miners from Cornwall, who were exploring the mine, grey copper, (fahlerz of the Germans.) But according to an accurate analysis which we have made of this ore, it is to be considered as the vitreous copper, (kupferglanzerz,) which is more valuable than the grey copper ore. We have taken for our model the analysis of the vitreous copper ore from Siberia, detailed in the celebrated essays of Klaproth. As our results differ somewhat from those of this excellent analyst, and no source of fallacy can be discovered on repetition of the process, we shall give an account of the method pursued, although it possesses no claim to originality, but was purposely conducted after the manner of this chemist. We are the more disposed to do this, as many of our readers cannot have access to the work of Klaproth, which has become scarce, and may still wish to see the *modus operandi* exemplified.

## ANALYSIS.

A specimen of the copper ore was selected, having the specific gravity 5.7. It was sectile, possessing on the cut surface a brilliant metallic lustre, resembling polished steel, but more of a lead grey appearance. It was carefully freed from the surrounding matrix and envelope of lignite, and reduced to powder.

A. Two hundred grains of this powder were introduced into a matrass, and pure muriatic acid affused upon it, which dissolved nothing, even when heated to boiling; shewing that the metals do not exist in the state of oxides, but in a metallic state.

B. To the contents of the matrass while boiling, hot concentrated nitric acid was added by drops, which at each addition occasioned a violent effervescence, with the extrication of red fumes. The acid was added until it ceased to produce action. A flocculent greyish white precipitate had formed on the surface of the fluid, which was the sulphur extricated from the ore. When cool, the contents of the matrass being diluted with pure water, and carefully washed from its surface, were thrown on a filter of known weight. The precipitate collected on its surface, washed with dilute nitric acid, and afterwards with water, being dried, was found to weigh thirty-eight grains. This was ignited in a crucible of platinum over an alcohol lamp, and burned away, leaving two grains of a dark grey powder, which was a portion of the ore that had escaped decomposition. This was treated with nitro-muriatic acid, and being dissolved by it, was added to the filtered solution. The sulphur then in two hundred grains amounts to thirty-six grains, or eighteen per cent.

C. The liquid which had passed the filter was of a bluish green color, and transparent. It was divided into two equal quantities. In one portion a polished cylinder of iron was immersed, and in forty-eight hours the copper had precipitated upon it in a dendritic form. That it had entirely separated the copper was known by the solution ceasing to give a tarnish of copper to a polished steel instrument. The copper removed from the cylinder of iron, washed and dried rapidly to prevent oxidation, was found to weigh 79.5 grains.

D. The other half of the solution was treated with aqua ammoniæ to excess of saturation, when a muddy brown precipitate took place, which, when collected on a double filter of known weight, washed, dried, and ignited with a little wax in a platinum crucible, was reduced to the protoxide of iron attractable by the magnet, and weighed 3.4 grains, indicating 2.5 grains of metallic iron.

E. To determine whether the solution was equally divided, and to prove the correctness of the process C. the ammoniated solution was saturated and acidulated with sulphuric acid, and a plate of polished iron immersed in it. The copper precipitated in a brilliant metallic coating, and when separated, washed and dried, weighed with the loss of a trifling fraction, like the result of the former process 79.5 grains.

This ore contains, then, in a hundred parts,

| | | |
|---|---|---|
| Copper, - - - - - | (C) | 79.5 |
| Sulphur, - - - - - | (B) | 18.0 |
| Iron, - - - - - | (D) | 2.5 |
| | | 100.0 |

The sandstone continuing its eastward course through the district of Pictou, approximates to the slate of the South Mountain range, which it meets in the township of Egerton, near the sources of Middle and East Rivers. In the village of New Glasgow, there occurs an important bed of bituminous coal near the East River. It is included between the strata of sandstone and is overlaid by a decayed, blackish shale. The coal is of a jet black color, has a glossy appearance, and is highly charged with bitumen. It burns with a bright flame, and smokes much when first kindled. It appears to melt and cake like the Newcastle coal, and when completely on fire, after the bituminous matter is dissipated, it burns like coke. These characters show that it is a valuable coal, and of good quality, fitted for all the purposes of that brought to this country from England. All that has yet been raised has a fault which greatly injures it for the market. It is very soft and friable, insomuch that it is broken into "small coal," or even ground into dust by friction in transporting it to any considerable distance. There have been five or six shafts sunk in different parts of this bed, mostly under its former lessee, Mr. Carr, who resides at this place. One of these is seventy or eighty feet deep, sinking perpendicularly like a well through the surface into the bed of coal. This has been effected by "gins" and buckets worked by horse power. We believe it never afforded much profit to the persons engaged in working it, for the mine had been abandoned for a long time when we visited it, and the former machinery was almost destroyed by decay. Preparations were then making to explore this mine on a generous scale. A company had been organized in London to work the coal, and two very intelligent and practical gentlemen, Messrs. Smith and Brown, had been sent to superintend the operations, with more than a hundred European miners to assist in the work. They were building two steam engines to pump the water from the shafts, and to raise the coal. With such adequate means, strong hopes are entertained of obtaining coal of a more compact nature suited for exportation. We are unable to form any opinion respecting the foundation of these sanguine expectations, as the state of the shafts, being partly filled with water, precluded the necessary examination of the bed and associated rocks. We were informed that Mr. Carr had cut through the whole thickness of the bed with his principal shaft, and had found the black shale beneath, which he did not perforate. We saw masses of this rock lying in the vicinity of the shaft, which we were told were obtained in his last diggings. If another stratum of coal lies beneath this layer of shale, it is doubtless more compact, from the pressure of the overlying rocks during its formation. We must remain undecided as to the fact until the mighty strokes of the steam engine break away the obstacles to its examination, when treasures may be brought to light rewarding the labors of the miner, and contributing new facts to the imperfect science of geology.

We observed several fine specimens of remarkably perfect stony casts of culmiferous plants, in possession of Mr. Blanchard of Truro, which he informed us were obtained at the New Glasgow Mines in raising the coal. They resemble those found at Cumberland, and mark this deposit as coeval with that formation.

About twelve miles northeast from the coal mines of New Glasgow, and eighteen miles from the town of Pictou, the sandstone, with its accompanying shale, approximates to the transition clay slate of the South Mountain range. The immediate junction of these rocks was not discovered on account of the deep, unbroken soil which overlaid and concealed from view their respective strata. It appears evident that the strata unite near this place, from the fact that their lines of bearing here intersect each other at an acute angle; the bearing of the clay slate being north sixty degrees east, while that of the sandstone is directly east. The clay slate dipping at an angle of fifty or sixty degrees to the northwest, while the sandstone dips at angles of only ten or fifteen degrees to the north, clearly indicates the former rock to be of greater antiquity than the latter, and seems a well founded character for considering the clay slate of the South Mountains as belonging to the transition class of rocks, which we shall confirm when treating of that formation. The sandstone was before proved to be secondary from the fossils it contained. It evidently lies over the clay slate, and we regret exceedingly that we were unable to discover a single spot from which the soil and gravel had been removed, so as to exhibit the connexion of the two rocks. Future explorers by traversing the forests, may perhaps find an outcropping somewhere along the line of their union, which will repay the labor of research, by illustrating their relations and comparative age.

On the estate of Alexander Grant, we observed, in the bed of a brook proceeding from the forest, a section of red sandstone and shale, including a bed of red and brown hematitic iron ore twenty feet wide, and of unknown thickness, it not having as yet been explored for practical purposes. This hematite exhibits all the varieties of imitative form usually assumed by this ore, and resembles precisely those beautiful specimens brought from the Salisbury mines in Connecticut which so frequently adorn mineralogical cabinets. It occurs botryoidal, and stalactitical, and sometimes possesses a brilliant, tubercular surface, consisting of small hemispherical elevations.

Grey oxide of manganese is associated with this ore, and forms a considerable proportion of the bed. It is sometimes crystallized in the cavities of the hematite, but more frequently is disseminated in radiating acicular fibres or distinct concretions through the mass. Its color is between lead and steel grey, and it possesses a high metallic brilliancy, which is not tarnished by exposure to air and moisture. The geodes in the hematite are frequently occupied by crystals of arragonite, in six-sided prisms, and also sulphate of barytes in compressed or tabular crystals, usually of a pure white color, and but very loosely attached to the matrix, or they are sometimes completely isolated. Several masses of a foliated structure, composed entirely of this substance, were also found in the soil near this brook. Whether the manganese, intermixed with this ore, will prove injurious to the iron in the operation of smelting it, or not, is, we think, a question of importance to those interested in the establishment erecting at New Glasgow for working it extensively, or as is contemplated with the coke or carbonaceous base formed by the destructive distillation of bituminous coal, which is now exclusively employed in England, in the reduction of iron ores. It is certain that this substance, whether reduced to the metallic state or not, so as to combine chemically with the iron, must nevertheless have an injurious effect in the smelting furnace; for in consequence of its existing in the state of per oxide, a large portion of heat and carbon is taken up in the form of carbonic acid, or oxide, by uniting with the oxigen; and thus depriving the iron of more or less of its carbon, renders it of inferior quality.

A bed of buff colored limestone occurs in the sandstone near the hematite locality, and will prove a valuable fluxing material to the ore, which may be worked in this section of the province.

Four miles southeast of this place a very important and extensive bed of iron ore exists, in the clay slate of the South Mountains, which we shall describe after noticing generally the whole transition clay slate formation of Nova Scotia, commencing at the eastern extremity of the district of Pictou, and extending west south west, through the province to St. Mary's Bay, where it approximates to the secondary trap rocks, and is connected with them by Digby Isthmus, which is composed of sandstone, as observed in the first part of this article. For this connexion, see the map.* This rock presents a larger extent of surface, than any other in the province, forming more than one third of the whole face of the country. It presents every where a uniform geological character, and containing fossil organic remains, belonging to the marine world alone, (no vestiges of the vegetable kingdom being discoverable,) it must obviously, according to the great geological division of rocks, be regarded as transition, and as having existed long before the neighboring plutonic rocks had emerged from the central regions of the earth. That this rock is older than the trap rocks we have additional, and almost decisive evidence, derived from another source, which we shall state by and by, when our observations are directed more particularly to the iron ore bed which we have no hesitation in saying is co-extensive with the whole formation.

The direction of the strata composing this formation is uniformly north, 60° east, dipping at an angle of 50° or 60°, from the horizon. The color of this rock on fracture, is black, greyish or bluish black. Its structure is slaty or foliated, frequently separating by a gentle blow into broad sheets which are sufficiently smooth and compact to be employed for writing slate. This is the case at Rawdon, where it is obtained for this purpose, and extensively quarried for roofing slate. In other places being less distinctly foliated, its tendency is to break into huge rhomboidal fragments, as it has natural seams both in the direction of, and at right angles with its stratification. This renders it a valuable building material as it forms convenient shapes for rearing walls

---

* In Vol. XIV.

of houses, for which purpose it is employed in many places, as at Clement's, in Annapolis county.

The soil resulting from, and lying over this formation is naturally and very perceptibly inferior, to that produced by the disintegration of the trap rocks of the North Mountains, and the neighboring sandstone, its vegetation being less luxuriant, and requiring for its culture greater labor from the husbandman. This is a fact which a traveller in passing through the country, cannot fail to observe. The soil has been much improved of late years, and the present state of agriculture in Nova Scotia, is much indebted to Mr. John Young, the author of a series of interesting and practical letters published in Halifax under the signature of "Agricola," and which resulted in the formation of several agricultural societies.

The continuity of the strata of this rock is interrupted in two places by dykes of green stone porphyry, which, entering the rock nearly at right angles with its stratification, completely cut off, or intercept the bed of iron ore which is continuous and parallel with the strata. We shall notice these dykes more particularly in another place, as also the patch of granite represented on the map in Annapolis county, which is undoubtedly subordinate to the clay slate, and all the other rocks in Nova Scotia.

