# TRANSACTIONS

OF THE

# NEW YORK ACADEMY OF SCIENCES.

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OF THE

# NEW YORK ACADEMY OF SCIENCES,

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**1882.**

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### GENERAL TRANSACTIONS.



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## ERRATA.

Page 3, 11th line from top, for Asaphas, *read* Asaphus.
" 8, 9th and 11th lines from bottom: for Stylomurus, *read* Stylonurus.
" 50, 14th line from bottom: for graduation, *read* gradation.
" 85, 6th " " " for Palorthis, *read* Polorthus.
" 92, 2d line from top: for Prozopis, *read* Prosopis.
" 92, 6th " " " for monolifera, *read* monilifera.
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" 92, 18th " " bottom: for Scutillaria, *read* Scutellaria.
" 92, 17th " " " for Cardioz permum, *read* Cardiospermum.
" 93, 6th line from top: for vaccata, *read* baccata.
" 93, 21st " " bottom: for Texamum, *read* Texanum.
" 94, 18th " " " for Gryphea, *read* Gryphæa.
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" 151, 15th " " " for grivigula *read* griseigula.

# TRANSACTIONS

OF THE

# NEW YORK ACADEMY OF SCIENCES.

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October 2, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-three persons present.

A paper was read by Prof. ROBERT H. THURSTON, entitled:

NOTE IN REFERENCE TO A NEWLY-DISCOVERED ABSOLUTE LIMIT TO ECONOMICAL EXPANSION IN STEAM ENGINES.

(Published in the Annals.)

The paper was discussed by Prof. W. P. TROWBRIDGE.

The following paper, by Mr. GEO. N. LAWRENCE, was then read by title:

CHARACTERS OF A NEW SPECIES OF BIRD OF THE FAMILY CYPSELIDÆ.

In accordance with the usual custom at the first meeting of the season, observations and notes made during the past summer were presented.

The PRESIDENT referred to various papers of interest before the recent meeting of the American Association for the Advancement of Science at Montreal, by Drs. RAE, CARPENTER, and others; to the collection of the Geological Survey of Canada at Ottawa, including its full series of specimens of *Eozoön*; and especially to the remarkable series of Devonian fossil fishes from the North side of the St. Lawrence, collected and described by Mr. WHITEAVES. Of these a large number of specimens were collected from two localities. They resemble those described by HUGH MILLER, being almost precise counterparts of the Devonian fishes of Scotland. Most American deposits of the kind were derived from the sediments of the open sea, but these must have come from a bay.

Dr. NEWBERRY had also visited the Saguenay, which occupies a fiord like those which fringe the coast toward the north and along the coast of Northern Europe. It consists of a valley cut deep into the old coast, now forming, in its submerged position, a tideway for a distance of a hundred miles, with tides sometimes reaching a height of eighteen feet. At its upper end the valley is supplied by only two or three insignificant streams. It is, in fact, a glacial channel, bearing on its sides abundant marks of glaciation, with cliffs towering up, sometimes to a height of 2000 feet. There are also deposits of clays belonging to the category of the Champlain clays, stratified and often terraced. Clays of this age have been observed, at Polaris Bay, up to a height of 1800 feet above the sea, often enclosing Arctic shells. These terraces may be traced for miles along the Saguenay and indicate interesting alternations of level. Similar terraces are found along the Hudson River. The subsidence during which they were produced affected the whole eastern and, perhaps, western part of the Continent. These clays are only the wash from the ancient glaciers, and formed the sediment of an icy-cold sea, which stood higher than it does now. The subject of the causes of glaciation had met with a spirited discussion at the recent meeting at Montreal, especially on the part of Dr. DAWSON, whose views, largely founded on the peculiar action of shore-ice in the St. Lawrence, would meet with wide modification by a visit to other portions of the glaciated area of the Continent.

Prof. A. R. LEEDS called attention to the recent death of a very illustrious member of the Academy, Prof. FRIEDRICH WÖHLER, whose life, linked with the progress of science for three-quarters of a century marked an epoch in its history. He was born in 1800, and, without awaiting a further advance in his years, a great Jubilee was arranged and carried out, in connection with his eightieth birthday, among the chemists of the German Universities; and in this many American chemists united. A large bronze medal was struck off for distribution in commemoration of this event. He was one of the favorite pupils of BERZELIUS, and has given an interesting account of his studies with that master, at that time a mere country doctor, in the kitchen of his house and on the kitchen tables, the simple articles used being washed up by the old "hausfrau" at the end of the day. We owe to him the discovery of the true constitution of many mineral compounds. Many American students gradually resorted to his laboratory and to them he became the favorite teacher. Prof. BOOTH was the first American chemist to go abroad and was the first American student under WÖHLER'S care. It is a wonderful fact that the life of this one man should have been sufficient to include most of the important discoveries of modern chemical science. He was the first to unlock the mysteries of organic compounds, by his classic investigation into the constitution of urea, showing that this was made up of inorganic constituents. His life, in fact, links the modern discoveries in organic chemistry with the glorious achievements of the first quarter of the present century.

## October 9, 1882.

### SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-five persons present.

The following specimens were exhibited; by Mr. W. L. CHAMBERLIN, apatite from Renfrew, Canada, and crystals of emerald enclosing crystals of red rutile, from Hiddenite mine, N. C.; by Mr. G. F. KUNZ, "star mica" from St. Lawrence County, N. Y., and a crystal of zircon, weighing twenty-eight Troy ounces, from Sebastopol, Renfrew County, Ontario, Canada; by the PRESIDENT, a cast of a trilobite (*Asaphas gigas*), from Illinois, which clearly exhibited the legs, and is remarkable as being the first specimen in which any locomotive organs have been discovered; and by Mr. DOUGLASS, a beautifully carved pipe from San Salvador, found fourteen feet below the surface, in old Indian workings, and which is regarded as antedating the Spanish invasion.

A paper was read by Mr. F. COPE WHITEHOUSE, largely illustrated by magic lantern views, entitled:

### THE CAVES OF THE ISLAND OF STAFFA: ARE THEY NOT ARTIFICIAL?

(This is embodied in a paper in the *Popular Science Monthly*, December, 1882.)

### DISCUSSION.

Prof. E. H. DAY remarked on the great interest of the subject, and at the same time on the large amount of caution required in the investigation and acceptance of such views. Nature, having been the undoubted author of so many caves, can very well afford to man the credit of having made one here or there, and these perhaps amongst them. But to establish this claim we need, either direct proofs of man's handiwork, which, if beyond dispute, would be conclusive evidence; or else proof that geological action could not have produced such results, a proposition that it would be impossible to solve beyond greater or less probability. In the first line of proof, Prof. DAY had heard scarcely a word of direct evidence that would stand scientific test, and in the second, he thought that the author had ignored some of the most important geological factors.

Perhaps the strongest geological evidence, in favor of the artificial origin of the caves in Staffa, was the fact that at the Giant's Causeway, in similarly formed basaltic and columnar rocks, there are no caves, although the coast there is exposed to the full force of the Atlantic seas; whilst in the neighboring chalk cliffs there are several deep caves. Prof. DAY described one of these caves which can be descended into at the landward end. (Mr. WHITEHOUSE here exhibited to the audience a view of this cave, which he said was "the very one that first suggested to him, that the caves of Staffa, as well as these, were artificial.") In continuation, Prof. DAY stated that Mr. WHITEHOUSE laid great stress on the necessity of very heavy waves to produce such caves. He reminded him that water charged with gravel and sand was the real agent of erosion, and that water so charged, even if only gently moved, could in the course of time produce great destruction. Moreover, waves of very limited size have very great destructive powers, as evidenced in the displacement of the granite blocks, that form the turtleback built to protect Execution Lighthouse in the Sound. Nor is there any proof, that the speaker knew of, that heavy ocean waves do bore caves into cliffs in the direction of their impact. The very violence and evenness of their attack is opposed to such a result. If one section of a cliff is weaker or more exposed than the rest, a bay will be formed; and a projecting headland between two such bays may be eaten through from each side, not by the direct attack of the heavy breakers, but rather by the incessant swirl of the waters, as they eddy around in the bays at its base. In such case, first a cave, then a high arch, and finally a chasm would be formed, but transversely to, not in the line of attack of, the ocean waves. Such arches, and the isolated pinnacles which are the final results, are common features on every rock-bound coast.

Moisture laden with sea-salts was a powerful though slow agent of erosion, very effective, as the speaker had seen, alike on churches on the south coast of England, built of perishable marlstone, and on the granite cliffs of Cornwall. To assume, as the author did, that frost had played no part in the formation of these caves, because there was at the present day no frost to speak of in that locality, and to argue that the sea could not at its present level have its share in the work, is to assume that there have been no changes of level in the coast of Scotland, and no changes of climate, since the commencement of the formation of these caves—a proposition that begs the whole question of the date of their origin.

Again, the author had totally ignored the action of water percolating through rocks, as another assistant in the work of erosion. That water did percolate through these rocks was evident from the mention made of stalactites in these caves; and, in some of the pictures shown, it certainly appeared as if the caves had been formed along lines of fissure. (Mr. WHITEHOUSE stated positively, however, that there were no fissures.) In all limestone cliffs we may expect to find caves which had been underground water-courses, when the land stood at a different level; and the very form and arrangement of the cave, just now alluded to, in the chalk, near the Giant's Causeway, as being of artificial origin, showed that it was nothing but an ordinary limestone cave, which had been laid open by the encroachment of the ocean, and subsequently modified by atmospheric and aqueous agencies.

The argument, that the three caves described, on Staffa, were placed by design directly opposite Iona, would have more force if there were not other caves on the island not so situated; nor could great stress be laid on the approximate similarity of the measurements in case of two of the caves.

In conclusion, it seemed futile to argue that the action of the sea and of running water and of the atmosphere, as we find them at Staffa now, were unable to have excavated these caves in times past. Much less was it safe to drag in chalk caves as evidence of the artificial character of caves in basalt. The only argument of any weight in support of the whole theory seemed to be the general statement that caves such as these are not ordinarily met with in rocks at all resembling in character those of Staffa.

Mr. KUNZ enquired as to the depth of water and form of the terminal slopes in the caves.

Mr. WHITEHOUSE replied that there were no appearances of change of level at Staffa, and that the force of the waves did not reach the upper part of the caves. The depth of water in the Clamshell Cave was nine feet at the inner end, and the cave there terminated in an irregular steep slope. In recapitulation of the principal arguments:

1. There is no probability that five caves in a thousand yards would be formed by five different causes.

2. If a trap dyke formed Fingal's cave, it is geologically impossible that there was any "fault" in Boat, Cormorant's or Clam Shell.

3. There is no "*fissure*" above Cormorant's cave. The triangular opening in its columnar basalt corresponds to that in the confused basalt above Fingal's.

4. Confused basalt could not crack in a long straight fissure.

5. Tuff, underlying columnar basalt, makes a rocky shore surmounted by a steep slope of basalt. The basalt is practically solid—forms a "pier" not a "hay."

6. Why was the debris removed to an unknown distance?

7. Why did the momentum of the waves limit itself without apparent cause, and leave thin walls of tuff or basalt?

The PRESIDENT stated the impossibility of deciding such a question without a visit to the locality. He had seen many coasts undergoing erosion, but never any excavated like this, merely by the force of the waves. If in fact no dykes nor fissures existed, such tunnel-like chambers could hardly have been perforated by natural causes, for they are on various sides of the island, in various kinds of rocks, and the debris is entirely cleared away. If the caves had been produced by causes now in action, the fallen blocks would remain. The material of the blocks is tough and not liable to disintegration; nevertheless it has been thoroughly cleared out, as though by the hand of man; no shingle being found on the shore. It is important to notice that the approaches to the caves are over low, flat ground, furrowed by canals leading up to their entrances, *i. e.*, as if artificially excavated for the entrance.

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October 16, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

A paper was read by Dr. ALEXIS A. JULIEN, on

## THE GENESIS OF THE CRYSTALLINE IRON ORES.

(Abstract.)

Theories of two classes have been advanced, referring the origin of the crystalline ores to extraneous and indigenous origin. Under the first class, three may be mentioned:

1. Meteoric fall.—This was suggested in reference to the huge hematite deposit of Cerro de Mercado, in Mexico.

2. Eruption as dykes.—A theory advanced to account for many foreign deposits, and also those of Huronian age in the vicinity of Lake Superior, etc.

3. Sublimation into fissures.—A theory founded on the observation of crusts of specular oxide of iron in the lavas of Vesuvius, etc.

Objections to these theories were briefly presented. The theories attributing the origin of crystalline ores to indigenous origin are of two kinds, chemical and mechanical. Several chemical theories have been proposed:

4. Concentration from ferriferous rocks, or lean ores: if silicious, by thermal solutions: if calcareous, by carbonated waters. Subaerial processes of this kind cannot account for the origin of submarine sediments, such as the crystalline iron ores.

5. Saturation of porous strata by infiltrating ferriferous solutions.—Such a process could not produce huge bodies of pure ore, nor the alternation of pure materials in the lean laminated ores.

6. Infiltration into subterranean chambers.—The form, lamination,

and coincidence with the bedding planes, separate the ore bodies of crystalline character from recent deposits formed in this way.

7. Derivation from deep-sea deposits.—The form and structure of the nodules in the ooze differ widely from those of the ores under discussion, while the strata associated with the latter are evidently shallow-water deposits.

8. The metamorphism of ancient bog-ores.—This theory, now commonly accepted and taught in all the text-books, is unsatisfactory, from the absence of evidence, within the crystalline strata, of any terrestrial or subaerial surfaces on which such bogs or marshes could have rested ; all the surfaces appear to be submarine.

Two theories of mechanical origin remain yet to be considered :

9. Violent abrasion and transport, by volcanic agencies combined with powerful currents.—To this it has been properly objected that the results of such violent agencies would be altogether conglomeritic.

10. Concentration and metamorphism of iron-sands.—Abundant instances of such concentration are shown along our coasts, and the deposits found along the St. Lawrence often contain but five or six per cent. of siliceous impurity. As the loose sands so concentrated consist at various localities of quartz, garnet, chrysolite, menaccanite, magnetite, etc., so we find in the metamorphic rocks their indurated counterparts, quartzyte, garnetyte, dunyte, menaccanyte, magnetyte, etc. The intermixture of garnet with magnetite, or its intercalation in separate alternating beds, is as common in the rocks as in the present oceanic sands. The thin interlamination of magnetite, martite or hematite with jasper, in the Huronian jasper-schist, corresponds to the still more frequent association now found along our sea-beaches. The abundance of ore beds of pure magnetite, free from apatite, in the strata of the Lower Laurentian of Ontario, and of menaccanite, more or less mixed with the other ore, in those of the Upper Laurentian of Quebec, Canada, appear to correspond with the general distribution of magnetite grains through the gneisses of the former, and grains of menaccanite through the anorthosites and traps of the latter formation. In bog ores no concentration of titanic acid has ever been found ; its abundance in the form of menaccanite seems to necessarily involve a mechanical origin, and a vast source of that mineral is presented in its form of fine distribution through the rocks mentioned.

## DISCUSSION.

Dr. J. S. NEWBERRY said that he would not claim that the chemical theory best explained the origin of all bodies of iron ore, but, he thought, it was applicable to most. It was not limited to mere terrestrial deposits like bog ores, but equally well accounted for marine deposits like the the Clinton ore, which in his view was most like the magnetites and hematites of the Archæan rocks. At various places iron-sands are accumulating on our present coasts, as at Moisé, on the St. Lawrence, on Long Island, and on the coasts of Japan and New Zealand. It is only reasonable to suppose that such accumulations took place in ancient times, and that these were represented in some of the ore beds now known. The suggestion of Mr. JULIEN was new and important; but various facts, such as the presence of phosphorus, the absence of foreign minerals and the retention of limonite structure, seem to indicate that nearly all of our important iron ore deposits had been formed by chemical rather than organic processes.

Prof. D. S. MARTIN then remarked upon

### A NEW EURYPTERID FROM THE CATSKILL GROUP.

(Abstract).

The specimen of the fossil referred to had recently been seen by him in the State Geological Collection at Albany. The family of the Eurypterids forms an exceedingly interesting group of crustaceans, constituting, with the Trilobites and the Xiphosura or Limuloids, the order Merostomata—which has by some authors been separated from the other crustacea and raised to the rank of a distinct class, or at least sub-class. The existing *Limulus*, or "horse-shoe crab," of our own sea-coast, is a familiar type of the group, which is otherwise almost wholly extinct; its relations to the other orders were briefly referred to. The Eurypterid family was best developed in the Water-lime Group of the Upper Silurian, but has been found to range through a large part of the Palœozoic rocks, both of our own country and of Europe—Mr. Walcott's lately-described genus, *Echinorhynchus*, carrying it down to the Utica Slate of the Lower Silurian, while others are known even as high as the Carboniferous. The specimen in question consists of a very large head-shield—nearly a foot in length and breadth—and is named *Stylonurus excelsior*. It was found in the Catskill group, at Andes, in Delaware County, N. Y., and from its form and the position of the eyes, has been referred to the genus *Stylonurus*, which has not before been recognized in this country.

### DISCUSSION.

The PRESIDENT stated that the original specimen, to which reference was made by Prof. Martin, was now in the possession of Prof. Geo. H. COOK of New Jersey. The rocks of the Catskill group were generally barren of fossils, only a few fishes and plants having been found. It was a local deposit, probably of fresh water origin, corresponding in character to parts of the Old Red Sandstone of England, but it was not of Devonian age. The coal measures of Pennsylvania contain similar crustacea, many having recently been discovered at Darlington.

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October 23.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-two persons present.

The resignation of Mr. STRANG was accepted.

The following specimens were exhibited: by Mr. G. F. KUNZ, white pyroxene, found associated with white garnet in the vicinity of the Gatineau River, Canada, and also geodes of calcedony, filled with water, from Uraguay; by Mr. W. F. CHAMBERLIN, a garnet weighing 2 pounds and 11 ounces, $3\frac{3}{4}$ inches in diameter, with faces curiously striated parallel to the lines of cleavage, found on New York Island, near 145th street, where another had been also seen, 5 inches in diameter, but broken.

The PRESIDENT remarked that he had found geodes in cavities of the tufaceous rocks of Oregon. These had been once filled by hot water, carrying silica in solution, then partly or completely occupied by a deposition of agate, onyx, etc., and on the erosion and removal of the surrounding matrix, the geodes remained, thus representing casts of the cavities.

A series of TRUBELOW'S astronomical drawings was then exhibited by Dr. NEWBERRY, and pronounced the most striking and satisfactory ever made.

Dr. N. L. BRITTON then presented the following paper, illustrated by a collection of fossils:

NOTES ON THE CRETACEOUS MARL-BELT OF NEW JERSEY.

(Abstract.)

The notes had been taken during a six weeks' collecting tour, in connection with the Geological Survey of New Jersey. The special object was to procure invertebrate fossils from the different marl beds and associated strata, in order to aid in the preparation of a report, on the invertebrate palæontology of the State, by Prof. R. P. WHITFIELD.

The geological structure, and the relations of the three marl beds, to the other Cretaceous and Tertiary strata, were described.* The beds are all referred to the Cretaceous Age, with the exception of the upper

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* For a detailed description, see "Geology of New Jersey," 1868.

layers of the Upper Bed, which are supposed to belong to the Eocene Tertiary.

The strike of the marl outcrops is about S. 55° W., and these croppings extend from the Highlands of Navesink and Deal Beach on the Atlantic coast, to the head of Delaware Bay, the outcrops of the beds running in a general way parallel with each other. The Lower and Middle Beds outcrop at points throughout this entire distance of one hundred miles, while the Upper Bed croppings are not found further southwest than Clementon, about sixty miles from Deal Beach. Beyond this place the Upper Bed does not come to the surface and is not known to exist.

The strata dip toward the southeast about thirty feet to the mile.

### *The Lower Marl Bed.*

This bed rests on strata of laminated sands, which compose the upper layers of the deposits called the "Clay Marls," from the nature of the materials of which they are constituted. These clay marls contain numerous fossils; but few openings have been made on them, as the material is less valuable for fertilizing purposes than the greensand marls occurring higher in the series. The component layers of the Lower Bed are: (1), two to four feet of sandy marl, containing a small percentage of greensand; (2), twelve to sixteen feet of blue marl, with much greensand and considerable carbonate of lime; and (3), a layer of about ten feet of clay and marl mixed, which shades off into (2), the upper part of (3) containing little greensand. Much sulphate of iron occurs in the upper layer, often rendering the marl very astringent.

One of the prominent features of this bed is the "shell layer." This stratum is about half-way through the blue marl (2), and is almost entirely made up of shells of *Gryphæa vesicularis*, Cuv. It varies from six to fourteen inches in thickness and extends entirely across the State. The shells are generally large—many of them six or eight inches across, frequently even larger—the convex valve commonly well preserved, the flat one mostly imperfect. The marl which underlies this "shell layer" contains the rarer fossils of the bed, mostly as casts, the substance of their shells being very generally removed. Above the shell layer are most of the more common fossils, whose shells are generally preserved. Among these are *Exogyra costata*, Say; *Ostrea larva*, Lam. (most abundant in the clay and marl layer (3); *Terebratella plicata*, Say; *Belemnitella mucronata*, Schloth (the phragmocones of this species are abundant at some localities); and *Neithea Mortoni*, D'Orb. (abundant in fragments). Under the *Gryphæa* layer occur most of the other fossils of the Lower Bed, and it seems that, the deeper the marl is penetrated, the more numerous and varied do these become. Here occur the *Ammonites* and *Baculites;* the *Pectens, Cucullæas, Arcas, Cardiums* and the many forms of gasteropods.

Above the Lower Marl Bed lies a stratum of sand, colored more or less red by sesquioxide of iron, and hence termed the "Red Sand Bed." This attains in places a thickness of one hundred feet and contains Lower Bed fossils, as at Mullica Hill, where the very numerous fossils are found in a hard indurated marl, which there occurs near the summit of this Red Sand Bed.

*The Middle Marl Bed.*

This overlies the Red Sand and is composed of three well defined layers, viz.:

(1), A green marl layer, made up almost entirely of greensand grains; this merges into the indurated marl of the Red Sand Bed, or into a chocolate colored marl, in its southwestern extension. This layer contains few shells, but many bones and teeth of saurians; and some very perfect skeletons of *Mosasaurus*, etc., have been taken from it.

(2), A shell layer; this is another feature in the marl bed geology. It averages about five feet in thickness, and is composed of two species of shells, thickly imbedded in greensand. The lower two-thirds of its thickness are made up of *Gryphæa vesicularis*, Cuv., of a very uniform size—about three inches across—none of the very large ones which compose the shelly layer of the Lower Bed being here observable. The upper third is composed of shells and casts of *Terebratula Harlani*, Mort., and occasionally some of the very closely allied *T. fragilis*, Mort. The *Terebratulas* are commonly called "squirrel-heads," and when well preserved make beautiful fossils. This shell layer extends from Long Branch to the Delaware. It is overlain by (3), the stratum of limestone and less compact limesand, generally of a white or light yellow color, which forms the top of this bed and is a deep water deposit. It is thickest in the southwestern part of the marl belt, attaining a thickness of over twenty feet in Salem County. It may be traced entirely across the State, being observable, on the Atlantic coast, about Long Branch, where the rock is occasionally washed out by the waves. Here, however, its thickness is much less. In Monmouth County, it is almost all "limesand," but parts of it become more compact as we proceed southwestwardly, and the rock is sufficiently hard to be burned for lime.

This stratum contains numerous fossils. Bryozoa of many species occur, the most common one being *Eschara digitata*, Mort. A few foraminifera of quite large size have been found at this horizon in Monmouth County. The spines of echinoderms are abundant, and rarely a well preserved test is found. The coral, *Montivaltia Atlantica*, Mort., occurs (scarce). Quantities of *Polorthus tibialis*, Mort., the tubes varying greatly in size, and some other small lamellibranchs occur; there are also a few gasteropods. The coiled articulate, *Spirulæa rotula*, Mort., is abundant.

The limesand layer becomes somewhat mixed with quartz sand in its upper portion, and finally changes into the Yellow Sand Bed, which is forty or fifty feet thick in Monmouth County, but only ten to twenty feet thick in the western part of the State. This stratum is barren of fossils.

*The Upper Marl Bed.*

This rests on the Yellow Sand. As has already been stated, its outcrop is not so extensive as those of the other two beds; for further southwest than Clementon, Camden County, it has not been noticed. Its greatest development is in eastern Monmouth County, in the vicinity of Farmingdale, Squankum, Shark River and Deal Beach. Here it is represented by:

(1), Seventeen feet of green marl, mainly composed of glauconite (greensand), with numerous fossils. Among these may be noted the lamellibranchs, *Cyprina Morrisii*, Con., *Crassatella Delawarensis*, Gabb, and a small unnamed *Gryphæa*; two or three species of gasteropods, which are not abundant; the coral, *Trochosimilia conoides*, Gabb and Horn; the echinoderm, *Nucleolites crucifer*, Mort., and numerous teeth of sharks and rays of several species.

(2), About eight feet of the "ash marl," so-called from the ashy appearance of the heaps. This contains no greensand, but is composed of fine quartz sand, mixed with a greenish white clay; it is nearly barren of fossils.

(3), About eleven feet of blue marl, which tops this series of marl beds. The upper two to four feet of this layer is a hard, rock-like, light blue substance, which is full of fossils and has been referred to the Eocene. This stony marl is well exposed at Shark River, Deal Beach, and along the Manasquan River, near Squankum, but is unknown in the western continuation of the bed. Among its fossils are the large coiled cephalopods, *Nautilus Dekayi*, Mort., and the rarer *Aturia Vanuxemi*, Conrad; the conchifer, *Venericardia perantiqua*, Con., which is the most common fossil occurring in it, and several other bivalves and gasteropods of a large size, abundant and of several species.

From the eastern Monmouth County localities, above mentioned, to the vicinity of New Egypt, Ocean County, a distance of thirty miles, there are no outcrops of the Upper Marl Bed. When it reappears at the last mentioned place, the layers referred to the Eocene are absent, and they do not again appear further towards the west.

The fossils, *Crassatella Delawarensis*, Gabb, and *Nucleolites crucifer*, Mort., are more abundant at New Egypt than in eastern Monmouth County. Here occurs also another unnamed bivalve, in the green marl layer, which has not been noticed about Farmingdale, etc. This green layer is dug at Poke Hill and Vincentown, Burlington County, and contains the shells of a small *Gryphæa*, apparently *G. vesicularis*, Cuv., in a dwarfed condition, about one and a half inches across.

DISCUSSION.

Mr. G. F. KUNZ remarked that he had observed abundant cretaceous fossils at Ruby's, including a piece of amber of the dimensions of 1 by 6 by 20 inches: also, at Mullica Hill, dufreynite, vivianite, etc., in abundance, the latter sometimes in crystals one inch in length.

Dr. BRITTON stated that vivianite occurred in great abundance in the sands of the lower marl-bed, entirely replacing many of the shells; also at the well-known locality, still unexhausted, at Mullica Hill, in radiated forms and often occupying the casts of belemnitella; at Colson's Pits, on the drift; in clays on the Delaware River, at Fishhouse Station, etc.

A paper was then read by Dr. J. S. NEWBERRY,

ON THE ORIGIN OF CRYSTALLINE IRON ORES.

(Abstract.)

At a recent meeting of the Academy, Dr. JULIEN read an interesting and instructive paper on the origin of crystalline iron ores, in which he attempted to show that they are the product of mechanical rather than chemical agencies.

In bringing this subject again before the Academy, it is not my purpose to attempt to refute, but rather to supplement and limit, the theory of Dr. JULIEN.

I will not deny that some of the beds of magnetic iron ore, described by Dr. JULIEN, in the Alleghany belt, have been formed by the sorting power of shore waves, and that he has made an important contribution to the literature of iron, by his careful study and description of these beds; but that such cases, if they exist, are exceptional, and do not affect the truth and validity of the organico-chemical theory, I shall endeavor to prove by a brief report of some facts which have come under my observation.

The most important deposits of iron ore, known to exist in the United States, may be grouped as follows:

1. Magnetic ores of the Laurentian rocks of Canada, the Adirondacks, and the Alleghany belt.
2. The Huronian hematites of Lake Superior and Missouri.
3. The crystalline ores of the Rocky Mountains and the Wasatch.
4. The limonite ores of the Atlantic slope and the Mississippi Valley.
5. The Clinton ores.
6. The carbonates of the Coal-Measures.
7. The spathic carbonates of New England, Idaho, etc.

The Laurentian magnetites form lenticular sheets, sometimes more than one hundred feet in thickness, and extending half a mile or more. In many instances they are enclosed in walls of gneiss, slate, or marble. They often contain much titanium, and have, as almost universal impurities (somewhat vicarious with titanium,) pyrite and apatite. Some of the beds are also highly charged with manganese; they usually contain but little silica and alumina, and are the richest of our iron ores.

The characters they present, which seem incompatible with the theory of mechanical accumulation, are the following. First, their great magnitude, combined with their prevailing purity. Secondly, the large quantity of apatite contained, which we must regard as of organic origin and therefore supporting the chemical theory, and so different from the magnetite in gravity as impossible to be mingled with it by any mechanical agency. Thirdly, the occurrence of great sheets of magnetite between strata of limestone, like the Franklinite ore, or enclosed in layers of limestone and argillite, like the bog-bed at Marmora, Canada. The fact, that the slate and the limestone are deposits from deep and quiet water, seems incompatible with the view that these strata have been brought into their present association by mechanical means. Fourthly, the frequent impregnation of magnetites with manganese, a material of much lighter gravity, and an almost constant constituent of limonite, goes far to prove such magnetic beds chemical rather than mechanical deposits. Fifthly, the aluminous magnetites, like that of Croton Landing, which contain almost no silica, could hardly have been formed by the agency of shore waves, which always mingle more or less sand with whatever they deposit.

For these reasons, I must consider the mechanical theory as inadequate to account for the genesis of most of the magnetites of Canada and the Eastern States.

The specular ores of Lake Superior and Missouri offer objections to the mechanical theory, in both their regularity of deposition, and their mineral character. First, they are sometimes interstratified with jasper —once fine silicious sand—in layers of great regularity and of extreme thinness: a structure which would be the natural product of sedimentation but hardly of mechanical washing. Secondly, they could never have been deposited as hematite by shore waves, since this mineral forms an impalpable powder which never accumulates by itself. We must therefore suppose that all these great iron ore beds are pseudomorphs after magnetite, or that they are the result of sedimentation by organic agencies and subsequent metamorphism.

The iron ore of Iron Mountain is enclosed in "porphyry"—probably a metamorphosed sediment really fused in place,—but some of the masses of ore are thickly set with crystals of apatite, which afford an equally conclusive argument against the volcanic and the mechanical theories. In the ore of Simmons Mountain, masses of magnetite occur which retain perfectly their radiated, limonite structure; and there can be no question but that this has been deposited by a chemico-organic process.

The deposits of magnetic iron in Southern Utah,—the most extensive of which I have any knowledge,—are in places very conspicuously and evenly stratified and thus exhibit all the signs of having been deposited as sediments. They are associated with limestone and a granitoid metamorphic rock. Along certain lines, the ore is thickly set with crystals of apatite, and some of the largest masses are in great part composed of magnetite, which shows everywhere limonite structure. From these facts it is easy to see that these great deposits have not been formed by mechanical agencies.

In regard to the sparry carbonates which form vein-stones, and the earthy carbonates of the Coal measures, there can be no question of their origin. They have all been formed by chemical precipitation.

The Clinton ores are interstratified with limestone, form continuous sheets of great extent, and constitute on the whole the most considerable deposits of iron ore in this country. They were apparently formed in the same way that the granular lake ores are now deposited, by the precipitation of iron from solution in a water basin, surrounded by land having a ferruginous drainage. The quantity of phosphorus they contain, derived from the organic matter deposited with them, is a conspicuous feature in the composition of the Clinton ores, and apparently explains its abundance in many of our crystalline ores. After a careful study of the structure, composition and surroundings of our most important deposits of magnetic and specular ores, I am compelled to conclude that they have generally been derived from stratified deposits, accumulated by chemico-organic agencies, and once closely resembled our stratified ores of the upper Silurian and Devonian; and that any beds which accumulated as iron sand on beaches must be rare exceptions to the general rule.

DISCUSSION.

Mr. A. A. JULIEN pointed out that the theory thus presented by Dr. Newberry was a new one, and might be designated as the "Lake ore theory," in contradistinction from the marsh or bog ore theory now commonly accepted. The difference is sharply defined in the following quotations from the Manual of Geology by Prof. J. D. DANA. In his discussion of the Upper Silurian deposits, that author states (p. 231): "the beds of argillaceous iron ore . . . could not have been formed in an open sea, for clayey iron deposits do not accumulate under such circumstances. They are proof of extensive marshes, and, therefore, of land near the sea level. The fragments of crinoids and shells found in these beds are evidence that they were, in part at least, salt water marshes, and that the tides sometimes reached them." Again he remarks (p. 357), concerning the American continent during the Carboniferous age: "It may have been long a region of barren marshes, and in this condition it might have received its iron ore deposits, as now marshes become occupied by bog ores."

In reference to the Laurentian deposits (p. 155), he states: "Limestone strata occurred among the alternations, and argillaceous iron ores, though vastly more extensive." And again, "the argillaceous iron ore has become the bright hematite or magnetite, and it is banded by or alternates with schist and quartz, etc., which were once accompanying clay and sand-layers."

However, it is hard to conceive the growth of crinoids and shells in salt water marshes, even if reached by the tides, in the free abundance indicated by the crowded organic forms in the Clinton ore beds, and of these the lake ore theory presents a more satisfactory explanation. It also well accounts for the origin of the enormous ore deposits of hematite, of magnetite still retaining a pseudomorphous structure after limonite, and of all iron ores rich in calcium phosphate. This theory is not necessary to account for the presence of pyrite, since the presence of any vegetable matter, *e. g.*, algæ growing and decaying in sands or mud, is always likely to produce the de-oxidation of sulphates and iron oxide; nor does it account at all for the abundance of titanic acid and alumina in many iron ores.

On the other hand, the mechanical accumulation of iron sands, by agitation of the waves and currents, would appear to account more simply for the smaller but more numerous deposits thickly dispersed throughout the crystalline rocks, varying in size from scattered grains to little flakes and lenses a few centimeters in length, and even thick ore beds many meters in thickness and diameter. The close association, often observed, of materials of widely different specific gravity, e. g., shale and limestone with the magnetic ores, need not appear anomalous, since they may all have a shallow water origin, deposited by marine currents differing in force and direction at different times. The absence of such mechanical deposits from the sedimentary formations is not established, since even some of the hematites and bog ores may represent the results of oxidation and hydration of original magnetite sands; while, on the other hand, the huge beds of menaccanite found in Canada and elsewhere, which have not yet found their parallel among the sedimentary strata, may indeed show a certain difference of conditions during the deposit of the ancient crystalline rocks. The comparative regularity of the thin alternating laminæ, which make up the ferruginous jasper schists of Huronian terranes, appears analogous to that everywhere prevailing in a cross section of beach sands along our oceanic border; while the mountain masses of this rock, with laminæ of magnetite, or of octahedra of martite after magnetite, or of hematite in triangular scales after martite—all these ores being remarkably free from calcium phosphate—are most simply explained by the accumulations upon a sea bottom, strewn alternately with fine silicious silt, and with octahedra of magnetite. The presence of manganese oxide in iron ores may often be due, as at the Buckhorn mine in North Carolina,* merely to the decomposition of a manganese garnet originally concentrated as a mechanical sediment, while the concentration of titanic acid and of alumina, in many iron ores, is perfectly explained by the accumulation of heavy sands of menaccanite, corundum, etc. In a magnetic iron ore of S. G. 4.5, occurring in serpentine at South Ham, Quebec, Canada, the percentage constitution reported †(Fe 44.69, $Cr^2O^3$ 8.31, Ti $O^2$ 21.64) is equivalent to a mixture of three minerals known to occur in iron sands: magnetite, 50, chromite, 13, and menaccanite, 37 per cent.

The consideration of these facts would lead to the conclusion that the mode of genesis of a bed of magnetic iron ore may be often determined by the following diagnosis:

When the ore presents structural characteristics allied to those of limonite, or when hematite occurs in included masses, or when the ore contains a notable amount of phosphorus, a chemical origin is probably indicated.

When the ore is almost free from phosphorus or is rich in titanic or chromic acid or alumina, or closely associated or mixed with granular garnet or olivine, a mechanical origin may be inferred.

Mr. N. F. DARTON stated that he had found over two per cent. of chromic acid in the limonite ores of Staten Island, and Mr. N. L. BRITTON, from 1.6 to 3 per cent. in the ores of the same region.

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* W. C. Kerr, Geol. of N. C., I, 222.

† B. J. Harrington, Can. Nat., 1881, IX, 309.

October 30, 1882.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-two persons present.

The following specimens were exhibited:

By the PRESIDENT, proustite or ruby silver from Chile, remarkable for rich color and beautiful crystallization.

By the SECRETARY, wad (bog manganese) from Norwich, Vt., made up of aggregated nodules easily crushed by the fingers and entirely dissolved in chlorhydric acid. It is found near outcrops of mica slate, on high ground overlooking the Connecticut river, in a bed six inches thick, directly below the turf of a pasture, and in masses of 6 or 8 pounds.

Also soapstone, from one of two transported masses, lying above high water mark on the west bank of the Connecticut river, at Olcott's Falls, Norwich, Vt. These masses are about 6 ft. x 2 ft. x 1 ft. each, entirely unworn, and transported, we may fairly conclude, in the glacial period, and from the nearest northern locality, which is Sunday Mountain in Oxford, N. H., about 20 miles directly north. No transported masses of this material are mentioned in the Geological Reports of New Hampshire or Vermont.

The PRESIDENT remarked on the somewhat frequent occurrence of such forms of "bog manganese," and the similarity of its production, in the chemical processes involved, to that of "bog iron ore."

A paper was read by Prof. W. P. TROWBRIDGE, entitled,

IMPORTANCE OF EXPERIMENTAL RESEARCHES IN MECHANICAL SCIENCE.

(Published in full in the *New Englander*, February, 1883.)

The following paper was read, by Prof. JOHN K. REES:

RESUMÉ OF OBSERVATIONS ON GOULD'S COMET (NOW VISIBLE).

*I. Discovery.*

In accordance with the custom of naming a comet after its discoverer, it appears that this grand visitor to our system should be called Gould's Comet. M. CRULS, of Rio de Janeiro, saw the comet in the morning sky on Sept. 12th, and, as he was thought for some time to have been the first to see the comet, it was called after him.

DAVID GILL, writing from the observatory at the Cape of Good

Hope, remarked that Mr. FINLAY, the First Assistant, saw the comet at 5 A. M., Sept 8.

Dr. GOULD, of Cordoba, in a letter dated Sept. 15, to S. C. CHANDLER, Jr., of Boston, stated that he had been observing a large comet for over a week. This undoubtedly was the one now visible, and Dr. GOULD appears to have been the first to see it.

The comet was first observed in England, by Mr. A. A. COMMON. He was observing the sun "with a special telescope (reflector with glass reflecting surfaces only)," on the morning of September 17th, when he found a "bright comet," "five minutes preceding the sun, and approaching fast." This observation was made at 10.45 A. M.

Mr. CRULS thought his comet might be the expected Comet Pons of 1812. This is considered an oversight, as the comet of 1812 should appear much *further north or south* of the present comet, depending on whether the 1812 comet was approaching, or receding from, perihelion.

Since the discovery of this grand comet, much attention has been given it by observers here and abroad. The bad weather has greatly interfered with the observations.

### *II. Aspect and Form.*

This comet will rank among the remarkable comets of the century. Mr. COMMON, as we have mentioned, saw the comet close to the sun at almost noontime ; and Mr. GILL observed the "*sudden disappearance of the comet at ingress on the sun's disc.*" The comet was not visible on the sun. "Mr. Gill's remarkable observation," says *Nature*, "is without a precedent, and an extraordinary illustration of the intense brilliancy which the comet attained at perihelion." The comet swept around the sun, passing the perihelion point in three and a half hours. The velocity in turning about must have been enormous.

The tail, before the comet passed around the sun, does not seem to have been of any great visible extent. Mr. COMMON estimated the length of the tail, on the 17th of September, just before reaching the perihelion, as 4′ in length. But the bright sunlight undoubtedly hid from view much of the tail's faint light.

Since the passage of perihelion, many observers have been watching the comet with every means in their power—telescope, spectroscope and polariscope.

M. BULARD, of Algiers, gives, in *Nature* for Oct. 12, a drawing of the head of the comet, showing the system of envelopes rising from the nucleus. Several recent bright comets have exhibited this same peculiarity.

In *Nature* for Oct. 19, sketches by RICCO of Palermo are given. Prof.

YOUNG, at Princeton, has sent me a letter from which I obtain the following data:

"The weather has been so bad here that we have been able to make but few observations of the comet.

"I send a note, from the *Siderial Messenger*, of observations made here on the 19th and 20th of September. It has since been observed at the Halsted Observatory (with the 23-inch telescope) on October 2, 4 and 15 (*civil time*), and at the S. S. Observatory with the 9½ telescope, on the 10th and 24th.

