A MEMOIR

OF

THOMAS STERRY HUNT, M.D., LL.D. (Cantab.),

Fellow of the Royal Society; Member of the National Academy of the U. S., the Imperial Carolinian Academy, the American Philosophical Society, the Amer. Academy of Sciences, the Royal Society of Canada, the Geological Societies of France, Belgium and Ireland; Officer of the Orders of the Legion of Honour, SS. Mauritius and Lazarus, etc., etc., etc.

BY JAMES DOUGLAS.

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OBITUARY NOTICE

OF

THOMAS STERRY HUNT.

BY JAMES DOUGLAS.

(Read before the American Philosophical Society, April 1, 1898.)

Among the most versatile men of science, of the present generation, must be classed Thomas Sterry Hunt.

He was prominent as a chemist nearly half a century ago, not only in the field of original investigation, but as one of the first interpreters of the new chemistry then being taught by Gerhardt, and he not only grew with the growth of his favorite science up to the date of his death, but helped to enlarge its scope, to expand its relations, and place it on a new and more consistent basis.

As a geologist his work was almost confined to the crystalline and palæozoic rocks, not only because his practice in the field under Sir William Logan, in the Canadian Geological Survey, was among the older rocks, but because the investigation of their origin, decay and metamorphosis in its fullest sense, fell within the scope of his studies as a chemist, and gave wider range to his faculties as a theorist. For Hunt, besides being an exact student of nature, was a poet, and, being a theorist, was possessed of vivid imagination. He brought his chemical knowledge to bear on the geological problems which presented themselves to him in most perplexing profusion, while trying to conceive of the genesis of the crystalline rocks. And he was of necessity led on from the conception of the primal conditions of our own globe to speculations on the constitution of the universal atmosphere and the building of worlds in interstellar space.

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It was natural that the phase of mineralogy, which to him would have most attraction, and which he would most sympathetically elaborate, would be the chemical. Minerals being chemical compounds, he applied to the study of their constitution and classification the chemico-physical law which he had been groping after all his lite, and clearly formulated only in 1886, viz., "that the value not only of gases and vapors, but of all species, whether gaseous, liquid or solid, is constant, and that the integral weight varies directly as the density." Under the guidance of that law he propounded an entirely new and original classification of mineral species.

It was therefore preëminently as a chemist, whether he was laboring in the laboratory or in the domain of geology or of mineralogy, that Hunt was most at home, and that he left his impress on the science of his day, an impress which will never be effaced.

Thomas Sterry Hunt was proud of his second Christian name, his mother's patronymic, as more than one of his direct ancestors had made the name conspicuous and famous. He could trace his descent almost without interruption from that Peter Sterry who was chaplain first to Lord Brooke and then to Oliver Cromwell—who could preach Puritanism to the Long Parliament, and astutely secure his own pardon from Charles II. A much more uncompromising and typical preacher of the Commonwealth was a member of the same stock, that Thomas Sterry who wrote *A Riot Among the Bishops; or, A Terrible Tempest in the Sea of Canterbury.*

A branch of the family, consisting of three brothers, Roger, Robert and Cyprian Sterry, and a sister, came to America about 1753, and settled in Providence. Roger alone left legitimate offspring. Two of his sons, John and Consider, attained eminence as mathematicians and edited and published *The True Republican*, a leading organ of the old Jeffersonian party. Nevertheless the world at large will hardly subscribe to the epitaph which commemorates Consider Sterry's fame in Norwich churchyard, Connecticut. "Consider Sterry, aged 56 years; died November 15, 1817.

When the world lost a genius for mathematics and astronomy seldom equaled, rarely surpassed. This monument is erected by the Society of Freemasons, of which he was an ornament, by whose lustre the path to the high eminence to which he attained is made plain to those who strive for equal excellence."

Jane Elizabeth, a daughter of the mathematician, Consider Sterry, was married to Peleg Hunt in 1823. Thomas Sterry, their oldest child, was born on September 5, 1826, in Norwich, Conn.

Mr. Hunt moved his family to Poughkeepsie, N. Y., when his son was about ten years old. There the father died in 1838, and the mother returned with her surviving children to her old home in Connecticut. She was a woman in whom strength of character was combined with tenderness. She made a successful struggle; by her own exertions educated her children, and was rewarded by their unflagging affection. Thomas' first earnings were devoted to relieving her from the burden of self-support and to providing her with a home of her own. After her death he devoted a large share of his income to the maintenance in comfort of his two sisters.