The bed of iron ore before alluded to is apparently sixteen feet wide, though from its not having been explored at the time we visited it, so as to present the contiguous strata of slate, we cannot state the exact width with certainty. Its direction, like that of the strata in which it is included, is north 60° east, and is traceable for a considerable distance into the forest, until it is entirely obscured by the soil and underbrush.—The ore on the surface from which considerable quantities may be detached, is usually of a compact structure, sometimes inclining to slaty. Its external color is brown and reddish brown, but its streak and powder are between brick and blood red ; consequently, it is in the state of the red or peroxide of iron. It is destitute of magnetism and metallic brilliancy. Its specific gravity is on an average 4.00—hence, according to Rinman's method of calculation, it contains fifty per cent of pure iron, a very near approximation to the truth, as proved on assaying the ore in the crucible, and making an allowance for the carbon combining with it in the process. Some specimens of this ore in which the fossil remains are uncommonly prevalent, contain lime in the state of carbonate, readily effervescing with acids. It contains besides, a portion of alumina, and silex, which in smelting perform the important function of a flux.

To be continued.

Obituary.*—Died, at his residence at Tottenham, (five miles from London,) on the 4th of April last, William Phillips, F.R.S. &c. co-author of the Geology of England and Wales, author of a treatise on mineralogy, and of various other useful publications. The death of this philosopher and philanthropist, leaves no inconsiderable blank among the worthies of his age and country. But little past the middle period of life, his friends were encouraged to expect from his genius and industry more extended labors in those regions of science which he cultivated with so much success. As a husband, parent, and companion, the language of eulogy would scarcely admit of exaggeration. Buoyant in spirits, yet acute in his feelings, generous and indulgent in his sympathies, though quick in the perception of error, with a mind stored with various knowledge, and a heart formed for friendship, his conversation and correspondence possessed attractions which will long be prized by those who enjoyed them. He was a member of the society of Friends, highly respected, and though educated by pious parents, his eventual belief was the result of investigation, and of a conviction of the truth of the Gospel Dispensation and of its invaluable benefit to man. By this his principles were enlightened and his conduct guided, though at all times free from the forwardness of religious pretension.

---

* It so happened, that the miscellanies of the present number were printed, before the preceding articles were finished; and we therefore insert in this place, the painful notice of Mr. Phillips' death, just received from Professor Griscom.—Ed.

*Sept.* 10, 1828.

# INTELLIGENCE AND MISCELLANIES.

## I. Foreign.*

1. *A Summary of an "Account of an Orang Outang, of remarkable height, from the island of Sumatra. By Clarke Abèl, M. D.*" Communicated in a letter to Dr. Brewster.

In his letter to Dr. Brewster, the author states; "The notice is taken from a paper which I had lately the honor of reading to the Asiatic Society."

I have little to remark in addition to what the notice contains, except that the youth of the animal, was equally proved by the state of its teeth, and by the apophysis of the bones of its hands and feet being incompletely ossified. The general conclusions to which I have come, from a consideration of all the circumstances I have collected respecting this animal, is, that it is identical with the Orang Outang, described by Wurmb in the *Batavian Transactions*; that Cuvier is right in considering Wurmb's animal as the adult of the young eastern Orangs seen in Europe; but he is mistaken in supposing that it is also the adult of the African species.

The height of the animal under consideration, as described by authors, varies from five to seven feet; it has so near an approximation to the human form, as to have been thought by some superficial naturalists, a part of the human species. The last joint of its fingers, the palms of its hands, the soles of its feet, and its face, like the same parts of the human form, are free from hair. The depression of its nose, however, the lowness of its forehead, the absence of a prominence of the chin, and the general proportion and orbicularity of the face, strongly distinguish it from the symmetry of the human countenance. The animal is represented as walking erect, as possessing a degree of sagacity approaching to human intelligence, and as exhibiting in common with man, feelings of aversion and attachment. These traits so far as

---

* We now give the sequel of the "extracts and abstracts" mentioned in the last number, page 369, which were prepared some time since, but which appear to be still interesting and valuable. Prof. Griscom's recent extracts follow as usual.—Editor.

they are not common to the brute creation, are deemed the results of tuition.

The Orang Outang which is the subject of the present article, was discovered on the north coast of Sumatra, by a party from the Mary Anne Sophia, Capt. Cornfoot, landed there for the purpose of watering. When the animal made its appearance, it seemed as if it had come from some distance; and to all appearance, it had been walking through a swamp, its legs, up to the knees, being muddy. Its gait was slovenly, and as it went, it waddled from side to side. Captain Cornfoot dwells much upon the human like expression of his countenance, and especially on the beautiful arrangement of his beard. He also obliged me with some account of his capture, as reported to him by his officers, and feelingly described the piteous action of the animal on being wounded, and its apparent tenacity of life. It seems that, on the spot where this animal was killed, were five or six trees, which occasioned his hunters great trouble in procuring their prey; for in consequence of the extreme agility, and power of the animal in springing from branch to branch, and bounding from one tree to another, his pursuers could not fix their aim, until they had cut down all the trees but one. When thus limited in his range, the Orang Outang was shot, but did not die till he had received five balls and the thrust of a spear. One of the first balls probably penetrated his lungs, as he immediately after the infliction of the wound, slung himself by his feet from a branch, with his head downwards, and allowed the blood to flow from his mouth. On receiving a wound, he always put his hand upon the wounded part, and distressed his pursuers by the human like agony of his expression. After the fifth shot, it climbed a tree and reclined against its boughs to all appearance in great pain, and vomited a considerable quantity of blood. When on the ground, after being exhausted by his many wounds, he lay as if dead, with his head resting on his folded arms. It was at this moment, that an officer attempted to give the coup de grace, by pushing a spear through his body, but he immediately jumped on his feet, wrested the weapon from his antagonist, and shivered it in pieces. This was his second, and last great exertion; yet he lived some time afterwards, and drank, it is stated, large quantities of water.

The height of the animal, as stated in general terms, was upwards of seven feet, from measurements of the prepared animal, by Dr. Clarke, seven feet six and an half inches were obtained as his approximate height.

The measure from the extremity of one arm to that of the other, eight feet two inches.

### *Description of the remains of the animal.*

The face of this animal, with the exception of the beard, is nearly bare, a few straggling, short, downy hairs, being alone scattered over it. It is of a dark lead color, excepting the margin of the lips, which are lighter. The eyes small, in relation to those of man, and are about an inch apart. The eye-lids are well fringed with lashes. The ears one inch and an half in length, and barely an inch in breadth, are close to the head, and resemble those of man, with the exception of wanting the lower lobe. The nose is scarcely raised above the level of the face, and is chiefly distinguished by two nostrils, three quarters of an inch in breadth, placed obliquely side by side. The muzzle projects in a mammillary form. The opening of the mouth is very large, when closed the lips appear narrow, but are in reality half an inch in thickness. The hair of the head is of a reddish brown, grows from behind forwards, and is five inches in length. The beard is handsome, and appears to have been curly in the animal's life time. Its color is lighter than that of the head, approaching to a light chestnut, it is about three inches long, springing very gracefully from the upper lip, near the angles of the mouth, in the form of mustachios, whence descending, it mixes with that of the chin, the whole having a very wary aspect. The face of the animal is very much wrinkled.

The palms of the hands are very long, are quite naked from the wrists, and are of the color of the face. Their backs are covered with hair to the last joint of the fingers, and this inclines backwards towards the wrists, and then turns directly upwards. All the fingers have nails, which are strong, convex, and of a black color. The thumb reaches to the first joint of the fore-finger. The soles of the feet are bare, and of the same color as the hands; they are covered on the back with long brown hair to the last joint of the toes. The great toe is set on nearly at right angles to the foot, and is relatively very short. The original color, however, of the hands, arms and feet is somewhat uncertain, in consequence of the effect of the spirit in which they have been preserved.

### *Description of the skin of the animal.*

The skin itself is of a dark, leaden color. The hair is of a brownish red, but when observed at some distance, has a dull, and, in some places, an almost black appearance, but in a strong light, it is of a light red. It is in all parts very long; on the fore arm it is directed upwards. On the upper arm its general direction is downwards, but, from its length, it hangs shaggy below the arm. From the shoulders, it hangs in long and large massy tufts, which, in continuation with the long hair on the back, seems to form a continuous mass to the very centre of the body. About the flanks the hair is equally long, and, in the living animal, must have descended below the thighs and nates. On the limits however of the lateral termination of skin, which must have covered the chest and belly, it is scanty and gives the impression that these parts must have been comparatively bare. Round the upper part of the back, it is also much thinner than elsewhere, and small tufts at the junction of the skin with the neck, are curled abruptly upwards, corresponding with the direction of the hair at the back of the head.

### 2. *Observations on the temperature of Man, and other Animals.*—By John Davy, M. D. F. R. S.

The conclusions to which Dr. Davy arrives after his numerous experiments are, "That the temperature of man increases after passing from a cold, or even temperate climate into one that is warm,—that the temperature of the inhabitants of warm climates is permanently higher than the temperature of those of mild,—and that the temperature of different races of mankind, *cæteris paribus*, is very much, influenced by the climate; these are conclusions which the preceding observations on man may seem to warrant.

The first conclusion, I am aware is not novel; but I do not know that it was ever drawn before, excepting from very scanty data.

The second conclusion, though conformable with the first, is I believe, new; indeed it is contrary to a received opinion that the temperature of man in warm climates, is actually lower than in cold. The opinion alluded to, I conceive, arose partly from hypothetical views of the subject; and if I recollect rightly, it has been supported only by two or three observations recorded by Dr. Chalmers in his history of South Carolina, which were made at a time when thermometrical experiments were not very common, and when the standard temperature of man, was rated much too low. Farther refutation of this opinion is perhaps unnecessary. The experiments I have made, with all the care in my power, are so numerous, and their results are so consistent, that if I do not deceive myself, they put the question beyond the shadow of doubt, and fix as a fact, that if the standard temperature of man, in a temperate climate, be about 98°, (which I believe is the nearest approximation to the truth,) in a hot climate, it will be higher, varying with atmospheric variation from 98½° to 101.

The third conclusion I believe to be perfectly accurate; I say *believe*, because it is difficult, if not impossible, to collect more than presumptive evidence on the subject. However, may not the evidence be considered sufficiently satisfactory, since the variation of the temperature of the different races I tried did not exceed, in degree what may be witnessed amongst different individuals of a ship's company, all of one nation, or even amongst different members of the same family? The similarity of temperature in different races of men is the more remarkable, since between several of them, whose temperatures agreed, there was nothing in common but the air they breathed, some feeding on animal food almost entirely, as the Vaida,—others chiefly on vegetable diet, as the priests of Buddho,—and others, as Europeans and Africans, on neither exclusively, but on a mixture of both.

Farther, that the temperature of birds, of all animals is the highest, that of the mammalia next, that of the amphibia, fishes and certain insects, next in degree,—and lowest of all, that of the mollusca, crustacea, and worms,—are conclusions, with few exceptions, that may be deduced from the preceding experiments on temperature of animals in general. Moreover since in general, as far as experiment and observation have yet gone, there appears to be a decided connexion between the quantity of oxygen consumed by an animal and the animals heat, is there not good reason to consider the two in relation of cause and effect. If animal heat be owing to nervous energy, or any way connected with the nervous system, why, it may be asked, are birds so much hotter than the mammalia? why is the temperature of most quadrupeds higher than that of man? Or if it be owing to digestion, and secretion, and animal action, why is the temperature of the amphibia and of fishes so low where powers in respect to these functions are so considerable?

Or if it be connected with muscular energy, why are the animals whose muscular powers are most remarkable, the animals belonging to all the lower classes, equally remarkable for the lowness of their temperature?