"On the 2d, the Spectrum showed very plainly the D lines in addition to the usual cometary (carbon) bands.* There was no sensible displacement due to motion. In the middle carbon band (near *b*), the three bright lines, observed in the comet of 1881, came out finely. No dark lines could be seen, though there was a pretty strong continuous spectrum from the nucleus of the comet.

"On the 4th, the D lines were barely visible, and since then the spectrum has been simply that ordinarily shown by comets. The three bands have been visible in the spectrum of the tail to a considerable distance from the head. This I mention in opposition to the statement (which I think a mistake) that the spectrum of the tail is simply continuous.

"*In the Telescope.*— On the 2d, the nucleus was elliptical, about 4″ by 8″. There was one well-formed parabolic envelope, and there was a *dark* streak following the nucleus. The edges of the streak were nearly parallel, pretty well defined, and it could be followed for about 20′, till it lost itself in the tail.

"On the 4th, the nucleus had become much elongated—something like an Indian club in form—large end towards the sun. The envelope had lost all definiteness of outline. The dark stripe beyond the nucleus was very faint, and along the northern edge of it there was a *bright* streak.

"On the 10th, the nucleus had assumed the appearance it has since retained, consisting of a spindle-shaped, slightly curved, nebulous streak of light, with five or six knots or centres of brightness scattered through it. The brightest of these knots (perhaps the true nucleus)

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* In the Dun Echt circular No. 56, sent from Lord Crawford's Observatory, England, we read: "The spectrum of the nucleus continuous, with many bright lines, of which D is by far the brightest; all the bright lines displaced towards the red by about one-eighth of the interval of the D lines." This separation would correspond to a motion of *recession* of about twenty miles per second. Prof. YOUNG's observation was made after the comet had passed perihelion; so also were the observations made at Dun Echt. The date of the Dun Echt observations was September 18. If a displacement showing motion really occurred, it will be the first time that such a phenomenon has been noted with reference to a comet. The observation is one of such delicacy that we must wait further corroboration before accepting the Dun Echt observation, especially as Prof. YOUNG has not been able to discover any sensible displacement.

was the *third* from the sunward end of the spectrum; the fourth was nearly as bright, and the nebulosity between them was so much fainter than elsewhere, that in a small telescope, or in the large one after day-dawn, the nucleus seemed to be broken in two at this point.†

"The nuclear streak was slightly curved, and the knots in it were a little out of line. A bright wisp extended from the end of it out into the tail. These appearances were well seen on the 10th with the 9½-inch glass, and still better on the 15th with the 23-inch; on the 24th the moonlight was very strong, and the comet rather faint, but the same features could be still made out.

"On the 15th, the nuclear streak measured 48″ in length.

"On the 15th and 24th, the companion comet was looked for, but I could not find it.

"On the 2d, the head of the comet was brighter than Regulus, but not so bright as Sirius. It disappeared in the dawn, before Procyon even, but Procyon was farther from the sunrise. The tail was very bright, and well defined at both edges—about 14½° long.

"On the 4th, the head equalled Regulus. On the concave side of the tail (the northern), there was near the head a good deal of scattered nebulosity, visible to the naked eye, and veiling the outline of the tail in that region.

"On the 10th, nothing of special interest was noted, except that the outline of the tail, near the head, was less definite than before.

"On the 15th, a very curious phenomenon* was noted, to which my attention had been called by a letter from Prof. SMITH, of Kansas State University. From the head of the comet there extended toward the sun a faint streamer of light, about ½° wide, with nearly parallel edges, which were pretty sharply defined. It seemed to originate in the *tail* of the comet, a degree or so above the head, and extended towards the sun about 3½° or so below the head, being 4° or 5° long in all. It faded away at the lower (sunward) end, without any definite boundary. It could be faintly made out with the naked eye, but was best seen with a small telescope of two inches aperture, magnifying about ten times.

"The tail was nearly 20° long, and distinctly forked at the end, the convex side being prolonged by an oblique streamer. Head on the 15th brighter than α Hydræ, not so bright as Regulus. On the 24th, the head was about fourth magnitude star. I believe this embodies everything of importance noted here."

† This will account for the many reports of the breaking up of the nucleus of the comet. Three condensation points were noted at Washington with the 26-inch glass, but nothing like a *split* was observed.

* This same phenomenon was observed at Washington as early as October 8, when the sunward appendage was between 30′ and 50′ long, and on the morning of the 10th it was 3° long.

### *III. Orbit and Motion.*

Prof. BOSS, Director of the Dudley Observatory at Albany, was the first to point out the supposed identity of this comet with the comets of 1843 and 1880, and prophesied its speedy return.

Mr. HIND'S elements also lead us to believe that the 1843 comet and this one are the same.

Mr. PROCTOR explains, in the last number of *Knowledge*, how he was misled, by the careless marking of a diagram, into a promise to show that the great comet is to be seen where the comets of 1843 and 1880 could not have been seen. "I am unable to do so," he says, "simply because there is every reason to believe that the comet, which circled close around the sun on September 17, is no other than our friend, the Menacing Comet, come back in less than two years and eight months. The observations agree so well with the theory that the comet is moving in the orbit of the comets of 1843 and 1880 (at least in the part of the orbit near the sun, for at aphelion the orbit has been entirely changed), as to leave scarcely any room for any doubt that the comet has come back again long before it was expected—how soon to return yet again, and how soon to be finally absorbed by the sun, it were at present somewhat rash to say." But after some further calculations, he says: "for my own part—so far as observations hitherto made enable me to judge—I expect the comet back in less than half a year."

Some of you will recall the grand comet of 1843. All remember the beautiful appearance of the comet of 1880. The period calculated for the 1843 comet was 175 years. If the supposition of Prof. BOSS is correct, we have a change in the period of the comet from 175 to thirty-seven years, and then to about three years. This immense change must be ascribed to the resistance the comet meets with in passing so close to the sun's surface, thus diminishing the linear velocity of the comet, but increasing its angular velocity, and shortening its time of revolution. The inevitable result of this must be a precipitation of the comet into the sun.

The comet of 1843 came within 500,000 miles of the sun's centre, or 70,000 miles of the sun's circumference. The comets of 1880 and of 1882 came nearly as close, if not closer. We know that the terrible solar cyclones and volcanoes, if I may use the term, throw up masses of hydrogen and other gases to a height more than sufficient to surround the head of the comet, when so near the sun. Moreover we know that the mysterious coronal atmosphere extends many millions of miles out from the sun. Thus the comet has to plough through this atmosphere, and one would expect as a result a retardation in the motion of the comet.

The result of this retardation would be a shortening of the comet's period; and, after a few returns, the comet would not have sufficient centrifugal force to overcome the sun's attraction, and so would plunge into the photosphere. Although this plunge might be made at the velocity of 200 miles per second (according to PROCTOR), yet no results disastrous for the earth are likely to follow. The study of the comets, at their successive returns, shows us that they decrease in mass and size, owing to the heat of the sun; and moreover the mathematical astronomers have never been able to find the least effect of the attractions of the comets on the planets or satellites.

Comets have been entangled among the satellites of our planets—notably, LEXELL'S comet of 1770, and have been swung off in the planets' attraction to pursue totally different orbits. Yet the comets never affected the motions of the smallest satellites, thus showing that the mass of comets must be small compared with the planets and satellites. The result, therefore, of a collision with the sun, might be only a solar disturbance, which would evidence itself in a large spot and cause a display of auroras here, and the swinging of the magnetic needles. At least the mathematical chances are in favor of some such slight disturbance. But if this comet is to return in about six months, it may be our good fortune to test the truth of these statements very soon. Per contra, there are those among the astronomers who do not consider that the identity of the comets of 1843, 1880 and 1882 have been proved.

Mr. S. C. CHANDLER of Harvard Observatory points out the fact that the orbit of the comet of 1843 was computed from observations after its perihelion passage, and therefore *after it had experienced all the perturbing effect* of the passage so close to the sun; it was found that it could not return for 175 years, and that the orbit of the comet of 1880 was in like manner computed from observations after its perihelion passage, and that comet cannot return for at least ten years. He now computes the orbit of the present comet, representing all observations from nine days before the perihelion passage to thirty-two days after it, and shows, not only that its orbit is an ellipse so extended that the comet cannot return for many years, but also that the passage in close proximity to the sun did not materially affect the orbit. This testimony is a severe blow to the theory of the identity of the comets of 1843, 1880 and 1882.

[The paper was supplemented by explanatory remarks in regard to the chemical and physical constitution of comets. In the lantern exhibition, the following points were dwelt upon. 1. Connection between comets and meteors. 2. Various forms of comets. 3. Observations made on the tails of comets. Theory of a repulsive force emanating from the sun. 4. The immense extent of the sun's "atmosphere" through which some comets plunge.]

November 6.

SECTION OF GEOLOGY.

The President, Dr. J. S. Newberry, in the Chair.

Thirty-six persons present.

The following persons were elected as Resident Members:

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| E. L. Snow, | J. McDonald, |
| N. A. Darton, | C. E. Pellew; |

and, as Corresponding Members:

H. A. Alfred Nichols, of Dominica, W. I.

F. W. Stoebner, of State Normal School at Westfield, Mass.

The following resolutions were passed by unanimous vote:

*Resolved*, That authors of papers offered for reading before the Academy be earnestly invited to present them previously in full, or in satisfactory abstract; and that, except by vote of Council, preference shall always be given by the Committee on Papers to those which shall be so presented in writing.

*Resolved*, That all addresses or remarks before any meeting of the Academy, on scientific subjects or on business, which may not have been previously accepted and announced on the weekly card, shall be limited (with the exception of the Reports of Council, Officers or Committees) to five minutes, unless by special vote and permission of the Academy; and they must at any time be discontinued at the request of the Chairman, whenever in his judgment they are not pertinent to the subject before the Academy.

A communication was received from Jas. C. Cox, M. D., President of the Linnean Society of Sydney, New South Wales, announcing the entire destruction by fire, on September 22, of all its property—library, correspondence, records, instruments, and collections—in the burning of the Garden Palace, a loss estimated in money at £3,000. On motion, it was resolved to send an expression of the regrets and sympathy of the New York Academy of Sciences and to supply the Linnean Society with as complete a series as possible of the Annals and Transactions of the Academy.

Mr. G. F. Kunz remarked on an interesting series of minerals, collected during the past summer by Mr. C. D. Mimms, of Philadelphia, Jefferson County, N. Y., from a new locality at the village of Fine, St. Lawrence County, N. Y., twelve miles from Edwards and forty miles from Philadelphia, N. Y., on the border of the Adirondacks. Titanite occurs in very large crystals, only equaled by those of Renfrew, Canada, one group of three crystals measuring over 30 centimeters across and weighing 45 pounds, a single crystal weighing 20 pounds, etc.; all the faces are unpolished. Pyroxene is found in huge crystals, one being 120 cm. long and 45 cm. through. Orthoclase, in crystals 5 to 15 cm. through. Zircon and fine green fluorite also occur.

Mr. KUNZ also exhibited minerals, from a new locality at Stoneham, Maine, which very much resemble those described by Profs. Dana and Brush, from Branchville, Conn. Among these may be mentioned triphylite, triplite, damourite, spodumene, and a pink mineral, as yet unidentified. He had also recognized topaz, a mineral new in that association, never before found in that State, and known to occur at but one locality in New England. A crystal of this mineral observed was well-formed but much broken, and measured 38 cm. across the brachydiagonal; though others, 15 to 18 cm. in length, were destroyed in the process of blasting. He also exhibited a specimen of chalcopyrite, in a rare association, with pyrrhotite and pyrite, from Untersalzbach, Tyrol.

A paper was read by Mr. N. F. DARTON, entitled:

### ON THE GENESIS OF THE ORES AND MINERALS IN THE GRANULAR LIMESTONE OF SUSSEX COUNTY, N. J.

#### DISCUSSION.

A *member* pointed out that the content of crystallized tourmaline, epidote, and beryl, in the "dykes of granite" mentioned by the author, identified these as granite veins instead of true eruptive dykes.

Prof. T. EGLESTON remarked that all the crystals of so-called "idocrase" from this region, which he had examined, turned out to be tourmaline.

Mr. G. F. KUNZ reported that fifty crystals of supposed "idocrase" from this region, now in the cabinet of the Pennsylvania Geological Survey, were really tourmaline.

Mr. DARTON stated that, at Sparta, the granite holding tourmaline, cut across the limestone beds, and might occur in true veins, and that he believed that crystals of idocrase from Franklin had been identified by analysis.

November 13, 1882.

SECTION OF CHEMISTRY.

Vice-President, Dr. B. N. MARTIN, in the Chair.

Sixteen persons present.

The following specimens were exhibited: by Mr. G. F. KUNZ, crocidolite catseye, from Cape of Good Hope: by Mr. JULIEN, a young echinus, curious shelly aggregates of sand, ten cm. in diameter, from the beach off the Navesink Highlands, N. J., and a fossil Ostrea, found in the boulder clay, in 112th street, between Ninth and Tenth avenues, New York city: by Mr. N. H. DARTON, supposed clintonite, from a vein five cm. thick in serpentine, at Honolulu, Sandwich Islands.

Prof. D. S. MARTIN identified the echinus as a very small and young individual of *Echinarachnius parma*, belonging to the New England coast at its southward limit, hardly ever found before on the beaches of New Jersey, though reported to occur on a far out bank.

The CHAIRMAN showed that the sandy aggregates were the egg-casts of a large species of the mollusk, *Natica*, known to occur along that beach, and that the fossil exhibited, probably *Ostrea*, was the first he had seen from the till of New York Island; and further remarked on the distribution of the oyster along the Atlantic coast of this continent.

A paper was read by Dr. PIERRE DE P. RICKETTS, entitled:

ANALYSIS OF THE FRANKLINITE ORES OF NEW JERSEY, AND METHODS FOR THE SEPARATION OF THE RED OXIDE OF ZINC.

(Abstract.)

Some time since, my attention was called to the question of determining a method for estimating the amount of Red Oxide of Zinc, contained in certain deposits of these Franklinite Ores. Some of the results obtained have not been published, other than in the testimony taken in law suits about these deposits.

The methods employed were briefly as follows:

The first was a mechanical separation, made by Mr. A. F. Wendt and myself, for the purpose of obtaining the mineral constituents of the samples treated, as nearly as possible.

The ore was crushed down to below 40 meshes to the inch, and sieved. The Franklinite was then extracted by the magnet from an average portion of the sample, and the red oxide separated by hand, under a powerful magnifying glass, from the residue, by using a fine wire with a small hook at the end.

The result of the separation was:

| | *A.* | | *B.* | |
|---|---|---|---|---|
| Franklinite | 48.2 | per cent | 44.7 | per cent. |
| Red Oxide | 2.7 | " | 7.4 | " |
| Silicates & Carbonates | 49.1 | " | 47.9 | " |
| | 100.0 | | 100.0 | |

The next method adopted was to take average samples of the Franklinite ore, carefully separate from a portion of the sample the mineral constituents contained in the same, and analyze the separated minerals. Several analyses of average samples were then made, and from these, and the analysis of the separated minerals, the mineralogical constitution of the ores was calculated.

The complete analyses of the average samples were as follows:

| | *A* | *B.* | *C.* | *D.* |
|---|---|---|---|---|
| Silica | 11.85 | 11.59 | 8.64 | 10.70 |
| Oxide of zinc | 34.13 | 40.83 | 34.70 | 33.09 |
| Proto-sesqui-oxide of iron | 28.48 | 29.94 | 28.34 | 31.05 |
| Alumina | 0.58 | trace. | trace. | trace. |
| Protoxide of manganese | 14.13 | 8.35 | 15.50 | 15.51 |
| Lime | 5.51 | 4.16 | 5.70 | 4.59 |
| Magnesia | 0.13 | 0.79 | 1.44 | 0.27 |
| Carbonic acid | 4.96 | 4.12 | 6.26 | 4.38 |
| Copper | 0.07 | undetermined. | trace. | trace. |
| | 99.84 | 99.78 | 100.58 | 99.59 |

The analysis of the constituent minerals gave the following figures, as representative of their constitution, after separating and cleaning them from adhering gangue, etc., under a magnifying glass:

| | *A. Franklinite.* | *B. Zincite.* | *C. Willemite Residue.* |
|---|---|---|---|
| Silica, and insoluble matter | 2.62 | 0.81 | 24.36 |
| Oxide of zinc | 21.60 | 95.23 | 48.06 |
| Proto-sequi-oxide of iron | 55.80 | trace. | } 1.97 |
| Alumina | trace. | trace. | } .... |
| Protoxide of manganese | 17.06 | 3.51 | 12.25 |
| Lime | 1.28 | 0.32 | 6.29 |
| Magnesia | 0.30 | 0.10 | 0.99 |
| Carbonic acid | 1.35 | 0.37 | 6.28 |
| Copper | none. | undetermined. | trace. |
| | 100.04 | 100.34 | 100.20 |

The Franklinite, after deducting foreign constituents, such as silica, magnesia, lime, etc., would have the following composition: oxide of zinc, 22.90, protoxide of manganese, 18.08, and proto-sesqui-oxide of iron, 59.15. The Zincite, allowing for the impurities which even careful picking could not separate, would have the following constitution: oxide of zinc, 96.44, protoxide of manganese, 3.55, proto-sesqui-oxide of iron, a trace.

The Willemite analyzed evidently contained considerable limestone and impurities, and although the analysis is stated, it was thought safer to take the composition of Willemite as given by Dana, in calculating the mineralogical constituents of the ore.

Taking the analysis of sample marked "A," considering the constitution of the Franklinite and Zincite as determined, and using the mechanical separation marked "A," we would have the following as the mineralogical composition of the sample:

| *Zincite.* | | *Franklinite.* | *Willemite (Dana).* | |
|---|---|---|---|---|
| ZnO | 96.44 | 22.90 | | 72.90 per cent. |
| MnO | 3.55 | 18.08 | $SiO_2$ | 27.10 " |
| $Fe_3O_4$ | | 59.15 | | |

Mechanical separation of 1,700 ton sample gave: Franklinite .. 48.2; Zincite...... 2.7; Silicates and Carbonates 49.1

48.2 per cent Franklinite = 11.04 per cent. ZnO.
2.7 " Zincite . . = 2.60 " "

13.64

Analysis of Sample "A" gives:

| | |
|---|---|
| ZnO | 34.13 |
| ZnO for F. and Z. | 13.64 |
| | 20.49 per cent. for Willemite: |

which will require 7.617 per cent. of $SiO_2$ and correspond to 28.107 of Willemite.

| | |
|---|---|
| $SiO_2$ in 1,700 ton sample= | 11.850 |
| " for ZnO........... = | 7.617 |
| " " MnO and $Al_2O_3$ | 4.233 |
| $SiO_2$ for $Al_2O_3$, etc. | 0.340 per cent. |
| | 3.893=Balance $SiO_2$. |
| Which would require | 4.589 per cent. of MnO. |
| | 8.482 per cent. of Rhodonite. |

| | |
|---|---|
| Willemite= | 28.107 |
| Rhodonite= | 8.482 |
| Silicate of Alumina, etc.= | 0.920 |
| Total Silicate.................... | 37.509 |
| Carb. of CaO & MgO.. ............ | 10.110 (by analysis.) |
| Total Silicates and Carbonates.... | 47.619 |
| Found by Wendt..................... | 49.100 |
| Difference= | 1.481 |
| Carb. of Manganese, calculated from excess of Carbonic Acid........... | 1.270 |
| | .211=Cu, etc. |

STATEMENT.

| | $SiO_2$. | $ZnO$. | $Fe_3O_4$. | $MnO$. | $Al_2O_3$. | $CO_2$. | $CaO$ & $MgO$. | *Calculated* |
|---|---|---|---|---|---|---|---|---|
| Franklinite.................. | ---- | 11.04 | 28.51 | 8.71 | --- | --- | --- | 48.200 |
| Willemite.................... | 7.617 | 20.49 | ---- | --- | --- | --- | --- | 28.107 |
| Silicate of Alumina, etc ...... | 0.340 | ---- | ---- | --- | 0.58 | --- | --- | 0.920 |
| Red Oxide.................. | ---- | 2.60 | ---- | 0.10 | --- | --- | --- | 2.700 |
| Rhodonite .................. | 3.893 | ---- | ---- | 4.589 | --- | --- | --- | 8.482 |
| Carb. of Manganese .......... | ---- | ---- | ---- | 0.78 | --- | 0.49 | --- | 1.270 |
| Limestone .................. | ---- | ---- | ---- | --- | --- | 4.47 | 5.64 | 10.110 |
| Copper, etc.................. | ---- | ---- | ---- | --- | --- | --- | --- | 0.211 |
| Totals .................. | 11.850 | 34.13 | 28.51 | 14.179 | 0.58 | 4.96 | 5.64 | 100.000 |
| Found by Analysis.......... | 11.85 | 34.13 | 28.48 | 14.13 | 0.58 | 4.96 | 5.64 | 99.77 |

To check this calculation, the average composition of Franklinite, Willemite and Zincite, as given by Dana, were used in connection with the mechanical separation already referred to, and the following calculation made as to the composition of Sample "A."

| *Zincite.* | | *Franklinite.* | | *Willemite.* | |
|---|---|---|---|---|---|
| ZnO.... ......... | 95.20 | ZnO.............. | 20.72 | ZnO............... | 69.97 |
| MnO............. | 3.19 | MnO.............. | 12.72 | MnO.............. | 1.14 |
| | | $Fe_3O_4$............ | 63.90 | $Fe_3O_4$. ........... | trace |
| | | | | $SiO_2$............... | 26.81 |

| | | |
|---|---|---|
| Mechanical separation gave | Franklinite.... | 48.2 |
| | Zincite.... .. | 2.7 |
| | Silicates and Carbonates | 49.1 |

| | | |
|---|---|---|
| 48.2 per cent. Franklinite= | 9.99 | per cent. ZnO. |
| 2.7 per cent. Zincite= | 2.57 | " " |
| | 12.56 | " " |
| Total ZnO in sample= | 34.13 | |
| | 12.56 | |
| | 21.57 | per cent. ZnO due to Willemite. |
| | 8.27 | $SiO_2$. |
| | 30.84 | per cent. Silicate of Zinc. |
| Total $SiO_2$ in sample= | 11.85 | |
| | 8.27 | |
| | 3.58 | per cent. $SiO_2$ due to Rhodonite. |
| | 4.22 | per cent. MnO. |
| | 7.80 | per cent. Rhodonite. |
| By analysis.................... | 10.11 | per cent. Limestone. |
| Carb. Manganese for excess $CO_2$..... | 1.27 | |

| | | |
|---|---|---|
| Franklinite.................. | 48.2 | |
| Zincite.................... | 2.7 | |
| Willemite ....... ......... | 30.84 | =38.64 Silicates. |
| Rhodonite........... .. ... | 7.80 | |
| Limestone............. .... | 10.11 | =11.38 Carbonates. |
| Carb. Manganese............ | 1.27 | |
| | 100.92 | 50.02 per cent. Silicates and Carbonates. |

Other methods of calculation were employed, such as applying the various standard analyses of Franklinite to the complete analysis given, considering that all the iron found came from the Franklinite, and using that as a starting point. For instance, taking an analysis of Franklinite as given by Cook, and applying it to complete analysis marked "D," we should obtain the following calculation and results:

The analysis of Franklinite gives sesqui-oxide of iron, 62.36—equivalent to proto-sesqui-oxide, 60.28; oxide of zinc, 22.95; protoxide of manganese, 17.20. Taking the proto-sesqui-oxide of iron in the sample at 31.05, and comparing with the proto-sesqui-oxide of iron in 100 parts, as found in the Franklinite, the amount of Franklinite corresponding to 31.05 is easily obtained. Calculating the silicate of manganese as rhodonite, taking all the oxide of zinc necessary for silica, etc., and calling what remains red oxide, we would have the approximate mineralogical composition of Sample "D":

| | |
|---|---|
| Franklinite | 51.51 |
| Red Oxide of Zinc | 6.40 |
| Rhodonite | 11.13 |
| Willemite | 20.23 |
| Carbonate of Manganese | 1.24 |
| Limestone | 8.76 |
| | 99.27 |

The next trial made was to determine some solvent which would dissolve the red oxide of zinc, and practically leave the other mineral constituents, with the exception of the limestone, unacted on.

The experiments made by Prof. H. Carrington Bolton, of Trinity College, with organic acids, upon minerals, suggested to me the use of an organic acid for the quantitative estimation of the red oxide. Citric acid was first employed, but without satisfactory results; and, after several experiments, acetic acid was adopted as the best solvent obtainable.

The first step was to determine the solubility of Franklinite, Zincite, Willemite, Rhodonite, etc., in acetic acid, and a number of experiments were made with this object, the results being as follows:

*Solubility of Franklinite.*

| Specimen. | Locality. | Amount Dissolved. |
|---|---|---|
| No. 1 | Franklinite (analyzed) | 5.42 per cent. |
| No. 2 | Mine Hill | 2.63 " |
| No. 3 | Mine Hill | 1.45 " |
| No. 4 | Crystals | 0.57 " |
| Average | | 2.52 " |

Time 1 hr. 30 min. 50 per cent. acid; 50 per cent. water.

*Solubility of Red Oxide.*

Dark Red—Entirely soluble.

Light Red—*Slight* residue reacting for Manganese.

*Solubility of Rhodonite.*

| Specimen. | Locality. | Amount Dissolved. |
|---|---|---|
| No. 1 | Mine Hill | 1.66 per cent. |
| No. 2 | Sterling | 2.33 " |
| No. 3 | Franklin | 1.03 " |
| No. 4 | Mine Hill | 2.18 " |
| Average | | 1.80 " |

Time 1 hr. 30 min. 50 per cent. acid; 50 per cent. water.

*Solubility of Willemite.*

| Specimen. | Locality. | Amount Dissolved. |
|---|---|---|
| No. 1 | Mine Hill | 22.53 per cent. |
| No. 2 | Franklin | 32.23 " |
| No. 3 | Mine Hill | 28.43 " |
| No. 4 | Franklin | 34.08 " |
| Average | | 29.32 " |

Time 1 hr. 30 min. 50 per cent. acid ; 50 per cent. water.

Comparing these various solubilities, we arrive at the following conclusions:

1st. That *Franklinite*, if pure, is practically insoluble.

2d. That *Red Oxide of Zinc* is entirely soluble.

3d. That *Rhodonite* is slightly soluble.

4th. That *Willemite* is partially soluble.

5th. That the *Carbonates*, etc., are almost totally soluble. Therefore in the solution from the treatment with acetic acid, there would be: silica, from the Willemite and Silicate of Manganese, oxide of manganese, in small quantities, and oxide of zinc, from the Red Oxide and Willemite, provided a definite method of treatment be adopted, and all contact with the acid be avoided, as soon as examination shows that the red particles in the ore are dissolved.

The following method of analysis was therefore adhered to:

A. *Sampling.*—Crushing and quartering through three successive stages, until the sample was sufficiently fine for analysis.

B. *Method.*—Weigh out two grms. and treat with a mixture of acetic acid and water (fifty per cent. No. 8 acetic acid, and fifty per cent. of water). Allow to stand approximately one and one-half hours, examining occasionally under a powerful magnifying glass; heat gently, if any red particles are visible, and continue the treatment until no red oxide is contained in the residue. Filter and wash.

*Residue* A.

Dry and weigh on weighed filter.

*Solution* A.

Acidify with HCl, and evaporate to dryness; take up with HCl and water; warm, filter and wash.

*Residue* B.

Silica—dry, ignite and weigh.

*Solution* B.

Neutralize with $Na_2CO_3$, acidify with acetic acid, and precipitate with $H_2S$ gas.

*Solution C.*

Boil with $KClO_3$, to oxidize sulphur. Neutralize carefully and precipitate Manganese with Br water as usual. Filter and wash, diss. in HCl, and re-precipitate with $Na_2CO_3$.

Ignite and weigh $Mn_3O_4$.

*Precipitate C.*

Wash with $H_2S$ water, diss. in HCl, oxidize sulphur, re-precipitate with $Na_2CO_3$. Dry, ignite and weigh the *ZnO*.

*Results.* -1st. Residue insoluble in acetic acid.
2d. Silica in acetic acid solution.
3d. ZnO dissolved by acetic acid.
4th. $MnO_2$ dissolved by acetic acid.
*Undetermined;* CaO and MgO dissolved.

Taking into consideration the previous determinations of the solubilities of the Silicates of Zinc and Manganese, etc., we have the following data:

*Ratio of Solubilities.*—29.32 (solubility of Willemite) is to 1.80 (solubility of Rhodonite) as 16.5 is to 1.

*Ratio of Silica in these minerals* (Dana), 27 to 46. Occurrence of these minerals by supposition in these ores, 1 to 1. Multiplying these ratios together we have 445.5 to 46. Hence, approximately 90.64 per cent. of the silica *in solution* will be due to the Willemite, and 9.36 per cent. to the Rhodonite—say 9-10 and 1-10. Applying this method and adopting this basis of calculation, I obtained the following results from a series of analyses made on ten different samples:

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Residue | 78.35 | 74.81 | 79.86 | 80 17 | 80.86 |
| Silica | 1.82 | 2.39 | 2.71 | 1 80 | 1.71 |
| Oxide Zinc | 8.66 | 8.14 | 7.77 | 11.29 | 11.63 |
| Oxide Manganese | 3.32 | 2.83 | 3.46 | 3.13 | 2.71 |
| Oxide Zinc for Silica | 4.42 | 5.80 | 6.58 | 4.37 | 4.15 |
| Oxide Zinc for Red Oxide | 4.24 | 2.34 | 1.19 | 6.92 | 7.48 |
| Red Oxide | 4.42 | 2 43 | 1.24 | 7.23 | 7.79 |

| | 6 | 7 | 8 | 9 | 10 | *Average* |
|---|---|---|---|---|---|---|
| Residue | 80.22 | 74.76 | 75.31 | 72.97 | 70.86 | 78.042 |
| Silica | 2.34 | 2.74 | 2.31 | 3.86 | 2.33 | 2.227 |
| Oxide Zinc | 12.56 | 11.59 | 14.57 | 11.42 | 11.99 | 10.778 |
| Oxide Manganese | 3.76 | 3.29 | 3.06 | .... | 3.22 | 3.185 |
| Oxide Zinc for Silica | 5 68 | 6.65 | 5.61 | 9.38 | 5.66 | 5.407 |
| Oxide Zinc for RedOxide | 6.88 | 4.94 | 8.96 | 2.04 | 6.33 | 5.370 |
| Red Oxide | 7.16 | 5.14 | 9.33 | 2.13 | 6.59 | 5.593 |

Other experiments and analyses were made, and the basis of calculation changed by allowing 75 per cent. of the silica found in solution for the Willemite. The red oxide might also be slightly raised by adding some of the manganese found in solution, the amount to be added being calculated by comparison with the analysis of Zincite already given. Rhodonite has been taken as the silicate of manganese found in these ores, instead of Tephroite, although the latter occurs to some extent—the ratio of occurrence of the Willemite and Rhodonite assumed, *i. e.*, 1 to 1, being thought to more than compensate for any silicate of manganese which might go into solution from the presence of Tephroite. This mineral is somewhat more soluble in acetic acid than Rhodonite, and some allowance should, therefore be made for its possible occurrence.

The foregoing method, owing to slight variations in solubility, may not be accepted as an exact analytical process, but it undoubtedly gives, within close limits, the red oxide of zinc in the sample treated, provided that proper care be taken in the analysis that the ore is not too finely pulverized, and that the treatment with acid is stopped at the point where the last trace of red disappears.

Of course, if this latter be continued beyond this point, or the ore be too fine, more silicates will be dissolved than is absolutely necessary, and the error in calculating will be increased, the results being proportionally incorrect.

DISCUSSION.

Mr. A. H. ELLIOTT enquired concerning the condition in which the copper probably existed.

Mr. N. H. DARTON stated his observation of the occurrence of silicate of copper at Franklin ; and that Dr. Hayes had established by microscopic examination that the color of red oxide of zinc was due entirely to disseminated scales of specular oxide of iron.

Mr. JULIEN remarked on the importance of the discovery of the complete solubility of the red oxide of zinc in acetic acid. The purity of the minerals used in the analyses might have been ensured by previous microscopic examination, all but the Franklinite being translucent in thin section. The variation in the recorded analyses of Willemite, etc., may be largely due to the absence of this precaution. The proportion of the minerals present in the ore might have been ascertained in the fine powder, by microscopic examination. It was a question whether both the alumina and oxide of copper may not have existed in replacement of oxides of iron and zinc. Dependence upon the inexactly defined ratio of solubilities seemed of doubtful value for the determination of the proportion of Willemite and Rhodonite, the quantities of these minerals in the powder under treatment being unequal.

Dr. RICKETTS replied that the investigations in which he had been engaged were entirely of a practical nature, in which an accuracy within one-fourth to one-half per cent. was aimed at, and for this the use of a powerful magnifying glass was sufficient. The determination of the condition of the alumina and copper was not essential for his purpose; both probably existed as silicates. The method founded on the solubilities of certain minerals had been found practically useful, closely agreeing with the general run of analyses. The pure zincite was considered the dark red mineral, colored by oxides of manganese and iron, and its average amount in the ores of Franklin had been determined and admitted as about six per cent.

The CHAIRMAN remarked on the intricacy of the problem, which had been the subject of this investigation, and on the interesting and suggestive solution which had been presented: the recognition of the proportion of so large a number of minerals as occur in this ore being extraordinarily accurate.

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November 20, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was filled to overflowing.

The following letter from Prof. J. K. REES, Director of the Observatory of Columbia College was read:

(Abstract.)

"I beg leave to call the attention of those members of the Academy possessing telescopes to the grand sunspot on the western portion of the sun. Many of them have seen notices of this spot in the daily papers. It deserves especial study in connection with the late displays of auroras and the great electric storm, also as throwing some light on the connection of comets and sunspots. This spot I have seen at noon, and at four o'clock without a telescope, by protecting the eye with colored glass. I saw it once without any protection to the eye, by looking through a narrow slit formed by my fingers.

The great spot is really made up of several mutually encroaching spots. Three nuclei are very well defined, and out into the darkest one protrudes a penumbral finger.

The disturbed region about this spot is about 80,000 miles square, or covering 6,400,000,000 square miles.

There are four other spots on the sun, three near the center of the sun of quite small size, and a fourth near the eastern limb, consisting really of a group of three conjoined."

The PRESIDENT referred to the death this morning, from acute disease, of a resident member of the Academy, Dr. HENRY W. DRAPER, at the age of 45—a great loss to science—and to his distinguished researches and labors in celestial physics.

The lecture of the evening was delivered by Rev. HORACE C. HOVEY, of Fair Haven, Conn., on the subject of—

## SUBTERRANEAN SCENERY.

(Abstract.)

An impression prevails that having seen one cave you have seen all caves. As well might you say that, having seen one hill you have seen all hills, or that, having seen one cataract,you have seen all cataracts. There is variety in the subterranean world, almost as great and striking as that encountered in the surface-region men are more familiar with. Just as there are prairies and table-lands without the semblance of a hill, so there are broad areas of non-cavernous rocks; and indeed only a limited portion of the globe is favorable to the formation of large cavities beneath its crust. The causes producing those that exist are as unlike and distinct as those carving the contour of the mountains.

Volcanic agencies are conspicuous in undermining the earth. Examples of flaming caves, like those in the mountains of Cumana, are due to the fires of still active volcanoes. Caves of great size and beauty are sometimes caused in beds of lava by the over-lapping of the fiery torrent, or by the sinking away of a portion of the fluid mass from the cooling crust—in either case leaving walls lined with blister-holes and lava-froth. Iceland claims the finest of known lava caves, adorned with superb black icicles of obsidian, rivaling in beauty the rarest zeolites.

Marine caves differ materially from those formed by volcanic causes. They are found wherever the swell and lash of the billows have excavated rocks too hard to be wholly displaced by their action. Long galleries join each other in bold and grotesque arches, whose walls are polished by the waves and painted by the sea-water. At low tide it is often as if one were walking at the bottom of a deep sea, and examining objects ordinarily brought to view only by dredging. Here and there one encounters deep pools where fishes swim; while in shallower waters are star-fishes, sea-urchins, and sea-anemones, under a vaulted roof decked by a living tapestry.

A celebrated example of marine caves is the Grotto Azuro, in the

Island of Capri, where the walls, the stalactites and every object is tinted blue by the rays reflected from the brilliant skies of Italy.

Fingal's Cave, and others in the basaltic district around the Island of Staffa, may probably be ascribed to a combination of causes, of which oceanic violence was but one. The broken ends of columns, above which rise lofty ranges of those that are entire, the plash of the waves, the play of colors in the soft twilight that fills the cave, and the tall gothic archway with its archæological suggestions, have been repeatedly described.

Probably the most exquisite grottoes in the world are the ice-caves occasionally formed in the heart of glaciers, and also, in severe winters, under great cataracts, such as Niagara Falls.

Beauty of a far different sort characterizes some of the caves in tropical regions ; for example, that of Cacahuamilpa in Mexico, and the cave of the Guacharo, in South America. You enter the abyss through a luxuriant grove, and find the vegetation continuing far under ground. Pale plants lift their blanched stalks amid sparry growths, while the oil-birds flit through the mazes of subterranean shrubs and vines.

Some of the most noted caverns are hardly worth describing so far as their scenery is concerned ; for the reason that their fame is due to the quantities of old bones that encumber the floor and lie buried in the dripstone. Of these the cave of Gailenreuth, whence were exhumed the remains of 800 gigantic bears, may serve as a specimen.

Contrasted with bone caves is the elaborate temple-cave of Elaphanta, whose chambers of imagery are guarded by colossal figures. The views exhibited of this cavern were taken a few months ago for the Rev. Joseph Cook, by whose permission lantern-slides have been prepared for this occasion.

As has often been remarked, marine caves are usually of little depth. "Along the whole Atlantic coast", observes Prof. N. S. Shaler, "from Nova Scotia to Mexico, I do not know of a single cavern deep enough to give darkness, and above the present level of the sea. The existence of deep caverns is a sign that the region has long been above the sea."

Hence, he who would explore those vast labyrinths, where one may wander on for miles, must forsake the sea-board for the interior.

One reason for this is purely lithological. The rocks along the Atlantic sea-coast are usually quite heterogeneous, and are split by fissures and crossed by veins, so that a cave could not extend very far into them, without destroying itself. This, indeed, is sometimes done in regions remote from the sea. An instance may be seen at Madison, Indiana, where thin strata of the Lower Silurian are overlaid by thick strata of the Upper. Grottoes are here washed out by the removal of the softer material, leaving the harder ledges above. After a while the weight of the over-hanging mass causes it to fall. Thus valleys are made with precipitous sides and encumbered by rocky debris. Thus also natural bridges are left, like that famous one in Rockbridge County, Virginia, which is but a remnant of the roof that once over-arched the valley.

The homogeneity of the limestones of the Ohio Valley is extremely favorable for the formation of extensive caverns. It is estimated that there are 8000 square miles of cavernous limestone in Kentucky alone. I remember seeing, in a marble quarry in that region, a block without a flaw, 150 feet long by 30 feet square, cut simply to show what could be done.

The thickness of the sub-carboniferous limestone, from which Mammoth and Wyandot Caves are excavated, varies from 100 to 1,oco feet. This makes possible the formation of long, winding avenues, with here and there extraordinary enlargements, spacious halls, deep pits and lofty domes, cutting through all galleries from the surface down to the drainage level.

The Virginia caves, on the other hand, of which Luray Cave is the noblest specimen, are examples of excavations from rock tilted and fractured by upheavals, the resulting seams having often been afterwards filled with crystalline material. Hence, instead of well defined arcades, and symmetrical halls and domes, there are extremely irregular rooms, adorned with such a profusion of stalactitic ornamentation, that in Luray Cavern, there seems to be hardly a square yard left bare showing the naked rock!

Subterranean scenery is also effected by various mineralogical modifications. The sharp, glassy needles of obsidian, in the lava cave of Surtsheller, differ greatly from the snowy embellishments found in the Grotto of Antiparos, carved from statuary marble. And again, the majestic columns of basalt, that guard Fingal's Cave, strike the eye differently from the frowning arches of the granite caves of Norway or of Maine.

Certain metallic ores may stain the cavern walls red, yellow, blue or black. And when this incrustation is broken through by the efflorescence of the shining white crystals of the sulphate of lime, of magnesia, or of soda, remarkable effects are produced.

Gigantic silhouettes seem to be cut from the ceiling of creamy limestone; grotesque forms start out from the darkness; grim spectres seem to wave their shadowy arms. These illusions are purely mineralogical. A strangely beautiful example of such transformations may be seen in the so-called Star Chamber of Mammoth Cave; where the gray walls support a lofty ceiling coated with the black oxide of manganese, which is studded with thousands of white spots caused by the efflorescence of the sulphate of magnesia.

Cleveland's Cabinet, in the same cave, is a very treasure house of alabaster brilliants. Imagine symmetrical arches of fifty feet span, where the fancy is at once enlivened and bewildered by a mimicry of every flower that grows. Similar crystalline conservatories are to be seen in other parts of Mammoth Cave, and also in Wyandot and other Western caves.