He was twelve years of age when his mother returned to Norwich. For a short period he attended the grammar school, but it was necessarily for a short period. The financial exigencies of his home were peremptory, and the lad of thirteen had to earn his own living. His first employment was in a printing office. His next master was an apothecary, and his third a bookseller. His inclinations probably dictated his choice in each case, for books and chemicals were already the tools with which he was shaping his future career. But more profitable work offering in the corner grocery of the village of Greenville near Norwich, the future chemist accepted it. Fortunately his duties were not exacting, for they left him time to read and even carry on some original investigation, with the stove as his furnace and the shelves beneath the counter as his laboratory. A scientific career was the aim of his efforts and studies. His most appreciative advisers and allies were the local physicians and their libraries were his stock of books. His thoughts turned, therefore, to medicine and surgery, as the most available if not the most congenial of scientific pursuits, and a skeleton was hidden away among the boxes and barrels of the grocery store, with his home-made chemical apparatus. But his natural bias finally asserted itself, and circumstances combined with his tastes to enable him to follow the pursuits for which he was best fitted.

The sixth annual meeting of the Association of American Geologists and Naturalists, the progenitor of the present American Association for the Advancement of Science, was held in New Haven in 1845. The young chemist attended it as correspondent for a New York newspaper. There was read at it more than one paper which must have stimulated his thoughts and imagination—above all, a most suggestive rather than conclusive discussion of the atomic theory by that brilliant but eccentric genius, J. D. Whelpley, a paper glittering with such aphorisms as "gravity is affinity at a distance," "affinity is gravity near at hand," and "the extended atmosphere of an atom (Sanscrit *atma*, breath, omnipresent power, first principle) is therefore its proper ether, through which it radiates pulses of heat and light, and is electrically, magnetically and attractively present in the whole space."

Thomas Sterry Hunt's name appears among those of the gentlemen unanimously elected members of the Association. He therefore took more than the ordinary newspaper reporter's perfunctory interest in its proceedings. That of his future chief, William Logan, also stands on the same list, with the strange title, "Geol. Surveyor of Canada."

The elder Silliman had lectured at Norwich, and had there previously seen the precocious boy. When Hunt met him now again, his wonderful acquirements and natural grace of manner gained for him the friendship of that famous chemist, as noted for his generous appreciation of genius in others as for his own scientific position. He secured his admission to the Scientific School, and gave him a position in the chemical laboratory. There he at once became so useful to Silliman, Jr., in making a series of water analyses as to earn a salary, and ere long gain admission to the professor's household. His first paper to Silliman's *Journal*, "A Description and Analysis of a New Mineral Species containing Titanium, with Some Remarks on the Constitution of Tellurium Minerals," is dated from Yale chemical laboratory in February, 1846, and exhibits the same care in noting every step of the analysis and every resulting reaction as characterized his laboratory work throughout life.

He wrote to a friend from Yale college laboratory, New Haven, June 25, 1845 :

" I have seated myself in the laboratory with the flasks by my side, so as to work and write at the same time. I am busily engaged in the analysis of corals collected by the U. S. expedition, and now being analyzed for Government. They are almost pure carbonate of lime, with a few thousandths of phosphoric acid and ammonia, and occasionally alumina. One specimen which had been sent as a coral mud or sand, I found to be *white arsenic*, probably put up by mistake on board the ship. . . . . I am generally occupied one or two hours each day in assisting the professor (Silliman) in arranging drawings and specimens for the lecture. I have free access to the cabinet, and a key to unlock all the cases. . . . . I am boarding in a club of students at $1.25 a week. We have little or no meat. I do not like this very well, but it is cheaper, though I think I will board myself after a while. The room I expected to have had been occupied, as it was uncertain whether I was coming, and so I have taken up lodgings in the loft of the laboratory building itself, and am so quite at home with chemical apparatus and preparations all around, but they are congenial spirits as Mr. Silliman remarked when he showed me the room."

He writes again on March 23, 1846 :

" My time is wholly occupied in part by chemical analyses. I have made an elaborate analysis of a mineral from Amity,

N. Y., supposed to be Warwickite, but which I have decided to be a new species, and have named Enceladite. The results will be published in the *American Journal* for May, when I shall send you a copy. I am now engaged in an examination of our Norwich minerals, the Edwardsite and Monazite. Prof. Shepard's researches did not entirely settle the question relative to its composition, or identity with the Russian Monazite. I have also been assisting Mr. Silliman in the preparation of an elementary chemistry, which he is compiling for the use of schools. It is but partly finished, and I shall recommence the work in a day or two."