Or lastly, if animal heat depend at all on peculiarities of structure and organization, why, it may be asked, is not the temperature of the amphibia, elevated like that of birds—the structure of the respiratory, and digestive, and secreting organs of one class, being so much like those of the other?—*Ed. Phil. Jour.*

3. *East Coast of West Greenland, formerly inhabited by Europeans.*—Early history informs us that a part of the east coast of West Greenland, was colonized by Norwegians from Iceland. The colony appears to have been considerable, and to have extended northward to Lat. 65° or 66.° Some authors, (and particularly a writer in the Edinburgh Review,) maintain, that no such colony ever existed; on the contrary, that the Norwegians landed and colonized the west, not east coast of old Greenland. The late observations of Scoresby, and the details given by Gieseckè, in a memoir published in the Transactions of the Royal Irish Academy, demonstrate the futility of the opinion, just mentioned. Gieseckè, who spent eight years in Greenland, tells us he met with upwards of fifty Norwegian houses, in the fiords or firths of South and East Greenland, fragments of church bells, and sculls of the Caucasian or European race of men. In the language of the Greenlanders, he detected many Scandinavian or Icelandic words, used in domestic life, a proof that there existed a friendly intercourse between both nations. Many plants foreign to this part of the Arctic Flora were met with, probably imported by the Norwegian settlers, such as the sorbus aucuparia. In reference to the destruction of the colonists, our author remarks; "All the ruins of Norwegian houses were surrounded by immense mas-

ses of rocks, probably precipitated from the summits of the adjacent mountains, and heaped together in the most fantastic groups. Places of desolation of this kind, are frequently met with among the mountains, connected with the sea by water-falls, which are precipitated with tremendous velocity from the rocks covered with glaciers. I have no doubt that such changes, caused by the bursting of glaciers, and the subsequent inundations, have produced these scenes of desolation; and that perhaps the Norwegian settlers perished, and were buried in the ruins caused by such destroying powers."—*Ed. Phil. Jour.*

4. *On the Preservation of Zoological Specimens from the depredations of Insects; by* THOMAS S. TRAIL, M. D. F. R. S. E., &c. Communicated by the Author.

The author remarking upon those compositions which contain as ingredients, arsenic and corrosive sublimate, says "they are well known to be very effectual, when properly applied; but unless used with caution, they are apt to injure the natural pliancy of the skins, and they can scarcely be effectually employed to protect collections of insects. I have known these substances, even in the hands of the most expert, produce such *tenderness* of the skins impregnated with them, as to form a considerable obstacle to setting up the specimens." After speaking of tallow and camphor, (the first of which he has not tried, the other has known to fail) he proceeds; "Every substance which I have yet tried seems to be inferior in efficacy and ease of application to the following,"—the method of Mr. William Gibson, preparer of objects of Natural History, residing in Liverpool, which I shall transcribe from his own communication to me.

"I have found" says he, "that nothing destroys insects so effectually as *rectified oil of turpentine*, and my method of using it is as follows: I put the turpentine into a bladder, the mouth of which is firmly tied with a waxed string and nothing more is necessary than to place the bladder, thus prepared, in the box with the birds, or tie it to the pedestal on which the birds are perched in a case. If there be any maggots on the birds, I have invariably found, that they will soon be dislodged from the feathers, fall to the bottom of the case, and die in the course of a few days. It is also stated that the turpentine is equally hostile and fatal to the common house-fly, the large blue-bottle-fly, moths, and cockroaches; that a single drop applied to the corselet is more effectual in speedily killing perfect insects, than the more common method of dipping the transfixing pin in aquafortis. For destroying the minute white *acari*, that infest the hairs of specimens it proves speedily effectual." As far as I can judge, this method promises, from its cheapness, and easy application to be very useful, not only to collections of natural history exposed to public view, but will materially abridge the labor, and save the precious time of the scientific traveller in preserving his collections. It will also, I doubt not, prove an acceptable boon to furriers, and other dealers in peltry. And the anatomist would probably also convert it to his use with much advantage.—*Ed. Phil. Jour.*

5. *Falling Stars.*—Dr. Brandes of Breslau, and several other meteorologists, have for sometime past been actively employed in making corresponding observations on falling stars. Although these remarkable meteors, apparently situated beyond the atmosphere of the earth, at first sight appear to move in every possible direction, yet according to the observations of Dr. Brandes and his friends, it would seem that the most frequent direction is that opposite to the course of the earth in its orbit.—*Ed. Phil. Jour.*

6. *Comparative durability of Marble and Granite.*—A fragment of a column in the ruins of Capernaum, mentiontioned by Prof. Hall, is of an extremely beautiful granular marble, which has all the freshness and brilliancy of a specimen recently taken from a natural quarry. It has been full proof against the attacks of the elements, during the lapse of perhaps two thousand years. Although limestone is softer than granite, it is frequently less liable to decomposition. This remark accords with the observations of several travellers in Egypt, Greece, and Palestine. The feldspar of the granite is affected by the action of the air and moisture, sooner than either of its other ingredients. "Of all natural substances used by the ancient artists," says Dr. Clarke, "Parian marble, when without veins, and therefore free from extraneous bodies, seems to have best resisted the various attacks made upon Grecian sculpture. It is found unaltered, when granite, and even porphyry, coeval as to their artificial state, have suffered decomposition.—*Ed. Phil. Jour.*

7. *On the Iron in the Cruor or red part of the Blood.*—Englehart of Göttingen, from a series of experiments, concludes, that the red color of the cruor of the blood is owing to iron, although this opinion has been controverted by Brande, Vauquelin and others. He found, when the cruor is deprived of its iron, that it becomes colourless. The iron is separated from the cruor by means of chlorine, a method much superior to those at present in use.—*Ed. Phil. Jour.*

8. *Manufacture of Paper from Marine Plants.*—It is said, that it has been tried with success in Holland, to manufacture paper of marine algae. We have not seen this paper, and are unable to say any thing, with certainty upon the subject, but we entertain no doubts, regarding the success of such an undertaking, provided it were conducted by proper hands. The tenacious texture, and the nature of these plants, seems to render them well adapted for this purpose.—*Ed. Phil. Jour.*

9. *Manufacture of a Paper, which has the property of removing Rust from articles of Iron and Steel.*—After having dried a certain quantity of pumice stone among live coals, and reduced it to powder, grind it with linseed oil varnish, and then dilute it with the same varnish, until it is thin enough to be laid upon paper with a pencil. To give this layer, a yellow, black, or brownish red color, the mass is mixed, before applying it to the paper, with a little ochre, English red, or lamp black. Care must be taken to lay the substance on as equally as possible, and to dry it in the air. When the first coat thus applied to the paper is dry, another is to be laid on in like manner. Those who manufacture it for sale, pass the paper thus prepared under a cylinder, to render it smooth. It is further to be observed, that the mass must be liquid, and that it must be stirred about before applying it to the paper.—*Ed. Phil. Jour.*

10. *On the Poisoning of Plants.*—Plants are liable (as Carraderi has seen) to lose their power of contraction, by the action of distilled oleander water; thus this water, or even better, the volatile oil of oleander, extinguishes all the power of contraction of the capsule of *momoidaca elaterium*, and of *balsamina impatiens.*

Mr. Marcet, of Geneva, having soaked sensitive and other plants in an aqueous solution of opium, remarked, that it also extinguished the action of vegetable life. Thence, Carradori concludes, that plants have contractable muscular fibres. Mr. Marcet has thought that vegetables also possess something analogous to a nervous system, since the first of these poisons acts on contraction, the second on the sensibility in animals.—*Jour. de Pharm. Ann. of Phil.*

11. *Raining Trees.*—In the ancient histories of travellers in America, and also by Thévet in his Cosmographia, mention is made of a tree which attracted the clouds from the heavens, and converted them into rain in the dry deserts. These relations have been considered as fables. There has lately been found in Brazil a tree, the young branches of which drop water, which falls almost like a shower. This tree to which Leander has given the name of *cubea pluviosa*, is transferred by M. Decandolle to the genus *cæsalpinia* (pluviosa,) in his *Prodromus*, vol. II. p. 483. Also, many vegetables, as the *calamus rotang*, and tender climbing plants, the vine, and other twigs, at the season of sap, *weep* abundantly, particularly when they are cut.—*Jour. de Phar. Ann. Phil.*

12. *Phosphorescent Plants.*—Several cryptogamous subterraneans, have been observed to be luminous in the dark. M. Neas, of Esenbeck, cites after M. Heinzman, the rhizamorpha phosphorescent found in the mines of Hesse, in the north of Germany; the light is visible at the extremities of the plants, especially when it is broken. This phosphorescence disappears in hydrogen gas, oxide of carbon, and chlorine gas. Some other *rhizmorpha* as the *subterranea* and the *acidula*, have also appeared phosphorescent, to several persons working in the mines.—*Jour. de Pharm. Ann. Phil.*

*Extracted and translated by* Prof. J. Griscom.

13. *Instruction in Geography.*—M. Alexander De Humboldt is on the point of opening in this place, (Berlin,) a course of instruction in physical geography. The influx of persons who have inscribed their names as attendants upon his lessons is so great that the Hall is found insufficient to receive all the auditors. M. De Humboldt, who is acquaint-

ed with the fine establishment in Paris, called the Georama, regrets that there is not in Berlin one of the same kind. This would enable him to exhibit to the audience on a chart of vast dimensions the different voyages of discovery, and give a sort of *instruction* of the terrestrial globe, considered at one view both in its locality and in its details. Comparative geography is, like comparative anatomy, a new science, eminently calculated to advance the geographical sciences.—*Rev. Encyc. Oct.* 1827.

14. *Homage rendered by power to genius.*—A short time since the town of Weimar, presented to the literati of Europe a scene extremely touching. The patriarch of German literature, the illustrious GOETHE, received the homage of a monarch, a true friend of the arts and sciences, who is himself one of the most enlightened men of Germany, and who omits no occasion of manifesting the noble enthusiasm which animates him on behalf of generous principles. The king of Bavaria having learned that the anniversary of the birth of GOETHE was about to be celebrated, went to Weimar, unexpectedly to the poet, pressed him in his arms, and hung around his neck the grand cordon of the order of Bavaria with which he was invested.

On his return to Munich, the young prince expressed, in an ode, the lively impressions which he felt on leaving Weimar, and in which he bestows a solemn homage to poetry; to the Grand Duke of Weimar, Charles Augustus; and to GOETHE, his illustrious friend.

This ode, in the true spirit of the German language, contains much depth and grace of imagination, and great precision of style.—*Ibid.*

15. *Marseilles*, (France.)—The *Society of christian morals*, established at Marseilles, about fifteen months since, has, even in this short space of time, by its untiring charity, rendered important services to suffering humanity. A stranger to all party spirit, indifferent to all national rivalships, enquiring into no man's religious opinions, it advances silently to the practice of well-doing, intent only upon the means of obtaining some amelioration, moral or physical in the lot of humanity. This society aspires only after a single object—the happiness of men; and its generous intentions, which embrace at once, the warrior and the man of letters, the la-

borer as well as the philosopher, the Jew as well as the christian, are so well known, and so evident, that no reasonable person can entertain the least doubt with respect to it.

This declaration of the principles which govern the society, renewed by M. Chasson, one of its secretaries, at the meeting of the 27th of September, 1827, was followed by a report upon the situation of the society and the results already obtained. Afflicted by the fury with which so many persons yield to an excess of gambling, and the misery occasioned by this detestable passion, the society ordained a prize for the best work against this shameful vice. The number of competitors was considerable; but the prize was adjudged, and the society doubled its value for the next year. It will be three hundred francs.

The society had conceived the project of forming, in Provence, a colony composed of Greeks expelled from their country, without a home and without resources; but circumstances, which could not be foreseen, occasioned the postponement of this interesting project; but the hope is cherished of resuming it next year. In the mean time, the society has extended its care to the young orphan Greeks, and it is estimated that a capital of one hundred and forty-four thousand francs will be necessary for this charitable purpose, within the year. But this sum is very small compared with the number of unfortunate beings which require assistance, and the society of Marseilles invites the other inhabitants of France to unite in this work of mercy.—*Rev. Encyc. Dec.* 1827.