Earthquakes have had comparatively little to do with subterranean scenery, though generally credited with having wrought many changes. Among possible effects of earthquake shocks one of the most remarkable is the dislodgment of huge masses of dripstone in Luray cavern; upon which new formations have since grown, whose brilliant white contrasts vividly with the rusty red or rich bronze of the more ancient deposit. Examples of this fresh formation are Titania's Vail, the Empress Column, and Brand's Cascade. The Fallen Column, twenty-one feet long and twelve feet thick, has been regarded as cast down by an earthquake shock. It was evidently wrenched away at some remote period from its point of attachment above, and fell swaying to and fro.

Most of the variations in subterranean scenery, usually ascribed to earthquakes, are really due to the chemical and mechanical action of water. Acidulated water cuts into the limestone, searching out the lines of weakness, until channels are made leading down to some subterranean outlet. The agency of running streams carries on the work begun by water freighted with carbonic acid. Sand and gravel borne in with these streams make of them powerful cutting-engines.

Thus may be explained the huge pits and domes of Mammoth Cave; and in the same way the deep chasm known as Pluto's Ravine, in Luray Cave. To the same cause I attribute the dislodgment of the Fallen Column and other great stalactites in the latter cavern. My theory is that Luray Cave was first hollowed out by acidulated water; then it was partly filled by dripstone; then the outlet was stopped and the entire cavern flooded with strongly acidulated water, whereby the first set of stalactites was partly destroyed; and when the outlet was re-opened, or a new one found, then came the catastrophe that hurled mighty masses down and left them as proofs that water may be as energetic as fire. And finally the fresh set of stalactites was created, out of the already refined materials, by the beauty of which the eyes of the civilized world have been attracted.

The scenery of certain caves is modified by the presence of considerable bodies of running or standing water. Echo River, in Mammoth Cave, is about three-quarters of a mile long, from 20 to 200 feet wide, and from 10 to 40 feet deep. The "Dead Sea," "Lake Lethe" and the "River Styx," are smaller bodies in the same cave. These all have secret communication with the adjacent Green River, and are liable to sudden floods, sometimes rising 60 feet, and one result is the deposit of immense mud-banks. (It is aside from the purpose of this paper to describe the living objects found in these waters, or the remarkable acoustic properties of Echo River passage-way.)

Agreeably contrasted with these dismal lakes are the exquisitely clear pools occupying the crystal basins of Luray Cavern. These build their own walls, by the process of crystallization, till some of them are more than five feet high and enclose lakes fifty feet across. There are more than a hundred of them in this cave, as clear as ether, and holding their unruffled surface as a mirror to reflect the countless stalactites hanging above them. By as careful an estimate as could be conveniently made, the Imperial Spring is adorned by 48,000 such stalactites! The "Castles on the Rhine" are but the incrusted stalagmites remaining where one of these pools once lay, but whose waters have long ago been drained.

Stalactites and stalagmites are referred to in every description of cavern scenery, and their causes are well understood. The carbonate of lime left by the water, on evaporation, makes a ring on the ceiling, followed by ring after ring, till a cylinder grows that finally is thickened into an elongated cone; and this is a stalactite. The deposit on the floor is a thin film, which by repeated coating grows into the blunt stalagmite. The two are often united into a column. The Pillar of the Constitution, in Wyandot Cave, is one of the largest known stalacto-stalagmitic columns, being 40 feet high and 25 feet thick, and homogeneous throughout. The material is Oriental alabaster (to be distinguished from the softer gypsum, being a very hard carbonate of lime), and this stately pillar was once resorted to by the Indians as a quarry for materials from which to make amulets and images. Some of the stalactites in Luray Cavern are 50 feet long; and the Double Column, composed of two consolidated stalagmites, rises to the height of perhaps sixty feet above the floor. Stalactites sometimes are blade-like and highly sonorous. Again they hang like scarfs or shawls, pure white or striated: many fine examples of which are found in Luray. Stalactitic distortion is quite a study in itself. Among assignable causes are the growth of fungi, the influence of atmospheric currents, and the outgrowth of lateral crystals.

The lantern views of Subterranean Scenery represent Fingal's Cave, the Cavern-Temple of Elephanta, the Ice Caves of Niagara, the Bone Cave of Gailenreuth, and several other miscellaneous selections; but the great majority of them were taken from scenes in Wyandot, Mammoth and Luray caverns, and were made expressly for this exhibition.

The efforts of Mr. Charles Waldach to take photographs by aid of magnesium light resulted in a number of interesting pictures of localities in Mammoth Cave. His magnesium alone cost him $500. But for practical use these photographs were not found so desirable as a series of sketches, made in black and white, under my supervision, by Mr. J. Barton Smith. This artist also made the sketches from Wyandot Cave. These were prepared for the lantern by Mr. J. M. Blake, of New Haven. The advantages for taking views in Luray Cavern were superior, since it was lighted by a series of electric lamps placed at the most interesting localities. The thirty-six lantern views now shown to illustrate Luray Cave, were taken and prepared by Mr. C. H. James, of Philadelphia. Special mention should be made of Col. Francis Klett, manager of Mammoth Cave, and Mr. R. R. Corson, manager of Luray Cavern, by whom every needed facility was cheerfully given for obtaining the facts of a scientific nature sought, and also the pictorial representations exhibited of subterranean scenery.

At the close of the lecture a resolution was passed, conveying thanks to Mr. Hovey, for his very interesting and instructive lecture.

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November 27, 1882.

The President, Dr. J. S. Newberry, in the Chair.

The audience filled the large hall.

A lecture was delivered by Dr. J. S. Phene, of London, England, illustrated with a large number of diagram views, and entitled:

## RECENT ARCHÆOLOGICAL DISCOVERIES RELATING TO THE MOUND-BUILDERS.

At the close of the lecture the President remarked that the geological evidence rendered it by no means impossible that the theory of the lecturer might be well founded, of the contemporaneous existence of the mound-building race with the ancient horse, whose remains, exactly like those of the modern horse, have been found in deposits of very recent age in Oregon, etc., and with animals of the elephant family, whose remains, (both the elephant and mastodon) occur abundantly in many quaternary deposits. As to the camel, there is less evidence, but no impossibility of its existence at the same time.

A resolution of thanks to Dr. PHENE, for his interesting lecture, was passed, and, on motion, Dr. PHENE was nominated and unanimously elected Corresponding Member of the N. Y. ACADEMY OF SCIENCES.

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December 4, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-two persons present.

The following persons were elected:

Resident Member, ISIDORE OSORIO.

Corresponding Member, Dr. HENRY R. ROGERS, of Dunkirk, N. Y.

Honorary Member, Sir HENRY CRESWICKE RAWLINSON, LL.D.

The resignation of the following members, on account of removal from the city, etc., were accepted:

| | |
|---|---|
| I. DEVLIN, | C. HEITZMAN, |
| R. DUNLAP, | A. A. REDFIELD, |
| Q. A. GILLMORE, | I. H. STEBBINS, JR., |

W. H. VAN ARSDALE.

Mr. G. F. KUNZ exhibited a specimen of topaz from the new locality at Stoneham, Me., as the finest ever found in America; also a number of smaller crystals of the same, all full of fluid cavities, and some showing a curious iridescence when looked upon from one direction, *i.e.*, from the O plane; also crystals of monazite from the same locality, there associated with albite, columbite, triphyllite, etc.; also a fine crystal of chrysoberyl from Brazil, a crystal of andalusite, and a catseye.

Prof. EGLESTON pronounced the topaz crystal as certainly the largest ever found on the continent, its iridescence being due to fine lines produced by the easy cleavage parallel to the base. The crystals of chrysoberyl were now very uncommon, though such were not rare 25 to 30 years ago. The crystal of andalusite presented faces and distortion which were novel and well worth description in detail.

A paper was then read by Mr. WILLIAM L. LAY,

## ON THE DEPOSITS OF EARTH-WAX (OZOKERITE) IN EUROPE AND AMERICA.

(Abstract).

There exists a large mining and manufacturing industry in Austria, that of ozokerite, or earth-wax—which has nothing like it in any other part of the known world, an industry that supplies Europe with a part of its beeswax, without the aid of the bees. It may not be generally known that the mining of petroleum was a profitable industry in Austria long before it was in this country. In 1852, a druggist near Tarnow distilled the oil and had an exhibit of it in the first World's Fair in London. In America the first borings were made in 1859. Indeed, the use of petroleum as an illuminator was common at a very early age in the world's history. In Persia at Baku, in India on the Irawada, also in the Crimea, and on the river Kuban in Russia, petroleum has been used in lamps for thousands of years. At Baku the fire worshippers have a never-ceasing flame, which has burned from time immemorial. The mines of ozokerite are located in Austrian Poland, now known as Galicia. Near the city of Drohabich, on the railway line running from Cracow to Lemberg, is a town of six thousand inhabitants, called Borislau, which is entirely supported by the ozokerite industry. It lies at the foot of the Carpathian Mountains. About the year 1862, a shaft was sunk for petroleum at that place. After descending about one hundred and eighty feet, the miners found all the cracks in the clay or rock filled with a brown substance, resembling beeswax. At first, the layers were not thicker than writing paper ; but they grew thicker gradually below, until at a depth of three hundred feet they attained a thickness of three or four inches. Upon examination, it was found that a yellow wax could be made of a portion of this substance, and at once a substitute for wax was manufactured.

The discovery caused an excitement like the oil fever of 1865, in America. A large number of leases were made. When I saw the wells of Pennsylvania, in 1879, there were more than two thousand. The owner of the land received one-fourth of the product and the miners three-fourths. In the petroleum region, the leases at first were whole farms, then they were reduced to 20, then 10, then five, and at last to one acre, which is a square of 209 feet.

But in the ozokerite region of Poland, where everything is done on a small scale, when compared with like enterprises in this country, the leases were on tracts thirty-two feet square. These were so small that the surface was not large enough to contain the earth that had to be raised to sink the shaft ; consequently the earth had to be transported to a distance, and, when I saw it, there was a mound sixty or seventy feet high. Its weight had become so great that it caused a sinking of the earth, and endangered the shafts to such an extent that the Government ordered its removal to a distance and its deposit on ground that was not undermined. The shafts are four feet square, and the sides are supported by timbers six inches through, which leaves a shaft three feet square. The miner digs the well or shaft just as we dig our water wells, and the dirt and rock is hoisted up in a bucket by a rope and windlass. But one man can work in the shaft at a time. For many years no water was found ; but, as there is a deposit of petroleum under the ozokerite, at a depth of six hundred feet from the surface, the miners were troubled with gas. This is got rid of by blowing a current of fresh air from a rotary fan, through a pipe extending down the shaft as fast as the curbing of timber is put in place. The ozokerite is imbedded in a very stiff blue clay for a depth of several hundred feet; bolow, it is interlaid with rock. [Specimens of crude and manufactured ozokerite were on exhibition, through the kindness of Dr. J. S. Newberry].

That part of the earth's surface has more miners' shafts to the acre than any other part of the globe. As wages are very low in Poland, averaging not more than forty cents a day for men and ten cents for children, a very small quantity of ozokerite pays for the working. If thirty or forty pounds a day is obtained, it remunerates the two men and one or two children required to work each lease. When the bucket, containing the earth, rock and wax, is dumped in the little shed covering the shaft, it is picked over by the children, who detach the wax from the clay or rock with knives. The miners use galvanized wire ropes and wooden buckets. When preparing to descend, they invariably cross themselves and utter a short prayer. The business is not free from danger, carelessness on the part of the boy supplying the fresh air, or the caving in of the unsupported roof, causing a large number of deaths. One of the Government inspectors of the mines informed me that in one week there had been eight deaths from accidents.

The ozokerite is taken to a crude furnace, and put into a common cast-iron kettle, and melted. This allows the dirt to sink to the bottom, and the ozokerite, freed from all other solids, is skimmed off with a ladle, poured into conical moulds, and allowed to cool, in which form it is sold to the refiners, for about six cents per pound. The quantity produced is uncertain, as the miners take care to understate it, for the reason that the Government lays a tax upon all incomes, and the landowner demands his one-fourth of the quantity mined. The best authority is Leo Strippelman, who states the quantity produced in fifteen years at from 375,000,000 to 400,000,000 pounds, worth twenty-four millions of dollars. As the owners of the land get one-fourth of the sum, they received six millions. This is at the rate of four hundred thousand a year, a rather valuable crop from some two hundred acres of land.

The miners do not support the earth by timber or pillars, as they should; the result is that the whole plot of about two hundred acres is gradually sinking, and this will eventually ruin the industry in that part of the deposit. In another part of the same field, a French company has purchased forty acres, and it is mining the whole tract and hoisting through one shaft by steam power. In that shaft they have sunk to a depth of six hundred feet, and are troubled with water and petroleum. These they pump out very much the same way as in coal and other mines, worked in a scientific manner. The thickest layer of ozokerite found is about eighteen inches, and this layer or pocket was a great curiosity. When first removed at the bottom of the shaft, it was found to be so soft that it was shovelled out like putty. During the night it oozed into the space that had been emptied the day before; this continued for weeks, or until the pressure of the gas had become too weak to force it out.

I have been occupied in the petroleum region of Pennsylvania since 1860, have seen all the wonderful development of the oil wells, and was very much interested in contrasting the Austrian ozokerite and petroleum industry with the American. It is a good illustration of the difference between the lower class of Poles and Jews and the Yankee. Borislau, after twenty years work, was unimproved, dirty, squalid and brutal. It contained one school house, but no church nor printing office. None of its streets were paved, and, in the main road through the town, the mud came up to the hubs of the wagon wheels for over a mile of its length. In places, plank had to be set up on edge to keep the mud out of the houses, which were lower than the road. It contained numerous shops, where potato whiskey was sold to men, women and children. It depends on a dirty, muddy creek for its supply of water. Its houses were generally one-story, built of logs and mud.

On the other hand, Oil City, a town of the same age and size, contained eight school houses (one a high school building), twelve churches, and two printing offices. It has paved streets, which, in 1863, were as deep with mud as that in Borislau, in 1879. It has no whiskey shops where women and children can drink. Many of its houses are of brick, two, three, four and five-stories high. Its water-works cost one hundred and fifty thousand dollars. All this has been done since 1860, when it did not contain forty houses.

I saw in the market-place of Borislau women, standing ankle deep in the mud, selling vegetables. One woman really had to build a platform of straw, on which to place a bushel of potatoes ; if the straw foundation had not been there, the potatoes would have sunk out of sight. Borislau is three miles from Drohobich, a city of thirty thousand inhabitants ; between the two places, in wet weather, the road was impassable. For a third of the way, it was in the bed of the creek ; and I had to wait a day for the water to fall so as to navigate it in a wagon. On enquiring why they did not improve the road, I found the same difficulty as the Arkansas settler encountered with his leaky roof ; when it rained he could not repair it, and when it was dry it did not need repair : so with the road to Borislau.

Ozokerite (from the Greek words, "Ozein," to smell and "Keros," wax), is found in Turkistan, East of the Caspian Sea—in the Caucasian Mountains, in Russia—in the Carpathian Mountains, in Austria—in the Appenines, in Italy—in Texas, California, and in the Wasatch Mountains, in the United States. Commercially, it is not worked anywhere but in Austria ; although, I believe, we have in Utah a larger deposit than in any other place. I made two journeys to examine the deposits in the Wasatch Mountains. For a distance of forty miles, it crops out in many places, and on the Minnie Maud, a stream emptying into the Colorado, I found a strata of sand-rock, from ten to twelve feet thick, filled with ozokerite.

No systematic effort has been made to ascertain the quantity of ozokerite in Utah. I saw a drift of some fourteen feet, at one place, and a shaft twenty-three feet deep, at another. In this shaft, the vein was about ten inches wide ; and it could be traced along the slope of the hill, for several hundred feet. The largest vein of pure ozokerite is seen on Soldiers' fork of Spanish Cañon, which enters Salt Lake Valley near the town of Provo. This vein is very much like the ozokerite of Austria, and contains between thirty and forty per cent. of white ceresin (which resembles bleached beeswax), about thirty per cent. of yellow ceresin (which resembles yellow wax), and twenty per cent. of black petroleum ; the residue is dirt. Dr. J. S. Newberry, of Columbia College, and Prof. S. B. Newberry, of Cornell University, made examinations of the ozokerite found in Utah ; those who are interested in the subject will find the papers published in the *Engineering and Mining Journal* for the year 1879.

A deposit of white ozokerite occurs on the top of the Apennine Mountains, in Italy, of which a specimen is here exhibited. An interesting story is told of its discovery. A church at Modena was robbed; among other articles taken was a quantity of wax candles. A short time afterwards, a woman brought to a druggist a quantity of wax and offered it for sale. The druggist bought it and afterwards suspected it consisted of the stolen candles melted down. Soon afterward she brought another lot. He had her arrested. When questioned by the magistrate, she said she found the wax in the clay on her farm, about twenty miles from the city. This story confirmed him in the belief that she had stolen the candles, or was the receiver of the stolen goods; for such a thing as a deposit of wax in the soil was unheard of. She was therefore remanded to jail. On three several days, she was brought before the Court, and, when questioned, told the same story. She was a member of the church, and requested the priest to be sent for. He came, and, after an interview between them, he said it was easy to disprove her story, if it was a lie, by sending her home, in company with an officer, to investigate. The Court sent the priest, who was the only one who believed her. On coming to her house, she took her pick and shovel, and going to the place at the top of the hill, she dug out of the clay a quantity of white ozokerite, proved her case, and was at once set at liberty. She performed the same service for me, and I saw her dig the specimen and heard her tell the story as I have told it to you. The hill was composed of loose clay and stones. It appeared as if it had been forced up by gas or some power from below the surface. The quantity that could be gathered, by one person, laboring constantly for a week, was only twenty-five or thirty pounds. An attempt had been made to sink a shaft; but, at a depth of fourteen feet, the pressure of the clay was sufficient to break the boards that held up the sides. The earth caved in and the shaft was abandoned.

It is not necessary here to describe the various processes of manufacture, it will be sufficient to enumerate some of the forms of ozokerite, and the uses to which it is put. At Borislau, there are several refineries, where candles, tapers and lubricating oils are made. In Vienna, there are five factories; in one of these, they make white wax, wax candles, matches, yellow beeswax, black heel-ball, colored tapers, and crayon pencils. In Europe, large quantities of the yellow wax are used to wax the floors of the houses, many of the finer ones being waxed every day. It is a curious fact that the Catholic Church does not allow the use of paraffine, sperm or stearine candles; at the same time nearly all the candles used in the churches in Europe are made from ozokerite, which is a natural paraffine, made from petroleum in nature's laboratory. In the United States, the only uses made of ozokerite, so far as I know, are chewing gum and the adulteration of beeswax. In this the Yankee gives another illustration of the ruling passion strong in money-making, which gives us wooden nutmegs, wooden hams, shoddy-cloth, glucose-candy, chicory-coffee, oleomargarine-butter, mineral sperm-oil made from petroleum, and beeswax made without bees.

After this paper was written, the following translation from a pamphlet, published by the First Hungarian Galician Railway Company, in 1879, came to my notice. The writer's name is not published.

"Mineral wax, in the condition in which it is taken from the shafts, is not well adapted for exportation, since it occurs with much earthy matter; and, at any rate, an expensive packing in sacks would be necessary. It is therefore first freed from all foreign substances by melting, and cooled in conical cakes of about 25 kilos. weight, and these cakes are exported. There are now, in Borislau, 25 melting works, which, in 1877, with one steam and 60 fire kettles, produced 95,000 metric centners (9,500,000 lbs.).

The melted earth-wax is sent from Borislau to almost all European countries, to be farther refined. Outside of Austro-Hungary, we may specially mention Germany, England, Italy, France, Belgium and Russia, as large purchasers of this article of commerce.

*Products and their Applications.*

The products of mineral wax are:

(*a.*) *Ceresine,* also called ozocerotine or refined ozokerite, a product which possesses a striking resemblance to ordinarily refined beeswax. It replaces this in almost all its uses, and, by its cheapness, is employed for many purposes for which beeswax is too dear. It is much used for wax candles, for waxing floors and for dressing linen and colored papers. Wax-crayons must be mentioned among these products. The house of Offenheim & Ziffer, in Elbeteinitz, makes them of many colors. These crayons are especially adapted to marking wood, stone and iron; also, for marking linen and paper, as well as for writing and drawing. The writings and drawings made with these crayons, can be effaced neither by water, by acids, nor by rubbing.

Concerning the technical process for the production of ceresine, it should be said that, when the industry was new (the production of ceresine has been known only about eight years, since 1874), it was controlled by patents, which are kept secret. This much is known, that the color and odor are removed by fuming sulphuric acid.

From mineral wax of good quality about 70 per cent. of white ceresine is obtained. The yellow ceresine is tinted by the addition of coloring matter (annatto).

(*b.*) *Paraffine,* a firm, white, translucent substance, without odor. It is used, chiefly, in the manufacture of candles, and also as a protection against the action of acids, and to make casks and other wooden vessels water-tight, for coating corks,etc.,for air-tight wrappings,and,finally, for the preparation of tracing paper. There are several methods of obtaining paraffine from ozokerite (see the Encyclopedic Handbook of Chemistry, by Benno Karl and F. Strohmann, Vol. IV., Brunswick, 1877).

The details of the technical process consist, in every case, in the distillation of the crude material, pressure of the distillate by hydraulic presses, melting, and treating by sulphuric acid.

In the manufacture of paraffine from ozokerite, there are produced from 2 to 8 per cent. of benzine, from 15 to 20 per cent. of naphtha, 36 to 50 per cent. of paraffine, 15 to 20 per cent. of heavy oil for lubricating, and 10 to 20 per cent. of coke, as a residue.

(*c.*) *Mineral oils,* which are obtained at the same time with paraffine, and are the same as those produced from crude petroleum, described above. The process consists, as in the natural rock oils, besides the distillation, in the treatment of the incidental products with acids and alkalies.

Of the products of ozokerite, manufactured in Galicia, the greater part goes to Russia, Roumania, Turkey, Italy and Upper Hungary. The common paraffine candles made in Galicia—which are of various sizes, from 28 to 160 per kilo—are used by the Jews in all Galicia, Bukowuina, Roumania, Upper Hungary and Southern Russia, and form an important article of commerce. Ceresine is exported to all the parts of the world. Of late a considerable quantity is said to have been sent to the East Indies, where it is used in the printing of cotton."

DISCUSSION.

Mr. KUNZ enquired whether any rocksalt occurred in Galicia; as a specimen in his possession was lined with ozokerite.

Mr. LAY replied that no salt was found in that region.

The PRESIDENT stated that ozokerite was undoubtedly a product of petroleum. Little was known by the public concerning its use and value. He exhibited specimens of natural brown ozokerite, of yellow ozokerite, sold as beeswax, and of a white purified form, which had been treated by sulphuric acid. Specimens from Utah had already been shown before the Academy. There was no mystery as to its genesis in either region, as it had been shown to be the result of inspissation of a thick and viscid variety of petroleum. The term "petroleum" includes a great variety of substances, from a limpid liquid, too light to burn, to one that is thick and tarry. These differ widely also in chemical composition: some yielding much asphalt by distillation, resembling a solution of asphalt in turpentine; some containing so much paraffine, that a considerable quantity can be strained out in cold weather. The asphalt in its natural form is a solid rock, to which the term "gum beds" has been applied in Canada. These differences in constitution have originated in the differences in the bituminous shales from which the petroleum, ozokerite, etc., have been derived. In Canada, as excavations are sunk through the asphalt, this becomes softer and softer, and finally passes into petroleum. This is also the case in Utah. Mr. Lay has become interested in the material, has visited all the localities of its occurrence, and is best acquainted with them.

A paper was then read by Dr. John S. Newberry, on

THE PHYSICAL CONDITIONS UNDER WHICH COAL WAS FORMED.

[Published in School of Mines Quarterly, 1883].

Discussion.

Dr. B. N. Martin enquired whether any graduation has been recognized in the types of plants, in passing through the Coal-measures from below upwards.

Dr. Newberry replied that differences existed, but the types were largely interlocked by insensible changes. Some floras prevail throughout the series: while, on the other hand, other types, *e.g.*, the sigillaria, are abundant below, but in passing upward, decrease and and disappear.

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December 11, 1882.

Section of Chemistry.

The President, Dr. J. S. Newberry, in the Chair.

Fifty-six persons present.

A crystallized specimen of native gold, of remarkable beauty, from El Dorado, Cal., belonging to Mr. Terry, was exhibited by the President. Prof. J. K. REES, Director of the Columbia College Observatory, presented a report (published in the Annals) upon

### OBSERVATIONS OF THE TRANSIT OF VENUS.

(Abstract).

The station occupied was the roof of the unfinished observatory of the college. The telescope was placed in the southwest corner of the roof. This roof is extraordinarily strong and solid, the beams being of iron, twelve inches in depth. Solid brick arches spring from beam to beam. The height of the roof from the street is about one hundred and ten feet. The walls supporting the roof are four feet thick. An unobstructed view was had of the whole transit. The position of the instrument was only a few feet from the old observatory, so that we may take the longitude and latitude of our instrument from the American ephemeris :—

Latitude, + 40° 45′ 23″ .1.

Longitude :—From Washington,—0h. 12m. 18.40s.

Longitude :—From Greenwich, + 4h, 55m. 53.69s.

"The timepieces used were a mean time chronometer, No. 1853, made by Parkinson & Frodsham, of London, England, and a sidereal chronometer, No. 1564, made by Negus & Co., of New York City. The instrument used in the observations was an equatorially mounted refractor by Alvan Clark & Sons. Aperture, 5.09 inches; focal length of object glass, 74.3 inches. The magnifying powers used were 48 on the I. contact, 165 on the II. and III. contacts, 95 on the IV. contact. The telescope was moved by clockwork, supplied with a Bond spring governor. In making chronometer comparisons, the sidereal chronometer was left at the college, and the mean time chronometer was carried to the instruments on which signals were to be received.

Professor Rees had prepared, but omitted to give, an elaborate system of chronometer comparisons with the Western Union time signals and the Washington time signals. The object of the comparisons was to obtain the exact error of the chronometer used at the time of the observations.

ADOPTED CONTACT TIMES.

| | Mean Time of Columbia College. | | | Mean Time in Washington. | | |
|---|---|---|---|---|---|---|
| | H. | M. | S. | H. | M. | S. |
| I. | *21 | 8 | 50.0 | 20 | 56 | 31.6 |
| II. | 21 | 28 | 45.9 | 21 | 16 | 27.5 |
| III. | 2 | 52 | 13.5 | 2 | 39 | 55.1 |
| IV. | †3 | 11 | 52.1 | 2 | 59 | 33.7 |

* Notch plainly on. Estimated a minute late.
† Poor contact. Cloudy.

The observation of the first contact was interfered with by the clouds. Between the first contact and the second contact the light shining through Venus' atmosphere was a fine sight. I should say that it first appeared to my eye when the planet was a little more than half way on the sun, and disappeared about a minute before the planet reached second contact.

The line of light, marking out the portion of Venus' disk not on the sun, changed its appearance considerably while my attention was fixed upon it. I first saw a faint curved line of light off of the sun, and apparently marking out the part of Venus' disk not on the sun, this curved line being entirely disconnected from the sun. A little later this arc of light was lengthened to a semi-circular thread and touched the edge of the sun, marking out the complete outline of the part of Venus' disk not on the sun. The semi-circular gold thread seemed to be an exact continuation of the dark rim of the planet. Finally this line broadened at the point where it touched the sun's rim, or edge, and the summit of the arch disappeared. The wings of light thus formed were, at their base, not in the exact continuation of the dark outline of the planet. I watched for the repetition of these appearances between the third and fourth contacts, but failed to see anything. The sky between the first and second contacts was much clearer of haze than between the third and fourth contacts.

At second contact I saw no indication of the black drop. The tangency of Venus' and the sun's disks was well seen. During the passage of Venus over the sun's face I observed her disk with magnifying powers of 48, 95, 165 and 345, but saw no indications of an atmosphere. The disk of Venus did not appear to be uniform in blackness, but to be spotted with grayish or whitish matter, reminding one of patches of snow. This was seen under the different magnifying powers used.

When Venus neared the third contact, a very peculiar phenomenon was noticed. The preceding edge of Venus was seen to be darker than the central portion. Later the edge of the planet became of a bluish black color, and this extended around to the following edge. The phenomena connected with this were very distinct. When the planet was near third contact, these appearances were not seen longer. Just before third contact, a faint black drop was observed for a short time. It disappeared very quickly and third contact was finely seen.

The fourth contact was interfered with by the haze and clouds and was probably called too early.

Prof. H. Carrington Bolton of Trinity College, Hartford, Conn., read a paper entitled:

HISTORY OF CHEMICAL NOTATION, PART I., METALLURGIC ASTRONOMY AND ITS SYMBOLS.

(Abstract.)

He defined chemical notation as a method of expressing in symbolic characters and abbreviations the composition and mutual relations of chemical substances, and showed that it has been a marked feature of the science of chemistry in all stages of its history. Symbols occur in Greek alchemical manuscripts of the 10th and 11th centuries, several hundred of which are preserved in the foremost Libraries of Europe. The fact that symbols were in common use at a very early period is indicated by the existence of manuscripts containing keys to these signs, the so called "Lexicons of the sacred art;" these however are unsatisfactory, being almost unintelligible. We are told, for example, that "magnesia is the female antimony of Macedonia," and the expression, "sacred water," is applied to substances as diverse in nature as marble, litharge, asbestos, antimony, and white-of-egg. Among the earliest signs are those which were applied indifferently to the metals and the heavenly bodies and are still used in astronomy.

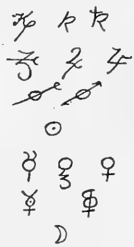
The influence of astrological ideas on alchemy was prodigious, and it is not surprising, if we reflect on the intellectual degradation of the period referred to. Several authors have discussed the mystical associations of the planets and the seven metals, and have sought to discover the origin of their common symbols. Some claim that the signs were first given to the metals and then transferred to the planets: this view was held by those influenced by the vagaries of alchemy. Others derive them from supposed resemblances to symbolic articles associated with the divinities who presided over the corresponding planets. According to the celebrated philologist Scaliger, the signs have the following origin:

♄ the scythe of Time, or Saturn.
♃ the thunderbolt of Jupiter.
♂ the lance and buckler of Mars.
☉ the disk of the Sun.
☾ the crescent of the Moon.
♀ the mirror of Venus.
☿ the caduceus of Mercury.

This symbolic derivation of the signs was very generally adopted by the historians of astronomy, especially by Lalande, Huet and Roger Long.

Salmasius regarded the symbols for the sun and the moon as ideographic, and traced the origin of the remaining five signs to hastily written initial letters of the Greek names of the planets. This is illustrated in the following table :

| METAL. | Name of Planet. | Ancient Name. | Old forms of signs. | Symbols in use. |
|---|---|---|---|---|
| Lead | Saturn | Κρονος | | ♄ |
| Tin | Jupiter | Ζευς | | |
| Iron | Mars | Θοῦρον | | ♂ |
| Gold | Sol | Ηλιος | ☉ | ☉ |
| Copper | Venus | Φωσφόρος | | ♀ |
| Mercury | Mercury | Στίλβων | | ☿ |
| Silver | Luna | Σελήνη | ☽ | ☽ |



Salmasius' theory is ingenious, and has been favorably regarded by Letronne, Delambre and others ; it has, however, weak points. Mars was commonly called πυρόεις or Ἄρης, and the epithet Θοῦρον, "impetuous," is rare. Again, the derivation of ☿ from Στίλβων seems forced, but Beckmann defends it in this wise : the old form for Σ was indisputably C, and this turned on its back and written above a τ resembles the character for mercury. The speaker stated that, in confirmation of this, he had found a sign for mercury thus ☿ . Early Greek MSS. abound in ligatures and abbreviations, which are not farther removed from their parent letters, than this sign from the initials of its ancient name.

The paper was illustrated by several diagrams giving early forms of the symbols used to designate planets and metals. The subject of alchemical symbolism in general was reserved for a future paper.

DISCUSSION.

Prof. W. GOOLD LEVISON remarked that, however obscure may be the origin of these long neglected symbols, Prof. BOLTON'S effort to trace it may be encouraged by an interest of more dignity than mere curiosity. It is no less appropriate to designate apparatuses by such symbols than the elements themselves, although in the former case they can never serve so important a purpose. For many years he has used such symbols as a short-hand method of recording the results of quantitative work and has suggested the use of them to his students. When, for instance, the word "crucible" must be repeatedly entered upon a record, it is very convenient to indicate it by a cross (×) (the object from which it is derived), or by a cross within a triangle, a cross within a circle, or, if preferred, by the abbreviation "×ble" all of which were used by the alchemists. Again the letter V may conveniently be used as an abbreviation of the word precipitate, and the same symbol, inverted thus Λ, may be applied to indicate a gas.

As an illustration of the use of symbols in this way take the following common form of record of an analytical operation :

| | |
|---|---|
| Weight of the crucible and cover containing the precipitate and ash............ | 26.4573 |
| " " crucible and cover alone... .. . | 26.1729 |
| Weight of the precipitate and ash............ | .2844 |
| " " ash..... ..................... | .0010 |
| " " precipitate=$Al_2O_3$.............. | .2834 |

and note how much more conveniently it may be represented by symbols as follows :

| | |
|---|---|
| W, × + c + V + *E........ ............... | 26.4573 |
| W, × + c only............................ | 26.1729 |
| W, V; + *E................................ | .2844 |
| W, *E..................... ............. | .0010 |
| W, V=$Al_2O_3$............................... | .2834 |

The signs he has personally used were adopted with no especial respect to conventionality, but in "Hall's Encyclopœdia," a book published in 1812, he lately met with a table of "Chymical, &c., Characters," which was engraved in 1793, and he found that many of them were identical with those he was using. So he has inserted on the inside cover of his Laboratory note book, a photographic copy of the table which seems quite complete, and such of its symbols as are appropriate he applies to a practical use.*

Chymical &c. Characters.

To Abstract
Acid
— Marine
— Nitrous
— Phosphoric
— Vegetable
— Vitriolic
Volatile Sulphureous
Æther Æ
Air A
— Fixed fA
— Mephitic m
Alcahest or Alcohol of Wine
An Alembic
Alkali S
— Caustic Fixed c
— Volatile c
— Fixed
— Milder Fixed m
— Vol
Amalgam aaa
Antimony
— Flowers of
Aqua Fortis AF
— Regia AR
— Vitae AV
Arsenic
— Regulus of
Ash or Ashes EA E
— Pot or Pearl
Auripigment
Bath B.
— Sand AB BA.
— Vapour VB.
— Water BM MB.
Bismuth B W.
Blood Stone
Bole Armenian AB
Borax
Bottle
Brandy AV
Brass
Calamine Stone LC
To Calcine A
Camphor yr.
Caput Mortuum
To Cement Z
Cerus
Cinnabar
Clay
Copper
Crab
A Crucible
Curcubit
Day
Dige

To Dissolve
To Distill
Dram / Drachma
Drop G gt. gut.
Each A ā āā
Earth
— absorbent
— of Allum A
— Calcareous c
— Fluor or Fusible
— Sealed
— Siliceous or Vitrescible
Essence Ess
Fire
— Circular
— Reverberating AR.
Fluors
Glass XX
Gold
— Filings of
— Leaf
— Potable OP
A Grain gr. o
Gum
Gypsum
Half ss.
Harts Horn CC.
Honey
An Hour
Iron
— Filings
Layer upon Layer SSS.
Lead
Lime C
Litharge
Magnesia M M.
Mercury
— Precipitated
— of Saturn
— Sublimed
Metallic Bodies CM.
— Substances SM MS.
Mix m.
Modius M.
A Month
Nickel N
Night
Nitre
Oil
— Essential E
— Fixed
— Olive
An Ounce
A Part p. p.
Phlegm

Phlogiston
Phosphorus
A Pound P lb p
Precipitate
Prepare PP. pp.
A Pugil P p.
Quick Lime CV
Quicksilver
Quintessence QE
A Receiver
Regulus
— of Antimony Stellated
— Stellated
Retort
Saffron
— of Copper
— of Iron
Salt
— Alkaline
— Ammoniac
— Common
— Gem
— Sea
— Sedative SS
Sand
A Scruple
Seal Hermetically SH.
Steel
— Filings of
Spirit
— of Wine SV
— Proof (See Brandy)
— Rectified
Sublimate / Sublime
Sulphur
— Liver of
— Mineral called Sulphur Vivum
Talc X X.
Tartar
Tin
Tutty
Urine
Verdigrise
— Distilled dd.
Vinegar
— Distilled
Vitriol
Volatile
Water
— Lime
Wax
Wine V.
— Lees
A Year
Zinc

* * The accompanying reproduction is taken from a copy of the work in the Library of Mr. D. B. Brainerd, of Brooklyn, N. Y.

Dr. BOLTON referred to the symbol, still in use by physicians at the head of their inscriptions, as probably an altered form of the symbol of a planet, formerly adopted for the purpose of invocation.

Prof. O. P. HUBBARD stated that the specimens of Col. Gibb's famous Cabinet, Yale College, imported from Europe in 1805, originally in large part brought from Russia, still retained, as late as the year 1836, circular labels marked with these ancient symbols of the metals.

The PRESIDENT stated that the heading of the prescriptions of modern physicians was commonly understood to be an antique **R**, standing for the Latin word, Recipe (Take!) However, this explanation was probably incorrect, the symbol having descended from antiquity.

The subject was further discussed by Mr. HAWKINS and other members.

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December 18, 1882.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-four persons present.

The resignation of Dr. W. I. BAUER, as a Resident Member, was accepted.

A paper was read by Mrs. ERMINNIE A. SMITH, illustrated with early and remarkable manuscripts, dictionaries, etc., entitled:

## LANGUAGE OF THE IROQUOIS INDIANS.

The impossibility of clearly understanding a people or its literature, especially the latter if it be unwritten, without some knowledge of its language or medium of thought, cannot be disputed.

Admitted as they are to be the most remarkable of all our American Indians, and those most intimately connected with our early national history, it is unaccountable that so little has been known of the six Iroquois dialects.

A brief, but as it has since proven most important Mohawk vocabulary, taken down in the 16th century by Jacques Cartier; a small Latin-

Mohawk dictionary by the Jesuit Father Bruyas, and another in French-Onondaga by a priest of the same order of the 17th century, have for some time been in the possession of students. Beyond this, the Mohawk prayer-book by Brant, a few gospels and hymns in several of the dialects, a few numbers of a Seneca periodical, edited by their missionary, Mr. Wright, a spelling-book by the same author, together with numerous very incorrect short vocabularies in each of the dialects, and later, a few interesting pamphlets concerning the Mohawk by Père Cuoq, constitute all the published material heretofore within reach of the historian, philologist or ethnologist.

Some account therefore of my labors in this direction, after the uniform scientific system, originated by the Bureau of Ethnology, and in use by those engaged in its service, may prove of interest.

That these Six Tribes were originally but one is obvious from a comparison of the six dialects. The chart on exhibition contains some of the words in most frequent use, and illustrates the character of their dissimilarities. The dialect spoken by the Tuscaroras, who were for a time widely separated from the others, presents the greatest differences.

That this period of separation was not of necessity one of great length, may be inferred from the remarkable differences which have arisen between two portions of the Mohawk tribe, less widely separated for a little more than two centuries.

On exhibition are the completed chrestomathies of the Seneca, Onondaga, Mohawk and Tuscarora dialects, prepared for the Bureau of Ethnology, after its admirable system of phonetic spelling and with its highly perfected alphabet for Indian dialects.

To obtain synonyms for the newly collected 8,000 Tuscarora words, the nucleus to an Iroquoian dictionary, the Catholic missions on the Canadian banks of the St. Lawrence were selected as the field for inquiry.

Over two hundred years ago, the ancestors of these Mohawks were christianized and transplanted to these missions from among their pagan surroundings, south of Lake Ontario, by the zealous Jesuit missionaries.

The archives of the old Catholic Church at Caughnawaga were found to contain, among other interesting and remarkable manuscripts, the most valuable French-Mohawk dictionary, now before you, compiled by Father Marcoux in the early part of this century.

Through the kindness of Superior Antoine and Père Burtin, this will furnish the desired synonyms, many of which would otherwise have been unobtainable.

Through their courtesy and that of Père le Clair, the Superior of the Sulpician Seminary at Oka, several hundred new titles were, during the past summer, added to the catalogue of Indian Linguistics, being edited by Mr. Pilling at Washington.

The black-board illustrations show the extreme length of some of the words, and, in their dissection, illustrate their marvelous composition.

For example, the following shows how the accidents of an Indian verb may affect its length, to the extent of producing in one word a very complicated phrase, viz.:

*Le–côñ–wâ–ti–at–â-wit-se-ra-h-ni-non-se-ron-ni-ôñ-tôñ-ha-ti-es.*—43 letters, 21 syllables.

The translation of this word is as follows:

*Some one has just come here expressly to buy again all kinds of clothes with that* (*money*).—66 letters, 20 syllables.

There is in this verb, 1st, the relation of the third person indefinite to the third masculine.