During 1845, 1846 and 1847, while a student at Yale, he contributed to Silliman's *Journal* no less than eighteen articles and notes long and short; and wrote the organic sections for Silliman's *First Principles of Chemistry*. Prof. Silliman thus acknowledges his debt in the Preface to the first edition. published in December, 1846: "The author takes pleasure in acknowledging the important aid derived in this portion of the work from his friend and professional assistant, Mr. Thomas Sterry Hunt, whose familiarity with the philosophy and details of chemistry will not fail to make him one of its ablest followers. The labor of compiling the organic chemistry has fallen almost solely upon him."

Hunt's connection with the Yale College analytical laboratory was short. It terminated by his appointment as chemist and mineralogist to the Geological Survey of Canada in the autumn of 1846, after refusing an offer from Edinbro', of assistant to Prof. Johnston, of agricultural chemistry fame, and declining the post of chemist on Prof. C. B. Adams' Geological Survey of Vermont. The elder Silliman, in urging his appointment on the Governor-General of Canada, Lord Cathcart, says: "I cannot entertain a doubt that he (Hunt) will, if appointed to the post named within, fully justify the strong recommendations of his friends." Prof. Silliman, Jr., says: "His youth might be an objection to his holding a place of high trust and responsibility, but I can assure you that his conscientiousness and maturity of mind are quite sufficient to warrant his appointment." Prof. C. Uphan Shepard predicts that "he will discharge all the duties of the place in such a manner as to enrich science with many valuable discoveries," while Prof. J. D. Dana "takes pleasure in testifying to the ability of Mr. Hunt, believing that his personal character as well as talents entitle him to high regard."

The results justified the estimate his friends had formed of the ability of the youth of twenty to be the chemical and mineralogical mentor to the old trained geologist, Sir W. Logan. Just before leaving New Haven, he wrote to the same friend to whom the letters previously quoted were addressed: "It will give me great pleasure to be enabled to place my dear mother in a situation where she no longer will be obliged to labor." He then rather gloats over some of those who evidently had not aided him in his lofty aspirations and adds: "This is perhaps a boyish spirit, but I am a boy yet, and *am not anything else*." The italics are his own.

He entered into office in February, 1846, and though he did not write a separate report for the year 1846 and 1847, the influence of his mineralogical learning on the stratigraphical tendencies of his chief is clearly noticeable in Sir W. Logan's report for that year. His summers were spent in the field where he learned from his director his first lessons in stratigraphical geology. There was assigned to him the investigation of the economical natural resources of Canada and the determination and description of the technical processes best suited for their utilization. The first branch of study was pursued in the summer, and obliged him to visit such remote and inaccessible districts of Canada as could be reached only by canoe. The latter branch, involving an immense amount of minute laboratory manipulation, was his winter employment. But the routine even of analytical work was not dull, for every determination was stored away for future theoretical use, and the most commonplace facts were fitted into the hypothetical structure which he was already building.

His first report appears in the Canadian Geological Survey report for 1847. It and those which followed till 1852 were devoted chiefly to the record of his examinations of the mineral waters of Canada. From the analytical results thus obtained he drew generalizations which inevitably led him into the field of geological chemistry. His subsequent official studies among the limestones, dolomites and gypsums, and later on among the granites and gneisses of the crystalline rocks, supplemented his earlier speculations on the agency of water as a rock-forming and transforming medium, and opened up those wide vistas of research and speculation which he followed, till they led him to the clear conception of his *crenitic* theory. His official reports contained the facts which were of interest to the public, but those same facts, with the theoretical deductions he drew from them, he embodied in articles, which were contributed to the journal of his old friends, the Sillimans, and were in many cases widely reproduced in Europe. But in addition to articles suggested by his purely professional work, he had hardly been domiciled in his room, which opened off the laboratory of the Survey, when he inaugurated his career of independent thought and original investigation in theoretical chemistry by a "Review of the Organic Chemistry of Mr. Charles Gerhardt," and by a paper "On the Anomalies presented in the Atomic Value of Sulphur and Nitrogen, with Remarks on Chemical Classification, and a Notice of Mr. Laurent's Theory of Binary Molecules." These were followed in 1849 by a paper "On Some Principles to be Considered in Chemical Classification."