16. *Figure of the Earth.*—M. Biot read a memoir on this subject, before the Institute, on the 3d of November last. His own observations, confirming the results at which many others have arrived, have induced him to admit that the action of gravity is not the same at all points on the same parallel, and that there is not a uniform variation on the same meridian. He has discovered that at Paris, particularly, the annual variation is sufficiently great to occasion a daily variation of five seconds in the going of a clock. He thinks that this variation in the force of gravity on the same parallel, is the cause of the different measures assigned to the flattening of the earth. He points out the manner in which it will be proper hereafter to direct observations on the length of the pendulum, to render them as useful as possible. Every isola-

ted observation, will in his opinion, be hereafter of little consequence, unless, by a chance on which it would be unsafe to rely, it should happen to be made at a point where the action of gravity would be a *maximum* or a *minimum*. In general, observers should hereafter endeavor to repeat their observations, either along the same parallels, or on the same meridian, in order to ascertain the laws (if any such exist) which regulate the diversity which can now no longer be contested. The author concludes his memoir in observing that the English have erred in taking the length of the pendulum as the basis of their metrical system, as this length may vary from causes which are quite independent of mere topographical position, and which may not remain constant at the same place during a course of ages. On this account, the basis of the French measure is not liable to the same inconvenience to the same extent.—*Idem.*

17. *The Society of Encouragement at Paris, offer the following premiums.*—3000 francs, for a black dye for hats which will resist the prolonged action of the sun's rays, without losing its lustre, or altering the suppleness of the fabric.

2000 francs for a cheap and effectual mode of preserving ice for domestic purposes.

1500 francs for a Rasp, which will reduce six hundred Kilogrammes (one thousand six hundred pounds troy,) of beet roots to a pulp, with the force of four men. And 2000 francs for the best press, which will extract seventy-two to seventy-five per cent of juice from the pulp.

2000 francs for the perfection of the method of producing *Ichthyocolla.*

6000 francs for an economical process of making solid pieces of ultramarine, equal to that which is obtained from lapis lazuli.

5000 francs for a process for drying meat, which will secure it from putrefaction or taint in long southern voyages. A portion of meat has been exposed during ten years, in the mint at Paris, in a situation in which it is not protected either from dust or atmospheric changes, and which after being washed and cooked, is still savoury and good. It was dried or preserved by *M. Vilaris*, an apothecary of Bordeaux, whose secret died with him.—*Programmes des pris. &c.*

18. *Action of the Moon on the Atmosphere.*—The Bib. Univ. for Dec. 1827, contains a valuable memoir on this subject by M. Flaugergues, astronomer at Viviers in France. The author observes that many geometricians, have been engaged in researches on the action of the moon upon the barometer, but that their labors have not been attended with very satisfactory results. Nor have the labors of meteorologists been much more successful. The observations of some of these are contradictory and irreconcilable with each other. Several have inferred that the barometer is higher during the time the moon is in perigee than when she is in apogee; and others, that the mean height is greater in the syzygies than in the quadratures; but other observers, have drawn opposite conclusions. The results of different years do not correspond. The fault may in many cases have lain in the instruments, which for want of proper care and management are liable to deteriorate. Considering also the many irregularities, which attend the moon's motion, it is only by a long series of observations, that correct and satisfactory deductions can be formed. The author describes at length the instruments he employed, and the precautions which he observed to ensure accuracy in his observations. He extended his researches throughout a whole *Saros* or lunar cycle, and sums up the result as follows:—

*Table of the mean heights at noon, of the barometer, at the observatory of Viviers, in the phases of the Moon, in the Apogee and Perigee of that luminary, and in the lunistices; deduced from the meridian observations of nineteen years,* (*19th Oct.* 1808—*18th Oct.* 1827.)

| LUNAR POINTS. | Number of observations. | Mean heights of the barometer. | Reduction to millimetres. |
|---|---|---|---|
| | | pou. lig. | m. m. |
| **Mean general height,** | 6915 | 27 11.29 | 755.44 |
| **Conjunction, or new Moon,** | 234 | 27 11.27 | 755.39 |
| **First Octant,** | 234 | 27 11.26 | 755.37 |
| **First quadrature,** | 234 | 27 11.26 | 755.37 |
| **Second Octant,** | 235 | 27 10.94 | 754.65 |
| **Opposition, or full Moon,** | 234 | 27 11.20 | 755.23 |
| **Third Octant,** | 234 | 27 11.47 | 755.70 |
| **Second quadrature,** | 234 | 27 11.68 | 756.32 |
| **Fourth Octant,** | 235 | 27 11.31 | 755.48 |
| **Northern Lunistice,** | 258 | 27 11.42 | 755.73 |
| **Southern Lunistice,** | 258 | 27 11.28 | 755.42 |
| **Moon in Perigee, (Parall. equa. 60′ 24″)** | 252 | 27 10.97 | 754.72 |
| **Moon in Apogee, (Parall equa. 54′ 4″** | 252 | 27 11.46 | 755.82 |

It evidently appears from this table,

1st. That in a synodical revolution of the moon, the barometer rises regularly from the second octant, when it is the lowest, to the second quadrature, when it is the highest; and then descends to the second octant to commence again its rise, &c.

2d. The varying declination of the moon also modifies her influence upon atmospheric pressure. It is greatest (at least in the latitude of Viviers,) when the moon's declination is south; whence it evidently results that the barometer is higher in the northern lunistice than in the southern. This observation is contrary to what M. de Laplace had concluded from his theory, viz. "that the sign (signe) of the declination of the two luminaries (sun and moon) has no sensible influence on the modifications of the atmosphere."*

3d. Lastly, the action of the moon, in diminishing the pressure of the atmosphere, varies with its distance from the earth. The mean height of the barometer is less when the moon is in perigee than in apogee, whence we may infer that her action in diminishing pressure, is greater in the former than in the latter situation.

There exists between the phases of the moon and the days of rain which coincide with these phases, a constant relation which would appear very singular, if what we have observed with respect to the barometer did not furnish an immediate explanation. Agreeably to the extract which I have made from my meteorological journal of the rainy days which coincide with the days of the moon's phases and with those of the perigee and apogee during the period of nineteen years, I have found the number of those days as follows.

| | PHASES OF THE MOON. | | | | | |
|---|---|---|---|---|---|---|
| | New Moon. | First quarter. | Full Moon. | Last quarter. | Perigee. | Apogee. |
| No. of rainy days coincident with the days of the Moon's phases. | 77 days. | 82 days. | 79 days. | 60 days. | 93 days. | 78 days. |

We perceive by this table that the number of rainy days which coincide with the days of the phases, &c. follows the same march with the mean heights of the barometer corres-

---

* Mécanique celeste, t. ii, p. 298.

ponding with these phases, but in an *inverse order:* thus the number of days of new moon on which it has rained, is less than the rainy days of the full moon, and the mean height of the barometer on the days of conjunction is greater than that of the days of opposition; in like manner the rainy days of the first quarter greatly exceed those of the last quarter, and the barometer heights are also inversely correspondent; lastly the wet days of the perigee are much greater than those of the apogee, and the barometer follows a correspondent change.

We may therefore conclude that the diminution of the pressure of the atmosphere caused by the attraction of the moon, ought to be reckoned among the causes which determine the fall of rain.—*Viviers*, 19 *Novem.* 1827.—*Bib. Univ. Dec.* 1827.

19. ***Helvetic Society of Natural Sciences, held at Zurich on the 20th, 21st, and 22d of August***, 1827.—M. Debur, of Geneva, furnished a table of meteorological observations of his father, exhibiting the years remarkable for heat from 1768 to 1800.

| Maximum of the thermometer after noon.—F. | | | Maximum of the thermometer after noon.—F. | | |
|---|---|---|---|---|---|
| 1771, | July 25, | 91° | 1792, | July 19, | 90½° |
| " | " 26, | 92¾ | 1793, | June 30, | 90½ |
| 1780, | July 30, | 90½ | " | July 18, | 94½ |
| " | " 31, | 95 | " | " 17, | 98¼ |
| 1781, | May 31, | 83¾ | 1794, | July 7, | 88¼ |
| " | Aug. 28, | 80 | " | " 23, | 92¾ |
| " | " 31, | 79¼ | 1797, | July 19, | 90½ |
| 1787, | Aug. 1, | 92¾ | " | " 21, | 90½ |
| 1791, | July 28, | 90½ | 1778, | Aug. 4, | 91½ |
| " | " 31, | 90½ | " | " 13, | 98 |
| " | Aug. 1, | 92¾ | " | " 14, | 98 |
| " | " 8, | 89¼ | 1800, | Aug. 14, | 92¾ |
| 1792, | July 18, | 90½ | " | " 19, | 95 |

1780. The vintage took place at the end of September, and the wine was of a superior quality.

1781. Wine of same superior quality.

1791. The harvests all suffered by drought, except that of the wine.

1800. The grass withered on the mountains.

An examination of the intervals which separate the years remarkable for great heat, shows that their return is subject to no regular law; sometimes the intervals are very long, sometimes very short: thus in the last thirty years, they are nine, seven, four, two, one and six years.—*Bib. Univ. Dec.* 1827.

20. *Necrology.*—The following* are the epochs of the death of the philosophers whose names are mentioned.

Schubert, - - - - 22d October, 1825.
Fuss, - - - - 23d December, 1825.
Reichenback, - - 12th May, 1826.
Frauenhofer, - - 7th June, 1826.
Bode, - - - - 23d November, 1826.
Laplace, - - - 5th March, 1827.
Volta, the same day with Laplace.
Chladni, - - - 4th April, 1827.
Ramond, - - - 14th May, 1827.
Fresnel, - - - 14th July, 1827.

*Ferrussac's Bul. Juillet*, 1827.

21. *Sideroscope.*—An instrument has been invented in France to which the above name has been given, provisionally from the extreme facility and delicacy with which it indicates the smallest portion of iron in any substance, mineral, vegetable, or animal.

It consists, briefly of a small straw, nine inches long, through one end of which pass at right angles, two fine sewing needles, sixteen lines in length, both strongly magnetised, weighing only one grain. They are inserted in contrary directions. Through the other end passes a single sewing needle, of the same length, weighing a grain and a half, magnetised in the same manner. This instrument is suspended inside of a glass case, by a single untwisted fibre of raw silk, twelve inches long; substances to be examined, are introduced into the case, by a lateral opening. The whole instrument weighs but four grains, and the utmost care is observed to exclude from the frame or table of wood which supports it, the smallest particle of iron, and to avoid the disturbing effects of a current of air, and even of the breath.—The substances to be presented for trial, are pasted to a small strip of card or pasteboard, to avoid the heat of the hand or fingers.

Almost every piece of money, French or foreign, ancient or modern, gold, silver or copper, but especially the silver coins of Italy, attracts the sideroscope with greater or less activity: it is the same with all substances, mineral, vegetable or animal, which contain the least atom of iron, nickel or cobalt. Platina exercises a decided action, notwithstanding all the chemical operations necessary to bring it to a soft state.

Small masses of any of the following substances, weighing at most, eight or ten grains, affect this delicate instrument. All kinds of ashes, compacted by a little gum water; blood simply dried or swelled; chocolate; bottle glass; tourmalines, green and black, not rubbed or warmed; granite; rhomboidal quartz; yellow topaz; green talc; sulphate of iron; all volcanic products; all metals not chemically pure; brass pins, even the finest used by entomologists; various galenas and other minerals; all ærolites; burnt hoofs and horns of cattle, &c.

The most surprising effect of the Sideroscope is the *repulsion* of the needle by bismuth and antimony.—*Idem.*

22. *Purity of Tin.*—M. Oehngern undertook in 1822, the analysis of the various kinds of tin employed in the manufacture at Closter of sheet tin (fer-blanc) in order, to discover the cause of the superiority of certain kinds. He discovered that the English grain tin, which gives the finest tinned surface contains no foreign body.