2d. Composition of the verb, *ni-non* (*to buy*), with the noun, *â-ti-ât-a-wit* (*clothes.*)

3d. Final relative, (*to buy for some one*).

4th. Movement, *se-ron* (*come to buy*).

5th. Frequentation, *ni-on*.

6th. Causality, *tôñ*, added to the perfect.

7th. Reduplication and locality, together denoted by *te* before the person.

8th. Transition, *ha-ti-e*, added to the perfect of the verb, denoting the transition from one place or one state to another, or the progress of the same state or action. This word is of unusual length.

What the possibilities of this group were, we can at present only conjecture, and should hasten to preserve them with all their hidden lore, ere they have been forever displaced by that more rapid vehicle of thought, the English language.

## Discussion.

Bishop Stimpson, of Ontario, Canada, confirmed the general accuracy of Mrs. Smith's observations. He stated also, that at Rice Lake, opposite Rochester, one of the tribes resident there, which still refuses to accept Christianity, had come originally from the Mohawk Valley, in New York.

In reply to enquiries of Prof. O. P. Hubbard, Mrs. Smith stated that the league of the Six Tribes probably occurred over 300 years ago, but the date was uncertain. Contrary to a general opinion, however, such leagues were not rare, but had been commonly formed among other Indian tribes.

The reason of the great difference in the language of the Tuscaroras from those of the other tribes, was due to the fact that the Tuscaroras formerly lived in North Carolina, and were thence driven out, in 1712, came North to the Confederation of the five tribes of the Iroquois, and formed the sixth tribe. Their original isolation had probably caused these dialectic differences.

General Ely Parker, spoke on the early history of the Tuscaroras, and the necessary conciseness of their language, which contains no circumlocutions, hardly any words with double-meaning. A similar mythology runs through all the tribes, which embraces a multiplicity of gods, *i.e.*, the spirits of familiar but important objects, *e.g.*, of the strawberry, maple, chestnut, oak, etc. At the annual festivals, as that of First Fruits (the strawberry), or that of Green Corn, they refer to all these spirits, but at the same time to a great Good Spirit, who presides over them all. They believe also in many evil spirits. They have never had any written language; oral tradition was their only possible means for handing down matters of history; but it was necessary to present them in a fanciful form in order to impress the youthful mind—not merely the bare abstract facts. These people are dying out, and the valuable materials of their history, language, etc., are passing beyond our reach. Even in New York State, the few remaining Indians on the Reservation, are being affected by the influences of civilization around them, and will soon lose their tribal connection, their Indian habits and Indian memories. It is important to collect this material now, and assist investigations of this kind.

Dr. B. N. Martin expressed his gratification over researches so original, novel, and interesting, and remarked, that it sounded strangely to speak of the history of the races, who so recently trod and ruled over our soil, as a novel subject. The peculiar feature of the Indian language, the use of undivided long words, conveying all shades of thought without separation, throws light on the origin of language among primitive peoples.

Rev. Dr. Dacosta referred to recent re-searches of a student of the Indian languages, who by means of carefully compiled tables, had found a similarity in the system of nomenclature of rivers, something resembling the Latin, *aqua*.

The subject was further discussed by Mr. R. JOHNSON, in regard to the poetry of the Indians, and by a VISITOR, who had found apparent resemblances between words of the Chippewa and Oriental languages. For the names of rivers, very figurative expressions were used by the Chippewas, *e.g.*, the great gathering of waters (Mississippi), the river that follows the shore, the straight river (Hiwassee), the middle river, the river beyond the land, etc.

Mrs. SMITH had remarked that, in the Iroquois names of rivers, some terms imply "flowing," but no definite system prevailed. Five hundred Indian tongues have been spoken in the United States, but little is yet known concerning any of these; and it seems both difficult and unwise to endeavor to trace analogies among them, before a single one has been thoroughly studied.

The PRESIDENT stated that the literature and destiny of the Indians had always been a subject of great interest to him. He had been among forty tribes, and had known something of the value of the materials, as bearing on the origin, structure and mutations of languages, which are soon to be lost. He had been associated for a time with George Gibbs, and with Turner, whose linguistic investigations were of the greatest value, and whose early death was much to be deplored. The subject under discussion was of the highest scientific character. The work of the Bureau of Ethnology promises to give a very important and well-digested series of investigations in regard to the Red Men, in place of the hasty observations and generalizations of Schoolcraft, and even those of Parkman, which are for the most part guess-work. Only by going among this people is their real spirit to be understood, and in this way the basis for a true history of the aboriginal occupants of this country will soon be gained. The policy of the early Government and colonists of Canada, and of some of our own colonists, *e.g.*, those of Penn, was a just one in the treatment of the Red Men, and very useful in the collection of ancient records which are now doubly precious. A very important contribution to history will be acquired when all these materials shall be properly arranged and written out.

January 8, 1883.

REGULAR BUSINESS MEETING.

Vice-President, Dr. B. N. MARTIN, in the Chair.

Twenty persons present.

Mr. C. E. COLBY was elected Resident Member, and the resignation of Mr. E. VANSYCHEL was accepted.

It was "*Resolved*, that the Publication Committee be authorized to prepare and publish an appeal for additions to the General Publication Fund."

Dr. ALBERT R. LEEDS read a paper, illustrated by specimens, upon FIVE NEW ORGANIC COMPOUNDS, VIZ:—ŒNANTHOLANILINE, ŒNANTHOLXYLIDINE, ŒNANTHOLNAPHTHYLAMINE, CRYPTIDINE, AND ACROLEINUREIDE.

(Abstract).

Œnanthol was prepared by fractional distillation at 150° of castor oil in partial vacuo. It unites, with great energy and elevation of temperature, with the aromatic bases, to form oils of closely related physical properties.

Purification by distillation was found impracticable, as was also the use of solvents, such as alcohol, benzol, chloroform and carbon disulphide. Finally the following plan proved successful. Each of the three compounds was dissolved in 150 grms. glacial acetic acid, heated for some hours on the water-bath, and, after complete combination of the excess of aromatic base, was converted into its respective acetic acid salt. A large excess of water was added, which precipitated the œnanthol compound, whilst the salt of the aromatic base remained in solution. After complete washing with water and drying at 100° C., the new compounds were submitted to analysis.

Œnantholaniline, $C_8H_7N$, $C_7H_{14}O$, is a reddish mobile oil of pleasant etherial smell; so is œnantholxylidine, $C_8H_{11}N$, $C_7H_{14}O$, and œnantholnaphthylamine, $C_{10}H_9N$, $C_7H_{14}O$. In the last case, the etherial smell is very pronounced and agreeable, resembling the odor of pineapple.

It is remarkable that these compounds, formed synthetically by the direct union of a molecule of œnanthol with a molecule of the aromatic base, without the elimination of molecule, should evolve so great heat of combination. They are permanent compounds, and can be sublimed with only partial decomposition. The sublimates are not crystalline,

and are identical in their physical and chemical properties with the original bodies.

By careful sublimation of xylidinacrolein, an oil is obtained which has an unpleasant smell and very bitter taste. It forms crystalline salts with sulphuric, hydrochloric and other acids. That with hydrochloric acid, after repeated purification by crystallization, was decomposed with caustic potash. The oil thus obtained was distilled at 270°, and yielded an oil of reddish color, unpleasant smell, and having the composition of cryptidine, $C_{11}H_{11}N$.

This is the first successful attempt to isolate this member of the pyridine series, only its salts having been obtained before, and it is of further interest as being accomplished by a process of synthesis.

This synthesis moreover throws light on the composition of these pyridine bases; since the mode of formation renders it probable that cryptidine contains one benzol ring, united with a side ring formed from the pre-existent members of the acrolein derivative of the fatty bodies.

The various oils derived from castor-oil were then described, and the different views of the constitution of these compounds.

Finally, the compounds of acrolein and urea were discussed, and the various statements put forth by HUGO SCHIFF concerning them.

DISCUSSION.

Mr. A. H. ELLIOTT pointed out the apparent identity in odor of cryptodine with a substance found in bone-oil, which he had obtained in considerable quantity in the oil derived from the destructive distillation of bones. This oil was nearly colorless, yielded the same odor as the one exhibited, had a specific gravity 0.835, and afforded, with hydrochloric and sulphuric acids, red salts which turned jet black in the air, though both their color and this change might have been due to some other substance present.

The subject was further discussed by Profs. MARTIN and LEEDS.

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January 15, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large hall was filled by an audience who listened with interest to a lecture, illustrated by many diagrams, by Prof. EDWARD D. COPE, of Philadelphia, on

THE EVOLUTION OF THE VERTEBRATA.

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January 22, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Seventy-five persons present.

Mr. G. F. N. KUNZ exhibited specimens of chrysoberyl, of remarkable size (one five by three inches), and crystalline marking, from Canton and Stowe, Me., and of rhodochrosite on drusy quartz from the Clay mine, Lake City, Col.; and Mr. N. L. DARTON, specimens of franklinite and chalcophanite from Sterling, N. J., iron ores from Marquette, Mich., and tabular calcite with drusy quartz from Anthony's Nose, N. Y.

A paper was read by Prof. EDWARD P. THWING on

THE TREATMENT OF SEA-SICKNESS BY THE TRANCE STATE.

(Abstract).

The phenomena of the trance have interested me for more than twenty years. For two years my experiments have confirmed the theory of Dr. Geo. M. Beard, that the concentration of the mind's attention in one direction induces an insensibility to other things, more or less complete. President Porter (Elements of Intellectual Science, section 81) says that pure sensation is simply an ideal or imaginary experience, and that, as the perceptional element is made stronger, the sensational is weakened. The intensity of the one is the suppression of the other. Some persons can excite expectancy sooner than others, and so gain control quicker. Some subjects take a consenting attitude more readily than others. One yields instantly, another only after repeated interviews, and some, perhaps, may never yield at all.

Nine cases of sea-sickness, occurring in the Atlantic and in foreign seas, are selected from many, to illustrate the speedy relief, often the complete cure, of this distressing ailment. Some showed little somnolence, while others sunk into as complete insensibility as in ordinary anæsthesia by chloroform.

One patient had been unable to retain any nourishment on the stomach after leaving port, two days' previous. Manipulations began about the temporal and frontal regions, particularly along the super-

ciliary ridges, and the patient at once exclaimed: "What a heaven to be relieved of pain!" Food was administered in small quantities, and, two hours after, a dinner of roast mutton was relished and retained. The other cases were treated in a similar manner, without the "passes" of the old-time mesmeriser, or the pretentious and dramatic display seen in stage exhibitions, without even fixing the gaze or standing before the individual. The voice probably did more than the hand, but in one case that, too, seemed superfluous; for the sufferer, a brawny Welshman, not understanding English, while busy casting his bread upon the waters, yielded to a pantomime, was led away from the ship side and made to recline on the shoulder of the operator. The trance became at once so profound that a pin introduced and left in the skin covering the back of the hand caused no wincing. Surgical operations have also been performed, some of which will be described by Prof. Jarvis of Bellevue College. Four facts may be stated as results:

1. The trance state in many cases relieves sea-sickness by restoring nervous equilibrium, and in surgery is sometimes an adequate substitute for ether. Not every one responds. Not every one is able to awaken that faith, belief, expectancy, which Dr. Beard has already shown before this Academy to be the subjective state out of which all these phenomena are evolved. This persuasion cometh not readily to every willing, yielding soul, still less to a reluctant, incredulous mind. Failures are mostly found in two classes. 1. The querulous, dogged, despairing sort, who, at home or afloat, nurse their pains and "enjoy poor health," as they say. 2. The curious, voluble and volatile, who wish to listen to and join in conversation. But failures with these, at the first or second meeting, are by no means final or decisive. Sequestration and silence on the part of the patient, and perseverance on the part of the operator, often secure success in apparently obstinate cases.

2. Tranciform states, *i. e.*, where control is partial and unconsciousness is incomplete, frequently afford proportionate relief.

3. The sense of subjugation and helplessness that comes over one, when in the grasp of Neptune or the surgeon, is sometimes a helpful accessory. It is analogous to the yielding attitude of the animal under a tamer or trainer, and not unlike the paralyzing influence of a panic.

4. The feeling of certainty on the part of the operator is a vital factor of success. It cannot be taught. It is gained by victorious achievement. Nothing is so successful as success. One subject under control will spread psychical contagion through a whole assembly, and at once exalt their ideas of the power of the controller. In private practice assurance is better shown by gentleness than by bluster, by undemonstrative, quiet tones, and by the general air of one who speaks

a personal, private, authoritative message, which he is accustomed to have immediately obeyed. *Possunt quia posse videntur.* Hardly anything is more contagious than confidence. Nothing is more masterful in power.

DISCUSSION.

Dr. W. C. JARVIS presented a patient from whose nasal fossa he had cut diseased turbinated tissue, while made to sleep by Prof. Thwing. There was in the second operation no wincing and no memory of pain. Respiration through the right nostril had thus been resumed after a year's closure. Another patient, so terrified on a previous occasion as to require three attendants to hold her, was enabled by the trance treatment to submit to the removal of a tumor behind the palate, near the base of the brain, remaining in a state of complete insensibility during the operation. He remarked upon the benefit of the possession of an influence so potent in preventing pain, especially in nervous cases, which are peculiarly susceptible to pain.

The CHAIRMAN remarked that these phenomena were not new but had been repeated for ages. Twenty-five years ago, when he was a medical student in Paris, he had seen Dr. Malgaigne, the distinguished surgeon, utilize this power in surgery. It could not always be depended upon, as a considerable number, perhaps the majority of cases would resist the influence, and with them the power is useless. There was no propriety or policy in denouncing it as a humbug, though unnecessary to clothe it with any wonder or mystery. It was a beneficial, wholesome influence, worthy all the attention being paid to it. It had been taken out of the hands of charlatanism and was now being properly studied and utilized.

A paper was then read by Dr. JOHN S. NEWBERRY, illustrated by a collection of plants and by lantern views, entitled:

NOTES ON THE BOTANY, GEOLOGY AND RESOURCES OF SOUTHERN TEXAS AND CHIHUAHUA.

(Published beyond, under report of meeting of Feb. 12).

January 29, 1883.

## Section of Geology.

The President, Dr. J. S. Newberry, in the Chair.

Seventy-five persons present in the large Hall.

The President announced the death of a Resident Member, Dr. George M. Beard, and remarked on his scientific attainments, and investigations of the phenomena of mesmerism and the trance state.

Dr. A. A. Julien read a paper on

### "THE DECAY OF THE BUILDING STONES OF NEW YORK CITY,"

(with Lantern Illustrations from American and Foreign Architecture).

(Abstract).

The paper, which will be published in full by the Building-Stone Department of the Tenth Census of the United States, considers the building stones employed in New York City and its suburbs, *i.e.*, Brooklyn, Staten Island, Jersey City and Hoboken.

*I. The buildings, their numbers and common materials.*

The materials of general construction occur in the following percentage proportion to the total number of buildings in the cities stated in the table below:

| | New York. | Brooklyn. | Staten Island. | Jersey City. | Hoboken. | Entire Metropolis. |
|---|---|---|---|---|---|---|
| No. of buildings.. | 100,193 | 75,526 | 7,725 | 20,880 | 6,284 | 210,608 |
| Brick and stucco. | 63.2 | 39.9 | 9 5 | 22.8 | 32.7 | 47.9 |
| Frame........... | 24.3 | 50.9 | 90 0 | 75.2 | 64.7 | 42.5 |
| Stone........... | 11.6 | 9.1 | 0.5 | 2.0 | 2.6 | 9.1 |
| Iron........ ... | 0.9 | 0.1 | | | | 0.5 |

In New York City proper, the several varieties of stone are used in the following proportion to the entire number of stone buildings:

| | | | |
|---|---|---|---|
| Brown sandstone | 78.6 | Ohio sandstone | 1.6 |
| Nova Scotia sandstone | 9 0 | Gneiss | 0.9 |
| Marble | 7.9 | Foreign sandstone | 0.1 |
| Granyte | 1.8 | Bluestone and limestone | 0.1 |

In Brooklyn, the Connecticut brownstone is the variety predominating among the stone buildings (95.7 per cent), and is employed almost altogether for the fronts of residences. Very few iron buildings occur, but over three times as many stucco-fronts as in New York. The frame buildings predominate, particularly in the outskirts, *e.g.*, Long Island City (80.5 per cent).

In Staten Island, stone enters in very small proportion into the fronts of buildings, though commonly employed, as in New York and throughout this district, for the dressing of apertures, the walls of enclosures, and other masonry.

In Jersey City, the proportions of the materials are much as in Staten Island. The selection of the dark trap from the Heights behind the city, for the construction of many fronts or entire buildings, is a local feature of interest.

In Hoboken, the same general features prevail as in Jersey City.

The annual reports of the Committee on Fire Patrol of the New York Board of Fire Underwriters, for the years 1881 and 1882, have yielded the following statistics, which, so far as they go, closely approximate my own:

| | Number of buildings. |
|---|---|
| South of Canal street | 10,553 |
| Between Canal and Fourteenth streets | 26,700 |
| Between Fourteenth and Fifty-ninth streets | 33,815 |
| Between Fifty-ninth street and Harlem River | 18,746 |
| Total | 89,814 |

The materials of construction for this district, which does not include the 23d and 24th Wards, North of the Harlem river, are reported as follows:

| | |
|---|---|
| Brick, with stone trimmings, and, in part, with stone facings | 64,783 |
| Brick and frame | 3,616 |
| Frame | 21,415 |

## II. *The Building Stones, their Varieties, Localities, and Edifices Constructed of Each.*

An exceedingly rich and varied series is brought to our docks, and the number and variety are constantly increasing. A few of the more important may be here mentioned.

Freestones (Carboniferous Sandstone), commonly styled "Nova Scotia Stone," or "Dorchester Stone," in various shades of buff, olive-yellow, etc., from Hopewell and Mary's Point, Albert, N. B., and from Wood Point, Sackville, Harvey, and Weston, N. B., Kennetcook, N. S., etc. A very large number of private residences in New York and

Brooklyn, etc., the fences, bridges, etc., in Central and Prospect Parks, many churches, banks, etc.

Freestone (Mesozoic Sandstone), commonly styled "brownstone," from East Longmeadow and Springfield, Mass., but chiefly from Portland, Conn., in dark shades of reddish-brown, inclining to chocolate. This is the most common stone used in the fronts of private residences, many churches, Academy of Design in Brooklyn, etc.

Freestone (Mesozoic Sandstone), "brownstone," from Middletown, Conn. Trinity Church, Brooklyn, etc.

Red Sandstone (Potsdam Sandstone), Potsdam, N. Y. Several residences, buildings of Columbia College, etc.

Freestone (Potsdam Sandstone), "brownstone," Oswego, N. Y. Part of Masonic Temple in 23d street.

Freestone (Mesozoic Sandstone), "brownstone," in several shades of light reddish-brown, orange-brown, etc., and generally fine-grained, from Belleville, N. J. Very many of the best residences and churches, *e.g.*, cor. 60th and 64th streets and Madison avenue, etc.

Also, varieties of the same "brownstone" from Little Falls, N. J. (Trinity Church, New York), from the base of the Palisades (part of the wall around Central Park), etc.

Freestone (Lower Carboniferous Sandstone), commonly styled "Ohio Stone," from Amherst, East Cleveland, Independence, Berea, Portsmouth, Waverly, etc., Ohio, in various shades of buff, white, drab, dove-colored, etc. Many private residences and stores, the Boreel building, Williamsburgh Saving Bank, Rosssmore Hotel, etc.

Freestone (Mesozoic Sandstone), often styled "Carlisle Stone," from the English shipping port, or "Scotch Stone," from Corsehill, Ballochmile and Gatelaw Bridge, Scotland; in shades of dark red to bright pink. Fronts of several residences, trimmings of Murray Hill Hotel, the "Berkshire" building, etc.

Also, varieties from Frankfort-on-the-Main, Germany, etc.

Blue Sandstone (Devonian Sandstone), commonly styled "Bluestone," from many quarries in Albany, Greene, Ulster and Delaware counties, N. Y., and Pike county, Penn. The trimmings of many private residences and business buildings, walls and bridges in the Parks, part of Academy of Design in 23d street, Penitentiary on Blackwell's Island, house at 72d street and Madison avenue, etc.

Freestone (Oolite Limestone), "Caenstone," from Caen, France. Fronts of several residences in 9th street, trimmings of Trinity Chapel, the reredos in Trinity Church, New York, etc.

Limestone (Niagara Limestone), Lockport, N. Y. Lenox Library, trimmings of Presbyterian Hospital, etc.

Limestone (Lower Carboniferous), styled "Oolitic Limestone," from Ellitsville, Ind. Several private residences, (*e.g.*, cor. 52d street and Fifth avenue), trimmings of business buildings, etc.

Also, varieties of limestone from Kingston and Rondout, N. Y., Isle La Motte, Lake Champlain, Mott Haven, and Greenwich, Conn., etc. Part of the anchorages of the Brooklyn Bridge, walls in Central Park, etc.

Granyte, Bay of Fundy, N. S. Columns in Stock Exchange, etc.

Red Granyte, Blue Hills, Me. U. S. Barge Office.

Gray Granyte, East Blue Hills, Me. Part of towers and approaches of New York and Brooklyn Bridge, etc.

Granyte, Spruce Head, Me. Part of towers of Brooklyn Bridge, bridges of Fourth Avenue Improvement, Jersey City Reservoir, etc.

Gray Granyte, Hurricane Island, Me. Part of New York Post Office and of towers and approaches of Brooklyn Bridge, etc.

Granyte, Fox Island, Me. Basement of Stock Exchange, etc.

Granyte, Hallowell, Me. Trimmings in St. Patrick's Cathedral, Jersey City Heights, etc.

Granyte, Round Point, Me. Seventh Regiment Armory, etc.

Granyte, Jonesborough, Me. Welles' building, panels in Williamsburgh Savings Bank, etc.

Granyte, Frankfort, Me. Part of towers and approaches of Brooklyn Bridge, etc.

Granyte, Dix Island, Me. New York Post Office, part of *Staats Zeitung* building, etc.

Also, varieties from Calais, Red Beach, East Boston, Clark's Island, Mt. Waldo, Musquito Mountain, Mt. Desert, Ratcliff's Island, etc., Me.

Granyte, Concord, N. H. Booth's Theatre, German Savings Bank, etc.

Granyte, Cape Ann, Mass. Dark base-stone and spandrel stones of towers and approaches of Brooklyn Bridge, etc.

Granyte, Quincy, Mass. Astor House, Custom House, etc.

Granyte, Westerly, R. I. Part of Brooklyn anchorage of Brooklyn Bridge.

Granyte, Stony Creek, Conn. Part of New York anchorage of Brooklyn Bridge.

Also, varieties from St. Johnsville, Vt., Millstone Point, Conn., Cornwall, N. Y., Charlottesburg, N. J., Rubislaw and Peterhead, Scotland, etc.

Gray Gneiss, New York Island and Westchester County, N. Y. A large number of churches, Bellevue Hospital, the Reservoir at 42d street, etc., and the foundations of most of the buildings throughout the city.

Gray Gneiss, Willett's Point and Hallett's Point, Kings County, N. Y. Many churches in Brooklyn, the Naval Hospital, etc.

Marble, Manchester, Vt. Drexel & Morgan's building, church corner 29th street and Fifth avenue, etc.

Also, many varieties from Swanton, West Rutland, Burlington, Isle La Motte, etc., Vt. The "Sutherland" building at 63d street and Madison avenue, residences at 58th street and Fifth avenue, etc.

Marble, Lee, Mass. Turrets of St. Patrick's Cathedral, etc.

Marble, Stockbridge, Mass. Part of old City Hall, New York.

Marble, Hastings, N. Y. The University building, etc.

Marble, Tuckahoe, N. Y. Part of St. Patrick's Cathedral, residence on the corner of 34th street and Fifth avenue, etc.

Marble, Pleasantville, N. Y., styled "Snowflake Marble." Greater part of St. Patrick's Cathedral, Union Dime Savings Bank, many residences and stores, etc.

Also, many varieties from Canaan, Conn., Williamsport, Penn., Knoxville, Tenn., Carrara and Sienna, Italy, etc.; used generally, especially for interior decoration, etc.

Trap (Mesozoic Diabase), from many quarries along the "Palisades," at Jersey City Heights, Weehawken, etc. Stevens' Institute, Hoboken, N. J., Court House on Jersey City Heights, old rubble-work buildings at New Utrecht, etc., on the outskirts of Brooklyn, etc.

Trap (Mesozoic Diabase), styled "Norwood Stone," from Closter, N. J. Grace Episcopal Church, Harlem.

Also, varieties from Graniteville, Staten Island, N. Y., and Weehawken, N. J.

Serpentine, Hoboken, N. J. Many private residences, masonry, etc., in Hoboken. Also, varieties from Chester, Penn.

In addition to the edifices referred to above, many public buildings of importance are constructed of stone, *e.g.*: Prisons in the city and on the islands, bridges in the Parks and over the Harlem river, in which sandstone, limestone, granyte and gneiss are used.

The sewers are constructed of gneiss from New York Island and vicinity, as well as of boulders of trap, granyte, etc., from excavations.

The Croton Aqueduct, the High Bridge, the Reservoirs in the Central and Prospect Parks and at 42d St., in which gneiss from the vicinity and granyte from New England were used.

The walls, buildings, bridges and general masonry in the Parks are constructed of the following varieties of stone:

Freestone (sandstone), from Albert, Dorchester, and Weston, N. B.

Brownstone, from Belleville and the base of the Palisades, N. J.

Bluestone and "mountain graywacke," from the Hudson River.

Limestone, from Mott Haven and Greenwich, Conn.

Granyte, from Radcliffe's Island, etc., Me.

Gneiss, from New York, Westchester and Kings counties, N. Y.

Marble, from Westchester county, N. Y.

The fortifications in the Harbor and entrance to the Sound, constructed of granyte from Dix Island, Spruce Head, etc., Me., gneiss from the vicinity, brownstone from Conn., etc.

The stonework of the New York and Brooklyn Bridge, as I am kindly informed by Mr. F. Collingwood, the engineer in charge of the New York Approach, is constructed of the following materials:

Granyte, from Frankfort, Spruce Head, Hurricane Island, East Blue Hill, and Mt. Desert, Me., Concord, N. H., Cape Ann, Mass., Westerly, R. I., Stony Creek, Conn., and Charlottesburg, N. J.

Limestone, from Rondout and Kingston, N. Y., also from Isle La Motte and Willsboro Point, Lake Champlain, and vicinity of Catskill, N. Y.

In the Anchorages, the corner-stones, exterior of the cornice and coping, and the stones resting on anchor-plates, consist of granyte from Charlottesburg and Stony Creek, in the New York Anchorage, and from Westerly, in the Brooklyn Anchorage. The rest of the material is entirely limestone, mainly from Rondout, largely from Lake Champlain. In the Towers, limestone was chiefly employed below the water line, and, above, granyte from all the localities named, except Charlottesburg, Westerly and Stony Creek. In the Approaches, the materials were arranged in about the same way as in the Towers. Additional particulars are given concerning the quantity, prices, tests of strength and reasons for selection of the varieties of stone.

For roofing, slate is largely employed throughout these cities, being mainly derived from Poultney, Castleton, Fairhaven, etc., Vt., and Slatington, Lynnport, Bethlehem, etc., Penn.

For pavements, the boulders of trap and granyte from excavations have been widely used in the "cobbletone" pavements. The trap (or diabase) of the Palisades across the Hudson, immediately opposite New York City, and from Graniteville, Staten Island, is used in the "Russ" and Belgian pavement; also, granyte from the Highlands of the Hudson, from Maine, etc., in the "granite block" pavement in both New York and Brooklyn; large quantities of crushed trap from Weehawken and Graniteville, for the macadamized streets and roads in the Parks and outskirts; and also wood, concrete and asphalt in various combinations.

For sidewalks and curb-stones, the material generally employed is the flagstone, a thinly bedded blue sandstone or graywacke from the interior of the State, the Catskill Mountains, and from Pennsylvania; also, granyte, chiefly from Maine. In the older streets, a mica-slate from Bolton, Conn., and micaceous slaty gneiss from Haddam, Conn., were once largely used, and may still be occasionally observed in scattered slabs.

Additional facts were given concerning the ruling prices for the varieties of stone, tables presenting all the determinations obtainable, in reference to the crushing strength of the varieties used in New York, lists of the dealers in building and ornamental stones, etc.

III. *Durability of Building-Stones,* in New York City and vicinity.

All varieties of soft, porous and untested stones are being hurried into the masonry of the buildings of New York City and its vicinity. On many of them the ravages of the weather and the need of the repairer are apparent within five years after their erection, and a resistance to much decay for twenty or thirty years is usually considered wonderful and perfectly satisfactory.

Notwithstanding the general injury to the appearance of the rotten stone, and the enormous losses annually involved in the extensive repairs, painting, or demolition, little concern is yet manifested by either architects, builders, or house owners. Hardly any department of technical science is so much neglected as that which embraces the study of the nature of stone, and all the varied resources of lithology in chemical, microscopical, and physical methods of investigation, wonderfully developed within the last quarter century, have never yet been properly applied to the selection and protection of stone, as used for building purposes. Much alarm has been caused abroad in the rapid decay and fast approaching ruin of the most important monuments, cathedrals, and public buildings, but in many instances the means have been found for their artificial protection, *e.g.*, the Louvre and many palaces in and near Paris, France, St. Charles church in Vienna, Austria, the Houses of Parliament, etc., in London, England, etc.

In New York, the Commissioners of the Croton Aqueduct Department complained, twenty years ago, of the crumbling away of varieties of the gneiss used in embankments; the marbles of Italy, Vermont, and of Westchester County, soon become discolored, are now all more or less pitted or softened upon the surface (*e.g.*, the U. S. Treasury), and are not likely to last a century in satisfactory condition (*e.g.*, the U. S. Hotel); the coarser brown sandstones are exfoliating in the most offensive way throughout all of our older streets and in many of the newer (*e.g.*, the old City Hall); the few limestones yet brought into use are beginning to lose their dressed surfaces and to be traversed by cracks (*e.g.*, the Lenox Library); and even the granytes, within a half century, show both discoloration, pitting (*e.g.*, the Custom House), or exfoliation (*e.g.*, the Tombs). To meet and properly cope with this destructive action, requires, first, a clear recognition of the hostile external agencies concerned in the process. These belong to three classes, chemical, physical, and organic.

The chemical agencies discussed were the following: sulphurous and sulphuric acids, discharged in vast quantities into the air of the city, by the combustion of coal and gas, the decomposition of street refuse and sewer-gas, etc.: carbonic, nitric, and hydrochloric acids; carbolic, hippuric, and many other organic acids, derived from smoke, street dust, sewer vapors, etc.: oxygen and ozone, ammonia, and sea-salt.

The mechanical and physical agencies discussed were the following: frost: extreme variations in temperature, amounting in our climate to 120° F. in a year, and even 70° in a single day: wind and rain, most efficient on fronts facing the north, northeast, and east: crystallization by efflorescence: pressure of superincumbent masonry: friction: and fire.

The organic agencies consist of vegetable growths, mostly confervæ, etc., within the city, and lichens and mosses, without, and of boring molluscs, sponges, etc.

The internal elements of durability in a stone depend, first, upon the chemical composition of its constituent minerals and of their cement. This involves a consideration of their solubility in atmospheric waters, *e.g.*, the calcium-carbonate of a marble or limestone, the ferric oxide of certain sandstones, etc.: their tendency to oxidation, hydration, and decomposition, *e.g.*, of the sulphides (especially marcasite) in a roofing-slate or marble, the biotite and ferruginous orthoclase in a granyte or sandstone, etc.: the enclosure of fluids and moisture, *e.g.*, as "quarry-sap," in chemical combination as hydrated silicates (chlorite, kaolin, etc.) and iron-oxides, and as fluid-cavities locked up in quartz, etc.

The durability of a stone depends again upon its physical structure, in regard to which the following points were discussed: the size, form, and position of its constituent minerals; *e.g.*, an excess of mica-plates in parallel-position may serve as an element of weakness: the porosity of the rock, permitting the percolation of water through its interstices, especially important in the case of the soft freestones and leading to varieties of discoloration upon the light-colored stones, which were described in detail: the hardness and toughness, particularly in relation to use for pavements, sidewalks, and stoops: the crystalline structure, which, if well-developed, increases the strength of its resistance: the tension of the grains, which appears to explain especially the disruption of many crystalline marbles: the contiguity of the grains and the proportion of cement in their interstices: and the homogeneity of the rock.

Again, the durability of a rock may depend upon the character of its surface, whether polished, smoothly dressed, or rough-hewn, since upon this circumstance may rest the rapidity with which atmospheric waters are shed, or with which the deposition of soot, street-dust, etc., may be favored: also upon the inclination and position of the surface, as affecting the retention of rainwater and moisture, exposure to northeast gales and to burning sun, etc.

IV. *Methods of Trial of Building-Stone.*

In such methods, two classes may be distinguished, the natural and the artificial.

The former embrace, first, the examination of quarry-outcrops, where the exposure of the surface of the rock during ages may give some indication of its power of resistance to decomposition, *e.g.*, the dolomitic marbles of New York and Westchester counties, some of which present a surface crumbling into sand: and, secondly, the examination of old masonry. Few old buildings have survived the changes in our restless city, but many observations were presented in regard to the condition of many materials, usually after an exposure of less than half a century.

Another source of information, in this regard, was found in the study of the stones erected in our oldest cemeteries, *e.g.*, that of Trinity Church. There could hardly be devised a superior method for thoroughly testing, by natural means, the durability of the stone, than by its erection in this way, with partial insertion in the moist earth, complete exposure to the winds, rain, and sun on every side, its bedding-lamination standing on edge, and several of its surfaces smoothed and polished and sharply incised with dates, inscriptions, and carvings, by which to detect and to measure the character and extent of its decay. In Trinity Church-yard, the stones are vertical, and stand facing the east. The most common material is a red sandstone, probably from Little Falls, N. J., whose erection dates back as far as 1681, and which remains, in most cases, in very fair condition. Its dark color, however, has led to a frequent tendency to splitting on the western side of the slabs, *i.e.*, that which faces the afternoon sun. Other materials studied consisted of bluestone, probably from the Catskills, black slate, gray slate, green hydromicaceous schist, and white oolitic limestone, all in good condition, and white marble, in a decided state of decay.

The artificial methods of trial of stone, now occasionally in vogue, whenever some extraordinary pressure is brought upon architects to pay a little attention to the durability of the material they propose to employ, are, from their obsolete antiquity, imperfection, or absolute inaccuracy, unworthy of the age and of so honorable a profession. They usually consist of trials of solubility in acids, of absorptive power for water, of resistance to frost, tested by the efflorescence of sodium-sulphate, and of resistance to crushing. The latter may have the remotest relationship to the elements of durability in many rocks, and yet is one on which much reliance of the architectural world is now placed. Sooner or later a wide departure will take place from these incomplete and antique methods, in the light of modern discovery.

Reference was made to certain experiments by Prof. J. C. Draper on the brownstone and Nova-Scotia stone used in this city, by Dr. Page on a series of the building-stones, and by Profs. J. Henry and W. R. Johnson on American marbles, in some cases with conflicting results, which were probably due to the limited number and methods of the experiments.

*V. Means of Protection and Preservation of Stone.*

We have here to consider certain natural principles of construction, and then the methods for the artificial preservation of the stone used in buildings. Under the first head, there are four divisions.

*Selection of stone.* As it is universally agreed that the utmost importance rests upon the original selection of the building-material, it is here that all the resources of lithological science should be called in. Only one investigation, aiming at thorough work, has ever been carried through, that of the Royal Commission appointed for the selection of stone for the Houses of Parliament. But the efforts of these able men were restricted by the little progress made at that time in the general study of rocks, and were afterwards completely thwarted by the discharge of the Committee and by the delivery of the execution of the work of selection to incompetent hands. There will be hereafter, from investigations made in the light of modern researches, no excuse for such annoying results and enormous expenses as those which attended the endless repairs which have been required, since a period of four or five years after the completion of the great building referred to.

*Seasoning.* The recommendations of Viturvius, 2000 years ago, have been observed at times down to the day of Sir Christopher Wren, who would not accept the stone, which he proposed to use in the erection of St. Paul's Cathedral, in London, until it had lain for three years, seasoning upon the seashore. Since then little or no attention appears to have been paid to this important requirement by modern architects, in the heedless haste of the energy of the times. Building-stone, even for many notable edifices, is hurried from the quarries into its position in masonry, long before the "quarry-sap" has been permitted, by its evaporation, to produce solid cementation in the interstices of the stone.

*Position.* The danger of setting up any laminated material on edge, rather than on its natural bedding-plane, has been widely acknowledged; yet it is of the rarest occurrence, in New York City, to observe any attention paid to this rule, except where, from the small size or square form of the blocks of stone employed, it has been really cheapest and most convenient to pile them up on their flat sides.

*Form of projections.* The principle is maintained by all the best English and French architects that projections (*i.e.*, cornices, sills, lintels, etc.) should be "throated," that is undercut in such a way as to throw off the dripping of rainwater, etc., from the front of the building but in New York this principle is almost universally neglected. It was pointed out that the severity of our climate even requires the further care that the upper surface of projections should be so cut as to prevent the lodgment or long retention of deposits either of rainwater or snow. It is immediately above and below such deposits that the ashlar of our fronts is most rapidly corroded and exfoliated, an effect evidently due mainly to the repeated thawing and solution, freezing and disintegration, which are caused by the water, slush and snow, which rest, often for weeks, upon a window-sill, balcony, cornice, etc. Thus from the initial and inexcusable carelessness in the construction and form of the projections, and, later, the neglect of the houseowner, due to ignorance of the results involved, to remove the deposits of snow, etc., as fast as they accumulate on the projections, is derived a large part of the discoloration of the marble, Nova Scotia stone, or light colored granyte, and especially the exfoliation of the brownstone beneath the window-sills, balconies, etc., by the water alternately trickling down the front and freezing, by day and by night, for long periods.

The artificial means of preservation are of two classes, organic and inorganic. The former depend on the application of some organic substance in a coating or on the injection of fatty matters; but, as the substances are with greater or less rapidity oxidized, dissolved, and carried away by the atmospheric fluids, the methods founded on their use have been properly denounced by many authorities as only costly palliatives, needing frequent repetition, and therefore exerting an influence toward the destruction of delicate carving. The following were discussed: coal-tar: paint, which has been used in New York for many residences, as in Washington for the Capitol and in London for Buckingham Palace, etc., but lasts only a few years and often even permits the disintegration to progress beneath it: oil, often used in New York, but as objectionable as paint: soap and alum-solution: and paraffine, beeswax, rosin, tallow, etc., dissolved in naphtha, turpentine, camphine, oil, etc.

The preparations of an inorganic nature, which have been proposed and used abroad, have in some cases met with success; but the exact nature of their action, and the conditions to which they are each suited, are yet to be investigated, especially with reference to the entirely different climate by which the stone in our city is being tried. The processes which have been proposed, and in some cases practically used, involve the application of the following substances: waterglass, in connection with salts of calcium or barium, or bitumen: oxalate of aluminium: barium solution, in connection with calcium superphosphate or ferrosilicic acid: copper salts, used by Dr. Robert in Paris to stop the growth of vegetation on stone, etc.. There is certainly a call for processes by which, at least, those stones which are used in isolated, exposed, and unnatural positions, may receive artificial protection, such as the stone-sills and lintels of windows, stone balusters, projecting cornices, and ashlar-stone set up on edge. It will doubtless be found that only those stones, which possess a coarse porous texture and strong absorptive power for liquids, will be found particularly available for protection by artificial preservatives, and that such stones should indeed never be used in construction in a raw or crude state. In the spongy brown and light olive free-stones, a marble full of minute crevices, and a cellular fossiliferous limestone, a petrifying liquid may permeate to some depth, close up the pores by its deposits, and encase the stone in solid armor; while, upon a more compact rock, such as a granyte or solid limestone, it can only deposit a shelly crust or enamel, which time may soon peel off. The carelessness with which stone is selected and used, and the ignorance in regard to its proper preservation, when the decay of a poor stone becomes apparent, have led to an increased use of brick and terra cotta, much to be deplored; durable stones are to be obtained in great variety, methods for the preservation of the porous stones can easily be devised, and stones of a fire-proof character do exist in this country in abundance.

In conclusion, three suggestions were offered: 1st, that householders invoke the magic use of the broom on the fronts of their residences as carefully as upon the sidewalks: 2d, that house builders insist upon the undercutting of all projections, and the exclusion of brackets or other supports to sills and cornices, which only lead to the oozing of water and a line of corrosion down the ashlar: 3d, that house repairers recut the projections in this way, whenever possible, and entirely avoid the use of paint, oil, or other organic preservatives.

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February 5, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-five persons present.

The following *Resolution* was passed, "that the New York Academy of Sciences endorse a petition for Congress to remove all duties on specimens of minerals and fossils, whether imported for sale by dealers, or by institutions of learning, or by private collectors, so long as they are intended for cabinet specimens and not for use in the arts."

The following elections took place:

MR. J. W. SMITH of Newark, N. J., as Resident Member.