The Bibliography (appended) shows how even at this early period of his scientific career Hunt not only combined the routine work of his profession as a chemist with theoretical speculations, but elevated the drudgery of the laboratory into work of highest scientific interest, by drawing far-reaching conclusions from every series of determinations which his duties required him to make. His analysis of the saline springs of Canada, its soils, rocks and minerals, undertaken from utilitarian motives, afforded material for those broad generalizations as to the genesis of the material of the earth's crust and the constitution of the whole solar system, which are the most brilliant products of his maturer thought. They also led him to distrust the finality assigned by the chemists of the day to the atomic theory, as propounded by Dalton, and therefore to advocate and expound the then revolutionary views of Gerhardt and Laurent. Without contradiction his contributions to literature at this period were potent agents in spreading the doctrine of the new chemistry, of which he was not only a disciple but one of the apostles. His essay, for instance, "On the Theory of Chemical Changes and on Equivalent Values," published in Silliman's *Journal*, March, 1853, was reprinted in the London, Edinburgh and Dublin philosophical magazines, and in German translation in the *Chemische Centralblatt*. Hunt himself considered that the views expressed in this essay, and which were elaborated and applied in his subsequent essays, "On the Composition and Equivalent Volume of Mineral Species," "On Solution and the Chemical Process," "On the Objects and Method of Mineralogy," and "On the Theory of Types in Chemistry," "form the basis of a rational theory of chemistry and of a true mineralogical classification."

When sending a copy of his "Essay on Chemical Changes" to a friend in 1853 he says: "This last, unless I mistake, will reform entirely the theory of chemistry, and although I can scarcely flatter myself that my ideas will all be admitted at present or even understood I am sure that a century hence my essay will be a landmark in the past history of the science."

Thirty-three years later, when the guesses at truth made in his earlier essays had become to him laws beyond question, he writes to the same friend: "I go to-morrow, Monday, to New York, to take the chair at a grand dinner, April 6, the tenth anniversary of the Chemical Society, at which, as senior Vice-President, I am asked to preside. My predecessors, J. W. Draper and J. Lawrence Smith, are gone, and now after forty years the boy you remember dabbling in acids, and making bad smells, is counted one of the veterans of the science. This is one of the rewards of a life of patient work, and it is a pleasant recognition of honest and faithful devotion to my early love. I feel that the volume now in press will make the new gospel of geology and mineralogy, and if I live to complete my mineralogical text-book, I shall do for the mineral what Darwin did for the organic world, or rather I have done that already, and I shall do for it in the next book what De Candolle did for botany. I shall be sixty years old in September, and then hope to have my new book bound and off my hands. I don't feel old yet, but I do feel as if I had done a great deal of work, and as if my training had been such that I am now able to preserve it all in such a shape that it will not be lost to the world."

There runs through Hunt's philosophy, as a fundamental idea, the unity of nature and natural processes, this unity extending from the simplest bodies to the most complicated, comprising the organic as well as the inorganic world, blending physical processes with chemical, and binding into a harmonious system the laws which regulate and the forces which control and the substances which compose the most remote bodies of the universe, as well as those which come more immediately within the reach of human research. His mature views were enunciated in "A New Basis for Chemistry," a chemical philosophy published in 1887, a book of such significance that Prof. W. Spring, of Liege, translated it into French, and added a preface from which we extract the following: " Mr. Sterry Hunt endeavors to lift the whole structure of chemistry above the plane of the atomic theory as received from Dalton, an hypothesis utterly insufficient to explain more than one fact.

" To Hunt a compound body is not the resultant of the mere juxtaposition of the material ultimates in which are combined in some manner the aggregation of properties to which we apply the term *matter*. But according to his views, it is rather due to an interpenetration of matter, an identification or a condensation in different proportions, as a consequence of which the properties of the bodies entering the compound are lost, as it were, in those of the new body. We think the intention of the author can be expressed with sufficient exactitude by comparing such a compound to a resultant of two or more forces or velocities. As a general rule the resultant will possess qualities which, though they are truly derived from the compound velocities in some definite proportion, are not necessarily their sum, except in a particular case.

"When the identification or the condensation of matter does not take place at the expense of species already chemically different, but exerts itself upon a single and similar species, it produces a series of new species, but these are not designated as compound but as allotropic bodies. The diverse states, physical and chemical, which any given body can assume, whether gaseous, liquid or solid, are dependent ordinarily on the different degrees of condensation of a normal species. Nevertheless, there are degrees in the constitutions as well as in the essential form of bodies, which are not betrayed by differences in specific weight.