M. Rinman, who has rendered great service to the Closter fabric, has been engaged in the examination of the saline residuum obtained in the purification of common tin in order to render it fit for tinning. He finds in the 100 parts,

| | |
|---|---|
| Tin, - - - - - | 85.3000 |
| Copper, - - - - - | 13.7178 |
| Iron and Zinc, - - - - | .3300 |
| Arsenic, - - - - - | .6712 |

He concludes that to the arsenic, and especially to the copper, ought to be attributed the property which impure tin possess of losing its lustre when used in tinning other metals.—*Ibid.*

23. *Prussian Blue.*—M. Gautier in his theoretical researches into the formation of cyanogen has been led to the following conclusions. First, calcined animal matter will

alone give very little cyanogen. Second, it produces more with potash, but the prussiate is not ferruginous. Third, ammonia is then produced in great quantity. Four, the substitution of nitre for potash and the addition of clippings or scales, (vattitures) increase the production of cyanogen, and give a ferro-prussiate. The author has practised this process for two years in the neighborhood of Paris. His method as he describes it is as follows,

| | |
|---|---|
| Blood, supposed dry, - - - | 3 parts. |
| Nitrate of potash, - - - | 1 part. |
| Scales of iron, - - - - | $\frac{1}{50}$ of the blood. |

After having coagulated the blood in a large copper kettle the serum is pressed out and the clot returned to the kettle, with the nitre and the iron. The humidity of the blood is sufficient to liquefy the salt, so that the mixture becomes uniform. It is then removed to an airy loft, where the desiccation is completed. The putrefaction of the blood is prevented by the nitrate of potash. When completely dry it is put into cast iron cylinders, arranged in a reverberatory furnace similar to those used for ivory black. The cylinders are heated to dull red, or until smoke ceases to be disengaged. The materials after being thoroughly cooled, are withdrawn, and put into a wooden vat, with twelve or fifteen times their weight of water, and left one hour. The fluid is then filtered through a cloth and evaporated to the thirty-second degree of Baumé's areometer. On cooling, a considerable quantity of the bicarbonate of potash is produced, in well formed crystals. The author has not been able to satisfy himself with respect to the manner in which this bicarbonate is formed at so high a temperature, since a portion appears to be decomposed during the evaporation of the ley, at first, but little alkaline, but which becomes very sensibly so, by a prolonged evaporation.

The same product is not obtained when the potash of commerce is used. It is probable that the elements of the nitric acid act an important and necessary part in this operation.

The solution which has furnished these crystals, contains a little sub carbonate of potash and much cyanuret of ferruretted potassium. The liquor is contracted to 34. placed in wooden vessels cased with lead. In the course of a few days a greenish crystalline mass is obtained: these crystals are re-dissolved in a fresh quantity of pure water, which evaporated to 32 or 33, yield crystals anew.—*Ibid.*

24. *Saltpetre.*—It is stated by Henri Braconnot, that the stem and leaves of the common Beet when dried and burned, yield ashes so rich in alkali, that it melts easily by heat, and surpasses many of the commercial varieties of potash. Beets which grow in a soil highly manured contain much nitre; those which grow in thin and sandy soils, very little. The leaves of the former when tied in bundles, and hung up to dry in places slightly moist, warm, and rather dark, will have their leaf stalks entirely penetrated and covered with an innumerable multitude of small crystals of saltpetre. The nitric acid, in this case must have entirely displaced the oxalic and malic acid. Is this acid formed under the influence of the animalised substance contained in the petioles, or is it produced exclusively by the elements of the atmosphere? The author tried in conjunction with a friend, to manufacture saltpetre from the residue of the beets used in a sugar factory but was not successful.—*Ann. de Chimie. et de Physique, Juillet*, 1827.

25. *Evaporation of water from hot surfaces.*—It was ascertained by Leidenfrost, in 1756, that between the boiling point and that at which iron becomes white hot, water evaporates from its surface less easily the greater the heat. Klaproth repeated these experiments and relates the result as follows.

A polished iron spoon being heated to whiteness, and a drop of water being let fall upon it, the drop split into pieces, but these were soon united again, and appeared like a crystal ball in a state of repose, touching the hot metal only in one point. On observing it closely, it was found to turn rapidly round its center, becoming smaller and smaller until it was dissipated with explosion. As soon as it was gone, he let fall another, and then a third, fourth, &c. the spoon cooling the whole time.

| | | |
|---|---|---|
| The first drop continued | 40 | seconds, |
| the second - - | 20 | “ |
| third - - | 6 | “ |
| fourth - - | 4 | “ |
| fifth - - | 2 | “ |
| sixth - - | 0 | “ |

Having let fall seven drops in a spoon heated to the proper point, they united in a globular mass which began to turn on its axis with rapidity. It afterwards separated at the top, and a spot of white foam appeared, the borders being indented. This curious phenomenon continued one hundred and fifty seconds. Ten drops formed a globule with like results, except that it lasted two hundred seconds, and went off without evaporation properly speaking, the spoon being very hot.

After these trials he used a capsule of pure silver and another of platina, which were heated on coals to whiteness. The phenomena were nearly the same. With the silver capsule, in the first experiment

the first drop continued 72 seconds,
the second - - 20 "
third - - 20 "
fourth - - 0 "

In the second experiment

the first drop continued 61 seconds,
the second - - 30 "
third - - 20 "
fourth - - 6 "
fifth - - 0 "

When there were three drops, the united ball continued two hundred and forty seconds, and the evaporation was afterwards instantaneous. With the platina capsule, the first drop continued fifty seconds, and a bubble of three drops ninety seconds.—*Ibid.*

26. *Contents of rain water.*—M. Liebig, professor of chemistry at Geissen, found on an examination of seventy-seven specimens of rain water, seventeen of which were procured during storms, that the latter all contained nitric acid in very different quantities, combined either with lime or ammonia. Among the other sixty specimens he found but two which contained a trace of nitric acid.

The same chemist examined the residue of fifty other varieties of rain water, collected by the late M. Zimmerman, in 1821, 1822, and 1823; among them twelve contained nitrates.

It thus appears, that during storms the azote and oxygen of the atmosphere, combine and form nitric acid—a fact by no means surprising, after the experimental results of Cavendish and Seguin.

Hence when nitrates are found in materials which contain neither animal nor vegetable matters, the acid is probably formed by the electricity of the atmosphere.

A memoir of Luiscius, (Rotterdam, 1798,) on the putrefaction of vegetable and animal substances, states, 1st, that these substances, in contact with water, are entirely decomposed, if the air have free access; 2d, that the decomposition is singularly accelerated by air; 3d, that under those circumstances, (air and water having free access,) much nitric acid is produced, and a little ammonia; 4th, that these substances putrefy in different times in the following order; urea, gluten, animal gelatine, muscular fibre, starch, white of eggs, gum, sugar, vegetable fibre, &c.—*Ibid.*

27. *Presence of ammonia in argillaceous minerals.*—It is the conclusion of M. Bouis, of Perpignan, from his experiments and researches, that the argillaceous odor of minerals is owing to the presence of ammonia. He has found it in pipe clay, impure gypsum of various formations, steatitic earths, anterior to the presence of organised bodies, &c. When these substances are moistened with a solution of caustic potash, the argillaceous odor is generally increased, and in that case a glass wet with hydro-chloric acid occasions white vapors when held near them. Litmus paper, slightly reddened, and placed over these earths, thus moistened, has its blue color restored.

Argillaceous odor has been generally ascribed to the oxide of iron, but it is difficult to conceive how this substance can render inert substances odorous. The presence of ammonia in these minerals may account for the odor they give out on being breathed upon, or slightly moistened. The ammonia becomes the vehicle of the peculiar argillaceous material.

An analogous phenomenon occurs in musk, tobacco, &c. which when perfectly dry, are almost inodorous but when moistened with a weak solution of ammonia, give out their characteristic odor.—*Ibid.*

28. *Magnetism.*—M. Scebeck, in making new researches on the property which the metals have of diminishing the number of oscillations of the magnetised needle, determined the different degrees of this force in each metal. He used a needle two and one eighth inches long, suspended by a fibre of silk, at the distance of three lines over metallic plates and observed that between the two amplitudes of 45° and 10° it made

| | | | | |
|---|---|---|---|---|
| 116 | oscillations above a plate of marble. | | | |
| 112 | over a stratum of mercury | 2 | lines | thick. |
| 106 | over a plate of Bismuth, | 2 | " | " |
| 94 | - - Platina, - | .4 | " | " |
| 90 | - - - Antimony, | 2.0 | " | " |
| 89 | - - Lead, - | .75 | " | " |
| 89 | - - - Gold, - - | .2 | " | " |
| 71 | - - Zinc, - - | .5 | " | " |
| 68 | - - - Tin, - - | 1.0 | " | " |
| 62 | - - Brass, - | 1.0 | " | " |
| 62 | - - - Copper, - | .3 | " | " |
| 55 | - - Silver, - - | .3 | " | " |
| 6 | - - - Iron, - - | .4 | " | " |

The author ascertained by experiment, that the metallic nature of the magnetic needle had the same influence on the oscillations as subjacent plates, and that by combining the metals, which, like iron, nickel and cobalt, are magnetic, with others, which, like antimony, diminish the magnetic force,—compounds are formed, which have no influence on the oscillations of the magnetic needle. He thus found that an alloy of 4 parts antimony with 1 of iron, of 3 copper with 1 anitimony, and of 2 copper with 1 nickel, produced not the least dimunition in the number of oscillations which were 116 as when over a plate of marble. He infers from these facts that those three alloys, would be the most suitable for compasses, and that that of copper and nickel deserves the preference, from its being the most malleable. —*Ferrussac's Bull. Aout*, 1827.

29. *Artificial Spider's web for micrometers*—Dissolve, to a convenient extent very thin caoutchouc in very pure spirits of turpentine. By drawing out the solution, extremely fine and smooth threads are obtained, which when dried, are very good for micrometers.—*Ibid.*

30. *Analysis of Potteries.*—M. P. Berthier has examined the composition of several kinds of pottery ware. He distinguishes them into three sorts—1st, porcelains, 2d, potteries, 3d, crucibles.

| | PORCELAIN. | | | |
|---|---|---|---|---|
| | Sèvres. | England. | Piedmonts. | Tournay. |
| Silica, | 0.596 | 0.770 | 0.600 | 0.753 |
| Alumine, | 0.350 | 0.086 | 0.090 | 0.082 |
| Potash, | 0.018 | - - | - - | 0.059 |
| Soda, | - - | - - | - - | |
| Lime, | 0.024 | 0.012 | 0.016 | 0.100 |
| Magnesia, | - - | 0.070 | 0.152 | - - |
| Water, | 0.008 | 0.056 | 0.136 | 0.006 |
| | 0.996 | 0.994 | 0.994 | 1.000 |

The paste of Sèvres is composed of

.633 of kaolin of Limoges, washed;

.105 of quartzose sand from the mound of Aumont;

.052 of chalk from Bongival;

.210 of fine sand extracted from the kaolin by washing; this sand is a mixture of quartz and feldspath.

The porcelain of Sèvres is known to be of an excellent quality, and as refractory as any in Europe.

The glazing is made of a rock composed of quartz and feldspath, reduced to a very fine powder. It is composed of

| | | |
|---|---|---|
| Silica, - - - | 0.730 | 0.982 |
| Alumine, - - - | 0.162 | |
| Potash, - - - | 0.084 | |
| Water, - - - | 0.006 | |

It melts into a perfectly transparent and colorless glass.—*Annales des Mines. T. I.* 469.

31. *On the measure of the intensity of Light.*—The most general method is to place an opake body before a white card or pastebord, in front of the two lights to be examined, to remove the latter from the screen until they produce shadows of equal intensity, and then to take the squares of the distances as the relative powers (inversely) of illumination. It has been found that the apparent intensity of the two shadows varies with the position of the observer. If they are equal when observed from a point situated perpendicularly over the screen and equidistant from each shadow, they will, if viewed from any other point appear to vary in intensity, the nearer having the deeper shade, so that in changing from right to left of the table, each will appear in its turn of the deeper hue. These differences are greater in proportion to the distances of the shadows from each other and the smoothness of the surface of the screen. Hence

in photometrical observations, screens should be used which are not very smooth, and the shadows should be brought near each other; and even so as to allow their borders to touch.—*Ferrusac's Bull. Oct.* 1827.