Marquis ANTONIO DI GREGORIO of Molo, Palermo, Sicily, as Corresponding Member.

Mr. W. E. HIDDEN exhibited nuggets of gold from Burke Co., N. C., from ten to fifty pennyweights in weight, an extraordinary size for that region. They were found in superficial deposits, and had evidently not traveled far.

MR. ROMYN HITCHCOCK read a paper entitled:

THE RETICULATE STRUCTURE OF LIVING MATTER (Bioplasson), with exhibition under the microscope of blood corpuscles and amœbæ, showing granular in place of reticulated structures, of corpuscles of blood and pus treated by potassium dichromate, and of the resolution of the lines, $\frac{1}{95000}$ of an inch apart, upon the diatom, *amphipleura pellucida.*

(Abstract).

The living matter of plants and animals, from the lowest prototype to the highest form of animal life, is, so far as our knowledge extends, identical. It is variously named protoplasm, bioplasm, sarcode, and, not having a sufficient number of names, still another has been applied to it—bioplasson—and a new hypothesis of the structure of living matter, termed the "bioplasson theory," has recently been put forward and upheld in this country, mainly by Drs. Carl Heitzmann and Louis Elsberg. It is of this so-called theory, which at the most is merely a hypothesis, that I desire to speak this evening. I shall rely upon ocular proof to show that there is no reticulum in the blood cells.

The microscope, like every other instrument of research, requires to be manipulated by a person of experience, to yield trustworthy and the most perfect results. Yet there is a vast difference between the ability to manipulate it and the ability to see what it reveals. Perhaps only a small proportion of this audience could use the instrument fairly well; yet I doubt if there is one person here who could not see the most minute details of any object, after the proper adjustments have been made.

We may consistently confine the discussion to three objects, viz., the *amœba*, and the red and the white blood-corpuscles. As those who have heard Dr. Elsberg's remarks before the Academy know very well, the theory is, essentially, that all living tissues are constituted of a fine net-work of very contractile, living matter, with inert matter filling the meshes. It is not necessary to explain the theory more at length, for the reason that the existence of such a net-work, readily seen by the aid of a microscope, forms the foundation of every observation in support of it. Moreover, as the reticulum is said to be clearly visible in all living matter, we have only to prove either that it does or does not exist in the *amœba*, or in a white blood-corpuscle, to sustain, or to utterly refute the theory.

I propose to demonstrate that there is absolutely no trace of such a net-work in a blood-corpuscle. When the object-glass is properly corrected and focused, no reticulum whatever can be seen. In other words, the apparent reticulum which Dr. Heitzmann shows is, undoubtedly, the result of faulty observation of some kind; but probably the faults are not of a kind that a student or inexperienced microscopist would be able to detect, or to point out with any assurance. It is said that the movements of a homogeneous jelly, such as protoplasm has been described to be, would be impossible—that some kind of reticulated structure is necessary to enable us to explain its power of movement. At present it is merely a question of fact whether there is a reticulum or not. After its existence has been demonstrated it will be time enough to theorize how it enables us to understand the phenomena of life.

The reticulum is supposed to explain the movement of living matter; movement is due to contractility; the contractility resides in the nodes and connecting threads of the net-work; the extension or contraction of the net-work explains the movement of the *amœba* and the blood-cell. It is an ingenious, mechanical explanation of a mystery that has puzzled the scientific world for ages. All the motions of life are due to the contraction and expansion of a reticulate structure, which is common to all living things. How easily all the observed facts are explained! What an admirable machine the *amœba* is! Perhaps somebody will ask, by what means the reticulum itself is enabled to extend and contract. I am not aware that any effort has yet been made to solve this problem. Enough, that the movements we see are explained upon mechanical principles. Like the thousands of persons who are satisfied to understand mesmerism as animal magnetism, and strange phenomena as due to electricity in the air, these gentlemen present, in the name of science, an explanation that does not explain.

The sources of error in microscopical observation are: 1. Improper illlumination. 2. Imperfect correction of the objectives. 3. Incorrect focussing. The first source of error does not concern us in the case under consideration, for no special niceties of illumination are required. The second is of more consequence; but, in order to eliminate it from my own observations, I have used objectives which were either adjusted by the makers and set in fixed mountings, so that their corrections could not be changed, or else I have adjusted the lenses myself by the use of suitable objectives, so that their correction was as perfect as possible. Finally, errors of focussing alone remain as the only ones which cannot be absolutely eliminated. Yet these, in the special objects of study, the *amœba* and the blood-cells, are of no consequence whatever; for no experienced observer can be in doubt as to the exact focus for a white blood-corpuscle.

A few words now about the appearance of blood-corpuscles when highly magnified. The red corpuscles, when examined in the serum, are double concave disks. When lying flat, in the focus of a good objective, they appear to be quite homogeneous in structure; the central portion of the disk, owing to the concave shape, appearing slightly darker than the rest. I am not aware that it is claimed that a reticulum can be seen in the red corpuscles under such circumstances. To demonstrate the net-work, it is necessary to use some reagent, and a saturated solution of potassic bichromate, diluted with about an equal volume of water, is recommended for the purpose. The addition of such a solution to fresh blood produces a great change in the appearance of the corpuscles. They become granular, and some of them undergo slow changes of form, budding, etc., as Dr. Heitzmann has described in his bcok, recently published. When the corpuscles begin to become granular, there is a time when they present an appearance of reticulation. But careful observation with high-powers fails to show any connecting net-work. There is nothing but a breaking up of the contents into separate granules; and, as the action of the reagent continues, the granules become more distinct, uutil they can be very clearly defined by a good objective.

It is a fact well known to observers with the microscope, that any body, regularly marked with fine and close dots, can be made to appear as though covered with fine, continuous lines. The dots merge into each other and form lines in the image. Thus, in the diatom, *pleurosigma angulatum*, an inferior objective will show the markings as fine, distinct lines, but a better lens will resolve the lines into rows of dots, a fact familiar to every microscopist. It is doubtless owing to this that the granular structure of protoplasm has been taken for a reticulum.

I believe the strongest and the most convincing argument, against this bioplasson doctrine, is the fact that the reticulum, which these gentlemen declare is so readily observed, has hitherto entirely escaped the notice of the best histologists in the world. Dr. Heitzmann has used these words: "Take a drop of pus, fresh, without adding anything, and you will see the wonderful structure in each pus-corpuscle *with great ease.*"

I will ask if it is reasonable to suppose that a structure, that can be seen "with great ease," could have been overlooked by such men as Beale, Balfour, Carpenter, Frey, Bütschli, and a host of other equally competent observers, and reserved for an individual of to-day to discover. Yet this is what Dr. Heitzmann declares he has discovered, and upon this discovery he has built up a totally new and comprehensive theory of the structure, not only of living matter, but of the whole living world, connecting all the different tissues of the animal and vegetable body through this reticulum, and utterly discarding the cell-doctrine, which has rendered such excellent service to science for thirty years. To an experienced microscopist the idea seems preposterous. The objects most familiar to the histologist and pathologist, coming almost daily under the eye of the physician who uses the microscope in his practice, are now declared to possess a distinctly reticulate structure, never before even dreamed of.

### DISCUSSION.

The CHAIRMAN enquired whether it had been established that the motions of the amœbæ were dependent on cilia or otherwise.

Mr. HITCHCOCK replied that at present there is no evidence nor knowledge of the structure of the amœbæ; indeed, they appear to be absolutely without visible structure.

Dr. L. SCHOENEY remarked that to see or not to see is the real question in regard to structure. More stress, however, is now laid upon the interpretation than on the supposed reticulum itself. In regard to the first, *i.e., seeing reticular structure,* the verdict of independent microscopists has, in the majority of cases, been unfavorable. The best authorities among those gentlemen have discussed and contested it. That which is described by the founder of this doctrine, as threads of a network, appears under the best objectives, well focussed, as a mass of granules, irregularly heaped, more or less approaching each other, and here and there leaving interstices ; but nothing is seen which would mark a distinction between mere granules, distinctly attached to each other, and a homogeneous line of thread. At the locomotion of an amœba, the granules within flow along, more or less adherent to each other, as globules of blood are seen to flow, attached to each other, during circulation—nothing more.

In regard to discrepancies in observation with the microscope, we may be permitted to refer here to the most remarkable discovery recently made in optics by Prof. Abbe, which may throw light in the future on many errors of observation with the microscope. Prof. Abbe distinguishes two kinds of microscopic vision : one like the ordinary vision, by rays directly from the object to the eye, which he calls *dioptric image:* the other, *diffractive image,* produced by rays that travel around the edge of a line or a minute object, so fine as to be but a small multiple of a wave-length of light. These images are formed by recomposition of the spectra, produced by these fine lines of objects. They are less than 1-3000 of an inch. Since these granules are smaller, the apparent blurred lines or threads are only diffractive images of granules. This would account for some objective errors. But are there not also some subjective, personal errors, to be accounted for in microscopy, as there exist in her sister science, telescopy—if astronomy may be so termed, by analogy. We know astronomers have to allow for personal equation, errors owing to the difference in time between the impression on the retina and the record by speaking or drawing, in different observers. May not microscopists be distinguished by individual delicacies of vision ? Moreover there are other subjective errors, individual anomalies, to be accounted for.

The fine pictures of Turner's, notwithstanding their beauty, have encountered much severe criticism. In fact it has been ascertained by Liebreich, who carefully examined Turner's gallery, that the painter was affected by astigmatism, producing oddities in color and chiefly in perspective, which formed the incongruities in his art. So, too, the great physicists of the future will doubtless determine the personal errors of one nature or another, which have attended the labors of former workers with the microscope. So much for the wondrous network itself.

But far more important is its supposed mode of motion. If we attempt to analyze the elements of this reticulum, in order to demonstrate by it the motion of living matter, even the *primum movens* of muscular fibre, we have to imagine one mesh of this network as a rhombus or a triangle, whose sides have granules at their angles, and which are impelled forward by the contraction of the sides, acting in the diagonal of a parallelogram of forces, of which these sides represent two. We have to deal, in the first place, with two forces instead of one, which we wish to define, and withal forces similar to the one to be defined. We are reasoning in a circle. The syllogism includes the postulate of contractility of the elements of the reticulum. To demonstrate in this way the contractility of muscular fibre is a *a demonstratio ad absurdum.*

The importance of this controversy cannot be overrated, if we consider that the question of the motion of protoplasm involves the highest reflection in regard to the origin of life—the *primum movens vitæ.*

Dr. L.S. BEALE, in the last edition of his great work on protoplasm, has an appendix, in which he treats upon the influence which this conception of vital motion exerts on the highest fundamental truths of Christianity. In this he discusses the connection between protoplasm and the machinery of the motion of life. If living matter has a mode of motion, this must be analogous to other modes produced by cosmic forces, or it must be peculiar and unique. But even if—as some suggest—living force and motion are evoluted from other inorganic or cosmic forces, we are, at the present state of physical science, where all the different wave and vortex motions are not at all yet determined, far from being able to venture a hypothesis on the mode of motion of living matter. Until then, we must content ourselves with the distant analogy, looking up to those stars that possess their given motion in their own centre, and applying the same inherent individual force, given to the simplest unit of organic matter, whether in the brain-cell (Hœckel's *soul*) of human beings, or in the lump of protoplasm dredged up from the bottom of the ocean; and observing it to move of itself, we exclaim "*de profundis.*"

Mr. A. H. ELLIOTT referred to the experiments of Dr. Crookes on "radiant matter," and enquired whether there were any means of explanation of the motion of the granules of living matter analogous to the molecular motion observed by that investigator.

Dr. SCHOENEY remarked that mere molecular motions were simply helped or retarded by the different physical forces, but that the agencies concerned in the phenomena of life were quite different from the other cosmic forces.

Mr. Hitchcock stated that it had been suggested, in regard to the distinction between living and non-living matter, that they may differ in the same way, as in inorganic bodies, atoms of the same substance are subject to different arrangements—one mode of arrangement being peculiar to living matter.

Mr. George F. N. Kunz then exhibited specimens of the blue amber from Catania, on the coast of Sicily, and a mass, three-fourths of a pound in weight, of a very good amber color, and partly covered with recent bryozoa, from the Tertiary deposits of Nantucket, Mass. He also read a paper:

## ON A LARGE MASS OF CRETACEOUS AMBER FROM GLOUCESTER COUNTY, NEW JERSEY.

(Abstract).

About twelve months ago, a mass of amber of uncommon size and form, (being twenty inches long, six inches wide, and one inch thick, weighing sixty-four ounces) was found at Kirby's marl pit, on Old Man's creek, near Harrisonville, Gloucester Co., N. J. A quarter-inch section showed a light greyish-yellow color. A section one and one-quarter of an inch thick showed a light yellowish-brown color. The entire mass (surface and interior) contained botryoidal shaped cavities, filled with glauconite, or green sand, and a trace of vivianite. The hardness is the same as that of the Baltic amber; but it is slightly tougher, and cuts more like horn, the cut surface showing a curious pearly lustre, differing in this respect from any other amber I have yet examined. This lustre is not produced by the impurities, for the clearest parts show it best. It takes a very good polish. The specific gravity of a piece of carefully selected amber is 1.061, and is the lowest density on record; the usual range being from 1.065 to 1.081. It was found at a depth of twenty-eight feet, covered with twenty feet of green sand or marl, in a six foot stratum of fossils, consisting mostly of *Gryphea vesicularis*, *Gryphea Pitcheri*, *Terebratula Harlani*, and others. The upper part of the marl consists of a layer of limestone, several feet in thickness, filled with *Palorthis*, echinoid spines, and an occasional shark's tooth of the genus *Lamna*, and this covered by eight feet of earth. The marl belongs to the middle bed of the Upper Cretaceous series.

No analysis has as yet been made of this amber, but the similarity of the specific gravity, the hardness, and the ignition, leave little

doubt of its being a true amber, very closely resembling the Baltic and other ambers.

DISCUSSION.

Dr. N. L. BRITTON enquired whether any lignite had been found with the amber. The Middle marl-bed was about a mile distant, and contained lignite. Also, in the clays of the Raritan river, a lignite-bed of coniferous wood occurred, containing many small pieces of fossil gum, one inch or so in length.

A MEMBER suggested that the identity of these fossil resins, from this and other American localities, with true amber, had not yet been established, no analyses ever having yet been made, to his knowledge, to determine the presence or predominance of succinic acid.

Prof. D. S. MARTIN remarked that it is a curious and interesting fact that the hardness of fossil resius, as a rule, increases with their age. Thus true Tertiary amber is much harder than the later Copals, etc., yet still it is easily cut and carved; while, in the lower beds of the Cretaceous, the amber is brittle and difficult to work.

Mr. W. E. HIDDEN stated that amber had been found last summer in the marl-beds of North Carolina, and the specimens were now deposited in the Geological Museum at Raleigh.

Dr. B. N. MARTIN had heard the well-known worker in amber in this city, Mr. Kaldenberg, remark that the largest specimen of amber he had ever seen was one from New Jersey, "found on the shore of Raritan Bay," and now deposited in the museum at Berlin, Germany.

Mr. KUNZ was not aware of any analyses of the New Jersey specimens, but pointed out that they possessed the specific gravity, hardness and general physical properties of true amber. In fact, there was now great danger of making too many species in mineralogical determinations.

The CHAIRMAN observed that it was remarkable that amber was found in so few places in any large quantity, such as occurred on the shores of the Baltic. The fossilgums introduced into commerce, *e.g.*, kauri, copal, etc., were all resins of different and generally known trees, but that of the Baltic—yellow, hard and aromatic—belonged to an an older formation. At present, there was a considerable number of coniferous trees which yielded resins. In the clay-beds, underlying this locality in Gloucester County, N. J., a great number of coniferous trees had been found, of remarkable beauty and interest, all differing from the conifers found elsewhere, and their resins must be different. This fossil gum therefore does not deserve to be called by the same name as that of the Baltic. In one pit a whole barrelful had been found and burned by the workmen. From Japan also a resin had been brought, called amber, upon which there were impressions of leaves (*Sequoia*).

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February 12, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-one persons present.

The CHAIRMAN called attention to the specimens of coal, exhibited by Mr. McDonald, from the Brier Hill seam at Massilon, Ohio, in the lower beds of the Carboniferous The material consisted of thin alternations of bright and lustreless laminæ, the latter forming partitions by which the bituminous matter was shut up in cells and thus prevented from melting together when used as fuel. As it does not cake nor agglutinate, it is the finest grate-fuel in the world. It is found in local basins of limited extent, corresponding, in origin and general features, to the peat-marshes now found in the same region, and which have sometimes filled up a deep cañon or valley to the depth of fifty feet or more.

Mr. McDONALD stated that the beds of coal appear to occupy great elongated basins, trending about ten degrees east of south or west of north, seldom exceeding five feet in thickness and thinning out at the edges. This basin embraces about one hundred acres of workable coal, from two and a half to five feet in thickness. The stratum is the lowest of the series, and is largely made up of detached basins, which are from ten to one hundred and fifty acres in extent.

The CHAIRMAN explained that the elongated form and trend of these basins was due to the excavation of the containing valleys by the ancient streams, which then as now must have, in general flowed southward from Lake Erie and Northern Ohio. Many were sluggish and became elongated peat-marshes. A submergence of this area, and the deposit of gravel and sand upon the marshes, would naturally produce such basin-like masses of coal.

A paper was read by Mr. B. B. Chamberlin, with an exhibition of a large number of specimens, on

### THE MINERALS OF THE WEEHAWKEN TUNNEL.

(Abstract).

The Palisade range, with its continuation southward, is a vast storehouse of minerals, increasing in quantity and quality with the depths from which they are obtained.

The question, "Why has the Weehawken tunnel yielded less plentifully than the tunnels west of Hoboken?" is partially explained by one fact, that it does not lie as far beneath the surface of the ground as the other tunnels, save in one portion of its course.

This section, nearest the Hudson, embracing shafts numbers 1 and 2, has proved fully as prolific of mineral trophies as an equal space in the tunnels below, where no less than six shafts in each received the attentions of collectors of the prized zeolites.

Most of the usual list of this class of minerals, obtainable in our vicinity, appeared in greater or less quantity at Weehawken, a description of which is here given:

*Pectolite.*—Weehawken tunnel has furnished science with perhaps some of the finest crystalline forms yet discovered.

A curious feature of much of the Weehawken pectolite consists in the numerous clefts and fissures, as though made by a knife or saw, an explanation of which is perhaps yet to be given.

*Datolite.*—This mineral, so common in the other tunnels of the ridge, here appears in very limited quantity. These few specimens are characterized by great brilliancy and beauty. The color is a delicate green, considerably lighter than usual in specimens from this vicinity.

*Analcime.*—The specimens of analcime are quite showy as cabinet specimens, and superior to those found elsewhere along the ridge.

The crystals are rarely over half an inch in diameter, in color often snow-white. Many present curious depressions on certain faces of the crystals.

*Prehnite.*—Much of the prehnite here found was intimately associated with an inferior quality of natrolite and pectolite, quite unattractive to a collector. Two or three small bits of green incrustation, somewhat paler than the ideal tint, are all which my cabinet contains to represent this noted mineral in this locality.

*Calcite.*—Many of the calcite specimens are peculiar to the locality.

The prevailing form is the scalenohedron, with a great variety of changes, sometimes carried to such an extent as to present rounded surfaces of great beauty. Compound groups and twinned crystals are unusually numerous. Forms highly modified are symmetrically associated with others equally interesting—varying in color as well as in shape.

*Natrolite.*—Seldom has this highly prized mineral appeared in greater abundance than at Weehawken. Between Shafts Nos. 1 and 2, large spaces of rock were coated with the mineral. The workmen gave glowing accounts of a blast, which released a block of stone "as large as a cooking-stove," one surface of which was white with natrolite—in some places finely rosetted. The stone was broken into sections and fragments, and carried away for disposal to collectors. One of the most interesting of these specimens is about eight inches square, supporting some twenty rosettes in fine condition. Incrustations of interlaced crystals, resembling cocoanut candy, several inches square and of a snowy whiteness, are among the specimens offered on this occasion. At other times, the acicular variety appeared in considerable quantity. An outburst of flowing water unfortunately injured a mass of the most promising material. Specimens from other cavities resemble snow-white plush. Aggregations of a globular form are among the most charming trophies the tunnel has yielded, especially when mounted on a surface of cream-colored stilbite.

*Apophyllite.*—Weehawken claims the honor of affording the first discovered pink apophyllite in the United States. The crystalline forms are generally simple. In size, some are an inch in length. In a few cases crystals are finely striated, the terminations vanishing into smaller crystals—a profusion of which cover the surface of the gangue. Interesting also are cases where opaque pinkish crystals present transparent terminations. Some few choice crystals of the usual color appeared, among them the glassy variety. In a drusy form, the mineral was quite as plentiful as datolite proved to be, in the tunnels back of Hoboken.

*Amethyst.*—Of interest to a local collector are the fragments of a lavender-colored amethyst, associated with the pink apophyllite of Shaft No. 1.

*Stilbite.*—The stilbite found varies in tint, from a snow-white to cream color and light brown.

The only other zeolite to be referred to is *Laumontite,* of which there appeared a few unimportant fragments. I have met no trace of chabazite or its relative, gmelinite. Some good bits of *Blende* are worthy of preservation.

No allusion need be made to thomsonite, unless the name be applied to certain mysterious specimens, the nature of which has not yet been determined. The crystals are acicular, of remarkable length, radiating from a globular nucleus of considerable hardness.

*Pyrite*, in brilliant and finely modified crystals, was brought out plentifully from Shaft No. 1. Some of the finest of these were half an inch in diameter.

The subject was further discussed by Mr. KUNZ and the Chairman.

DR. JOHN S. NEWBERRY then read the concluding part of his paper on

THE BOTANY AND GEOLOGY OF THE COUNTRY BORDERING THE RIO GRANDE, IN TEXAS AND CHIHUAHUA.

(Abstract).

Having recently spent some time in Southern Texas and Eastern Chihuahua, a country until recently overrun by the Comanches and Lepans, and, hence, but imperfectly known, I venture to hope that a few words of description of its aspects, geological structure, botany and resources, may not be unwelcome, especially as the attention of our people is being drawn in that direction, since it offers a new field for our surplus population and for the investment of capital.

The eastern and central portions of Texas are so well known, as to require no detailed description. Near the Gulf, the climate is warm and moist, and sugar and cotton are successfully raised. Beyond this belt, we pass on to plains on which there is little timber but mesquite, but the surface is covered with rich grass, and it is already one of the most productive grazing districts of the United States. The underlying rocks are, for the most part, of the cretaceous formation, without useful minerals, and the climate is dry.

On the western side of these plains, the country is traversed by mountain-chains, which belong to the Rocky Mountain system, and which form the outer rim to a region, of which the topography is more varied, the mineral resources greater, and the agricultural capabilities less, than those of central or eastern Texas. This is, in fact, part of a great table-land, that fills the interval between the eastern and western mountain ranges, here nearly a thousand miles apart, and which extends with diminished breadth, southward throughout the central portion of Mexico. The Rio Grande has cut deeply into this plateau, and, where it has forced its way through the mountains that

form its eastern rim, has excavated a series of deep and rocky cañons, which are impassable by boats and rival in their wild scenery those of the Colorado of the West. The country, immediately bordering the river, is much broken, but north and south there are intervals between the numerous and disconnected mountain-ranges, which are grassy plains, presenting on a smaller scale the features of the Llano Estacado on the north, and the Bolson de Mapimi on the south.

Further west, we reach a still more broken and arid country, in New Mexico, Arizona, Chihuahua and Sonora, where the ragged outlines of the mountains, and the peculiar vegetation—mostly cactus—give a special aspect to the scenery. This latter country, the home of the Apaches, has been the theatre of active mining operations, for many years, and the scene of unnumbered bloody tragedies. The country lying within southwestern Texas, eastern Chihuahua and western Coahuila, less rich in gold and silver, seems not to have proved sufficiently attractive to the Mexicans to induce them to brave the danger of its occupation, and it has been not only unoccupied, but much of it unexplored. The line of the Mexican Central Railway, which is being pushed southward from El Paso to the City of Mexico, passes about 200 miles west of the belt of country referred to; and the railway which crosses the Rio Grande at Laredo, and is now extended southwest to Monterey and Saltillo, is about as far away on the east. A concession has been granted by the Mexican Government to European capitalists, to build a road from Presidio del Norte, or Eagle Pass, or both, to Topolovampo, on the Gulf of California, and this road will probably traverse, almost centrally, the district under consideration. The general altitude of this country is from 4000 to 5000 feet, the Rio Grande, as it passes through it, falling from 3000 to 1000 feet above the sea level.

## BOTANY.

The country bordering the Rio Grande, in Chihuahua and Texas, is nearly destitute of trees, a feature which marks the aridity of the climate; yet, in certain localities, as on the bottom lands of the Rio Grande and Rio Concho, a vigorous and somewhat varied forest-growth was found at the advent of the whites. No better illustration of the relation between the kind of vegetation and the water supply in a country can be found, than that afforded by the luxuriant growth of trees of several kinds along the Cibola in the Chinati Mountains, Texas; while on all sides this oasis is surrounded by an apparently boundless, grass-covered prairie, where the rain-fall is inadequate for trees. On the mountain-summits, south of the Rio Grande, is a sparse growth of piñon (*Pinus edulis*), and evergreen oak, (*Quercus Emoryi*). The low lands, in certain localities over thousands of acres, are thickly set with mesquite, (*Prozopis glandulosa*), here a strong spreading shrub, never a tree, but with roots disproportionately large, composed of very dense tissue and furnishing a large amount of excellent fuel. Along the arroyos, cottonwood may occasionally be seen, either the narrow or the broad-leaved forms, (*Populus monolifera* or *P. angustifolia*), and more commonly the hacksberry, (*Celtis occidentalis*), and the nogal, the little black walnut (*Juglans rupestris*), the Mexican Buckeye (*Ungnadia speciosa*), and the Guyacon (*Guyacum Coulteri*). The dryer portions, especially the gravel terraces bordering the Rio Grande, are frequently covered with the creosote plant, (*Larrea Mexicana*) and *Tonquieria splendens.* The latter forms a cluster of fifteen or twenty canes, ten or twelve feet high, springing from the same root, and bristling with spines, an inch or more in length, of which the bases are in contact. Usually it is without leaves, and seems as though dead, but, for a brief interval in the rainy season, it is covered with small crowded obovate leaves, and from the summits of each stem springs one or more spikes of brilliant crimson flowers.

Among the shrubs which form the "chapparal" or thickets, the *Holacantha* is the most conspicuous, and *Salizaria* the most interesting. The former, as its name implies, is a mass of thorns which are often as large and strong as those of the honey locust. The branches and spines are covered with a green epidermis, which performs the functions of leaves, and, in the spring, these bear bunches of yellow flowers similar to those of *Berberis.* The *Salizaria* is a labiate allied to *Scutillaria*, and the seed is enclosed in a balloon-like capsule, similar to that of the balloon vine (*Cardioz permum*), also found here and having the same function, namely, dissemination by the wind. Two species of *Acacia* and one of *Berberis*, (*B. trifoliata*) all spiry, help to make the chapparal as nearly impenetrable as the thickets of cactus further west. We are here fairly within the confines of the cactus country, but not in its heart. Many species differing much in habit are constantly in sight—the "nopal," an *Opuntia*, being the most common, one species growing in a mass ten feet or more in height, with each leaf-like subdivision of the stem a foot in diameter. Though covered with spines, this plant is largely eaten by cattle, and nothing is more common than to see a patch of it trampled down, half eaten, and the flattened stems notched by their semi-circular bites. One species or variety of *Opuntia*, growing abundantly in Chihuahua, is of a deep purple color, which makes it conspicuous and often ornamental.

The most striking feature in the botany of this region is formed by the century plant and its allies: other species of *Agave*, *Habranthus*, and *Dasylirion*, and the yuccas. In many places these are the only plants attaining any large size, and are very numerous, scattered over the plains, and slopes of the mountains; the plants not crowded, but separated by intervals of a few feet, which are occupied with a luxuriant growth of gramma grass. The yuccas belong to four species or three species and two varieties, *Yucca angustifolia* and *Y. vaccata*. Of these, two rise to the height of five to fifteen feet, with trunks from six to twelve inches in diameter, the crowded radiating leaves crowning the summit in a round or oval mass, six feet or more in diameter, the old leaves hanging perpendicularly and forming a peculiar thatch around the trunk and extending to the ground.

The century plant is, in Chihuahua, represented by a variety with shorter and broader leaves than that commonly cultivated. From the center of the tuft, the flower stalk rises from 10 to 25 feet in height, composed of woody tissue and standing some years after bearing flowers. These persistent flower-stalks, crowning the ridges and visible for miles, give a peculiar aspect to the scenery. The century plants are, however, nowhere as numerous as the species of *Dasylirion*, with which they are associated, and which do not die with the effort of florescence. Further south, the agave supplies, from its sweet juice, the material from which an intoxicating drink is produced. In this region, however, an alcoholic beverage is obtained from the "Sotol" (*Dasylirion Texamum*), which, from its abundance and the use made of it, deserves a prominent place among the economical plants of the country. Hundreds of thousands of acres are covered with this Sotol, and it would seem that it might be much more largely utilized than it is, for the manufacture of alcohol. The leaves are three to three and a half feet long, by one and a half inches wide at the base, straight, flat and garnished on either side by strong recurved hooks. The color is yellow green, and the leaves are very numerous. From the center rises, at a certain stage of growth, a woody flower-stalk, ten feet high and at the base as large as one's arm. The trunk rises but a few inches above the ground and is completely concealed. The top of this trunk, composed of the closely imbricated leaf-bases, which are broad, yellow, shining, succulent and sweet—with a pulpy mass at the center, containing much saccharine matter, raw, or better roasted, is palatable and nutritious; so much so, that in the country where it grows, it is said the Indians never really suffer for want of food, as this affords them an abundant if not varied aliment.

In the preparation of Sotol whiskey—a liquid called *mescal*, as is also that made further west from other plants, the portion of the plant which has been described is trimmed so as to resemble a head of cabbage, then roasted and fermented, the product of the vinous fermentation being distilled in the ordinary way. For roasting the Sotol, a pit is dug, some ten feet in diameter and four feet deep, lined with rude masonry. In this a fire is built, and when it has been burned down, the pit is filled with several hundred Sotol heads. When roasted, they are chopped in pieces and fermented in vats.

Another interesting plant, the companion of the Sotol, is the "Lechuguilla," (*Agave heterocantha*), of which the leaves furnish a strong fibre, universally employed for ropes, sacks, etc., in Northern Mexico. This grows on the mountain slopes, generally at an elevation of about 4000 to 5000 feet, is common in all northern Chihuahua, and especially abundant on the Chinati Mountains in Texas.

## GEOLOGY.

The prevailing rocks of Chihuahua and Texas, are cretaceous sediments, chiefly limestones, broken through at frequent intervals by eruptions of trap of various kinds, trachyte, porphyry, diorite, etc. Presidio del Norte is surrounded by mountains, partly eruptive, partly upheaved sediments, with open intervals between them, occupied by the cretaceous strata, generally much disturbed. Between Presidio and the Sierra Rica, the middle and upper cretaceous rocks prevail—apparently the Colorado and Laramie Groups, the lower shales with bands of calcareous concretions filled with fossils, the upper sandstones and shales containing impressions of plants and thin coal. The concretions referred to above contain immense numbers of well defined cretaceous fossils, consisting of *Ammonites*, *Nautilus*, *Helicoceras*, *Ptychoceras*, *Baculites*, *Gryphea*, *Ostrea*, *Inoceramus*, etc. The Colorado shales here are very black, though much metamorphosed, and containing *Inoceramus*, form the walls of the vein of the Sierra Rica mine, a clean cut fissure, crossing the bedding of the shales nearly at right angles, having a quartz gangue, containing some very rich but very compound ore, copper, zinc, lead, silver and iron.

Seventy-five miles southeast from Presidio are the San Carlos Mountains, composed of cretaceous limestones set at a high angle and very much metamorphosed. The San Carlos cañon cuts through the greater part of the range, showing a section of several thousand feet of rock, mostly light blue, but sometimes black limestones highly metamorphosed, yet often crowded with characteristic cretaceous fossils.

The ore deposit at the San Carlos mine is of extraordinary magnitude and of special interest. It fills a series of chambers in limestone, one of which is several hundred feet in length and more than 200 feet in depth and breadth. It is evidently a chemical deposit, filling cavities made by solution, and consists of black, often crystalline magnetite, pyrites, galena, and blende, containing both gold and silver. Of this ore there are apparently many millions of tons, and in character it is, so far as I know, without parallel among all the ore deposits of the country. At a distance of half a mile, the limestones are cut through by a great dyke of diorite, which has doubtless furnished the heat that was the mainspring of the chemical affinities, but it has apparently contributed nothing to the mineral matter of the ore deposit. At a point further south, the dyke crosses the zone of limestone which holds the ore. It is there metamorphosed, but not at all mineralized.

In the same region are other mineral deposits, which will probably prove to be of considerable value. Among these is another series of chambers in limestone, filled with hard carbonate of lead and galena. Others still, which are rich in copper, also carry silver and gold.

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February 19, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was occupied by the audience.

Dr. ALBERT R. LEEDS, of Stevens' Institute, Hoboken, delivered a lecture on

HEALTH-FOODS, INVALID-FOODS, AND INFANT-FOODS,

illustrated by an analytical table and a series of specimens.

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February 26, 1883.

ANNUAL MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The CORRESPONDING SECRETARY reported as follows:

"During the past year, six names have been added to our list of Corresponding Members. The Academy has suffered the loss of two eminent Honorary Members, Charles Darwin and Friedrich Wöhler. The vacancy caused by the death of the former has been filled by the election of Major-General Sir Henry Creswicke Rawlinson; that by the latter has not yet been filled.

ALBERT R. LEEDS,
Corresponding Secretary."

From the book of the TREASURER, the EDITOR has compiled the following statement, for the year ending February 26, 1883:

## Receipts.

*Initiation Fees.*

| | | |
|---|---|---|
| Feb., 1882, to Feb., 1883, fees of 17 new members.......... | | $85.00 |

*Annual Dues.*

| | | |
|---|---|---|
| Feb., 1882, to Feb., 1883, 276 dues and back dues........... | | 1,380.00 |

*Subscriptions to Annals.*

| | | |
|---|---|---|
| Feb. 27, 1882, to Jan., 1883, 134 annual subscriptions.. | $268.00 | |
| Sales of annals and transactions, per D. S. Martin... | 53.72 | |
| | | 321.72 |

*Interest on Bonds.*

| | | |
|---|---|---|
| 1882. April 1, July 1, Oct. 2, and Jan. 1, 1883.............. | | 164.00 |

*Sundry.*

| | | | | |
|---|---|---|---|---|
| 1882. | Feb. 9. | A. J. Todd, donation for transactions | $25.00 | |
| | " 12. | C. S. Fisher, " " " | 15.00 | |
| | Apr. 10. | G. M. Beard, rent of hall.......... | 13.50 | |
| | | | | 53.50 |
| | | Total receipts ................................ | | $2,004.22 |

## Expenditures.

| | | | | |
|---|---|---|---|---|
| 1882. | Feb. 27. | Amount advanced by Treasurer.......... | | $202.19 |

*Treasurer.*

| | | | | |
|---|---|---|---|---|
| 1882. | Apr. 28. | Gregory Bros., printing receipts, etc. | $6.50 | |
| | Sept. 14. | G. P. Putnam's Sons, printing memorandum of fees........... | 7.25 | |
| 1883. | Jan. 17. | J. Cornelssen, collection of fees..... | 93.20 | |
| | Feb. 7. | J. H. Hinton, postage and stationery | 20.00 | |
| | | | | 126.95 |

*Recording Secretary.*

| | | | | |
|---|---|---|---|---|
| 1882. | Feb. 27. | O. P. Hubbard, postage, etc....... | $5.14 | |
| | Nov. 16. | C. H. Clayton, minute book....... | 3.75 | |
| | | | | 8.89 |

*Library.*

| | | | | |
|---|---|---|---|---|
| 1882. | Mar. 7. | A. Woodward, services in library.. | $22.83 | |
| | Apr. 15. | T. Egleston, postage.............. | 25.00 | |
| | Nov. 3. | B. Westermann & Co., importation charges .................... | 6.65 | |
| | " 9. | C. G. & F. Neumann, bookbinding. | 100.10 | |
| | " 9. | " " " . | 130.00 | |
| | " 29. | A. Woodward, services in library.. | 17.75 | |
| | | | | 302.33 |

*Annals.*

| | | | | |
|---|---|---|---|---|
| 1882. | May 4. | B. B. Chamberlin, engraving maps, etc. | 17.00 | |
| | " 8. | Gregory Bros., printing Annals, II, Nos. 7 and 8 | 227.61 | |
| | " 11. | D. S. Martin, services as editor of Annals | 100.00 | |
| | July 15. | G. Gregory, printing Annals, II, No. 9 | 128.93 | |
| | | | | 473.54 |

*Transactions.*

| | | | | |
|---|---|---|---|---|
| 1882. | Dec. 4. | A. A. Julien, bills paid for printing. | 100.00 | |
| 1883. | Feb. 13. | The Spectator Co., printing | 50.00 | |
| | | | | 150.00 |

*Lectures.*

| | | | | |
|---|---|---|---|---|
| 1882. | Apr. 10. | J. S Newberry, lecture expenses.. | 5.00 | |
| | June 20. | A. H. Elliott, " " .. | 11.50 | |
| | | | | 16.50 |

*Weekly Meetings.*

| | | | | |
|---|---|---|---|---|
| 1882. | Feb. 27. | D. S. Martin, postal cards, etc. .. | 55.73 | |
| | Apr, 4. | " " " .... | 12.10 | |
| | May 8. | Gregory Bros., printing ballot-cards, etc. | 50.75 | |
| | July 15. | G. Gregory, printing | 20.25 | |
| | Nov. 3. | D. S. Martin, postal cards, etc. | 37.92 | |
| | | | | 176.75 |

*General Expenses.*

| | | | | |
|---|---|---|---|---|
| 1882. | Apr. 10. | J. S. Newberry, postage, etc. | 10.18 | |
| | May 13. | Hussey's Post, delivery of notices.. | 17.74 | |
| | Nov. 25. | L. R. Weeks, addressing notices, annals, etc. | 61.59 | |
| | | | | 89.51 |

*Rent of Rooms.*

| | | | | |
|---|---|---|---|---|
| 1882. | May 12. | N. Y. Academy of Medicine | 118.75 | |
| | Sept. 26. | " " " ...... | 106.25 | |
| | Nov. 3. | " " " ...... | 106.25 | |
| 1883. | Feb. 7. | " " " ...... | 106.25 | |
| | | | | 437.50 |
| | | Total expenses | | $1,984.16 |
| | | February 26, 1883, Balance on hand | | $20.06 |

The RECORDING SECRETARY reported as follows:

"The annual meeting was held Feb. 27, 1882, when the officers of the Academy were elected and the ordinary business was transacted.

There have been nine sessions of the Council and thirty-four meetings of the Academy—fifteen before the summer recess and nineteen since.

The Proceedings of the Academy are well-known to the members.

The attendance on the regular meetings is unchanged, and that on the lectures indicates a high appreciation of their value.

The communications, oral and written, have been numerous and very varied. They have been fully illustrated by specimens, instruments, diagrams and the lantern, and may be classed as follows:

| | | | |
|---|---|---|---|
| Arts | 3 | Geology | 15 |
| Archæology | 1 | Mineralogy | 22 |
| Astronomy | 2 | Nat. History | 12 |
| Chemistry | 8 | Psychology | 2 |
| Engineering | 2 | Physiology | 4 |
| Total | | | 71 |

Nine lectures have been given by members and other gentlemen, on invitation of the Academy—on Archæology, Chemistry, Geology, Physiology and Zoölogy, and all well attended.

| | |
|---|---|
| The number of new Resident Members | 17 |
| The resignations | 14 |
| The deceased | 4 |

beside one Honorary and one Corresponding Member.

The Academy greatly needs re-inforcement by an increase of its Membership.

O. P. HUBBARD,
Recording Secretary."

The LIBRARIAN reported "the number of publications constituting our Library, at the end of the last year, aggregate to about 6500 volumes and 2000 pamphlets; and the addition received up to Nov. 27, 1882, to 205 volumes and 25 pamphlets. Since that date, 20 volumes, 135 parts and 197 pamphlets, reports, etc., have been received, amounting to a total accession, during the fiscal year of 1882, of 225 volumes and 357 pamphlets; which makes a grand total of 6725 volumes and 2357 pamphlets in our Library at the present time, exclusive of the publications presented this evening.

During the past year 211 volumes have been bound, leaving about 500 unbound volumes now on our shelves. The large number of periodical publications continually received, makes an arrangement for binding a continual necessity, to prevent our again falling behindhand, as we have done during many former years.

L. ELSBERG,
Librarian."

The Chairman of the Publication Committee presented the following report:

"During the year ending February 26th, 1883, there have been published three numbers of the Society's ANNALS, Nos. 9, 10 and 11, of Volume II. There remains still another part, No. 12, belonging to the regular issue for 1882, and with which the second volume would close, which is not yet published and is still due to subscribers for that year. This part, it is hoped soon to issue.