"It follows, therefore, that in proportion as condensation increases, so does the hardness of bodies, and, *mutatis mutandis*. As a further consequence the sensitiveness of bodies to chemical action diminishes with the progress of their condensation.

"These views of Hunt's it will be perceived coincide with those which guided us (Spring) some twelve years ago in making certain researches on combinations of bodies under pressure." The author then quotes from his paper, "Sur la formation de sulfures métalliques sous l'action de la pression," and adds: "If we have made this quotation, it is not to add a supplement to the views of our author, far less to lend them needless support, for it were puerile on our part so to do, considering the high position occupied by our author in the scientific world. But we have ventured to show that Hunt's work has awakened in us more than mere scientific curiosity and interest, and that the duty of introducing his thoughts to the chemists of France has naturally fallen to our lot."

We have remarked on the tendency of Hunt's mind to trace more than mere analogies between the processes taking place in the different great provinces of nature. He is careful to protest against confounding biotical, chemical and dynamical activities, but none the less he could see such unity of operation in diversity of modes and forms, that the very phraseology he adopted or invented implied closer resemblances than he actually wished to describe. The terms *interpenetration*, *condensation*, *identification*, by which he strove to explain chemical phenomena, and the creation of new chemical species, were suggested, I think, rather by physiology than, as illustrated by Spring, by dynamics. While he admits that "the mode of generation which produces individuals like the parent can present no analogy to the phenomena under consideration, *metagenesis* or alternate generation and *metamorphosis* are, however, prefigured in the chemical change of bodies." It was by extending to the domain of mineralogy his speculations on the relations of hardness to condensation and to the chemical susceptibility or chemical indifference of bodies that he was led ultimately to formulate what he considered as a general law of the highest importance, and of universal application. As I have said elsewhere:[1]

"Chemistry was Hunt's first love; and he never deserted her. When he studied geology, his impulse was to seek below the visible results of mechanical causes for the all-pervading chemical forces and agencies which, by disassociation and combination, by integration and disintegration of elemental matter throughout all space, are building up other worlds, as they built up ours. His lithological researches were made not with the microscope, but in the chemical laboratory; and in his system of mineralogy, neither outward resemblances nor similarity of crystalline structure, nor pos-

[1] "Biographical Sketch of Thomas Sterry Hunt," *Transactions of the Institute of Mining Engineers*, 1892.

session of common elements, but the relation of hardness to condensation and the further relation of these qualities to chemical indifference, constituted the basis for his classification of mineral species. Whether amidst such a multitude of individual species he, in his first arrangement, assigned to each its proper place, may well be doubted, without questioning the substantial correctness of the principle on which his chemical and natural-historical classification of minerals rests. Yet it is impossible to follow, in his *Systematic Mineralogy*, the beautiful progressive series of quotients deduced from the formula $V = p \div d$ (v being the coëfficient of condensation; p the chemical equivalent, and d the specific gravity) as calculated for the species under each genus, without being convinced that Hunt heard and expressed one of those wonderful harmonies of which it is granted to but few mortals to catch the theme, amid the complexity and often apparent discord of nature's contending voices. A very few catch even an indistinct echo of one or another of the motives which dominate the symphonies of nature; but fewer still hear and apprehend them so clearly as to be able to write the score. The doctrine of the equivalency of volumes, as applicable to liquid and solid species, as well as to the gases on which is founded Hunt's *Natural System of Mineralogy*, had dawned on his mind very early in his chemical studies; but its larger significance was revealed to him only toward the close of his life, when, though his physical strength was waning, his mental vision seemed to be gaining both clearer conception and wider range. To him the domain of chemistry was much wider than it had been held to be, under the old conventional theory, which drew such precise lines between chemical and mechanical forces. Like most philosophical chemists of to-day, he regarded all solution as chemical union, and all chemical union as nothing else than solution. In his view all precipitation and all crystallization from solutions involve chemical change, and all chemical species may theoretically exist in a dissolved state, from which they pass into polymeric mineral species, often insoluble. Regarding the same substance in its different polymeric states, due to different degrees of condensation, as representing so many different chemical and mineral species, he, like other chemists, was driven to construct chemical formulas much more complex than those which satisfied the requirements of the Daltonian atomic theory as it had been previously understood; for, once volume is admitted to be as discriminating an element in chemical change as weight and condensation are in the expression of volumetric change, the enormous volumetric difference between gaseous and solid states of the same substance, or rather between a gaseous chemical species and a solid mineral species, involves for its expression the use of numbers which dwarf those assigned till recently to even organic compounds. In his *New Basis of Chemistry* (second edition), Hunt calculates the equivalent weight of water to be 21,400.3; and to the last he continued wrestling with the problem of the actual coëfficient of condensation of each mineral and chemical species; liquid water at the point of condensation at standard pressure being taken as unity (1 : 21,400). This *New Basis of Chemistry* was to Hunt no longer theory, but fact. He had believed for many years that the solid and liquid mineral species known to us are formed by processes of intrinsic condensation, or so-called polymerization, from simpler chemical species. He knew, with every chemist, that the determination of the coëfficient of condensation is a problem of the highest moment, a problem which had been neglected in the belief that it did not admit of solution. When, therefore, in 1886, he reached what he regarded as a solution of this unsoluble problem, and propounded the theorem that 'the volume, not only of gases and vapors, but of all species, whether gaseous, liquid, or solid, is constant, and that the integral weight varies directly as the density,' he rejoiced in the conviction that he had realized and expressed one of the great laws of nature, after which he had been groping all his life."