32. *Impurity of rain water.*—In evaporating thirty ounces of rain water every month, which at the end of the year amounted to three hundred and sixty ounces, M. Brandes obtained a total residuum of 2.75 grains. It was composed of resin, pyrrhin, (a vegeto-animal substance,) mucus, hydrochlorate, sulphate and carbonate of magnesia, hydro-chlorate of soda, sulphate and carbonate of lime, hydro-chlorate of potash, oxide of iron and manganese, and an ammoniacal salt.—*Ibid.*

33. *Sulphur in assafœtida.*—In treating assafœtida with caustic potash, and adding an acid to the solution, effervescence is produced, and a gas disengaged which colors paper of acetate of lead like sulphuretted hydrogen.

If an alcoholic solution of assafœtida be evaporated, and the residuum be treated with aqua regia, a liquid is produced which contains sulphuric acid.

In burning the volatile oil of assafœtida in a pure state, a very strong odor of sulphurous acid is developed. This oil, heated to redness with potash, produces a mixture of charcoal and sulphuret of potash. M. Zeise presumes that his ulterior researches will enable him to discover sulphur in a great number of organic substances. It may be remembered also that M. Planche has already detected the presence of sulphur in the umbellifera.—*Ibid.*

34. *Incompatible salts.*—M. Brandes has demonstrated by means of an artificial mineral water, that the waters of Pyrmont contain carbonate of soda and sulphate of lime, and not, as has been pretended, sulphate of soda and carbonate of lime; because if these latter salts co-exist, even in a large quantity of water, a material decomposition takes place.—*Ibid.*

35. *Steam Engines in Great Britain.*—It is confidently asserted that there are now in Great Britain, fifteen thousand steam engines. Some of them are of prodigious size. In the county of Cornwall, for example, there are some of the

power of six hundred horses. Admitting that on an average, they are equal to twenty five horses each, the total strength of these engines would amount to that of three hundred seventy five thousand horses. Now, agreeably to the estimate of Mr. Watt, a horse is equal to five and a half men. England, therefore, possesses in these engines, a force of about two millions of men. It may be further observed, that as each horse requires annually, the produce of two acres of land for his nourishment, the inhabitants of that nation have, by means of steam engines, seven hundred and fifty thousand acres more at their disposal than if the same labor were executed by horses.—*Ibid.*

36. *Crystal Bed.*—The public have been hastening to the palace de Tameda, to see a bed of massive crystal, destined to be sent as a present to the shah of Persia by the emperor of Russia. This magnificent bed, the only one of the kind perhaps in the world, is resplendent with silver, ornamented with columns of crystal, and ascended by steps of blue glass. It is constructed in such a manner that there can be made to issue from it, on each side, jets of odoriferous water, whose murmuring sounds may excite an agreeable slumber. It reflects by the light of flambeaux a dazzling splendor resembling myriads of diamonds. There is no doubt that this piece of furniture will astonish even eastern luxury and magnificence. It was made in the Imperial manufactory of St. Petersburg.—*Annales patriotiques, Oct.* 1825.—*Ibid.*

### 37. *Compressibility of water, by Prof. Oersted.*

1. As far as the strength of my apparatus allowed me to urge the compression of water, (viz. to seventy atmospheres,) I have found the compressibility proportionate to the compressing force. The compression produced by a single atmosphere, already discovered by Canton, is about forty five millionths of the whole volume. Mr. Perkins has obtained by a pressure of one hundred atmospheres, a compression of one hundredth of the entire volume, which is much more than can be inferred from my experiments. Calculating from the results I have obtained with pressures below seventy atmospheres, I obtain for one hundred atmospheres only 0.0045. Finding that my results differed so widely from the distinguished mechanician's who preceded me, I have repeated my experiments with the greatest care, and they are so simple that I can entertain no doubt of their correctness.

2. As far as I have been able to determine the temperature of compressed water, and I have done so to the extent of forty eight atmospheres, I have found no heat disengaged by compression.

3. The compression of mercury is but little more than a millionth of its volume for one atmosphere.

4. The compressibility of sulphuric æther is about triple that of alcohol, double that of sulphuret of carbon, but equal only to a third of that of water.

5. The compressibility of water, holding salts, alkalies and acids in solution, is less than that of pure water.

6. The compressibility of glass is excessively small, and far below that of mercury.—*Ibid.*

38. *Probability of Life. Comparative results deduced from Registers kept at Geneva, and calculations made by Dr. Odier.*—It appears from these registers that the probability of life, as well as its average period, has been continually increasing from the sixteenth century to the year 1826, particularly in its earliest stages; and that there is a slight diminution in the subsequent periods, but which is far from balancing the former gain. It is thus very manifest that the cares bestowed upon infancy have ameliorated its existence, and that children are now preserved in a very remarkable proportion. These successive improvements will be obvious from the following table.

| | Probability. | | Proportion. | Average life. | | Proportion. |
|---|---|---|---|---|---|---|
| | Yrs. | Months. | | Yrs. | Months. | |
| 16th century, | 4 | 9 | 100 | 18 | 5 | 100 |
| 17th do. | 7 | 11 | $166\frac{2}{3}$ | 23 | 4 | $126\frac{1}{2}$ |
| 1701 to 1760, | 27 | 3 | $573\frac{2}{3}$ | 32 | 8 | $177\frac{1}{3}$ |
| 1761 to 1800, | 32 | 4 | $680\frac{2}{3}$ | 33 | 7 | $182\frac{1}{3}$ |
| 1801 to 1813, | 37 | 10 | $796\frac{1}{2}$ | 38 | 6 | 209 |
| 1815 to 1826, | 45 | 10 | $964\frac{9}{10}$ | 38 | 10 | $210\frac{3}{4}$ |

The probability of the life of women, has always been superior to that of men, and agreeably to a table prepared by Dr. Odier, from the mortuary register of 1801 to 1813, married women and widows have a superiority over others, with respect to the average of life in the ratio of $112\frac{7}{10}$ to 100, notwithstanding the risques of child birth. He estimates the number of women, who perish from this cause, to be one hundred and twenty five in ten thousand, or one to eighty.

The regularly increasing ratio, which the tables present, authorize the opinion of a sensible amelioration in the vitality of our population, and even in our morality, for in reality, among the causes of this amelioration, may be reckoned the perfection of physical and moral education, which has in a great measure expelled the vices and excess to which an ignorant population is ever prone. To this must be added the increase of wealth and ease which is favorable to a more wholesome style of living, and contributes to that tranquility of mind which has a powerful influence on the health. The progress of *Medicine* and *Hygiene*, especially by the introduction of inoculation and vaccination has done much to promote longevity.—*Ibid.*

39. *A simple process for discovering and separating antimony from lead, brass, and other metals soluble in nitric acid; by* M. Bussolin.—If an alloy which contains no antimony be dissolved in sulphuric acid, all will be dissolved, except the tin, the white oxide of which will be precipitated; but if the alloy contain a very small quantity of antimony, the oxide of tin will become of a yellowish hue. Besides, the tin has the property of drawing away all the antimony by its precipitation in the nitric acid. These two facts have been usefully employed by the author, for the discovery of antimony, and the separation of it from the lead.—*Ferrusac's Bull. Jan.* 1828.

40. *Note upon the spontaneous combustion of Cobalt; by* M. Boullay.—Very recently, some cobalt, pulverised by mechanical means, became so strongly heated as to take fire. The combustion slow at first, and was not perceived till the end of two or three days; it was then very hot and luminous, if ever so little stirred. It was covered and set to cool. Some days after, twenty pounds of it, were packed up without any renewal of the combustion, and nevertheless, on the following night, the package of cobalt set fire to the objects with which it was in contact, and afterwards to the warehouse. The fire was extinguished.—*Ibid.*

41. *Note upon the Ioduret of Lead; by* M. Berthenot.—Iron and zinc decompose the ioduret of lead, by simple ebullition in water; the carbonates of soda, barytes, strontian, lime and magnesia, as well as the oxides, have also the property of decomposing the ioduret of lead.—*Ibid.*

42. *Observations upon some properties of sulphur; by* M. Dumas.—It is known that melted sulphur becomes thicker, the higher the temperature is raised, that just before boiling, it becomes more fluid, and that its color constantly advances to a reddish brown; that, finally, being suddenly cooled, when it has been strongly heated, it is soft and transparent, until the moment when it crystallizes. The only remark which M. Dumas appears to make, is, that it is not necessary to keep the sulphur hot a long time, but only to raise it to the necessary temperature, and to cool it suddenly, by dividing it, to reduce it to a soft state.—*Ibid.*

(Communicated by Dr. William Meade.)

43. *Death of the Hon. George Knox.*—We are concerned to have to announce in this Journal the death of the Right Honorable George Knox, F. R. S. and president of the Kirwanian Society of Dublin, who in making a scientific tour in the Tyrol last summer, was unfortunately overturned in his carriage, by which accident, he was deprived of his life, to the great regret of his numerous friends and acquaintance, by whom he was sincerely esteemed for his many amiable qualities. But by the friends of science in particular, his premature decease will be severely felt; few gentlemen of his high rank, have cultivated the sciences of Chemistry and Mineralogy, in all their branches with more zeal and ardor than Mr. Knox. The Transactions of the Royal Society of London, contain many of his papers on Analytical Chemistry. In one of their late journals, in particular, we have observed an ingenious essay of his, on the analysis of certain minerals, proving the existence of bitumen in several of those where it had not been previously suspected, and pointing out, from this circumstance, the probable cause of those discordant results, which have appeared in the Analytical enquiries of different Chemists on the same substances.

44. *Portable Gas.*—The lamps for portable gas are of all shapes and sizes; they are all of malleable iron, and, when placed in a room, are put into bronze or other cases, which combine the useful with the ornamental; the price is three farthings a cubic foot; and, we should suppose that a lamp, containing twenty cubic feet, would give light equal to that of two candles for a week, and burn five or six hours

every night. But it is not only for light that these lamps will be found useful, they will serve also for fire. By a small one, containing only twenty-five cubic feet of gas, water and eggs have been boiled, and a beaf steak very delicately dressed, every morning and evening, for a fortnight. A kettle full of water, placed over the jet, boils in four minutes. The light is found so delightful, that, we believe, many will soon give up candles altogether. With regard to any danger which the timid or the ignorant may suppose to be connected with the use of these lamps, no prejudice can be more absurd; for, even though the whole gas that any of them contains was to escape, no explosion could possibly take place, if the atmospheric air was in its natural state of healthy circulation. It is only where the atmospheric air is completely pent up, and stagnant, that it could become so impregnated with gas as to be susceptible of combustion. In no properly ventilated house is this ever the case; besides, it would only be in consequence of extreme negligence that the gas could ever escape at all; and the best of all proof that no accident *will* happen is, that no accident *has* happened.—*Edinburgh paper*.

## II. Domestic.

1. *Temperature of water in wells, observed by Gen. Field.*—The following is a table of observations, made on the waters of six wells, in this village, with a view of ascertaining the various degrees of temperature at different seasons of the year. The wells were from fourteen to twenty two feet deep, (none in the vicinity being deeper than twenty two feet,) most of which I carefully examined weekly for two years. To avoid prolixity, I have taken the mean temperature of all the wells monthly, and the following is the result.

| | | 1826. | 1827. | | | 1826. | 1827. |
|---|---|---|---|---|---|---|---|
| January | 15, | 43°.5 | 43°.0 | July | 15, | 48°.0 | 47°.5 |
| February | 15, | 42 .5 | 42 .0 | August | 15, | 49 .5 | 49 .0 |
| March | 15, | 41 .0 | 41 .0 | September | 15, | 50 .5 | 50 .0 |
| April | 15, | 40 .5 | 40 .5 | October | 15, | 51 .0 | 51 .5 |
| May | 15, | 43 .0 | 43 .0 | November | 15, | 48 .5 | 48 .0 |
| June | 15, | 46 .0 | 45 .5 | December | 15, | 46 .0 | 45 .5 |

*Remarks.*—From the above observations it appears, that, in this latitude, the maximum of temperature of the springs, which supply our wells with water, occurs about the 15th of October, and is about - - - - - - 51°.