Besides these, there were also published during the year covered by this report, although belonging to the issue for 1881, Nos. 7 and 8 of Vol. II.

The Academy is indebted to Dr. LAURENCE JOHNSON for Plate XVIII.,—the original map illustrating his article,—the entire cost of which was borne by himself; also, to Mr. Thomas Bland, Dr. Newberry, Mr. F. G. Wiechmann, and Prof. Thurston, for aid in the cost of illustrating with plates or cuts.

During the coming year, it will be necessary for the Academy to provide the additional amount needed for publishing the Index to the second volume.

The issue of the Transactions, which was begun in the fall of 1881, and referred to in the Committee's report, one year ago, has been carried on successfully during the year. Eight numbers,—one for each month of the Academy's session,—have been issued; and the second volume has been begun, for the session of 1882-3; although it is matter for regret that the means have not been provided to secure that promptness of publication so desirable, and so much hoped for, in a journal of this kind.

D. S. MARTIN,
Chairman Publ. Com."

The following officers were elected for the ensuing year:

President, J. S. NEWBERRY.

Vice-Presidents, B. N. MARTIN and A. A. JULIEN.

Corresponding Secretary, A. R. LEEDS.

Recording Secretary, O. P. HUBBARD.

Treasurer, J. H. HINTON.

Librarian, L. ELSBERG.

*Council.*

D. S. MARTIN. W. P. TROWBRIDGE.
G. N. LAWRENCE. A. C. POST.
T. EGLESTON. L. ELSBERG.

*Curators.*

B. G. AMEND. C. F. COX.
B. B. CHAMBERLIN. H. L. FAIRCHILD.
N. L. BRITTON.

*Finance Committee.*

T. B. CODDINGTON. P. SCHUYLER. T. BLAND.

The PRESIDENT communicated to the Academy that a Committee of the Council had conferred with the Trustees of Columbia College, in reference to a room in their new building on East Forty-ninth street, in which to hold the meetings of the Academy, and that they had given permission to occupy a room for this purpose, free of rent. It was

*Resolved*, that the thanks of the Academy be presented to the Trustees of Columbia College for the permission they have given the Academy to hold its meetings in the College-buildings.

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March 5, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifteen persons present.

The following persons were elected Corresponding Members:

Prof. LUIGI BOMBICCI, University of Bologna, Italy.

Prof. ANTONIO D'ACHIARDI, University of Pisa, Italy.

Prof. G. GRATTAROLA, Inst. Superior, Florence, Italy.

Dr. A. WEISSBACH, Bergakademie, Freiberg, Saxony.

M. EMILE BERTRAND, 15 Rue du Tournon, Paris, France.

M. A. JANNETAZ, College Sorbonne, Paris, France.

Prof. F. PISANI, Paris, France.

The CHAIRMAN exhibited a fine specimen of gold, associated with black oxide of manganese, from near the surface of a vein of quartz, in Southwestern Colorado, and also crystals of topaz, locally denominated quartz, from Nevada.

Dr. T. EGLESTON stated, that in 1862, two topazes were brought in by the Pacific Railroad Survey, which, after careful examination, lead him to announce that tin would be found in the vicinity from which they came. In 1874, he saw at Salt Lake City several specimens which were supposed to be a curious distortion of quartz, from Southern Utah, which turned out to be topaz. The discovery of these crystals, with the same associations, and of exactly the same form, as in Xacatecas, in the vicinity of tin mines already worked, is extremely important, as it implies the presence of tin, associated with these crystals, within the borders of the United States.

In speaking of the crystallized gold specimens, exhibited by Dr.

NEWBERRY, he pointed out that the native gold of the specimens was contained in the cavities left by the decomposition of pyrites.

Mr. ARTHUR H. ELLIOTT read a paper, illustrated by the apparatus, on

### AN IMPROVED METHOD FOR GAS-ANALYSIS.

(Published in the Annals, 1883).

#### DISCUSSION.

Mr. G. F. KUNZ stated that, in assisting Prof. Wurtz in a series of gas-analyses, they had found that the Orsat-apparatus required several days for each analysis. All joints of the apparatus were kept lubricated with glycerine.

Dr. T. EGLESTON remarked that the Orsat-apparatus, which resembled somewhat that of Mr. Elliott, possessed very great advantages in making commercial analyses of gas, in the quickness and convenience of its use. It was very portable, and he had carried it up a high ladder, to a vat, in a whitelead works, made there the analysis of a gas, and brought it down to the ground again without any difficulty. It was, however, expensive, and was sometimes sluggish, especially in the determinations of carbonic oxide. It is, however, very suitable for the commercial analyses of gases. Mr. Elliott's apparatus is more suitable for the laboratory than for the works, because it is so very fragile. It is likely, also, to be sensitive to changes of temperature, which would necessitate making corrections for the variations of the volume of the gas, especially in very cold or very hot weather, when it might be necessary to have the apparatus jacketed, to allow sufficient time for the observations. How quickly the volume of gas will change by temperature, is shown in the oscillations which occur in the delicate air-thermometer, used in the Doyer apparatus. The special advantage, which is very apparent in Mr. Elliott's apparatus, is that the efficiency of the apparatus is always at a maximum, since the chemicals used are always new, and are arranged in such a way that they are exposed to a very large surface; for, while the surface is not as large as in the Orsat apparatus, in general, either in the tube or in the gauze part of the apparatus, it is amply sufficient with fresh chemicals for all practical purposes. While this apparatus does not have the same relation to commercial work that the Orsat does, and is not so scientifically accurate as the Doyer, it must be regarded as a very great advance in laboratory work, both on account of its simplicity and its cheapness.

Mr. Elliott stated his preference for vaseline for the lubrication of the joints of the apparatus. In regard to the absorption of carbonic oxide, he had compared analyses with those by the Bunsen method, and, in one instance, had obtained 27 per cent., by his apparatus, against 26.7 per cent., by that of Bunsen. He did not claim any greater accuracy for his apparatus, beyond the determination of constituents which amounted to tenths of a per cent. He had never observed any changes of volume, due to temperature, greater than a few tenths of a cubic centimeter in 15 or 20 minutes, while he and other persons were standing near the apparatus.

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March 12, 1883.

Section of Chemistry.

The President, Dr. J. S. Newberry, in the Chair.

Thirty-one persons present.

Prof. H. Carrington Bolton, of Trinity College, Hartford, Conn., read the second part of his paper

## ON THE HISTORY OF CHEMICAL NOTATION.

(Abstract).

He had discussed on a previous occasion (December 11th) the early association of metals and planets, and the supposed origin of the signs used for both ; he now took up the subject of alchemical symbolism, and traced also the later developments in chemical notation from the days of Geoffroy to Berzelius.

The indefatigable alchemists discovered new chemical substances more rapidly than they became acquainted with their proper relation to known bodies and to each other, so that the names assigned to them were arbitrarily chosen and frequently misleading. The love of the mystical also influenced alchemical terminology, very greatly obscuring it ; in forming their vocabulary, the alchemists used the names of animals, plants, and of organic substances, as well as letters, numbers, signs of the zodiac, and an innumerable variety of arbitrary and conventional characters. To conceal their knowledge from the uninitiated, they gave the same name to many unlike bodies, and used also a great number of synonyms. A highly metaphorical language arose, and when certain enthusiasts attempted to graft Egyptian mythology and Greek fables on to alchemy, the height of absurdity in nomenclature was attained. Nitre, for example, was called a "venomous worm," a "scorpion devouring his children," and a "dragon." The labors of Hercules, the Argonautic expedition, in search of the Golden Fleece, and similar legends received alchemical interpretations. The method of notation, which existed at this period, was no less astonishing; sal ammoniac, for example, being called an eagle, on account of its volatility, was represented pictorially as the bird of prey; antimony being denoted as a wolf, and gold as a king, the fusion of the two metals was represented by the picture of a wolf devouring a prostrate and crowned man. Allegorical formulæ of this character were especially cultivated by Dr. Michael Maier, physician to Rudolph II., and author of several illustrated works now much sought by bibliophiles.

As early as the thirteenth century, the four Aristotelian elements were represented as follows:

🜁 Air.

🜂 Fire.

🜃 Earth.

🜄 Water.

At some uncertain period, the elementary principles of alchemical theories were represented thus:

☿ Sulphur.

🜔 Salt.

🜍 Mercury.

These are among the earliest of an enormous number of characters which the alchemists introduced into their writings. Many keys to these singular characters have been published; one of the earliest is that of Heinrich Eschenreuter, a reputed Bavarian priest of the fifteenth century; similar keys are found in the works of Crollius, Kircher, Juncker, Lefèvre, Lemery, Blancardus, *et al.*

The multiplicity of names in vogue among the alchemists gave rise to a large number of symbols, each synonyme having its appropriate character; thus mercury had at least 40 signs, borax 35, a crucible 18, cream-of-tartar 31, cinnabar 22, and so on. Dictionaries of these signs exist, the most noteworthy being that entitled the *Alchymis-*

*tisches Oraculum*, published at Ulm, in 1772, and a 400 page folio by J. C. Sommerhoff, published in 1701.

The speaker said he had carefully studied the abundant material afforded by these and other lists, and had sought some method of classifying these signs. He proposed the following scheme of classification:

*I. Abbreviations.*

| | |
|---|---|
| BM | Balneum mariæ. |
| SVR | Spiritus vini rectificatus. |
| ā ā ā | Amalgama. |
| CC | Cucurbita. |
| Σ | Sucrum. |
| ⊡ | A river. |

*II. Pictorial Signs.*

| | |
|---|---|
| | Feather alum (halotrichite.) |
| ≈ | Water. |
| ∴ | or ⁘ sand. |
| | Retort. |
| | Crucible. |

tin, iron, mercury and copper, and probably the signs for lead.

*III. Symbolical Signs.*

| | |
|---|---|
| ⧖ | Hour. |
| | Crucible (crux) or |
| ♆ | Lime (calx, a spur). |
| ☉ | Gold (sol). |
| ☽ | Silver (luna). |
| | Metallic regulus. |
| ∴ | Oil (three drops ?) |

*IV. Arbitrary Signs.*

| | |
|---|---|
| | Vinegar. |
| | Cream of Tartar. |
| | Common Salt or |
| ▽ | Water. |
| | Realgar. |
| | Burnt Alum. |
| | Iron. |

and a very large number of numerals, for example:

| | |
|---|---|
| 4 | Crucible. |
| 25 | Rock Salt. |
| 80 | Realgar. |
| 33 | Cinnabar. |
| 18 | Common Salt. |
| 63 | Cream of Tartar. |

*V. Complex Signs*, formed by uniting two or more of the preceding groups.

| | |
|---|---|
| | Reverbertory Fire. |
| | Aqua Fortris. |
| | Aqua Regia. |
| E | Tartar Emetic. |
| ⊙ | Gold Leaf. |
| ☽ | Silver Leaf. |
| ∴ B | Balneum Arenæ. |
| | Aqua Regia. |
| ♀ stum | Aes Ustum. |
| VE | Vinum Emeticum. |
| | Antimonii Regulus. |

By far the larger number of signs fall under Group IV, Arbitrary, but it is highly probable that many in this class are in reality distortions of signs belonging to one of the other groups.

The first intelligent use of these signs seems to have been made by the distinguished French chemist, Geoffroy, in 1718. He was the first to prepare tables showing the relative chemical affinity of substances; and he arranged the existing signs in columns to indicate their mutual relations. He added little to the notation, but discovered a new power in the symbols. The next step in advance was made by Torbern Bergman, who proposed to denote analogous bodies by similar signs having minor distinctions. His fundamental or basic characters were a triangle, a circle, a crown and a cross, and these he modified and combined in various ways to represent a great number of substances. Bergmann, however, carried out his excellent proposition very imperfectly. In Bergmann's Dissertation on Elective Affinities, we find the earliest style of chemical equations.

The speaker then referred to Lavoisier's scheme of notation, to the elaborate plan of Hassenfratz and Adet, and to the improvements introduced by Dalton, who revived the atomic philosophy and clothed it with new significance. None of these schemes were, however, destined to survive.

In 1814, the eminent Swedish chemist, Berzelius, published a memoir on nitrous acid, in which he discusses the different degrees of oxidation which nitrogen undergoes; in a modest foot note, he incidentally mentions that he frequently employs, in private memoranda, a convenient system of abbreviations for representing chemical bodies. This was the germ of the present rational system of notation, which has done so much to advance chemical science and to lighten the labors of students of every nationality. The Berzelian notation was not the result of any premeditated plan, carefully elaborated and presented to a Scientific Academy for their endorsement, but a simple device of a master mind, seeking to embody theoretical views in a practical manner. Twelve years later, Berzelius published a brief paper "On a method of expressing in formulæ the Composition of Bodies, as respects both their elements and the number of their atoms."

In this he describes the system, which, with slight modifications, now prevails wherever chemical science is known.

He proposes to denote each element by the initial letter or letters of its Latin name, and that such symbol shall represent the relative weight of one atom of the body designated. Berzelius remarks in this connection that the French mineralogist, Beudant, had the national vanity to employ the initial letters of French names, and suggests the desirability of employing Latin names, in consequence of the obvious inconvenience attending the use of English, German and Italian names. He then quotes Sir H. Davy's remark, "Science, like that Nature to which it belongs, is neither limited by time nor space; it belongs to the world and is of no country and of no age."

Berzelius gives a list of the then known elementary bodies—forty-nine in number—and explains the use of co-efficients, both small and large, of barred letters for double atoms and of dotted letters for oxides. He employs the plus sign with very nearly the same significance as that of the period used at present. In all essential points, the existing system is identical with that introduced nearly seventy years ago.

With the rapid growth of the science, the Berzelian notation was found insufficient to express fully the mutual relations of constituent atoms, and constitutional formulæ were devised; these displayed formulæ gradually developed under the influence of the theory of atomicity into graphic formulæ, and, for educational uses, into glyptic formulæ.

The multiplication of the compounds of carbon, and the necessity of presenting accurate views of the differences in the constitution of isomeric bodies have led to the construction of prismatic formulæ, the development of which is still in progress.

The subject was further discussed by Prof. Leeds, the President and the author.

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March 19, 1883.

Lecture Evening.

No meeting was held, on account of the unavoidable detention of the lecturer in a Western city, by sickness in his family.

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March 26, 1883.

The President, Dr. J. S. Newberry, in the Chair.

Seventy persons present.

A private communication was presented, from Prof. William B. Dwight, of Vassar College, Poughkeepsie, N. Y.:

"In some zoological explorations which I was making at Martha's Vineyard last summer, I was so fortunate as to find, what I never found before, a nest of newly hatched larvæ of *Limulus polyphemus*. As they are objects of much interest to zoologists, on account of their forming a connecting link with the ancient trilobite, and as few succeed in getting hold of any, I think it very likely that some of them might be desired, and shall be most happy to donate some of my specimens. They are 4 mm. or less in length, and without the abdominal spine....Staining improves them very much and brings out a curious oval spot on the head-shield, external and somewhat anterior to the compound eyes; but it is somewhat difficult to get the color to strike in. Moreover, the saline matter retained within the outer crust makes some trouble with the coloring. The latter cause is now partially removed, as I have several times changed the alcohol, and is probably quite removable by longer soaking and changing."

The CHAIRMAN remarked on the interesting relationship of the "horseshoe crab" (*Limulus*), and the ancient trilobite, and the difficulty of obtaining the larvæ, in spite of the abundance with which they somewhere breed.

About 200 specimens of the larvæ were distributed, later in the evening, among the members of the Academy present.

Prof. CHARLES B. WARRING, of Poughkeepsie, N. Y., then read a paper, entitled:

A STUDY OF THE CHALDEAN "ACCOUNT OF CREATION,"

as translated by Mr. George Smith and Profs. Sayce and Lenormant, and also of the account of Berosus, in reference to their connection with the first chapter of Genesis.

(Abstract).

There are three kinds of Chaldean myths; those purely mythological; those referring to the Deluge; and those said to give an account of the Creation,* and, which, it is claimed, are the originals of the story, in the first chapter of Genesis. Of these "creation" myths there are three: that on a series of tablets—the most famous one, that found on the tablet of Cutha, and the story related by Berosus.

The object of the present paper is to examine this claim, first, by inquiring whether there is historical evidence in its favor. There appears to be none. Secondly, are there strong probabilities in its favor, which themselves rest on admitted facts? Only two have been named, the great age of these myths, and the fact that the Hebrews were carried to Babylon and remained there many years. However it may be as to the other myths, all admit that the "creation" myth was written in the reign of Assur-bani-pul, 670 B. C., no very great age as

"*No Chaldean account of the Fall has as yet been found." Prof. Sayce's Smith's Chaldean Genesis, page 88.

compared with the epoch of Ezra, and many centuries after the time of Moses.

As to the Hebrews being in Babylon, it is an historical fact that those who returned to Judea did so with the most intense hatred of every form of idolatry; it is therefore incredible that they adopted the religious myths of hated and despised idolators and embodied them in their own sacred books, even giving them the place of honor.

As some will say, "however strange it may appear, nevertheless the Hebrews did take the heathen myths and adopt them, for here they are." This can be met only by a careful examination of the myths and of the Creative account in Genesis. If the two are identical in their teachings, then we may conclude that one was the source of the other. But if their agreements are few and of little importance, if, *e.g.*, both speak of earth and heavens, of plants and animals, such agreement would be of little value, because by no possibility could a cosmogony be written and not speak of these. If at the same time their disagreements are many and important, if in fact their statements are radically opposite, then it is impossible that the one should have been derived from the other. The paper then went into an extended comparison of the myths with the story in Genesis. The myths were given in full, and their few resemblances to the Hebrew account, together with their many flat contradictions were pointed out. For example, the myths place the heavens and earth before the gods. Genesis says, God was first. The whole first tablet is occupied with the origin of the gods. The "beginning," it says, was that point in the existence of the heavens and earth when the great gods began to be. In Genesis, the beginning is that point in the existence of God at which the heavens and earth began to be.

In the fifth tablet (all the others are missing, except possibly one little fragment which says only this: "The foundation of the caverns of rock thou didst form"), which is claimed to correspond to the fourth period in Genesis, it is said that one of the gods *arranged* the stars in three rows of constellations. Genesis says God *made* the stars. The myth says that the god made a stair-case in the midst of the earth. Nothing like this is found in Genesis. The myth gives great prominence to the stars, Genesis says little of them. The myth makes the month, and the moon in connection with its office as a measurer of months, by far the most prominent things in it. Genesis says absolutely nothing about months—does not mention them.

There is one more fragment. In this it is said that the gods made "cattle of the field, and beasts of the field, and creeping things." This is the only real resemblance to Genesis, and this could not well be avoided if both were to speak of animals.

The tablet of Cutha is so grotesquely absurd, that no one claims that it, or any part of it, is embodied in the Hebrew account. The same is true even in a stronger degree of the story related by Berosus.

The myths have no division into creative days. They have no fiats. The gods do not pronounce their work good. The Hebrew account is divided by the creative day verses into six periods. Every creative act is preceded by a fiat, and six times God pronounces His work good, and then He sees all that He has made and pronounces it very good.

There is nothing like this in the myths. It is therefore absurd to say that these were the sources from which was taken the account in our Bibles. In conclusion, it was stated that these myths are not a cosmogony at all, or, at least, this is not their primary purpose. They form a theogony. They set forth the origin and descent of the gods, and join to each his supposed share in arranging the world and the heavens. As such they are intelligible and duly proportioned.

## DISCUSSION.

Dr. B. N. Martin remarked on the interest of the comparisons which had been made, and assented to the conclusion, in regard to the scanty similarity of the two accounts. In the many gods worshipped by the Greeks, Egyptians, and Chaldeans, there was nothing ultimate, and the question always presented itself—whence these gods came. In the Hebrew account, however, the Supreme Agent was self-existent and self-dependent. Also, in modern philosophy, there is a continual tendency to the resolution of all the varied physical forces into a single, infinite, always existing Force—the "Force of the Infinite" of Herbert Spencer. It was an important distinction, made by the author of the paper, that all the other ancient philosophies were theogonies, while that of the Hebrews was a cosmogony, one produced by a personal Infinite Force.

Rev. H. C. Hovey observed that from a purely historical and rational point of view, although, on the one hand, the Hebrews had been closely associated with the Chaldeans, through their Chaldean progenitor Abraham, and in the early intercourse of his sons and grand-sons with that people—on the other hand, a long break of four centuries took place in that intercourse, while the Israelites were in Egypt; so that Moses was far more likely to have been influenced from Egypt than from Chaldea, in writing his cosmogony.

The CHAIRMAN considered the facts yet too few and imperfect to establish any fair criticism.

There was, however, another Chaldean account, that of the Deluge, which was very interesting and clear—so close to the Biblical account, indeed, that there must be some connection between them. The tablets under discussion were comparatively modern, reaching back not over 800 years B. C.; there was, therefore, no proof that the undoubtedly far more ancient Biblical account had been derived from these. He called attention to the recent discoveries by Mr. Rassam of ancient records, at Aboo Habba, in the valley of the Euphrates, in one place, of nearly 40,000 tablets, which, although composed of soft clay, had been nearly all preserved intact by the discoverer, by a method of careful baking. So, too, in the ruins of the so-called Tower of Babel, masonry, timbers, etc., had been recently found in such a state of preservation as to render probable the discovery soon of records of some kind at that locality.

At present there was too great an imperfection in the records, and also too little acquaintance with the languages of those records, as had been illustrated by the discrepancies of the several translations presented in this paper, to justify positive statements.

Nevertheless, it was a remarkable fact that, for the last two or three thousand years, a detailed record of the Creation has stood before the world. In the progress of geological discovery, astonishing correspondences have been established, in reference to this Biblical record, incomprehensible unless derived from a supernatural Power.

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April 2, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

A paper was read by Dr. J. S. NEWBERRY, on

AN INQUIRY INTO THE ORIGIN OF THE CARBON PRESENT IN BITUMINOUS SHALES.

(Published in the Annals.)

DISCUSSION.

A MEMBER assented to the general view maintained in the paper but inquired whether it was intended to draw any analogy between the vegetation from which the carbon in the shales was derived, and the aggregations of gulf-weed in the "Sargasso Sea," etc. It was entirely improbable that, however dense the vegetation might be upon the surface of the ocean in such regions, any accumulation of carbonaceous matter could take place upon the oceanic bottom, from the exceedingly slow rate at which mineral detritus can be there deposited to protect such organic matter from oxidation ; nor have any such accumulations been found in the deep-sea dredgings of the *Challenger* or other expeditions.

Dr. NEWBERRY doubted whether any dredgings had ever been made beneath the Sargasso Sea, but he also disbelieved in the possibility of such a carbonaceous deposit in the deep ocean. He had only desired, by the allusion to the Sargasso Sea, to indicate the probability of a similar aggregation of floating algæ upon the surface of the shallow waters beneath which these shales must have been formed.

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April 9, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

The CORRESPONDING SECRETARY called attention to the recent death of Dr. JOSEPH PRIESTLEY, of Northumberland, Penn., the last surviving descendant of the eminent chemist of that name, and remarked on his genial kindness and eminent talent as a physician, and the influence of his character and position, by which he generously assisted in the success of the Centennial Celebration of American Chemists at Northumberland, in the summer of 1874. After discussion by Mr. ELLIOTT and the President, it was

*Resolved*, that the Corresponding Secretary be requested to convey to the family of the deceased our sincere sympathy in their bereavement, and our high appreciation of his character.

Dr. ALBERT R. LEEDS then read a paper, entitled:

### AN ACTINIC METHOD FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER,

with the application of the method to the water supplies of Philadelphia, Newark, Jersey City, Brooklyn, and New York.

At the present time there is no method known of determining accurately the amounts and kinds of organic matter existing in the water we drink. The amounts are so small, the kinds so various, the instability of much of the organic matter so great, that the best we can do is to make a tolerably accurate estimation of the total amount, and endeavor to find out what portion of this is safe and what is possibly dangerous to health. To make this scientific guess, so to speak, various expedients have been hit upon, and a vast deal of thought, controversy and time have been expended. The mode most in vogue is to heat the drinking-water with an alkali and a powerful oxidizing agent, and to find how much ammonia distils off from it. The ammonia thus obtained is regarded as a measure of the putrefiable organic matter present. Another way is to find out just how much nitrogen and how much carbon are present, and, from the fact that animal substances have a much higher proportion of nitrogen to carbon than vegetable substances, to conclude whether any dangerous bodies of animal origin are present. These two ways are greatly in use in England. The Germans place great confidence in a third method, which is to find how much of the organic matter is capable of being oxidized by permanganate of potash when the water is being boiled with this strong oxidizer, and to regard this oxidizable fraction of the organic matter as the part dangerous to health, and of importance therefore to consider. In France, again, much stress is laid upon finding out how large an amount of oxygen is dissolved in the water, on the ground that if there is much less present than is always found in really pure water, there is reason for believing that the deficiency is due to the absorption of oxygen by bodies undergoing decay and putrefaction.

The new method, I am about to propose, depends upon the fact that compounds of silver are not decomposed by light, when they are in solution in water, unless organic matter is present in the water also. If sufficient care is taken to exclude every trace of organic matter, even such as might accidentally enter from the dust of a room, silver solutions may be kept in the sunlight for years without change. Another fact lying at the foundation of this new process is, that stable organic bodies, like sugar, starch, gum, etc., have very little influence, while decomposing substances, like excreta of all kinds, throw down the silver very rapidly.

[Here a bottle was shown in which some sewage-water had been added to a solution of nitrate of silver, and then exposed to sunlight. The whole interior of the bottle was covered with a bright mirror of metallic silver. Another bottle was shown containing some Croton water drawn at the Christopher St. Ferry last Saturday. It was covered at the bottom with a black deposit of metallic silver, nearly but not quite so great in amount as a similar sample taken from the Passaic River (the water-supply of Newark and Jersey City) a week before.]

The amount of silver thus thrown down can be readily weighed, and the relative amounts of organic matter present in the water thus determined. A sample of Brooklyn water, taken Mar. 4th, when the water had deteriorated, showed this fact by the large amount of silver which it precipitated. And during the month of January, when I was called on to Philadelphia to examine their water-supply, at that time very offensive to both smell and taste, this method of examination was extensively used. It showed, among other things, that when sufficient air was passed through the Philadelphia water to raise the percentage of oxygen to the proper amount, the decomposable organic matter was largely destroyed; and samples thus treated threw down just so much less silver, on exposure to sunlight, as there had been organic matter destroyed by previous oxidation in contact with air. This elucidated the origin of the difficulty with the Philadelphia water. It had not been aerated sufficiently to get rid of the decomposable organic matter which it contained, and which communicated its offensive taste and smell.

DISCUSSION.

MR. A. H. ELLIOTT remarked, in reference to the determination of free ammonia in water by distillation with sodium-carbonate, that albuminoids are decomposed in this way, and that the method is fallacious: since, for example, in the case of urea, ammonia is given off before potassium-permanganate and caustic potassa are added.

The potassium-permanganate is itself full of ammonia, unless it has been previously purified.

The methods of Wanklyn and Frankland were brought up in violent controversy at the meetings of the Chemical Society of London. Frankland's method was found to be too cumbrous, and there was nothing to be gained by it, since, like Wanklyn's, it only afforded an index of the organic matter present. The distinction between free and albuminoid ammonia was of little value.

The connection of the healthfulness of waters with their content of organic matter was but vaguely established, since, for example, that of the Dismal Swamp was dark-colored and teeming with organic matter, and yet was not proved unhealthful. Prof. Huxley could see only one use in the determination of the organic matter, with reference to it as a basis for the development of germs. Prof. Koch had proposed a method of the development of bacteria in gelatine-films, which had not yet apparently been sufficiently tested.

He farther inquired whether the solution of tartaric acid, and that of milk-sugar with silver nitrate, were not affected by light.

Dr. Schoeney described the precautions to be observed in Koch's method, and inquired whether the living germs in a water became recorded by the same results—envelopment in a cloudy vesicle—as the merely decomposable organic matter.

Prof. Leeds replied that he had applied his method to a series of polluted drinking waters and many organic substances.

He had applied Koch's method, according to the plan recently suggested by Dr. Angus Smith, to the Philadelphia water, in tall jars, compared with others containing sewage and a hay-infusion. But, strange to say, no action occurred even in the two latter after five days, only a slight turbidity appearing upon the surface of the hay-infusion. Eventually the liquefaction and turbidity of the gelatine took place in all and the results fell to the bottom, only micrococci and bacteria, not bacilli, being detected in the liquid.

The products of decomposition of the gelatine, that which had been transformed and stinking under the action of the micrococci and bacteria, and in which these organisms were now dead, affected the silver salts powerfully; the gelatine, which had not been transformed, but was in its original condition, exerted little influence upon the silver salts in the presence of light.

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April 16, 1883.

Lecture Evening.

The President, Dr. J. S. Newberry, in the Chair.

The large hall was filled by an interested audience, who listened to a lecture, illustrated with diagrams and lantern-slides, by Prof. Hamilton L. Smith of Hobart College, Geneva, N. Y., on

### THE GREAT PYRAMID, AND THEORIES CONCERNING IT.

(Abstract).

After a short sketch of the geographical position of the pyramids of Lower Egypt, illustrated by charts and maps, and a notice of their difference in structure, considered as tombs, from all the other tombs in the neighborhood, and a somewhat extended study of the monuments of the fourth dynasty, followed by a minute account of the Great Pyramid, and its peculiarities, and a notice of some of the fanciful theories with regard to it, the lecturer proceeded to show that the hitherto neglected difference of angle, between the descending and ascending entrance passage of the Great Pyramid, was really the key to the explanation of the otherwise unexplained fact, that all the pyramids have the entrance passage on the northern side, and approximately pointing toward the pole of the heavens. That these passages were intended, or rather that of the Great Pyramid, for some reason, to point as near as might be to the then polar star (Alpha Draconis) had already been generally admitted, but, in attempting to make this a basis for chronology, there is an uncertainty of some 1300 years in the case of the Great Pyramid, which has the entrance passage pointing about 3° 42′ from the true pole. Twice in the processional movement of the stars, Alpha Draconis has been at this distance, once 3400 years B. C. and again 2160 years B.C. The former era is adopted by Mr. Proctor in his recent book; the latter, or near this, by Prof. Piazzi Smyth. Neither of these authors seems to have considered that the difference of angle between descending and ascending passages was of any particular significance. Mr Proctor supposes that observations were made down the ascending passage, by reflection, for purposes of orientation. Some five years ago, the lecturer had suggested this use, not for purposes of orientation, but as indicating, by the change of angle of elevation of the pole star, the interval elapsed between the date of the commencement of the pyramid, and the time of arriving at the altitude of the king's chamber, and this difference, 9 minutes of arc, corresponded to twenty-five years. Moreover, the angle of the ascending passage being the smaller, indicated that Alpha Draconis had already made its nearest approach to the pole, and was now receding, thus deciding for the later of the two periods, *i. e.*, 2160, or thereabouts, for the date of erection of this pyramid.

The lecturer proceeded to apply this hypothesis to the other pyramids. The so-called third pyramid on the Jeezeh hill, that of Mycerenus, is acknowledged by all to be later than the Great Pyramid, and the angle of the descending passage of this pyramid, as given by Vyse and Perring, when compared with the angle of that of the Great Pyramid, as measured by Prof. Smyth, indicates that it was built some 80 years later.

The angles of the entrance passages of most of the pyramids have been very loosely measured, but taking them as they are, and applying the same hypothesis, the lecturer obtained the following results:

1. Great Northern of Dashoor, about ... ............2410 B. C.
2. Northern of Abouseer, about. .....................2260 B. C,
3. The "Second" of the Jeezeh group,.................2170 B. C.

4. The "Great" of the Jeezeh group, at elevation of Kgs. ch. 2136 B. C
5. The Southern of Dashoor ........................2113 B. C.
6. The Pyramid of Mycerenus, 3d Jeezeh................2090 B. C.
7. The Stepped Pyramid, Sakkarah.....................2010 B. C.

The last named had already been attributed by ablest Egyptologists, to the 5th dynasty; and in regard to the third in the list, it had already been assigned to Cheops by Bunsen, and the fourth, the "Great," to his successor Shafre, or Cephren, this being the hieroglyphic name of the pyramid of this monarch. It would seem, then, that the so-called "first" or "Great Pyramid" on the Jeezeh hill, was really the second, and it hardly seems probable, if it really was the first, that it would have been nearly pushed off the hill, when the whole situation was yet clear. The chalk marks, names of Shofo (Cheops) and Nu-Shofo, on some of the stones of the Great Pyramid, in places where it was never intended they should be seen, are of no value as determining that either of these kings built the pyramid; they were merely scribblings of the workmen. The lecturer showed that the builders of the pyramids had tube-drills and saws, charged probably with beryls, for cutting basalt, syenyte and dioryte; and that the testimony of the monuments, as interpreted by Mariette, Maspero, Brugsch and other scholars, contradicted the statements of Herodotus and proved that, so far from being a degraded people, tyrannized over by despotic monarchs, they were a highly intelligent and happy people, well governed, and with a comparatively pure and simple religious belief.

At the conclusion of the lecture, Dr. B. N. MARTIN moved a vote of thanks to the lecturer, which was carried unanimously.

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April 23, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large hall was filled by an audience to listen to the lecture of Chevalier ERNST VON HESSE-WARTEGG, postponed from March 19, on the subject of

SOUTHERN EGYPT AND THE COUNTRIES OF THE FALSE PROPHET.

The lecture was illustrated by a large map and many photographs, and at its close a vote of thanks was passed to Chevalier VON HESSE-WARTEGG for his instructive and pleasantly delivered lecture.

April 30, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons present.

Mr. G. F. KUNZ exhibited a fragment of the meteoric stone which fell at Alfianello, Lombardy, on Feb. 16, 1883, at 3.30 P. M.; also cut specimens of Siberian amethyst of wonderful color and brilliancy, and Siberian aquamarine, the finest gems of these kinds he had ever seen. He also stated that, in a large bag of pebbles of jasper, agate and chalcedony, from San Geronimo, Estado de Oaxaca, Mexico, near the Isthmus of Tehuantepec, he had found a worn pebble of blue and yellow corundum, weighing over nineteen grammes. The specific gravity is 3.9002, which is low, but probably caused by internal fissures, partly occupied by other material. It retains no trace of crystalline form, but the cleavage-planes reflect very plainly a pearly lustre. The discovery of this mineral in so good a form may imply its possible occurrence in quantity and perhaps with a gem value.

Mr. WILBUR exhibited, through Prof. D. S. MARTIN, a specimen of our finest and largest moth, *Saturnia* (*Samia*) *Cecropia*, which had been hatched out unusually early this spring, probably in in some sheltered spot.

The PRESIDENT stated that the meteorite, of which a fragment was exhibited, fell in a clover-field, and attracted such a crowd of visitors that the enraged proprietor of the field had it broken up and thrown out into the road. A portion of the fragments thence obtained was sold soon afterward for about 7000 lire (or francs), in which the proprietor of the field had no share.

A paper was then read by Mr. N. H. DARTON,

ON THE DISINTEGRATED SANDSTONE AT NEW DURHAM N. J.

(Abstract.)

In the construction of the road-bed for the New York, West Shore and Buffalo Railroad, numerous interesting exposures of the Trias in New Jersey have been revealed in its cuts, tunnels, etc. At several points the contacts of the trap and sandstone have been uncovered. One of the most remarkable of these is at the western entrance to the tunnel through the Palisades, between Weehawken and New Durham where the sandstone is very soft and friable, containing a large amount of water, and of nearly pure white or chromiferous green color. On drying, it falls to a fine powder, most of which will pass through a sieve of sixty meshes to the inch. It is composed of a mixture of about equal parts of a porous earthy substance and of grains or crystals of quartz. These crystals are frequently two or three lines in length, quite pure and transparent, and of simple habit; often their edges are rounded and show signs of abrasion. Whether they contain fluid-cavities or not, has not been determined. In places a few pebbles and sharp fragments of trap occur, besides a fair representation of all the formations below it, especially of Potsdam sandstone; of granyte no fragments characteristic of any particular locality were found.

The strata thus conditioned lie against the trap, and have a thickness of about two hundred feet; overlying them is a hard, light colored granular sandstone. Their dip, and that of all the sandstone exposed here, is 20° to N. 50° W. The trap stands at an inclination of about 80°, and at its contact the sandstone shows no marked signs of fusion.

There are a few other localities in the State where the sandstone is similar to this, viz.: about four miles from Trenton, and at two points north of the locality at New Durham. In the reports of the State geological survey they have been termed "crumbling sandstones," and described as a mixture of quartz-grains and of a decomposing feldspar. Samples were collected at New Durham in such a manner as to fairly represent the formation from the contact with the trap, and between this and the trap, at several points. The trap was also analyzed, and the results are given in the last column of the following table. Analyses of characteristic unaltered sandstones, made some years ago by Dr. P. Schweitzer, are also given for comparison. The alkalies were determined by Dr. J. Lawrence Smith's method, and the remaining constituents by fusion with carbonate of soda. Iron was estimated volumetrically.

| | | | | | | Dr. Schweitzer. | | |
|---|---|---|---|---|---|---|---|---|
| | **No. 1** | **No. 2** | **No. 3** | **No. 4** | **No. 5** | **No. 1** | **No. 2** | |
| | *At Contact.* | *30 Feet above No. 1.* | *60 Feet above No. 1* | *100 Feet above No. 1.* | *Top.* | *Newark Quarry.* | *Haverstraw.* | *Trap at Contact.* |
| $SiO_2$ | 70.01 | 74.41 | 73.24 | 75.18 | 79.10 | 80.53 | 77.70 | 51.23 |
| $Al_2O_3$ | 22.92 | 18.23 | 15.34 | 18.01 | 14.08 | 9.92 | 11.81 | 16.14 |
| $Fe_2O_3$ | .76 | 1.03 | 2.10 | 1.42 | .83 | 1.99 | 1.89 | 14.34 |
| MgO | 1.21 | .91 | 1.78 | .72 | 1.40 | .63 | .43 | 6.03 |
| $Mn_2O_3$ | .09 | Nil. | Nil. | .06 | Nil. | trace. | trace. | Nil. |
| CaO | .04 | " | " | Nil. | .23 | .63 | .55 | 6.75 |
| $Na_2O$ | 2.18 | 2.70 | 1.04 | 2.16 | 1.12 | 5.67 | 6.89 | 2.11 |
| $K_2O$ | Nil. | Nil. | .04 | Nil. | .09 | Nil. | Nil. | 1.47 |
| $H_2O$ | .433 | 2.46 | 6.68 | } 2.33 | } 3.18 | } 1.14 | } .82 | } 2.33 |
| $CO_2$ | .14 | Nil. | Nil. | | | | | |
| $SO_3$ | .03 | .23 | trace. | .07 | Nil. | Nil. | Nil. | Nil. |
| CuO | Nil. | .01 | Nil. | Nil. | trace. | " | " | " |
| Totals | 101.71 | 99.98 | 100.22 | 99.95 | 100.03 | 100.51 | 100.09 | 100.40 |

SOLUBLE IN HYDROCHLORIC ACID.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $SiO_2$ | .24 | .71 | .48 | .21 | .87 | .30 | .42 |
| $Al_2O_3$ | .16 | .08 | .74 | .11 | .40 | .12 | .36 |
| $Fe_2O_3$ | .74 | 1.06 | 2 04 | 1.48 | .87 | 2.01 | 1.87 |
| MgO | 1.21 | .90 | 1.82 | .70 | 1.46 | .31 | .43 |
| CaO | .03 | ---- | ---- | ---- | .25 | .33 | .37 |
| $Na_2O$ | .17 | .29 | .06 | .24 | .14 | .37 | .02 |
| $SO_3$, etc | .06 | .34 | .02 | .10 | .07 | .00 | Nil. |
| Soluble | 2.61 | 3.38 | 5.16 | 2.84 | 4.06 | 3.44 | 3.47 |
| Insoluble | 92.92 | 94.16 | 88.16 | 94.83 | 92.76 | 95.42 | 95.71 |
| Water and $CO_2$ | 4.47 | 2.46 | 6.68 | 2.33 | 3.18 | 1.14 | .82 |
| Totals | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The analyses show a nearly uniform composition for the entire thickness, and the only marked difference from the unaltered sandstone is in the soda. Whether this is the remains of a triclinic feldspar or not, I do not feel confident to claim, as the granytic areas, forming the basin in which the Triassic beds of the Eastern States lie, and from which we have supposed them to be derived, are not albitic in character, except in some very local instances. However, in a formation of this character, the content of soda is generally attributed to albite, of wnich, from the analysis, it would seem that there is from fifteen to twenty per cent. present in the disintegrated sandstone, and about fifty per cent. in the unaltered. These are very appreciable proportions and quite constant throughout the Triassic stratum. By our latest calculations the thickness of this seems to reach at least twenty-five thousand feet, on the western side of the uplifted granytic area, which separates the Triassic deposits represented in New England and in the South Central States.

DISCUSSION.

The PRESIDENT stated that the rock in question was called arkose, but often so rich in feldspar as to be a true feldspathic sandstone.