Minimum, about the 15th of April, and is about 40.

Difference, - - - - - - - - 11°.

*Fayetteville*, (*Vt.*) *May 26th*, 1828.

## 2. *Proceedings of the Lyceum of Natural History, N. York.*

[Continued from Vol. XIV., p. 190.]

*October*, 1827.—Specimens of talcose rock *in situ*, from the serpentine locality on the island of New-York, were laid upon the table by Mr. J. Cozzens.

Mr. Gale presented a suite of specimens from the celebrated locality at Franklin, N. J. Among them were particularly noticed granular *Franklinite*, in carbonate of lime, red ores of zinc, granular *pyroxene*, and foliated Jeffersonite.

Mr. De Kay read a paper on several fossils from the Chesapeake and Delaware canal. See An. Lyc. vol. 2.

A valuable and extensive collection of scientific books was received from Prof. N. S. Castrom, of Sweden.

Dr. Torrey communicated the result of his observations on the Gay Lussite from the Province of Venezuela, of which several specimens had been recently presented to the Cabinet by Mr. Robert Stephenson, of Newcastle, (England.)

Mr. Lyle presented several ores from the Republic of Colombia, chiefly consisting of *malachite*; red and grey silver ore in its matrix.

Prof. J. Aug. Smith read a paper in which he endeavored to exhibit specific differences between the bald and grey eagles, deduced from anatomical observations.

Mr. Gale presented a large slab of *Labrador feldspar*, from Corlaers Hook, in this city.

Mr. J. Cozzens announced that he had discovered a specimen of the genus *Uranoscopus* in the American waters.

Mr. Barnes read a notice of the *Fusus corona* (Lam) from the Gulf of Mexico; a very rare shell, and now positively identified.

Dr. Torrey presented specimens of andalusite with fibrolite, and cinnamon stone, from Massachusetts; and a specimen of gold in calcareous spar, from North Carolina. This is the first example of this metal having been found in its matrix in the United States.

Mr. De Kay communicated remarks on the supposed transportation of bowlders. See vol. xiii. p. 348, of this Journal.

Mr. Moore presented specimens of the flowers of that extraordinary South American plant, the *cheirostemon pentadactylon.*

*November.*—Specimens of the spirea opulifolia, from Owego creek, N. Y. were laid on the table by Dr. Mitchill.

A numerous and valuable collection of minerals and shells from the Mediterranean, was received from Capt. M. C. Perry, of the U. S. navy.

Dr. Mitchill presented the fossil grinder of an Elephant, from Erie county, Pennsylvania. It was much weathered, and resembles the E. *indicus.*

Capt. Basil Hall, of the English navy, and N. A. Vigors, Esq. of London, were elected corresponding members.

*December.*—An extensive series of the bituminous shale of Rhode Island, containing vegetable impressions, was received from Col. Totten, of the U. S. Engineers.

A specimen of oolite, from Key West, was transmitted by Dr. Swift, of the U. S. navy; to which the attention of the society was invited, it being the first evidence of an oolitic formation with fossils in that district.

Dr. Torrey commenced his course of lectures on mineralogy.

Mr. Barnes presented specimens of shale from the vicinity of Poughkeepsie, associated with anthracite.

Rhomboidal quartz, from Putnam, Washington county, N. Y. was presented by Dr. Harris.

A valuable donation of books was received from the Prince of Musignano.

Dr. Vaché presented a large collection of minerals, plants and fishes, made by himself at Para, Brazil.

*January*, 1828.—Mr. Halsey commenced his course of lectures on botany.

Specimens of the Date fish, or Mytilus Lithophagus, from Minorca, with the rock containing the animals, were presented by Capt. M. C. Perry, of the U. S. navy.

Major Delafield presented a specimen of tabular spar or schaalestein, from Bustleton, Pennsylvania, and sodalite from the Rhine.

The President announced to the society that Mr. Featherstonehaugh had recently returned from Europe with an extensive and valuable collection of minerals and fossils, amounting to more than eight thousand specimens. Among them were complete series of the rock formations of England, rare fossils from the continent, specimens of all the chalk fossils of England, many of the recent new mineral species, and an extensive collection of the bones from the celebrated caves of Torquay and Kirkdale, collected by Mr. Featherstonehaugh and Prof. Buckland. It was also announced that Mr. F. had deposited in the rooms of the Lyceum an instructive series of the English fossils.

*February.*—Mr. Halsey continued his course of Lectures on Botany.

Specimens of iron ore were presented by Dr. Boyd from Nova Scotia, with imbedded fossil shells. The ore yields 55 per cent. of iron.

The Anniversary Meeting occurs during this month; and the annual reports of the Treasurer, Committee of Publication, Corresponding Secretary, and Librarian, presented a very gratifying view of the present state and future prospects of the Society. The following gentlemen were chosen

*Officers of the Lyceum for* 1828.

Joseph Delafield, *President.*
A. Halsey, 1*st Vice-President.*
J. E. De Kay, 2*d Vice-President.*
Jer. Van Rensselaer, *Corresponding Secretary.*
L. D. Gale, *Recording Secretary.*

*March.*—Specimens illustrating the geology of the French coast, near Havre, were received from Dr. Townsend.

Major Delafield presented Arragonite from New-Brunswick, N. J.; a locality not hitherto noticed.

Dr. Torrey made a report on a specimen of what is termed Marle in New-Jersey. No lime whatever is found in it; and hence its name is obviously improper.

A gigantic specimen of the Date Palm, with its sterile flowers, was presented by Dr. Hosack, and seeds from Matanzas by Mr. R. W. Otis.

Dr. Mitchill read an abstract of a work entitled "Considerations sur l'enlevement, &c. des chevaux mort."

Mr. Halsey concluded his course of Lectures on Botany.

*April.*—Dr. Torrey communicated a paper by Dr. Clarke containing an analysis of a substance nearly allied to Jet, very abundant in the Newark meadows. It is highly inflammable. It has been called "extract of peat" by Dr. Macculloch, who considers it as a deposit from the watery solution of peat.

Mr. De Kay read a paper on a singular mal-conformation observed in the teeth of the *Arctomys monax*. In this individual there had been a caries of the lower jaw, which had prevented the growth of the incisor on that side. Its antagonist in the upper jaw having nothing to oppose it, had continued to be developed until it had described more than one complete spiral revolution.

A new mineral, the *Haytorite*, from Haytor, Devonshire, and specimens of *Retinasphaltum*, from Bovey Heathfield, (Eng.) were presented by Mr. Featherstonehaugh.

Dr. Torrey presented a specimen of *Asphaltum*, from a marl-pit twenty miles south of Trenton, the first locality noticed in the United States.

3. *Drinking Ice-Water.*—It has long been known, that ice-water debilitates the stomach, much more than spring water of nearly the same temperature. In a tour along the Erie canal with a section of students from Rensselaer School, we made some trials with ice-water, and cold spring water, on those two very hot days, the 27th and 28th of last June. We experienced as much difference in the effect as has usually been represented, when the difference in temperature was scarcely perceptible by the hand or tongue. These tri-

als led to the following enquiry. The experiments of Black and others have shewn, that when water is brought to the freezing point, a quantity of caloric sufficient to carry the thermometer through many degrees, may be imbibed or given off, without affecting the thermometer or the sense of feeling. May not the state of ice-water be such, that though it seems to be but little colder than spring water, it will take much more caloric from the stomach? Would not this enquiry afford ample materials for a medical graduates' dissertation? A. Eaton.

### 4. *Virginia Aerolite.*

TO THE EDITOR.

Bremo, Fluvanna County, Va., August 4th, 1828.

*Sir*—The fact that stones have fallen from the atmosphere, is now universally admitted by men of science, but as there may still be some persons not acquainted with the evidence, who may entertain doubts on the subject, it may not be amiss to make known the facts connected with an instance of the sort that occured in Chesterfield county in this state about seven miles south west of Richmond, on the fourth of June last—this case is as well attested as any of the kind I ever recollect to have heard of.

Being in Richmond at the time, and hearing of the fall, I made some enquiry and obtained a piece of the stone, about the size of a pigeon's egg. This resembled so much the only specimen of a meteoric stone I had ever seen, that my anxiety to see the whole stone and to learn the facts relating to its fall, was increased. It was very much like a fragment in your cabinet which was part of a stone that fell in Connecticut many years ago,* an account of which is published in the American edition of Rees' Cyclopedia—after some enquiry I obtained the greater part of the stone weighing three pounds, three ounces, avoirdupois. Most of the exterior is of a dark grey color; about one third is covered with a black crust. The fracture is granular and of a light grey, interspersed with white metallic points, which yield easily to the knife. For several days after the stone was taken from the earth it retained a strong scent of sulphur. The exterior exhibited several cav-

---

* Dec. 1807—A great event of the kind—several hundred pounds of stone fell—during the passage of the fire ball.—A specimen in the Cabinet of Yale College, weighs 36 lbs.—Editor.

ities from the size of a pea to that of a mustard seed; many of these are filled with earth and with fibres of the turf through which it passed on striking the earth. The whole stone, when entire, was said to have weighed about four pounds. Its form is nearly spheroidal and its specific gravity about 4.

The facts in relation to its fall, as I obtained them from a friend who visited the spot on the 7th of June, (the day after I got possession of the stone,) are as follows.

An overseer and several negroes were at work in a field belonging to a Mr. Matthew Winfree, about 9 o'clock on the morning of the fourth—an explosion was heard in the direction of Richmond towards the north east, which was at first mistaken for the report of a cannon, and in a short time after, there was a noise which was thought at first to be the rumbling of a carriage on a neighboring stony road. In a few seconds however it was perceived to be rapidly approaching, and presently after, seemed to be just over head, when it passed beyond, and ended by a sound resembling the fall of a heavy body on the earth—the persons hastened towards the place from which the stroke proceeded, and after considerable search, found a hole in the turf which seemed to have been made by the entrance of a ball; they dug, and got the stone above described. The stone had buried itself about twelve inches—the distance of the hole from the point where the persons were standing when the stroke was heard, was found by measurement, to be two hundred and sixty paces.

The person who gave the above account saw the hole the third day after it had been made. The bed from which the stone was taken was entire when he was there, and of the size and shape of the body said to have been taken from it.

A specimen will be submitted to the professor of chemistry at our University, as soon as possible. I should have taken great pleasure in sending it for your inspection but for the difficulty of getting it to New Haven.

Your most obt. serv't. JOHN H. COCKE, JR.

A promised specimen has not yet arrived.—ED.

5. *Note supplementary to Wright's Theory of Fluxions.*—In the Lemma, belonging to the demonstration of the identity of ratios in fluents and their fluxions, it is said [let AHNB be any curve whatever, and suppose DFME to be another drawn parallel to it, and consequently similar.] This will hold true only in cer-

tain cases. It should have been expressed, [and suppose DFME to be another similar to it.] Although all right lines, terminated by corresponding points in curves which are similar, are parallel; yet the curves themselves may not be parallel, as will appear evident upon a little reflection. For instance, two ellipses, that are similar, are not parallel. The subsequent train of reasoning, however, is not affected by this inaccuracy. The N. B. at the close of the theory may, I think, be more fully and accurately expressed thus: The projection is made by rays parallel to a line drawn from the nearest corner at the left hand at the top, diagonally, to the furthermost corner at the right hand at the bottom. The sides GHFE in fig. 2. and L–ON in fig. 6. stand on the plane of projection; and the opposite sides CDBA in fig. 2. and AKMP in fig. 6. are elevated. The sides ABFE in fig. 2. and PMON in fig. 6. front the reader. The sides GCAE in fig. 2. and LAPN in fig. 6. are situated on the left hand. The other sides, in the projection, fall behind and are hidden. The reader will notice that the position of the cube in fig. 6. is different from that in fig. 2. as is denoted by the letters. That the little blue cube in fig. 6. may be brought into view, the original cube is turned about, so that the side ABFE, which in fig. 2. fronts the reader, in fig 6. falls on the left hand side. E. W.

6. *Errors corrected in Dr. Robinson's Catalogue of Minerals.*—The localities mentioned in this manual, are, in many cases, not described with adequate particularity. The *township* is mentioned, but not the particular *spot* in which the mineral occurs. The traveller sometimes spends hours, and even days, in a fruitless search after it. Perhaps this marked deficiency was unavoidable. The compiler copied most of his localities from the public journals, where the same defect exists, and must have been observed by all who attentively read them.

There is another fault to be noticed. It is common to the catalogue, and to the journals. An individual discovers an interesting mineral—a small mass of fluate of lime, or lepidolite, or rose-quartz, and takes the whole, to his own cabinet, and then, publishes the locality; those who come afterwards, are of course disappointed, as the substance is not to be found in that region.

Localities of minerals should never be named in our public journals, without a statement of the quantity. This precaution would save much exertion, now thrown away.

The catalogue contains a number of *errors*, which are now making their appearance and circulating in other works, in our country. Two or three of these mis-statements, those with which my name is coupled—I will point out; and you, Sir, will do me a favor, by giving this paper a place in your

Journal. "Coccolite green and red," the catalogue informs us, is found in Charlotte, Vermont, and Professor Cleaveland is quoted for authority. If any one will take the trouble to turn to the article, in Cleaveland's valuable system of mineralogy, he will find, that reference is made to me. Indeed, the error must be charged to my account. It occurred in this manner. A Mr. Muzzy, who was attempting to manufacture at Middlebury, Vt. the Monkton porcelain earth, into China ware, gave me, in 1810, a mineral, which, he stated, came from Charlotte. I sent a part of it to Prof. Cleaveland, to be named. He called it Coccolite. I also published a brief notice of it in the Literary and Philosophical Repertory, from which Prof. Cleaveland's description is taken. Soon after this, Mr. Muzzy died. I made many enquiries after the locality of this substance, but gained no information on the subject. I have since been a number of times in Charlotte, and endeavored myself to find it, but always failed of success; and I now state, *that I have no knowledge of the existence of Coccolite, in that township.*

Dr. Comstock asserts in his Mineralogy, that Coccolite "is found *in abundance*, and of various colors," in Charlotte, and gives my name as authority. Such a broad assertion I have nowhere made, nor could I with truth on my side. I had received no information respecting the *quantity* found.

But it may be asked, "whence came the specimen, affirmed to have been brought from Charlotte?" It came, without doubt, from that place, but that was not, I think, the place of its origin. It was brought, originally, I am fully convinced, from the New York side of Lake Champlain, from the township of Willsborough, which is nearly opposite to Charlotte. "But that immense vein is not Coccolite;" nor was the specimen in question. It was colophonite. I have myself taken hundreds of specimens from the vein, precisely like the one transmitted to Prof. C.

This is the simple history of the error. I hope it will now be obliterated from the works in which it is published, and no more be copied.

Coccolite—red, brown and black—is very abundant, near Rogers' Rock, two or three miles south from the upper Falls in Ticonderoga, N. Y. This is the only locality, with which I am personally acquainted, where the mineral is found to be abundant. "Aluminous slate," Rockingham, Vt. "in argillaceous slate, which is quarried at horse-heaven." There has never been any argillaceous slate quarried, at the place called horse-heaven. A very limited quantity has been quarried, for grave stones, and perhaps, for other uses, half a mile or more, *below* horse-heaven.

"Hornstone" Cornwall Con. "on the late Judge Matthews' farm." Here is an error, committed by the compiler. The locality exists in Cornwall, *Vt.* but not in Cornwall, in Conn.

" Hornstone, Bridgeport," Con. " Hall." This should be *Bridport*, Vt.

There are many other errors of a similar nature, which I have not time at present to look up. F. HALL.

7. *Aurora Borealis—Magnetic Needle, &c.*—Communicated by L. D. Gale.—I noted in my private journal, some remarkable phenomena of the Aurora Borealis, during the 28th, 29th, and 31st of August, 1827, which I intended at that time to communicate for your Journal; but thinking that others more capable than myself, would better describe the same, I neglected to communicate my observations. Seeing, however, no observations on the magnetic needle, in the numerous notices in your Journal, except that of M. Arago, who states, that " The Aurora Borealis announced itself as early as 8 P. M. Tuesday 25th, by a very perceptible disturbance of the horizontal needle's diurnal variations." But the phenomena observed by M. Arago, could not have been the same observed in America, and described in your Journal, unless there was a mistake in the date: because August 25th came on Saturday, whereas, the 25th of September came on Tuesday, which latter must have been the time referred to by M. Arago, as a brilliant aurora was seen in this city the same evening, which even obscured the light of the moon.

When I first observed the luminous appearances of Tuesday, August 28th, at 10 P. M. I placed a horizontal needle, delicately mounted, in the window of my room, which was in the northern side of the house, and a dipping needle about ten feet distant in another window. On examination, I found that neither would come to a state of rest. The mean of the extremes in the horizontal needle, was at least 5° west of the magnetic meridian. After marking the extremes on a paper card, fixed in the window for the purpose, I left it. The dipping needle which oscillated from 64° to 75° was in constant agitation and very irregular in its motions; sometimes rising to nearly 60° and remaining for a moment with a tremulous motion, and then sinking back to 75° or 76°, having a mean dip of 69 1-2°, which is, I believe, according to the best needles I have seen, 2 1-2° above the true dip of this latitude.

The greatest variation of the needles was at 10 P. M. when I first placed them in the window, and it constantly decreased.

The brilliancy of the Aurora increased till 10 o'clock 30 minutes, when it gradually ascended towards the zenith, and at the same time diminished in brilliancy until 11 o'clock 30 minutes, when its luminousness had entirely disappeared: though there was a bright Aurora in the northern horizon.

On examining the horizontal needle, I found it constantly in a tremulous motion, though it did not oscillate more than 2° or perhaps somewhat less. The dipping needle was very quiet at 70°. On setting it to oscillating, however, a second time, it came to rest at 71°; the same was repeated with the same result, viz. 71°; whereas its ordinary dip is 72°.

The luminous appearances of the 29th and 31st, were less brilliant; and though I examined the needles to see if any effect was produced, nothing remarkable appeared during the Auroræ, except that the needles were seemingly a little longer than ordinary in coming to rest. *New York, April 21st*, 1828.

8. *Carpenter's Chemical Warehouse.*—We are pleased to announce, that Mr. Geo. W. Carpenter, who is advantageously known to our readers, by his papers on pharmaceutical subjects, has opened a Drug and Chemical Warehouse, at No. 301, Market street, Philadelphia. He has connected with his establishment, a laboratory for the manufacture of some of the most important articles, such as quinine, piperine, denarcotized opium, denarcotized laudanum, and acidulous tincture and extract of denarcotized opium, &c. &c.; and as these articles are manufactured by himself, or under his immediate superintendence, their quality may be depended upon.—Editor.

9. *Writ for the Medical Convention of* 1830.—Inserted by request of Dr. Mitchill.—Whereas the Convention that was held at the city of Washington, in the month of January, 1820, for forming a Pharmacopœia for our United States of America, did resolve that the President of that Convention should, on the 1st day of January, 1828, issue writs of election to the several incorporated State Medical Societies, in the northern, middle, southern and western districts of the nation, requiring them to ballot for three delegates to a General Convention, to be held at Washington, on the 1st day of January, 1830, for the purpose of revising the American Pharmacopœia; and whereas the several Institutions, as aforesaid, are, by the same authority, requested to forward to the President, on or before the first day of April, 1829, the names of the three persons so chosen; with sundry other provisions contained in the historical introduction to the work, to which the reader is referred.

Now therefore, I, *Samuel L. Mitchill,* by virtue of the power vested in me, by the Convention of 1820, *do hereby give notice,* to all the incorporated Medical Societies, Colleges of Physicians and Surgeons, Medical Schools, and Faculties of Universities and Colleges, and all other authorized Bodies, that they choose proper persons to represent them in the General Convention to be held in January, 1830, for revising the Pharmacopœia.

Given under my Hand, this first day of January, 1828, at the City of New York.

Samuel L. Mitchill, *President.*

# THE AMERICAN JOURNAL
OF
# SCIENCE AND ARTS,
CONDUCTED BY
## PROFESSOR SILLIMAN,
OF YALE COLLEGE.

## AGENTS.

| | |
|---|---|
| **MAINE.** | |
| Hallowell, | Goodale, Glazier & Co. |
| **VERMONT.** | |
| Brattleboro', | Holbrook & Fessenden. |
| **MASSACHUSETTS.** | |
| Newburyport, | Charles Whipple. |
| Salem, | Whipple & Lawrence. |
| Northampton, | S. Butler. |
| **RHODE ISLAND.** | |
| Providence, | Hutchins & Cory. |
| **CONNECTICUT.** | |
| Hartford, | H. & F. J. Huntington. |
| Litchfield, | S. S. Smith. |
| **NEW YORK.** | |
| New York, | A. T. Goodrich. |
| West Point, | John DeWitt. |
| Albany, | Ware C. Little. |
| Canandaigua, | Bemis, Morse & Ward. |
| Rochester, | E. Peck & Co. |
| **NEW JERSEY.** | |
| Patterson, | Day & Burnett. |
| Princeton, | J. Van Deventer. |
| **PENNSYLVANIA.** | |
| Pittsburgh, | Luke Loomis. |
| **MARYLAND.** | |
| Baltimore, | E. J. Coale. |
| **DISTRICT OF COLUMBIA.** | |
| Washington, | P. Thompson. |
| **NORTH CAROLINA.** | |
| Chapel-Hill, | Prof. E. Mitchell. |
| **SOUTH CAROLINA.** | |
| Columbia, | B. D. Plant. |
| Charleston, | Ebenezer Thayer. |
| **GEORGIA.** | |
| Savannah, | Wm. T. Williams. |
| Augusta, | Thomas J. Ray. |
| **MISSISSIPPI.** | |
| Natches, | W. C. Grissam & Co. |
| **LOUISIANA.** | |
| New Orleans, | Hotchkiss, Grissam & Clark. |
| **CANADA.** | |
| Quebec, | Neilson & Cowan. |

## TERMS.

Three dollars a volume, *in advance*—two volumes a year; in quarterly numbers; published on the 1st of January, April, July, and October. The postage should be paid on remittances and orders.

☞ Terms of credit to general agents, six months from the publication of No. 1, of each volume. *Complete sets* furnished to [illegible]dividuals, and to the trade, at a suitable discount.

## TO CORRES[illegible]NDENTS.

The Editor requests, that communicatio[illegible] considerable extent, may be placed in his hands, two months, or at least six wee[illegible] before the publication day, and that all communications, however short, may arriv[illegible] month before the time named above.

☞ Authors are requested to give their own [illegible] and those of their pieces, *exactly*.

---

## MOUNT HOPE GYMNASIUM.

Professor F. Hall and Mr. Daniel P. Bacon, will, on the 1st of November next, open a Literary and Scientific Institution, near Baltimore. Their plan is similar to that of other Gymnasia already established in this country, and their unquestionable qualifications entitle them to the public confidence.

---

LECTURES on *ANATOMY, PHYSIOLOGY*, and *SURGICAL ANATOMY*, will be delivered in Baltimore, between November 1st and March 1st; by Duncan Turnbull, M.D. The course will be fully illustrated by dissections, and the pupils will have every advantage for making preparations.