A MEMBER remarked that an outcrop of the same rock, in entirely unaltered condition, occurred all along the eastern foot of the Palisade range, from Jersey City to Weehawken. The absence of albite might possibly have been derived from the degradation of some albitic granyte on the shore of the Triassic sea, though he was not aware of the occurrence of such a rock in the Laurentian of Northern New Jersey; more probably it had been caused by the entire decomposition of the ferruginous orthoclase in the granyte derived from that region, with the corresponding concentration of the associated soda-feldspars.

Mr. DARTON referred to the existence of albitic granytes near the borders of the Triassic basin in Virginia, etc.

Prof. D. S. MARTIN observed that on the east side of the Palisade range, back of Hoboken, an exceedingly beautiful arkose was formerly seen at a locality, since largely destroyed, known as Fox Hill, but the feldspar in it was to all appearance orthoclase. In the rocks of New York island, the orthoclase has sometimes passed completely into kaolin, leaving the other feldspars unchanged. It is possible that a stratum of these rocks may once have formed the eastern shore of the Triassic basin, and their debris must have been rich in orthoclase. He had long ago adopted the view, since fully detailed in a paper by Mr. I. C. Russell, in our Annals, of the former union of the two Triassic sheets of New Jersey and the Connecticut valley, afterward separated by the elevation of the central ridge passing at present through New York island. A part of the Triassic deposits in our vicinity may have been then derived from the old eastern border of the original basin, in Connecticut, where albitic granytes occur.

The PRESIDENT referred to the confusion which had once existed in the views entertained regarding the sandstones and traps, the latter having been considered by some merely as the results of a metamorphic action along certain layers of the Triassic sediments. At that time he had initiated an investigation, which had been carried on to a satisfactory result by Dr. P. SCHWEITZER, demonstrating the complete difference of the sandstone and trap, and the true intrusive character of the latter.

A paper was then read by Dr. ALEXIS A. JULIEN,

ON THE DECAY OF BUILDING STONE, PART II,

with illustrations from the old cemeteries of New Utrecht, Flatbush, etc.

(Abstract).

The present and increasing magnitude of building operations in this city and vicinity must serve as an apology for bringing the subject of the decay of stone a second time before the Academy this season. The various suburbs and vacant districts have been gradually approaching a character sufficiently settled to justify the erection of entire and numerous blocks of private residences, huge buildings for business offices in the lower part of the city and for family flats in the central and upper wards, besides large numbers of public edifices, storage houses, manufactories, etc. The failure of stone to resist fire in the business district, and the offensive results of discoloration or serious

exfoliation, which the poor durability of many varieties of stone has rendered manifest in all parts of the city, have already largely diminished its proportionate use, in reference to brick. Nevertheless great quantities of stone of many kinds are yet introduced, as ashlar or the trimmings of apertures, into the buildings now in progress, and will soon be further employed, if the present activity in building be continued, not only in the private enterprises already mentioned, but others of more lasting and public importance; *e.g.*, the projected improvements and additions in connection with our water supply, as aqueducts and reservoirs; the new bridges proposed over our rivers; the replacement of our rotting wooden docks by more permanent structures; and perhaps, we may hope, the huge pedestal to support the Statue of Liberty on an island in our harbor. As the kinds of building-stone brought to this market for these purposes are increasing in number and variety, and their selection and mode of use, as it seems to me, are irregular and indiscriminate, whether from the ignorance or the carelessness likely to prevail in a busy money-getting community, it would appear proper that a voice of warning should now be heard, from a member of the Academy of Sciences, calling attention to the dangers involved in the use of bad stone or the bad use of good stone; in the enormous waste and expense soon required for repairs in our severe climate; or, in the consequent disuse of stone in favor of brick, by a natural reaction, to the injury of the beauty and comfort of our city.

There are three classes in the community to which such a warning is addressed:

1. A considerable number of house-owners, to whom it seems to come too late, since they have already expended tens of thousands of dollars in temporary repairs, patching and painting decayed stone, and many of whom have doubtless made rash vows to use hereafter, in construction, brick, iron, terracotta, wood—anything but stone.

2. House-owners, not yet aware of the coming dilapidation, and who can yet take precautions to delay or prevent its arrival—or others about to build, and who have implicit faith in the eternity of building-stone, since it comes from the "everlasting rock," or at least in a duration which will last their lifetimes—and, also a certain proportion of builders and architects willing to learn, and who have much to learn, since the practical scientific study of building-stones is yet to be made.

3. And lastly, the architects, builders and contractors, who know all about the subject, or who do not care what happens to the houses they build—and that large part of our population who never expect to own any houses. To all these the decay of the stone in this city is a matter of indifference, and the quotation recently presented

from an encyclopedia of architecture, "no modern building will stand a thousand years"—few of them, indeed, over a century or two, in fair condition—is only a matter of jest.

The following additional facts, observed in reference to the decay of stone in this city, have been gathered partly by observation in our streets, and partly by a study of the tomb-stones in the old cemeteries at New Utrecht and Flatbush, on the southern and northeastern outskirts of the city of Brooklyn, L. I., and in that of St. Paul's Church, at the corner of Broadway and Fulton street, in this city. In my last paper I presented observations on the stones in the churchyard of Trinity Church, built in 1841–6 (the first building having been erected on that site in 1696). St. Paul's Chapel was erected 1766, and, although this structure is older than that of Trinity, its cemetery is much more recent in its origin.

BROWN SANDSTONE.

In addition to the varieties already described, there is one quite recently introduced into this city from Hammelstown, Penn., in a building on Fifth avenue above 41st street. It has been largely used in Philadelphia, and is said to resist the weather very well.

The causes of the general decay of brown-stone may be definitely connected with some of the agencies which were detailed in my former paper.

*Erection on edge of lamination.*—Instances are very rare in this city where the stone has been laid "on its bed," with a deliberate regard to its durability: *e.g.*, a few houses on Fifth avenue above 51st street, the new wings of the Astor library, etc. On the other hand, from mere convenience in construction, many buildings, especially of our older churches, are fortunately so constructed, the blocks having been small and square and conveniently so laid. In some instances, (*e.g.*, the church on the southeast corner of 35th street and Fifth avenue), blocks occur in both positions and in both are affected by incipient decay; in others (*e.g.*, the church on southwest corner of 21st street and Fifth avenue), the blocks, although all on bed, are often deeply decayed. In the old City Hall, erected in 1812, the north face, although on the side usually least affected by decay, presents the brownstone of its ashlar set on edge and exfoliating in entire sheets, often traversed by fissures across the lamination, parallel to the joints. Notwithstanding these warnings, most of our newest edifices exhibit the same faulty construction: *e.g.*, the sandstone (from Massachusetts) n the trimmings and even partly in the pillars of the Union League Club on Fifth avenue, the fine new residences in the upper part of Madison avenue, the trimmings, etc., in the huge new buildings for "flats" and business offices throughout the city, often nine to eleven or more stories in height, in whose walls the crushing force exerted upon this soft stone must be excessive.

*Sea-salt in the atmosphere.*—A comparison of the forms of decay of stone observed in the cemeteries within this city and in those nearer the ocean, *e.g.*, at New Utrecht, yielded no evidence of any results, attributable to this agency, in greater action at the latter locality. Thus, too, in England, the sandstone of Sandysfoot Castle, near Weymouth, which has been washed by salt spray since the time of Henry VIII., remains as perfect as ever.

*Heat of the sun.*—There can be no doubt that this is one of the agencies which most severely attack our brown-stone. On the cross streets, the west sides of stoops become decayed and ragged, long before the eastern; so also the southern before the northern sides, on our north and south avenues. The ashlar at the base of the steeple of the church at 37th street and Fifth avenue is beginning to decay on the south side, but not on the north or east sides (the west side not being visible). The slender balusters of the balustrades of balconies and along the sides of stoops are commonly constructed of soft sandstone, with the lamination vertical and its plane set irregularly, either parallel or at right angles to that of the house front; the ill-judged exposure of the soft stone in such a way has led to the common mutilation of the carved work by exfoliation on the side exposed to the sun, *i. e.*, on the west side of the stoop-balustrades in the cross streets, and on the south side along the avenues.

*Lichens.*—It has been stated that these abound upon the brown-stone within the city, but, though found upon trees, I have never discovered them encrusting hewn stone within the city. Thus they never occur in the churchyards of Trinity church and St. Paul's chapel, though found abundantly in those of New Utrecht and Flatbush; *e. g.*, three species were distinguished upon a single tombstone (Rutgert Denyse, 1795) at New Utrecht. On their removal, the surface of the stone beneath is not found corroded, but only retains a fresh color.

*Imperfect pointing.*—The admitted energetic agencies of decay—frost, solution, hydration, etc.—have been largely favored by the imperfect and hasty construction of the masonry throughout the city, its joints when new often admitting a trowel. A cement-mortar of poor quality is largely employed and, soon dropping out, the joints are often allowed to remain open for years. The atmospheric attack is thus made, as it were in flank, directly through the exposed edges of the outer laminæ of the stone, and the decay rapidly affects the stone to a considerable depth, several inches in many cases, and even throughout the entire block, although the exfoliation may appear superficial.

*Cemetery at New Utrecht.*—Two varieties of sandstone were found commonly employed here, the stones standing vertically and facing the east.

1. Fine-grained and compact, warm red to reddish brown in color, apparently derived from Little Falls, N. J. The stones dated from 1830 back to 1785, and are in excellent condition, especially in proportion to compactness and fineness of grain (*e.g.*, C. Van P., 1796).

2. Red, often fine-grained, and generally laminated, the laminæ being one-eighth to one-half inch in thickness, with alternations of reddish shades of color. The stones date from 1854 back to 1820, and have weathered very poorly, splitting first near the west face of the stone and finally throughout, often with fissures cutting the stone across the lamination and parallel to the edges (*e. g.*, W. B., 1826).

A light gray graywacke also occurs (S. B., 1852), but is thinly laminated and split in fine cracks throughout.

*Cemetery at Flatbush.*—The same varieties are here employed and the stones stand in the same position. Those of the compact variety date from 1800 back to 1754, and are in excellent condition (*e. g.*, Marrytie D., 1797.) Those of the laminated structure date from 1826 back to 1754 and are generally in wretched condition (*e. g.*, Adriantie L., 1761), especially on and near the top and edge and the west face. Sometimes, however, the lamination has not allowed any decay (*e. g.*, Geljam C., 1754). In both cemeteries, however, the decay at its worst has split up the stone, but has little affected the sharpness of inscriptions.

*St. Paul's Churchyard.*—One variety of fine-grained sandstone predominates, dating from 1813 back to 1768. The finest-grained and most compact are often in perfect condition (J. J., 1768), but many coarser or more laminated stones, and sometimes fine and compact stones, are very badly split, and show exfoliation near the ground (A. Van B., 1813)—sometimes with fissures across the stone (J. A., 1813). The splitting begins, as usual, near the west face and near the edges.

LIGHT-COLORED SANDSTONES.

*Nova Scotia Sandstone.*—In regard to this name, I have indicated already, but it is fair to explain more fully here, that it originated many years ago, when grindstone-dealers obtained their supplies from some small surface-quarries located in and near Nova Scotia. As that stone was of a yellow color, the stone-trade has persisted ever since in calling every light-colored stone coming from anywhere in that section, " Nova

Scotia stone." However, 95 per cent. of the imported stone is derived from New Brunswick (probably 85 per cent. from Dorchester, N. B.), and the remainder from Nova Scotia and other points. The popular name has been applied to light-colored stones of every quality, quarried at various points of Eastern Canada, over a wide section of country, hundreds of square miles in extent, and variously worked out at tide-level, under tide-water from exposed reefs running out into the sea, or, as at Dorchester, N. B., from a hillside 900 feet high and a quarter of a mile from tide-water. The small quarries usually work out only such stones as they can obtain from outcropping ledges and boulders, and these are apt to be of bad and varying color, more or less full of iron and other defects; for example, the surface-quarries of Hillsboro, N. B., long since abandoned, used in the houses in 42nd street near Madison avenue, in Second avenue near 55th street, some of the bridges in Central Park, etc. At the quarries of Dorchester, N. B., it is stated that from 35 to 50 feet of inferior rock and debris are first stripped off to reach the sound rock which is sent to this market. The introduction of this stone into the city as a building material has been too recent to allow any measure of its durability. A little exfoliation may be however distinguished near the ground-line, and on the sides and posts of stoops, in many cases. Also, in panels, under heavy projecting mouldings, cornices, etc., where the sun has no chance tor each and dry up the dampness, the stone moulders away slightly over the surface. In the cemeteries it is rarely or never used; in one example, possibly of this material, in St. Paul's churchyard (W. J. M., 1841), the decay is plainly beginning around the carvings. The discoloration of good varieties of the stone would be very slow to affect vertical surfaces, properly protected by drips; but on sloping, horizontal, or shaded surfaces, especially near the street-level, street-dust is sure to lodge and cling, all the more after the surface becomes roughened by a slight disintegration; while the rough usage to which the stone of balustrades and stoops is always subjected in a busy street, renders this, as well as all other soft varieties of freestone, liable to chipping as well as offensive discoloration (*e. g.*, in the courses, trimmings, and posts of the church on the corner of 42d street and Madison avenue, etc.) and unsuitable for use near the ground-line.

*Ohio Sandstone.*—The buff variety from Amherst is said to contain "97 per cent of pure sand." Buildings constructed of this material in this city since 1857 (*e. g.*, on the corner of Barclay street and Broadway, on the corner of Howard and Crosby streets, etc.), show no decay, but only discoloration. In other instances (*e. g.*, rows of houses on 50th street, west of Fifth avenue, on Madison avenue between 34th and 43d streets, etc.) the blackened discoloration and frequent chipping of edges of the soft stone are quite offensive. On the other hand, it must be admitted that a stone which cleans itself, by the disintegration of its surface, the grains dropping out and so carrying away the dirt, as in the poorer and softer varieties of brown-stone or of Nova Scotia stone, is by that very action still more objectionable from its want of durability; and the discoloration of the Ohio stone is offset, at least in part, in the best varieties, by their hardness and promise of durability.

*Medina sandstone.*—This material is of recent introduction (*e. g.*, Baptist church on 57th street, west of 6th avenue), and its true durability cannot yet be estimated.

*Bluestone* (graywacke).—This stone is yearly coming into more general use, and, though somewhat sombre in tone and difficult to dress, seems likely to prove a material of remarkable durability. In one building in 24th street, between Madison and Fourth avenues, its condition appears to be excellent, after fifteen years exposure, perfectly retaining the tool-marks. The variety reported to come from the Wyoming valley (*e. g.*, in the building on the north side of Union Square) is really derived, as I am informed by Prof. H. L. Fairchild, from Meshoppen, Penn.

In this connection, we may refer to the experiments made by Dr. Hiram A. Cutting, of Vermont, on a series of American sandstones, in regard to specific gravity, weight, absorptive power, and resistance to fire. The results on varieties like those used in New York City are quoted in the following table (*The Weekly Underwriter*, 1880, Vol. XXII., p. 288):

| Local Name. | Locality. | Specific Gravity. | Weight of one Cubic Foot, lbs. | Ratio of Absorption. | Heated at 600° F. | Heated at 800° F. | Heated at 900° F. | Heated at 1000° F. | Heated at Higher Temperatures. |
|---|---|---|---|---|---|---|---|---|---|
| Freestone | Portland, Conn. | 2 380 | 148.7 | 1+27 | Not Injured. | Not injured. | Friable. | Tender. | Ruined. |
| Freestone | North of England | 2.168 | 135 5 | 1+27 | | " | Cracks badly. | Spoiled. | |
| Montrose Stone | Ulster County, N. Y. | 2.661 | 166.3 | 1+314 | | " | Not injured | Slight injury | Stands well. |
| Freestone | Belleville, N. J. | 2.350 | 146.8 | 1+27 | | " | Cracks. | Friable. | |
| Freestone | Nova Scotia | 2 424 | 151.5 | 1+240 | | " | " | " | |
| Carboniferous Sandstone | Br. Philips, N. S. | 2.353 | 147.0 | 1+19 | | " | Crumbles. | Cracks and crumbles. | |
| Freestone | Dorchester, N. B. | 2.363 | 147 7 | 1+26 | | Cracks. | Cracks and crumbles. | " | |
| Berlin Stone | Cleveland, O. | 2.210 | *138.1 | 1+22 | | Not injured. | Slight cracks | | Stands well. |
| Berea Stone | B·rea, O. | 2.254 | *140 8 | 1+20 | | " | " | Crumbles. | " |
| Amherst Stone | Amherst, O. | 2.200 | *137.5 | 1+18 | | " | Changes color. | Friable. | " |
| Brownstone | Hammellstown, Pa. | 2 346 | 146.6 | 1+28 | | " | Cracks. | Crumbles. | |
| Potsdam Sandstone | Beauharnois, Quebec | 2.512 | 157.0 | 1+38 | | " | " | " | . |

* It is claimed that these figures understate the true weight, which is said to approximate 155 pounds.

LIMESTONE.

The coarse fossiliferous stone from Lockport owes its rapid disintegration within ten years, wherever used in this city, in part to its careless arrangement in masonry. Thus, in the building of the Lenox Library, at 70th street and Fifth avenue, about 40 per cent of the material is set on edge, *e.g.*, the alternate receding courses of the ashlar, trimmings of apertures, gate-posts, etc.; so also, in part, in the stone used in the Presbyterian Hospital. The oolitic stone from Ellitsville, Indiana, shows an almost immediate and irregular discoloration, said to be produced by the exudation of oil. The oolite from Caen, France, has also been used in many buildings, and, unless protected by a coating of paint, has shown decay in several instances. Mr. G. Godwin, of London, has stated (Soc. of Arts, 1881,) that "the Caen stone which was sent to this country (England) could not now be depended on and ought not to be used for external work." The extensive decay of this, with other oolitic and magnesian limestones, in the walls of Westminster Abbey, has recently caused great alarm and will necessitate the renewal of its outer masonry at enormous expense.

One of the most thorough investigations, in regard to the porosity of a series of American building-stones, was made by Dr. T. S. Hunt in 1864, and with the following conclusion (Chem. and Geol. Essays, p. 164):

"Other things being equal, it may probably be said that the value of a stone for building purposes is inversely as its porosity or absorbing power." From the results given on 39 specimens, the following may be here quoted as pertinent to stones used in New York City:

| No. of Specimens. | Absorption Percentage. |
|---|---|
| 1. Potsdam sandstone, hard and white. | 0.50— 3.96 (usually about 1) |
| 2. Medina sandstone........ .... . | 3.31— 4.04 |
| 3. Ohio sandstone.................. | 9.59—10.22 |
| 3. Caen limestone.................. | 14.48—16.05 |

Of course the proviso, "other things being equal," covers a great deal of important ground, including the solvency of the material of a stone in the acidified rain-waters of a city. Some of the most impervious and non-absorbent readily decompose; while others, which are porous or even cellular, may afford an excellent resistance to decay. But judged in regard to both points, porosity and solvency, the Caen stone may be safely rejected hereafter as unfit for our climate.

MARBLE.

The dolomitic marble of Westchester County has been largely employed in our buildings, and some idea of its character for durability may now be gained. A fine-grained variety was used in the building of the U. S. Assay Office in Wall street ; its surface is now much discolored, and the edges of many of the blocks show cracks. A variety of medium texture was employed in the hotel at the corner of Fulton and Pearl streets, erected in 1823 ; the surface is decomposed, after the exposure of exactly sixty years, with a gray exterior, in a crust ⅛ to ¼ inch in thickness, soft and orange-colored in section. Many crystals have fallen out of the surface on the weathered eastern face, producing a pitted appearance. A very coarse variety has been used in the Bank-building at Thirty-second street and Broadway, in large part being set on edge ; very many of the blocks are more or less cracked, even in the highest story. In the U. S. Treasury building, in Wall street, a rather coarse dolomyte-marble, rich in tremolite and phlogopite, was used, the blocks being laid on bed in the plinth and most of the ashlar, but largely on edge in the pillars, pilasters, etc. ; in the latter case vertical fissures commonly mark the decay, but even elsewhere a deep pitting has been produced by the weathering out of the tremolite. The marble used in many other prominent buildings has been improperly laid, *e. g.*, in both of the buildings of the City Hall, the Drexel building at the corner of Broad and Wall streets, the Academy of Design at 23d street and Fourth avenue, etc.

*Cemetery at New Utrecht.*—Here a very fine white marble is used in many stones, perhaps that of Carrara—a few stones dating about or a little before 1800. These are in excellent condition, but on the east face are much roughened.

Another variety is a tremolitic dolomyte-marble, white, fine to coarse in texture, probably from Westchester County. It is in fair to good condition, but the weathered tops, sides, and east faces of the stones are in a pulverulent state. Sometimes the west face is the one roughened, and the stone is split near it.

Stones of a white veined marble, probably from Vermont, date from 1853 back to 1828. They are in good condition, but the east face is pulverulent.

A blue marble (C. Groenendyke, 1797) and a black and white marble (N. G., 1795) are in excellent condition, but the eastern faces of the stones are decidedly roughened, the inscriptions remaining sharp and distinct.

*Flatbush Cemetery.*—Marble here predominates in two varieties. The stones of a fine white marble (Italian), date from 1859 back to 1809. They are generally in good to excellent condition, but their surfaces are more or less roughened, becoming pulverulent when dating from 1836. That of 1809 (N. R. C.), a horizontal tablet, is blackened by a minute lichen, *lepra antiquitatis* (also J. V., 1800).

The stones of a coarse tremolitic dolomyte-marble date from 1847 back to 1818. They weather grayish and become much roughened over the east face, top and sides, and sometimes over a third of the surface down the west face. Fissures in the edges of the stone begin after about 30 years exposure. The polish has survived for about 40 years on the faces of some stones of this class, even when the edges are disintegrated. Near the ground for a foot the polish remains even much longer, *e. g.*, the double stone of Femetie and Peter Stryker (1730).

*St. Paul's Churchyard.*—The stones here date from 1851 back to 1798, and consist of a coarse white marble. It weathers grayish white, and becomes roughened. Only a small proportion of the stones are split. About one-tenth have their inscriptions entirely obliterated, and this fact, due doubtless to the acid rain-waters of the city, was not observed in the suburban cemeteries; in one case (A. W., 1851) it has been largely affected in a little over 30 years.

The horizontal tablets, supported on masonry, which has partially settled (*e.g.*, J. G., 1821), generally show a slight curvature in centre, only in part possibly produced through solution by standing rain-water.

Dolomieu first made the observation on an Italian marble called Betullio, that it possessed a degree of flexibility allied to that of the itacolumyte of Brazil. Gwilt states (Encyc. of Arch., p. 1274):

"Some extremely fine specimens of white marble are to be seen in the Borghese Palace at Rome, which, on being suspended by the centre on a hard body, bend very considerably. It is found that statuary marble exposed to the sun acquires, in time, this property, thus indicating a less degree of adhesion of its parts than it naturally possessed."

In the white marble-veneering of the facade of St. Marks, Venice, the same effect has been observed by Mr. C. M. Burns, Jr., in the lower half of a slab of veined marble, two inches thick, on the south side of the northernmost of the five portals, just behind the columns and about five feet from the pavement. The slab is eleven feet and two inches long, and one foot and six inches wide; it is hung to the backing by copper hooks driven into the brickwork, but the lower part, for a distance of five feet and seven inches, bulges out two and three-quarter inches from the backing. "The exposure is directly westward, and I found that it became decidedly warm in the afternoon sun, while the backing would be likely to keep its temperature lower. Though the outer surface is somewhat weatherworn, I could not find the slightest tendency to fracture in any part." (*The Am. Arch. and Build. News*, 1882, p. 118).

Also at the palace of the Alhambra, in Grenada, Spain, one of the two doors that have been christened "La Mezquita," exhibits an ancient facing of three slabs of marble, the upper resting as a lintel upon the two others, which form uprights, eleven feet in height, nine inches in width, and only two and one-half inches in thickness. At eighteen and one-half inches from the top of the door, the slab on the right begins to curve and to detach itself from the wall, attaining the distance of three inches at about three feet from the bottom. From a subsidence of the material of the wall, an enormous thrust has been exerted upon the right, and the marble, instead of breaking or of rupturing its casings. has simply bent and curved as if it were wood. (*La Nature*, 1882.)

I have also been informed at Sutherland Falls and other quarries near Rutland, Vermont, that the bending of thin slabs of marble, exposed to the sunshine in the open air and accidentally supported only at the ends, has been there repeatedly observed.

Fleurian de Bellevue discovered a dolomyte possessed of the same property in the Val-Levantine, of Mt. St. Gothard. Dolomieu attributed the property to "a state of desiccation which has lessened the adherence of the molecules of the stone," and this was supposed to be confirmed by experiments of De Bellevue, who, on heating inflexible varieties of marble, found that they became flexible.

This change, however, cannot be connected with the remarkably small content of water existing in marbles, but with a peculiarity of their texture, which has been briefly discussed by Archibald Geikie (Proc. Roy. Soc. Edinb., 1880), in an interesting investigation on the decay of the stones used in Scotch cemeteries. He has pointed out that the irregular and closely contiguous grains of calcite, which make up a white marble, are united by no cement, and have apparently a very feeble coherence.

It appears to me probable also that their contiguous crystallization has left them in a state of tension, on account of which the least force applied, through pressure from without or of the unsupported weight of the stone, or from internal expansion by heat or frost, produces a separation of the interstitial planes in minute rifts. Such a condition permits a play of the grains upon each other and considerable motion, as illustrated in the commonly observed sharp foldings of strata of granular limestones, without fractures or faults. In such cases, also, I have observed that the mutual attrition of the grains has been sometimes sufficient to convert their angular, often rhomboidal, original contours into circular outlines, the interstices between the rounded grains being evidently filled up by much smaller fragments and rubbedoff particles; *e. g.*, in the white marble of the anticlinal axis at Sutherland Falls, Vt.

These results are confirmed by the appearances, familiar to all lithologists, in the study of thin sections of marble, the latent interstices between the grains of calcite having been often developed by the insinuation of films and veinlets of iron-oxide, manganese-oxide, etc. While a polished slab of marble, fresh from the stone-yard, may not be particularly sensitive to stains; after it has been erected and used as a mantelpiece over a fire-place, its increased absorbence for ink, fruit-juices, etc., becomes strongly marked. On this property are founded the processes, always preceded by heat, for the artificial coloring of marbles.

In the decay of the marble, largely Italian, in the atmosphere of Edinburgh, Geikie has recognized three phases:

1. Loss of polish, superficial solution, and production of a rough, loosely granular surface. This is effected, Geikie states, by "exposure for not more than a year or two to our prevalent westerly rains." The solution of the surface may sometimes reach the depth of about a quarter of an inch, and the inscriptions may become almost illegible in sixteen years.

In our own dry climate, however, these results do not appear. The polish often survives ten years in our city cemeteries, and even for over half a century near the ground, in the suburban cemeteries; in one instance, at Flatbush, it has remained intact for over 150 years, on the tombstone of F. and P. Stryker, dated 1730. Inscriptions are decipherable in St. Paul's churchyard back to the date of 1798, but about one-tenth are illegible or obliterated; the latter effect was never seen in a single instance on the suburban stones, and is evidently due to the acid vapors in the rain-waters of the city.

2. Incrustation of the marble with a begrimed blackish film, sometimes a millimeter in thickness, consisting of town-dust, cemented by calcium sulphate, and thorough internal disintegration of the stone, sufficient, after a century, to cause it to crumble into powder by very slight pressure.

Neither the crust nor any deep disintegration has been observed in the oldest marble-tombstones in the cemeteries of New York; their absence is plainly attributable to the inferior humidity of our atmosphere and the absence of smoke from soft coals.

3. Curvature and fracture, observed in slabs of marble, firmly inserted into a solid framework of sandstone. This process consists in the bulging out of the marble, accompanied with a series of fractures, and has been accomplished by expansion due to frost. Tombstones are never constructed in this way, in our cemeteries; but the curvature of

horizontal slabs, observed in St. Paul's churchyard, produced by the sagging of the supporting masonry beneath the centre of the slab, is simply indicative of the flexibility of the material.

Geikie states: "The results of my observations among our burial-grounds show that, save in exceptionally sheltered situations, slabs of marble, exposed to the weather in such a climate and atmosphere as that of Edinburgh, are entirely destroyed in less than a century. Where this destruction takes place by simple comparatively rapid superficial solution and removal of the stone, the rate of lowering of the surface amounts sometimes to about a third of an inch (or roughly 9 millimetres) in a century. Where it is effected by internal displacement, a curvature of 2½ inches, with abundant rents, a partial effacement of the inscription, and a reduction of the marble to a pulverulent condition, may be produced in about forty years, and a total disruption and effacement of the stone within one hundred. It is evident that white marble is here utterly unsuited for out-of-door use." My own conclusions, from observations in New York, is that, in the cemeteries within the city, the polish on vertical slabs is usually destroyed in about ten years; that the inscriptions are only in small part effaced within thirty to fifty years, and are for the most part perfectly legible on the oldest tombstones, dating 1798; and that, although the reduction of the surface to a loose granular condition may reach the depth of ten millimetres, the actual lowering of the surface seldom exceeds five or six millimetres, the internal disintegration is never sufficient to affect sensibly the strength of the stone during the periods of exposure which have been noted, and a slight flexure, sometimes to the amount of twelve or fifteen millimetres, sometimes affects the centre of horizontal slabs, two metres in length.

In the cemeteries without the city, the polish may often survive near the ground, on the faces of vertical slabs, for over one hundred and fifty years; the granulation of the surface rarely exceeds a depth of three or four millimetres; and all the inscriptions remain perfect on the oldest vertical tombstones, suffering partial effacement only on horizontal slabs.

Although these facts show the far greater durability of marble in our dry and pure atmosphere, the frequent obliteration of inscriptions, the general, and often rapid, granulation of the surface, and the occasional fissuring of slabs, show that the decay of marble—in the varieties hitherto long used in New York City—is steady, inevitable, and but a question of time; and with Geikie, I, too, am convinced that, if unprotected, such materials are utterly unsuited for out-of-door use, at least for decorative purposes or cemetery-records, within the atmosphere of a city.

## GRANYTE.

The bluish variety from Quincy, Mass., has been used in many buildings and rarely shows as yet many signs of decay. In the U. S. Custom House on Wall street, most of the huge blocks appear laid "on bed," but, nevertheless, show some pitting in places, by the attack and partial removal of the larger grains of hornblende. In the church at Fourth street and Lafayette Place, erected in 1830, a little exfoliation has been produced by street-dust on the faces of some steps. In the Astor House, at Barclay street and Broadway, no decay was observed.

In the fine-grained granyte from Concord, N. H., employed in the building on the southeast corner of Twenty-third street and Sixth avenue, many of the blocks are set on edge, but the only change yet seen is that of discoloration by street-dust and iron-oxide from the Elevated Railway.

The light-colored and fine-grained granyte of Hallowell, Me., has been used for the construction of the City Prison, the Halls of Justice or "Tombs," in Centre street. This stone consists of a white feldspar, which predominates, a greyish-white quartz, which is abundant, and a considerable quantity of a silvery white mica, thoroughly intermixed. The rock possesses several properties—fineness of grain, homogeneity of structure, and freedom from iron, as shown by the color of the feldspar—likely to render it durable; the only unfavorable conditions are the predominance of feldspar and the laminated structure. The rock is a granitoid gneiss, with lamination often clearly marked; these markings at once show to the eye that most of the blocks are set, not on bed, but irregularly on edge.

The building is square and occupies an entire block. On a study of the weathering, the south face was found to present an exfoliation to the depth of one-eighth to one-fourth of an inch at many points, up to the very summit of the building, particularly on the sides of the pillars at the southeast entrance, on the ashlar near the southwest gate, under and over the cornice and string pieces. In some places the stone was loosened or peeled off in sheets of the area of a square foot. The west front presents much exfoliation all over the surface, though always thin; it seems to begin chiefly along and near the joints. In places, fragments have separated from the corners of the blocks. The north front exhibits very little exfoliation; so also the east front, in a few small scattered spots.

The exfoliation appears to be the result directly of the sun's heat, exerted most intensely on the southern and western sides of the building. An examination of the disintegrated material shows but little decomposition; a little kaolin may be distinguished in films, but the bulk of the feldspar, the weakest constituent, remains with bright facets, without change in color or lustre. It is by no means characteristic of the "maladie du granit," first described by Dolomieu and later studied by Dr. T. Sterry Hunt; but here the action seems to be mainly and simply a disintegration of the grains, initiated by expansion under the sun's heat, during the summer, and developed by the expansion caused by frost during the winter. An architect of the city recently stated that "he had built several large granite offices and considered Quincy granite the most durable of all building material. He thought the weathering of granite would hardly amount to one-thirty-secondth of an inch in a hundred years. According to that calculation many buildings might hope for a longer span than the thousand years spoken of by the professor."

However, it is a well-known fact that the weathering of granyte does not proceed by a merely superficial wear, which can be measured or limited by fractions of an inch; but by a deep insinuation along the lines of weakness, between grains, through cleavage-planes, and into latent fissures. Thus, long before the surface has become much corroded or removed, a deep disintegration has taken place by which large fragments are ready for separation by frost, from the edges and angles of a block. When directly exposed to the heat of the sun, an additional agency of destruction is involved, and the stone is suddenly found ready to exfoliate, layer after layer, concentrically. As yet we have little to guide us in the estimation of durability in years, since the best known granyte monuments are those which have been exposed to the exceptionally mild climate of Egypt; but even there some exfoliation has been noticed, *e. g.*, on the inner walls of the so-called Temple of the Sphynx.

In the cemeteries within the city and on Long Island, much granyte is now used in slabs and monuments, but its introduction has been everywhere of too recent a date to afford any measure of its durability. Geikie remarks: "traces of decay in some of its feldspar crystals may be detected, yet in no case that I have seen is the decay of a polished granite surface sensibly apparent after exposure for fifteen or twenty years. Even the most durable granite will probably be far surpassed in permanence by the best of our silicious sandstones. But as yet the data do not exist for making any satisfactory comparison between them."

## GNEISS.

The oldest building in this city, in which this material has been used, appears to be that of St. Matthews Lutheran Church, on the northeast corner of Broome and Elizabeth streets, erected in 1841. The stone is the micaceous gneiss, in part hornblendic, from excavations on the island, with trimmings, string-pieces, etc., of brown stone, the latter, as usual, being in a state of decay. On the west front, the gneiss is in excellent condition, occurring in small blocks, mostly laid on tbe bedding-plane. In the south front, many of the quoins are set on edge and are much decayed along the joints, sometimes with splitting or exfoliation, fracture of corners, and irregular chipping out of the surface to the depth of one-half to one inch below the level of the projecting cement-joints.

GENERAL CONCLUSIONS.

If a rough estimate be desired, founded merely on these observations, of the comparative durability of the common varieties of building-stone, used in New York city and vicinity, there may be found some truth in the following approximative figures for the "life" of each stone, signifying by that term, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal.

| | Life, in Years. |
|---|---|
| *Coarse brownstone* | 5–15 |
| *Laminated fine brownstone* | 20–50 |
| *Compact fine brownstone* | 100–200 |
| *Bluestone* | Untried, probably centuries. |
| *Nova Scotia stone* | Untried, perhaps 50–200 |
| *Ohio sandstone*, (best silicious variety), perhaps from 1 to many centuries. | |
| *Limestone*, coarse fossiliferous | 20–40 |
| *Limestone*, fine oolitic (French) | 30–40 |
| " " (American) | Untried here. |
| *Marble* (*Dolomyte*,) coarse | 40 |
| " " fine | 60–80 |
| *Marble*, fine | 50–200 |
| *Granyte* | 75–200 |
| *Gneiss* | 50 years to many centuries. |

Within a very few years past, it has become frequent to introduce rude varieties of rusticated work into the masonry of buildings in this city, or to leave the stone rough and undressed in huge blocks, especially in the basement or lowest stories, where it is under close and continuous inspection, and the results of its decay will be disguised by its original rough surface. Although there are certain large buildings in which such a massive treatment of stone may be appropriate, its common use, with stones of known feebleness or lack of durability, is a disingenuous evasion of responsibility and a mere confession of ignorance, want of enterprise, and despair, in regard to the proper selection of building material and in regard to its protection.

Finally, it may be pointed out that many of the best building stones of the country have never yet been brought into this city; *e. g.*, silicious limestones of the highest promise of durability, allied to that employed in Salisbury Cathedral: refractory sandstones, like some of those of Ohio and other Western States, particularly fitted for introduction into business buildings in the "drygoods district," storage houses, etc., where a fire-proof stone is needed; and highly silicious varieties of Lower Silurian sandstones, such as occur near Lake Champlain, quartzytic and hard to work, like the Craigleith stone of Edinburgh, but possessing the valuable qualities of that fine stone, in resisting discoloration, notwithstanding its light color, and in remarkable resistance to disintegration.

As it is, we have many and need many varieties of stone for our various objects, but do not know how to use them. It is pitiable to see our new buildings erected in soft and often untried varieties of stone, covered with delicate carvings of foliage and flower-garlands, which are almost certain to be nipped off by the frost before the second generation of the owner shall enter the house. It is now time for one who loves stone to express his indignation at the careless and wasteful way in which a good material is being misused.

DISCUSSION.

Mr. F. COLLINGWOOD remarked on the durability of the stone (Trenton limestone) used in Montreal, and on the general need of well established rules for the selection of stone. He suggested for investigation, the subject of the effect of internal moisture on cements, *i. e.*, whether the slow percolation of rain-water through the cement in the joints of masonry, *e. g.*, in an arch, is likely to injure the integrity of the structure, producing serious damage by the disintegration of the cement.

A VISITOR, a practical builder, stated that at present, in New York, the struggle of competition tended to produce satisfaction with temporary effects, and the mere question of cost was at the bottom of the hasty selection and cheap construction. Nevertheless, as nice workmanship in stone could be seen, and was being executed in New York to-day, as in any other place in the world. He asked for further explanation, and felt it due to the trade to say that stones were generally treated badly from ignorance rather than from intention. It was the duty of those who know all about these things, to inform those who had to build and work the stone all about its properties and capabilities, and then some good result might ensue. He himself felt the necessity of further knowledge on this important subject, and was sure that most of those in the trade felt as he did.

On invitation, Dr. T. Sterry Hunt observed that frost was the main agent of the disintegration of stone in our climate, often suddenly succeeding the moistening of the material by long rains, and thus producing violent expansion and crumbling. In England, no such extremes occurred. However, in visiting York Minster, a few years ago, he found the workmen engaged in repairing the magnesian limestone at one of the gates. He had climbed up the ladder, and, on examination of the stone, found a remarkable disintegration near the middle, to the depth of one or two inches, by which bars of the rock projected, marking the less absorbent layers.

As to the granytes, that of Hallowell, Me., and that vicinity, is only a granytoid gneiss, and not as compact as a true granyte; its exfoliation he knew to be a mere disintegration, favored by the greater porosity of its texture. The material of the granyte obelisk in Central Park is one likely to offer great resistance to disintegration and chemical decay, as the similar obelisks at Rome and Paris seem to show little or no effect of weathering.

The subject was further discussed by Messrs. Berg, Trotter, and by the President, who expressed a cordial welcome to practical men to attend the meetings of the Academy, and to contribute to their interest through the valuable materials acquired by their experience.

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May 7, 1883.

The President, Dr. J. S. Newberry, in the Chair.

Thirty-three persons present.

Mr. B. B. Chamberlin exhibited some curious concretions of pyrite from the clay-pits at Amboy, N. J. They presented oval, spherical, and sometimes annular forms, with radiated structure, or with finely granular nuclei and beautifully crystallized envelopes.

Prof. D. S. Martin remarked that similar concretions, sometimes exceedingly handsome and with curved crystals, occurred in the white clay beds of New Jersey, belonging to the base of the Cretaceous, and in the plastic clays of the same horizon, which may perhaps represent the Wealden in this country.

The President stated that these specimens were certainly concretionary, and similar to those found in the clays of Ohio, the Connecticut Valley, etc. A peculiarity of this mineral is the readiness with which some specimens oxidize, while others, apparently similar in all other respects, remain brilliant. Few more beautiful minerals ever enter a collection ; but many of the specimens of pyrite in the cabinet of the School of Mines, particularly those from Schoharie, N. Y., decomposed rapidly, absorbing oxygen and water, thus forming sulphuric acid, which has destroyed labels and trays, and has even cut through the bottom of the drawer in which they were placed. Others, like those from Roxbury, Conn., and from certain gold mines of Colorado, have remained unchanged, though for years lying in a room over the chemical laboratories. No facts in chemical geology were more interesting and mysterious than those connected with pyrite : such as its close companionship with gold, the conditions of which have not been determined; its unchangeableness in some cases, its destructibility in others. Sometimes its crystals or concretions are completely changed to limonite, with not the least change of form or markings; sometimes, by oxidation, it is converted into sulphate of iron, which is washed away, leaving cubical cavities, or a spongy mass of quartz; and sometimes even the iron has disappeared, leaving the cavities lined with sulphur. These differences have not yet been satisfactorily explained, and they constitute an inviting subject of investigation for the chemist and mineralogist.

Dr. NEWBERRY had noticed that the pyrites so common in coal, and pyrite replacing wood, are particularly prone to oxidation, the concretions in clays liable to it, and the brilliant crystallizations in mineral veins and in metamorphic slates less so.

Prof. D. S. MARTIN observed that these specimens do decompose with wonderful readiness at Keyport, and in a peculiar way, where exposed to the salt water, the ordinary alteration into sulphate of iron being there replaced by a change into limonite, apparently through some action of the sea-water, the pebbles in the vicinity being also encrusted by limonite.

The CORRESPONDING SECRETARY read letters from Dr. WEISSBACH, of Freiburg, Prof. JANNETAZ and M. EMILE BERTRAND, of

Paris, and Prof. A. D'Achiardi, of Pisa, accepting their election as Corresponding Members of the Academy.

Prof. A. R. Leeds exhibited a crystalline body obtained from human milk. The examination of the ratio between the constituents of milk afforded a subject of much interest and importance. In the course of an investigation of this subject, he had recently procured, through Doctors Thomas and K. Parker, sixty specimens, of two ounces each, of human milk. The albuminoid substances were first precipitated by a salt of copper, the filtrate evaporated, and from this residue an etherial extract was prepared. The ether carries into solution an organic fatty salt of copper which was not present in cow's milk. In the latter, the fats are colorless and solid at ordinary temperatures; in human milk, they are liquid. The object of his investigation was to determine the exact nature of the fatty bodies in human milk, and these results appeared to show that there may be a new fat which forms a crystalline salt soluble in ether. These fats must be numerous, but hitherto we have been content to know their general nature.

Dr. N. L. Britton read a paper, illustrated with specimens and drawings,

## ON THE FINDING OF PREHISTORIC INDIAN SKELETONS AT FAR ROCKAWAY, LONG ISLAND.

The skeletons here described were discovered in an excavation made for the cellar of a new house, erected for Mr. W. T. Bailey in September, 1882. The locality is locally called "Breezy Point," and is one and one-half miles west from the Far Rockaway Station on the Long Island Railroad. The cellar is 225 feet from the shore of a part of Jamaica Bay, and about five feet above high water mark.

Nine skeletons were unearthed, six of them from near the southeastern corner of the house, and three from along the eastern side. They had evidently been thrown into holes without much or any regard for the manner of burial. The positions of the former holes were plainly indicated by the difference in color of the materials filling them, and that of the undisturbed soil. The former was quite a dark brown; the latter, a light yellow.

The natural soil of the vicinity is the pre-glacial yellow sand and gravel drift, which is indistinctly stratified. The holes were filled with this soil for the most part, but mixed with shells of clams and oysters.

Some rude pottery was taken out in fragments. The brown coloration was probably derived from the decomposition of the bodies.

Of the six skeletons found in the larger hole, three had already been removed piece-meal, when he visited the spot on September 9th. They were about two feet from the surface of the ground. He found three still remaining in this hole. One was the skeleton of a very large man, and measured six feet and eleven inches in length, as it lay in the ground. The legs were drawn up, bringing the knees even with the breast, and the hands were seemingly clasped at a level with the face. This skeleton he secured and brought with him.

A child lay to the left of this man, and a fully grown person to his right; the bones of both were badly decomposed. The bones had all been removed from the smaller hole, and he was informed that these had all belonged to adults.

Shell heaps, composed of single valves of *Venus mercenaria*, the hard clam, of *Ostrea borealis*, the oyster, and of *Modiola plicatula*, occur all along the shore in the vicinity; these are as much as three feet in thickness in places, and twenty feet wide.

His attention was first called to these skeletons by Mr. Wm. A. Torrey.

DISCUSSION.

In answer to an inquiry, Dr. BRITTON stated that a tomahawk and several arrow-heads had been dug up in the vicinity.

Professor MARTIN remarked that the pottery showed the type of incised ornamentation, effected by some small hard point.

The PRESIDENT referred to similar collections of shells at many other points along the Atlantic coast. Some on this side of the peninsula of Nova Scotia were found to contain the bones of the great auk and of the walrus. Walrus bones have also been discovered further south, near Long Branch, but were partially silicified and probably much older. Many kjoekken moeddens also occur on the west coast of Florida, and have been described by Professor JEFFREYS WYMAN and others. One of these near Cedar Keys, which had been examined by Dr. NEWBERRY, is half a mile long, twenty to forty feet high, and covered with large live oaks and palmettoes. Further west, along the Gulf coast, the shell mounds are largely composed of *Gnathodon*, and have furnished the material for the famous shell roads. They are also found in the interior, and one on the Tennessee, near Chattanooga, gives its name to Shell Mound Railroad Station. The shells which compose these are mostly species of *Unio*. One near Palatka, Florida, is chiefly made up of univalves, belonging to a species of *Unio* (*Campeloma*).

The shell mounds of the Gulf coast are apparently the work of a peculiar people, who subsisted chiefly on mollusks; and the Atlantic coast mounds are also probably the work of maritime tribes, but not certainly the same with those living on the Gulf. They had this in common, however, that both were cannibals. This is learned from the condition of the human bones found in the mounds, some of which are split longitudinally for the extraction of the marrow.

The date of the shell mounds is uncertain, but we have evidence that they belong to a period long anterior to the advent of the whites. They are generally overgrown by the forest, and bear trees of many hundred years of age, so that the process of accumulation ceased hundreds of years ago. The Florida shell mounds exhibit another feature indicative of age, *i. e.*, they are in part composed of shells which are rare in the vicinity or not found there, and the specimens obtained from the shell mounds are often larger than any that can now be procured in that region. The early narratives of the experience of the whites in the Gulf mention the Caribs as the most important Indian tribe met with. These were maritime in their habits, living largely upon mollusks and fish, and were cannibals. It is quite possible therefore that the builders of the shell heaps on the Gulf coast were Caribs, who may have had formerly a more extended range than when seen by the Spanish historians. A skull, taken by Dr. NEWBERRY from a shell mound near Cedar Keys, must have belonged to a man of good size and creditable cranial development. It exhibited a character common to most of the crania of these coast tribes, namely, that the under jaw projected so that the upper and under teeth were in direct opposition, and worn down around the whole half-circle with great regularity. It is not uncommon to find sets of teeth nearly complete, but worn quite to the alveolus. This extensive wearing away of the teeth was probably caused by the use of food containing much silica, either that was not properly freed from sand, or more likely the seeds of plants which contained considerable silica in their tissues. The elongation of the under jaw gave greater space for the teeth than orthognathus races have. By the use of tender and cooked food, the work of the jaw in mastication has been diminished; and as nutrition is measured by action, and growth by nutrition, the jaw of civilized man is shorter, and the posterior molar (wisdom-tooth) appearing last, is cramped for room, imperfectly developed, and usually temporary. In the jaws of the shell mound people, the wisdom-tooth was one of the largest and most serviceable of the series.

The Far Rockaway skeletons were evidently many hundred years old—how many, none can say. The bones were extremely light and friable; but this is as often the result of special conditions as of time. From the relations of the skeletons to the shell heaps, it may fairly be inferred that they were the remains of the shell mound builders, and were consequently cannibals; but if so, the conditions of the bones indicate that they were rather the eaters than the eaten. The skeleton procured by Mr. BRITTON was that of a man fully six feet in height, well-proportioned, and with good cranial development.

Mr. B. B. CHAMBERLIN referred to a shell-mound which existed some years ago at Tarrytown, on the Hudson river, 28 miles from the coast. It was mostly made up of oyster shells, containing many arrow-heads, but has since been removed by the extension of a neighboring brickyard.

Prof. MARTIN stated that the late Mr. Leavitt had spoken of a shell-mound which formerly existed near Inwood, on New York Island. In New England large shell-mounds occur, such as one at Damariscotta, Maine, thirty feet in height above the river, but which was quarried several years ago for lime. In this the common shells were those of the oyster, but very large, long and narrow, a species which no longer exists there.

Dr. BRITTON remarked that there was formerly a shell-mound, which was a constant resort for collectors of arrow-heads, at Old Bridge, N. J., ten miles up the Raritan and four miles distant from the river.

Dr. JULIEN referred to the very numerous shell-mounds upon the salt-marshes all along the New Jersey coast, and some of which had been partially or wholly submerged, in the progress of the subsidence of that region, forming shell-banks beneath the bays and salt-creeks, as near Barnegat, Manahawkin, Tuckerton, etc. In the early settlement of that country, tribes of Indians were known to make periodical visits to the coast, collecting vast quantities of clams and oysters, drying and stringing them, and thus transporting them inland. It would therefore appear that, in that region, the accumulation of shells did not particularly imply the consumption of mollusks by the Indians who gathered them, as they were probably distributed in the interior.

In reply to an inquiry, the PRESIDENT stated that there was nothing characteristic about the fragment of pottery found at Rockaway. It is extremely rude, this mode of ornamentation being very common on such Indian pottery, having been effected by a small point, by the dentated edge of a shell, or by a cord.

Dr. DA COSTA stated that pottery of this character was found abundantly near Cape Truro, and was not regarded as very ancient.

A MEMBER pointed out that the position of the skeleton, with the knees bent forward, so as to touch the chin, was a common one in Indian burial. It was noteworthy that the skeletons occurred in groups of three, as if the wife and child had been sacrificed at the grave of the warrior.

Dr. BRITTON replied that only one skeleton, the largest, was drawn up in this position, the others lying extended. The three skeletons of the upper group did not lie at the same level, as if they had been irregularly thrown in.

The PRESIDENT remarked on the frequency of burial in the sitting posture, to which reference is made in Longfellow's lines on the "Skeleton in Armor," found at Newport, R. I. Elsewhere the bones are found extended, and, as in Europe, many have suffered cremation.

A paper was then read by Dr. JOHN S. NEWBERRY, on

### SOME INTERESTING REMAINS OF FOSSIL FISHES, RECENTLY DISCOVERED.

The specimens, now exhibited to the Academy, are the teeth and dental plates of some new and remarkable fishes, from the Devonian rocks of Ohio and New York. One group represents parts of the dentition of large ganoids, which have up to the present time afforded no other portions of their bony structure. The others are plates which composed parts of the armor of a new placoderm, allied to *Coccosteus* and *Pterichthys*. Fuller descriptions with figures will eventually be given to the public, but in the meantime the following notes upon them are submitted to the Academy, and will probably suffice for the identification of any similar fossils which may hereafter be found.

MYLOSTOMA, nov. gen.

Ctenodipterine ganoids of large size, of which as yet only the dentition is known. The teeth consist of strong and massive tables of bony tissue becoming more dense and resembling enamel above, and forming pairs in the upper and lower jaw. The dental plates of the lower jaw consist of long-oval or spatulate crowns, three to six inches in length by one to two inches in width, and half an inch or more in thickness, supported by strong, vertical, spatulate bones, which project downward and backward, terminating posteriorly in thin rounded margins. The upper surface of the crown of the inferior dental plates is raised into a more or less prominent tubercle or boss, which rises from the exterior margin a little anterior to the middle. The dental plates of the upper jaw are tables of dense tissue, apparently forming two or more pairs on each side of the median line. The largest of these is three inches in length, by an inch and a quarter wide in the widest part, somewhat triangular in outline, flattened where it rested on the probably cartilaginous floor of the cranium. It is about half an inch in thickness, the free surface somewhat irregularly excavated to receive the prominences of the opposing dental plates. Another of these palatal teeth is shorter and broader, with one margin concave, apparently for co-adaptation with the tooth previously described.

It is probable that we have not yet obtained all the elements in the peculiar dentition of this fish; and the parts yet discovered are so peculiar and anomalous as to make it difficult to co-ordinate them satisfactorily with any hitherto known. The flattened tabular dental plates, which I have supposed formed the roof of the mouth, have a general analogy in form and texture with those of *Chimæra*, and, it is evident, are their analogues and functionally their representatives. Still the teeth of the under jaw, found with these and exhibiting the same microscopic structure, differ widely from any portion of the dentition of chimæroid fishes and exhibit a striking resemblance to the dental plates of the Dipterine ganoids. They evidently form pairs; for we have the corresponding teeth of the right and left sides, and the triturating surface oval in outline, though wanting the radiating ridges of the Ctenodonts, seems to have occupied a corresponding position; and they are mounted on heavy vertical supports which, except that they are flattened vertically instead of horizontally, correspond with the splenial bones which support the dental plates of *Ctenodus*.

The resemblance of the teeth, which I have supposed formed the roof of the mouth, to those of *Ceratodus*, will strike any one who examines them ; and no other analogy in the whole range of ichthyic dentition suggests itself.

Until we shall obtain further information in regard to this strange system of dentition, it will be safest therefore to refer these fishes to the group which includes *Dipterus, Paledaphus, Ctenodus* and *Ceratodus*.

### MYLOSTOMA VARIABILIS, N.

Inferior dental plates, ovoid, or short-spatulate in outline, 3 inches long by 1⅛ wide in the widest part; crown composed of dense bony tissue, becoming enamel-like near the surface, 6 lines thick anteriorly but thinner toward the narrow posterior end. Surface granular or roughened with a vermicular marking, raised, near the middle and on the outer side, into a strong, oblique tubercle or boss. Below, the anterior portion of the tooth is excavated into rudely concentric furrows, from the centre of which descends, beginning at the anterior third, the obliquely compressed splenial bone, which projects downward and backward, to the length of several inches, becoming 1⅝ inches wide at its widest part.

Considerable diversity is shown in the degree of irregularity of the crown surface in corresponding teeth. Three of these, nearly of the same size, show in one a rudimentary irregular boss near the outer angle ; another, the opposite tooth, rises in a strong furrowed, posteriorly depressed, obtuse tubercle, half an inch in height ; while the third, corresponding in position to the last, is a little shorter and broader, and the tubercle is latterly deflected and compressed, till it forms a blunt edge.

Still another and very imperfect tooth, of a smaller size, has a crown elliptical in outline and a blunted, furrowed tubercle, relatively much larger than either of the others. This smaller tooth varies so much from the others, with which it is associated, as to lead to the suspicion that the dentition of the lower jaw like the upper consisted of more than one pair of dental plates.

The dental plates of the upper jaw, in one or several pairs, are rudely triangular in outline, with a flattened or concave triturating surface, bearing, as do some of the inferior teeth, evidences of the wear occasioned by the prominent bosses of the opposing teeth. The surface of attachment of these dental plates to the cranium is flat or concave, and somewhat rough from the coarse cellular tissue of the bone. The sides are straight or beveled, apparently for co-adaptation, and, by their character, favor the conclusion that the dentition consisted of many pairs of plates, constituting a tesselated pavement.

Like those of the associated species, the remains of this very remarkable fish are part of the fruit of the enthusiasm and indefatigable industry of Mr. Jay Terrell of Oberlin, Ohio, the discoverer of the great species of *Dinichthys* which bears his name, the only remains known of *Diplognathus* and various other interesting ichthyic fossils.

MYLOSTOMA TERRELLI, n. sp.

Inferior palatal teeth in pairs, each of which is spatulate in outline, with one margin nearly straight, the other strongly arched toward the exterior; length, 6 to 7 inches, by 1¼ inches in greatest breadth; crown composed of dense enamel-like tissue, 8 lines in thickness toward the front, and gradually thinning toward the narrowed posterior end. Triturating surface punctate or vermicularly roughened, slightly arched from front to rear, and rising into a low rounded boss near the external margin, where the tooth is broadest, and about one-third of the length from the anterior extremity. Below, the crown is supported by a strong bony keel which begins at the anterior fourth of the length and gradually descends backward until it has a width of 2½ inches, terminating in a thin irregularly rounded margin, 10 inches or more from the anterior extremity of the crown.

With all the other specimens of the genus, these teeth were discovered by Mr. Jay Terrell in the Huron shale on the banks of Vermi ion River, Ohio.

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May 14, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-six persons present.

Mr. G. F. KUNZ exhibited a specimen of graphite, containing apparently over twenty per cent. of carbon, from a vein at Bloomfield, Morris county, New Jersey. The vein has been traced for a distance of four or five miles, and contains, in association with the graphite, pyrrhotite, apatite, loxoclase feldspar, and muscovite. A shaft was sunk upon it twenty years ago, but mining operations have been recently resumed at this locality, with promise of success.

Dr. ALEXIS A. JULIEN read a paper, by Dr. H. CARRINGTON BOLTON and himself, on

THE SINGING BEACH OF MANCHESTER, MASS.

The paper was illustrated by a series of specimens of beach sands, from many American and foreign localities, some with the same sonorous property as that displayed on any disturbance or sudden pressure of the sands of the beach at Manchester, and others without it. The limited literature of the subject was discussed; the results of the microscopic examination of the sands given in detail; and a theory suggested in explanation of the peculiar sounds.

Dr. P. DE P. RICKETTS remarked on a specimen of sand in his possession, from the Desert of Sahara, which fell upon the deck of a ship fifty miles off the coast of Africa.

Dr. JULIEN then read a paper

### ON A FORM OF GRAPHITE FOUND AT TICONDEROGA, N. Y.

(Abstract).

The presence of carbon, in amorphous form or in combination, in meteorites, its wide distribution through a certain band of the Archæan strata, and the further evidences of an enormous amount of deoxidation, can be explained, in the present state of our knowledge, only by reference to the life-force. The occurrence of organic structure, more or less perfectly preserved, in the Cambrian strata of Great Britain, the Cambrian and Huronian of Canada, the Huronian of Michigan, and many strata of Cambrian or Siluro-Cambrian age along the Appalachian belt, as far south as Georgia, corroborate in part this view. The distribution of graphite in the crystalline rocks of Canada, and the obscure fibrous structures therein detected by Dawson, were then discussed, and its more limited dissemination through the crystalline rocks within the boundaries of the United States. A description was then given of the graphite vein at Ticonderoga, N. Y., and of a bed of fine-grained white marble penetrated by graphite in slender blades, with fine longitudinal fibration, which suggested the similar form and structure of the leaves of a water-plant.

#### DISCUSSION.

The PRESIDENT remarked that the comparison, made by Dawson, of the amounts of carbonaceous matter in the Laurentian and coal formations can only be accepted as local. In either case, it is far exceeded by the amount of carbon now found in the bituminous shales, etc., of Devonian, Carboniferous, and later age.

Graphite must be of organic origin and derived mostly from plant life. It is true that limestones are often found saturated with carbon derived from animal remains, at least in some portion; since there are usually only traces of animal organisms, and the presence of sulphur and nitrogen is an additional indication. Still these facts are not decisive, since sulphur and nitrogen occur also in plant tissue, and the soft material of seaweeds becomes so broken down by decay that its structure readily disappears. We cannot but believe that we must credit part of the carbon in some limestones to vegetable matter; and this may be true of the clouded marbles, presenting dark lines on a white ground, with wavy structure due to mechanical violence. Carbon often occurs in marbles as graphite, which is the residue from the distillation of hydrocarbons. Its quantity is sometimes small, but sometimes sufficient to color them even absolutely black. In metamorphism the carbon largely disappears, so that the graphite remaining may represent but a tenth part of that originally present. At Newport, R. I., films of carbon occur, converted into graphite, covering the impression of ferns, etc. Graphite is also capable of condensation and segregation, as illustrated by the graphitic carbon in cast iron, sometimes beautifully crystallized in cavities. Here it has been plainly derived from the carbon of the coal, *i. e.*, it is really of organic origin. So also in limestones beautiful crystallizations of carbon occur, the conditions having been favorable for its crystallization along with other crystallized minerals, *e. g.*, pargasite, tremolite, etc.; thus the purest of all graphites have been formed.

Dr. P. De P. Ricketts then made an exhibition of specimens, and spoke on the subject of

### CERTAIN ORES FROM NORTH CAROLINA.

(Abstract.)

Dr. Ricketts first gave an account of a visit to Fisher Hill, near Greensboro, N. C.

The country rock there is crossed by veins of quartz, with dykes of dioryte.

Reference was also made to a visit to some mines in Montgomery County, where the gold is native to a much greater depth than in the case of the Fisher Hill veins, and occurs along the line of contact between a silicified slate and quartzyte, the latter forming what might be called the hanging wall of the vein. The gold occurs native in thin films in zinc blende, which is associated with galena, and iron and copper pyrites. The richest portion of the deposit is along the line of the hanging wall mentioned; but the seams are very thin and uncertain.

A visit to some copper deposits in Person and Granville Counties

was also described. The veins in this region were first opened during the past summer.

The Gillis mine is the only one with a history, having been reported upon by Prof. JACKSON at the close of the war.

The country rock is slate, which dips east, with a strike north 10° east. Dykes occur, and evidences of the metamorphism of the slates, which, along the line of contact, contain metallic copper. The dykes themselves are sometimes strongly impregnated with sulphuret of copper and metallic copper, averaging a content of two per cent., at one place visited, in metallic copper. Epidote is also largely found along the centre of the ridge, or line of contact.

The quartz veins in this region carry carbonate, silicate, and sulphuret of copper, and generally strike north 10° east. One vein, however, which Dr. RICKETTS inspected, about 2½ feet in width, crosses this direction at right angles, dipping to the north.

The first-class ore from this vein yields forty per cent. of copper and 25 ounces of silver to the ton. A large number of specimens from these veins were exhibited.

These remarks were briefly discussed by the President, Dr. RICKETTS, and others.

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May 21, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was filled by the audience.

Prof. D. S. MARTIN read by title the two following papers: by Prof. EDWARD V. MARTENS, communicated by Mr. THOMAS BLAND,

DESCRIPTION OF TWO SPECIES OF LAND SHELLS FROM PORTO RICO—

Cistula consepta, *nov. sp.*

Chondropoma Tortolense—Pfr., *var.* major.

and by THOMAS BLAND,

DESCRIPTION OF TWO NEW SPECIES OF ZONITES FROM TENNESSEE—

Zonites Wheatleyi, *nov. sp.*

Zonites petrophilus, *nov. sp.*

Prof. JOHN K. REES, of the Observatory of Columbia College, New York City, then delivered the monthly lecture, on the subject of

THE GREAT TELESCOPES OF THE WORLD.

May 28, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty persons present.

The PRESIDENT exhibited specimens of coal plants, brought by Mr. Hague, from the northeastern part of China. These specimens were of Mesozoic age, like those of the Richmond basin. There is, however, a large development in the northern part of China of the true Carboniferous series, with anthracite, and including the remains of plants of that formation.

Prof. D. S. MARTIN then read a paper by Mr. GEO. N. LAWRENCE, entitled

DESCRIPTIONS OF NEW SPECIES OF BIRDS OF THE GENERA CHRYSOTIS, FORMICIVORA AND SPERMOPHILA

Chrysotis caniformis, *nov. sp.*, from the Island of Aruba, W. I.

Formicivora grivigula, *nov. sp.*, from British Guiana.

Spermophila parva, *nov. sp.*, from Mexico.

Dr. ALEXIS A. JULIEN read a paper entitled,

NOTES ON THE FLORA AND FAUNA OF THE ISLANDS OF CURAÇAO, BUEN AYRE, AND ARUBA, W. I.

This paper discussed in some detail the most characteristic features of the flora and fauna of these rarely visited islands, and concluded with the following contribution, by

Mr. THOMAS BLAND, entitled,

NOTES ON THE TERRESTRIAL MOLLUSKS WHICH INHABIT THE ISLANDS OF ARUBA, CURAÇAO, AND BUEN AYRE.

In 1882, my friend Dr. Alexis A. Julien, visited the islands above named, and collected a number of land shells, which he lately submitted to me for examination.

The following is a list of all the species known at this date to inhabit those islands.

It should be mentioned that the islands are at no great distance from the mainland of Venezuela, and within the 100 fathom line of soundings.

ARUBA.

* Tudora *megacheila*, Pot. & Mich.
* Bulimulus elongatus, Bolt.

CURAÇAO.

* Tudora *megacheila*, P. & M.
* Tudora *megacheila*, var.?
* Cistula *Raveni*, Crosse.
* Succinea *gyrata*, Gibbons.

Bulimulus multilineatus, Say. Also New Granada, Venezuela and Florida.

* Bulimulus elongatus, Bolt. Also Porto Rico, Virgin Is., St. Croix, and several of the Lesser Antilles ; also Central America.

* Cionella *Gloynei*, Gibbons, has dentition of the genus, W. G. Binney.

Geostilbia ? Sp. indet.

* Strophia *uva*, L. Gibbons found a young dead specimen at Sta. Martha, but supposed it to have been brought from Curaçao. Woodward and Paetel erroneously refer the species to Guadeloupe.

Pupa *longurio*, Crosse.

* Macroceramus inermis, Gundl. Also Cuba. I considered the Curaçao species to be *M. Gossei*, Pfr., which is found in Jamaica, Cuba, Bahamas and Florida. Dentition same as of *Gossei*, W. G. Binney.

* Cylindrella *Raveni*, Bland.

Stenogyra octonoides, C. B. Ad., Gibbons. Also Jamaica, Cuba, Bahamas, Hayti, and other of the West India islands.

BUEN AYRE.

* Tudora *megacheila*, P. & M.

* Tudora *versicolor*, Pfr.

* Tudora *versicolor*, ? var ?

* Cistula *maculata*, *nov. sp.*

I add the following description, which will serve to identify it. Shell, rimate, elongate, thin, finely striate, pale horn colored, with 4 to 6 spiral bands, on each whorl, of reddish-brown spots arranged in longitudinal lines ; bands and spots sometimes more or less obsolete ; suture deep, whorls, 7 to 8, convex ;—the upper 3 whorls usually absent, the last descending, solute ; aperture, circular ; peristome, simple, slightly thickened. Operculum, closely fitting upon, scarcely extending beyond the margin of the peristome.

Length of the shell, entire, 10 mill ; of remaining whorls, 8 mill, breadth of penultimate whorl, 4 mill ; diameter of aperture, 2 mill.

* Succinea *gyrata*, Gibbons.

* Conulus ?—indet., one dead specimen found.

* Bulimulus elongatus, Bolt.

* Cionella *Gloynei*, Gibbons.

* Strophia *uva*, L.

* Macroceramus *inermis*, Gundl.

* Cylindrella *Raveni*, Bland.

The species, to the names of which an asterisk is prefixed were collected by Dr. JULIEN. The species whose specific names are printed in italics, are peculiar to the islands named.

*Helix pentodon*, Mke., has been included in lists of Curaçao shells, but it is unquestionably a young *Strophia*, and probably of S. *uva*, L. PFEIFFER suggests (Mon. VIII) that it may be the young of S. *Milleri*, Pfr., found in the Bahamas.

It will readily be admitted, seeing the genera represented, that the fauna of the islands under consideration, is, as remarked by Gibbons with respect to Curaçao, by no means of the character one might expect from their geographical situation.

*Tudora* and *Cistula*, of the operculates, are alone represented. Of the former, nearly all the known species inhabit Jamaica, Cuba, and Hayti. The genus has no representative in the Lesser Antilles. The greater part of the species of *Cistula* are from Jamaica, Cuba, Hayti, and Porto Rico, in each of the islands of Sombrero, St. Croix, Antigua, and Trinidad there is one species.

The occurrence, in Curaçao and Buen Ayre, of *Strophia* and *Macroceramus*, is peculiarly interesting. Both genera are unrepresented in the Lesser Antilles. Nearly all the known species of *Strophia* inhabit the Bahamas and Cuba. In Hayti and Porto Rico are two, the same species—one in the Virgin Islands, one fossil, in St. Croix, and the impression of one is found in the phosphatic lime rocks of Sombrero.

*Strophia* is represented on the American continents, by one species only, in Florida and several of the adjacent Keys—a species which belongs to Cuba and the Bahamas.

With regard to *Macroceramus*, a large majority of the known species belong to Cuba and Hayti; to Jamaica, Porto Rico, and the Virgin Islands, 2; Bahamas and Turk Islands, 2; Anguilla, 1. There are four or five species in Florida, Mexico, and Central America.

Of *Cylindrella*, about three-fourths of the known species are found in Jamaica, Cuba, and Hayti. There are five or six species only in the Lesser Antilles.

I have thus conclusively shown that the land shell fauna of Aruba, Curaçao, and Buen Ayre has very marked alliance with the faunas, especially of Jamaica, Cuba, and Hayti; very little with that of the Lesser Antilles, in which *Tudora*, *Strophia*, and *Macroceramus* are wanting, and *Cistula* and *Cylindrella* have trifling representation.

The fauna of the three islands under special consideration has no appreciable connection with the adjacent continent, save, perhaps, as regards B. *multilineatus*.

Looking at the remarkable fauna of the the three islands, I may call attention to the interesting result of the soundings taken across the Caribbean Sea, in the winter of 1878–9, and reported to the Superintendent of the Coast Survey, by Prof. Alex. Agassiz, in a letter which was published in the Bulletin of the Mus. of Comp. Zoology, vol. v., No. 14.

NOTE.—In Los Roques, not far to the eastward of Buen Ayre, a peculiar form was discovered, described by M. Crosse in 1873, as *Ravenia Blandi*,—allied to *Spiraxis*, but with a tooth on the outer lip.

The paper was discussed by Dr. B. N. MARTIN, Dr. WM. ORMISTON, and the PRESIDENT.

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June 4, 1883.

BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons present.

Certain recommendations of the Council were adopted, and it was voted to adjourn the sessions of the Academy, as usual, for the summer. Notice was given by the President that when the meetings are resumed, at the beginning of October, they will be held in a Lecture-room of the new building of Columbia College, in East 49th street, where the Academy would be accommodated free of rent, according to the proposal made and accepted last spring.

Prof. D. S. MARTIN, the Chairman of the Publication Committee, was authorized to remove all the property of the Academy, now at No. 12 West 31st street, to a room provided without charge in the building of Columbia College.

It was "*Resolved*, that the Secretary of the Academy be empowered to act for the Academy in extending an invitation to the American Association for the Advancement of Science to hold its meeting of 1884 in New York city, and to communicate on the subject with the Permanent Secretary of the Association and with the other scientific societies of the city."

The resignation of Dr. RYLANCE was accepted.

The Publication Committee reported, through its Chairman, Prof. D. S. MARTIN, that Number 12, the closing part of Volume II. of the Annals, was in type, and nearly ready for issue and distribution.

Mr. GEORGE F. KUNZ exhibited a number of remarkable and interesting minerals, comprising a large set of fine zeolites from several tunnels through the trap ridge of Bergen Hill, and other species from North Carolina.

Dr. J. S. NEWBERRY then read the following paper:

THE EVIDENCES OF ANCIENT GLACIATION IN NORTH AMERICA, AND THEIR BEARING ON THE THEORY OF AN ICE PERIOD.

(Abstract).

Prof. Newberry exhibited a map of North America, on which he had represented all the known glaciated areas, and described, chiefly from his own observations, such as lie within the limits of the United States. He showed from the facts given, first, that glaciers once covered most of the elevated portions of the mountain belts in the Far West, as far south as the 36th and, in the eastern half of the Continent, the 40th parallels; second, that the ancient glaciers were not phenomena produced by local causes, but were evidences of a general climatic condition; third, that they could not have been produced by a warm climate and an abundant precipitation of moisture; fourth, that they were the products of a general depression of temperature, and therefore were proofs of the truth of the glacial theory. The facts presented may be briefly summarized as follows.

The glaciation of the Sierra Nevada is general and very striking; it has been described by Whitney, King, Le Conte, and others, who have given abundant proof that all the highest portion of the range was once covered with snow-fields, and that glaciers descended from these down the valleys on either side.

Mt. Shasta once bore many great glaciers, of which miniature representatives still remain.

The Cascade Mountains exhibit perhaps the most stupendous record of ice-action known. All the higher portions of the range are planed down and furrowed by glaciers, which descended into the valley of the Des Chutes on the east, and that of the Willamette on the west, as shown by the observations of the speaker in 1855, at least 2,500 feet below the present snow-line. Mt. Ranier still carries glaciers of considerable size; and all the country around, as well as about Puget's Sound and on Vancouver's Island, shows evidence of former glaciation In British Columbia the signs of ancient glacial action, as shown by George M. Dawson, Dr. Hector, Richardson, etc., are conspicuous in all the high country explored. The valleys of the Wasatch range were once filled with masses of ice as far south as central Utah. A type of these was the Little Cottonwood glacier of which the record has been carefully studied by Dr. Newberry. It formed in a cirque at Alta, 10,000 to 11,000 feet above the sea, had a length of about ten miles, a thickness—as shown by the line of granitic blocks left along its sides—

of 500 feet or more, and its lower end was only 5,500 feet above the sea.

The glaciation of the Uinta range has been graphically described by King, who says that the ancient glaciers of these mountains occupied a greater area than all those of the Alps.

In the Rocky Mountain belt the signs of glaciers abound, from the northern part of New Mexico through Colorado, and along the great divide in Wyoming, Montana and Idaho.

In these Western mountain ranges the glaciers were far more extensive than any now to be found on the earth's surface, unless on the Antarctic continent or Greenland. The record they have left consists of planed, grooved and striated rocks, covering immense areas, lateral and terminal moraines, moraine lakes, etc., etc.,—a record which is as legible and reliable as any printed page.

In the country east of the Mississippi, the evidence of ancient glaciation is even more widespread and impressive than in the Far West. All the surface rocks of Canada, of New England, of New York, and the greater part of Ohio, Indiana, Illinois and Wisconsin, bear marks of ice-action, and are generally covered with a sheet of drift material which has been carried by glaciers from the north southward, often many hundred miles. This glaciated and drift-covered area extends from Maine and Massachusetts westward in a belt parallel with the arch of the Canadian Highlands, 500 miles wide and more than 2,000 miles long. Its extension northward from the head-waters of the Mississippi has not been traced further than Lake Winnipeg, where it was studied by Hind; but there are good reasons for believing that it extends to the Arctic Ocean, and that the great lakes of the North, like those of the St. Lawrence chain (Superior, Huron, Michigan, etc.), are old river-valleys scooped out and modified by glaciers. Above the Canadian line, George M. Dawson reports that the glacial drift from the Canadian Highlands extends westward till it meets that which was spread eastward from the Rocky Mountain belt.

From the facts already gathered, it is a justifiable inference that fully one-half of the continent of North America, north of the 36th parallel, was at one time covered with ice or perpetual snow, and, so far as we can now judge, the glaciation of all the areas enumerated was synchronous, and that it occurred at the same time with the great expansion of the glaciers of Europe.

Some writers have attempted to prove that a large part of the glacial phenomena described are really the work of icebergs, and the consequences of a great continental subsidence; but no man who has studied the inscriptions made by glaciers will hold to such a theory, when he has traversed much of the glaciated areas east or west of the Mississippi.

While the phenomena described above are unmistakable, and constitute an indisputable record of the prevalence of ice-sheets over great areas of our continent, much speculation has been lavished upon the possible causes of such accumulations of ice and snow as have here left their marks. In a voluminous and elaborate review of the subject recently published by Prof. J. D. Whitney, the glacial record is misrepresented and belittled. By this author it is stated that ice has little or no eroding power, while every one who has traveled through the glaciated areas has noticed the peculiar impress left upon the topography by the old glaciers; and the sheet of drift material now remaining, as the result of ice-erosion,—over one area, 2,000 miles long and 500 miles wide, from 30 to 50 feet thick—is in itself a sufficient answer to this assertion.

But our drift deposits are only a remnant of the mass of material eroded by the glaciers. Most of the flour they ground—the clay—has been washed away, and, over great areas, only the bran—gravel, sand and boulders—remains. All the streams flowing from glaciers are turbid with sediment supplied by the grinding of rocks by ice. This has been measured in some cases, and the erosive power of glaciers has then been not only demonstrated but quantitatively determined; for example, the daily transport of sediment from the Aar glaciers in August is 280 tons, and Helland states that 69,000 cubic meters of solid rock are annually worn away by the Justedal glacier of Norway (Geikie); and yet we are told that ice has little or no eroding power!

By Professor WHITNEY the few glaciers, of which the record cannot be ignored or sophisticated, are considered as the product of local causes, and not as evidence of an *ice period*, which it is the great object of his book to disprove. The immense extent, however, of the glaciated area, reaching as it does, from the Atlantic to the Pacific, from the 36th parallel northward on high lands, and the 40th on low lands, as well as the evidence of approximate or exact synchronism in the phenomena, make it impossible to accept the theory of local causes.

We are in fact driven to the necessity of referring the record to a general climatic condition. What this condition was, is the next point for investigation; its cause or causes still another. Professor WHITNEY, following LECOQ and others, claims that since snow and ice are moisture evaporated elsewhere by heat, the extension of glaciers at any time or place is simply an effect of increased heat and not cold; and hence if there ever was an ice period—meaning a time when glaciers were more widespread than now—it must have been a warmer period than the present, with more copious precipitation. Only a few of many facts need be cited to show that this theory is untenable. First, glaciers are now confined to altitudes and latitudes, where the temperature is low—

Alpine summits and the Arctic and Antarctic continents. To widen and intensify the conditions which now produce glaciers would necessarily induce an extension of snow and ice. Second, on the Cascade mountains we find a copious precipitation of rain and snow, but no ice, where great glaciers formerly existed. The snow-line is 7,000 feet above the ocean ; and there the temperature is high enough to permit the most vigorous growth of trees and smaller plants. The fir forests here meet the snow-banks in actual mechanical conflict, and the front ranks of trees, though of good size, are weighed down by the snow, and grow prone and interlaced upon the ground.

The snow-fields rise 3,000 to 4,000 feet above the snow-line, and there are miniature glaciers at the heads of the valleys—relics of the great glaciers that once filled these valleys to their mouths. The precipitation remains, the snow fall remains, but the glaciers are gone !

Here we have just the conditions most favorable to the formation of glaciers, according to the theory of those who regard them as *thermal phenomena,* but no glaciers, *because of the high annual temperature.* With a depression of temperature, which should cause the rain-bearing winds from the Pacific to do all the year what they now do only in winter, viz., heap up snow on the highlands, the mountain slopes and draining valleys would soon be occupied by glaciers again. So if winter conditions could be made permanent on the great water-shed of the Canadian Highlands, and the flow of the St. Lawrence, Mississippi and Red River be retained in the form of snow and ice, glaciers would soon fill again the lake basins, over-ride the highest summits, and cover with an ice-sheet all the old glaciated areas. Even if the evaporation from adjacent seas was somewhat diminished by the cold, that would not change the result, though it would prolong the time. If the evaporation in the region surrounding the North and South poles is, as we have demonstrative evidence, sufficient to produce continental glaciers on Greenland and the Antarctic continent, it requires no argument to show that like conditions would produce like results in what is now the temperate zone.

The relations which the ancient great lakes of the Far West bore to the former glaciation of the same region is an interesting subject of inquiry. It has been suggested that it is the relation of cause and effect, but this seems hardly possible. They may have been synchronous, and to some extent co-operative phenomena, but the relationship was rather fraternal than filial. The cause of the former great breadth of water-surface was either an increased precipitation or a diminished evaporation. We not only have no record of any change in the relationship of the North American continent to the Pacific, in modern times geologically speaking, but the evidence against any change is conclusive.

Everything indicates that the system of rain-bearing winds, the topography, and hence the precipitation have been substantially the same for a long period. But any cause which could produce a depression of temperature would certainly diminish evaporation, and form lakes in the valleys and glaciers on the mountains. To prove this, we have only to cite the phenomena presented by summer and winter in the western territories. In winter, the snow-fall on the highlands is heavy, and the accumulation of moisture in this form is large. The skies are cloudy, and evaporation is small. In summer, the sky is cloudless, the heat intense, evaporation and desiccation rapid. In the spring the snows melt, flood the valleys and form temporary lakes, which in midsummer dry up to *playas*. A perpetuation of the conditions of winter and spring would inevitably produce glaciers and lakes, and these would be essentially synchronous. A depression of temperature, which should intensify and prolong the present winter, and make midsummer like the present May, would inevitably produce glaciers and lakes, in the main synchronous, and thus would accomplish all that we find recorded. But to intensify and prolong summer by an elevation of temperature, would not produce either lakes or glaciers.

That the ice period was cold and not warm, is further proved by the prevalence of an Arctic flora and fauna on the land and in the sea, in all regions near the old glaciers. The Arctic shells of the Champlain, the Arctic plants in the Quatenary clays, the reindeer, musk ox, woolly mammoth and woolly rhinoceros, all tell the same undeniable story.

From the facts cited, and others of similar import in the southern and northern hemispheres, we must conclude, 1st, that a glacial period has prevailed simultaneously or alternately in both hemispheres; and 2d, that the glacial period or periods were periods of lower temperature than that of the present day.

An inquiry into the *cause* of the cold of the ice period would open a question beyond the scope of this paper, and one too broad and suggestive to be discussed to any purpose in the time at our command. I may say, however, in passing, that I have elsewhere shown that no arrangement of land and sea, consistent with the known facts of Tertiary and Quaternary history, will enable us to refer that cold to any topographical or even telluric cause. Some extraneous influence, such as a variation in the heat radiated by the sun, as suggested by NEWCOMB, or a variation in the eccentricity of the earth's orbit, as advocated by CROLL, or some other cosmical cause, must be credited with effects so widespread and stupendous as the ice period has left behind it.

The Academy then adjourned to meet October 1 in the new building of Columbia College, at Forty-ninth street and Madison avenue.

ar. 3. 1883.

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