It is to be regretted that Hunt did not leave a more consecutive statement of his theory than that contained in his

New Basis and his *Mineralogy*. The defect of his literary method was his desire to claim and prove priority for his views. His constant references to earlier writings destroy often the continuity of his argument and weaken its effect. It was unfortunate that he could not merge his personality into his work, and let the work alone speak for itself. It was also unfortunate that his self-confidence and bigoted reliance in his own opinions involved him in bitter controversies, which alienated old friends, and which were not conducted with that humility and diffidence which is the spirit most becoming in discussing subjects so undemonstrable as problems in geology and theoretical chemistry usually are. These causes without doubt weakened his personal influence while he was alive, and now diminish unwarrantably the currency of his books, and retard the serious consideration, if not the adoption, of the magnificent generalization of which he was the author. How wide was his knowledge and his grasp of thought, how vivid his conceptions and incisive his style, can best be judged by a perusal of his essays: "A Century of Progress in Theoretical Chemistry," delivered at Priestley's grave; "The Chemistry of the Primeval Earth," a lecture delivered before the Royal Institute in 1867; "On the Chemistry of the Earth," contributed to the Smithsonian Reports for 1869, and the group of essays dealing with celestial chemistry, written about the year 1880, including "The Chemical and Geological Relation of the Atmosphere" and "Celestial Chemistry from the Time of Newton," read before the Cambridge Philosophical Society on the occasion of his receiving from the University of Cambridge the honorary degree of LL.D. When dealing with subjects like these, which gave full scope to his imagination, as well as drew upon the vast resources of general scientific learning which were stored away in his memory, the full breadth of Hunt's mind as well as the profundity of his knowledge and the intensity of his industry are displayed.

His speculations led him into the realm of all the sciences, in all of which he was more than superficially versed. He thus of necessity gathered from his wide reading germs of thought, of which when fully developed he forgot the source of inspiration. On the other hand, his own writings contain suggestions which have as unconsciously been adopted and expounded by others who have failed to give credit to the creative mind. For instance, the fundamental idea of Lord Kelvin's address to the British Association in Toronto in 1897 is contained in Hunt's paper, "The Primeval Atmosphere," presented at first meeting of the American Association for the Advancement of Science, after the War (1866). He there shows that a layer of ordinary coal one metre in thickness would suffice to convert into carbonic acid the whole of the oxygen of the atmosphere.

His courage was indomitable to the last. After condensing and summarizing the conclusions of forty years of thought in his *New Basis of Chemistry*, published in 1887, he set himself to applying to mineralogy his theory of condensation more systematically and thoroughly than he had done in his tentative papers in a natural system of mineralogy and the classification of silicates. He wrote this work when confined to his room by mortal lingering illness and hardly able to crawl from his bed to his desk. He needed but few books to supplement his memory in preparing the genera and species under which he ranged the principal individuals of the mineral kingdom. And no sooner was his arduous task completed, than he planned and commenced another work which he entitled *The History of an Earth.* In it his purpose was to elaborate his crenitic theory and trace throughout the growth of the earth's crust the influence of water as a chemical agent, under heat and pressure, in decomposing the fundamental rocks of our globe, and out of these decayed ingredients building up the older crystalline rocks and creating most of our mineral deposits. As these Azoic rocks came to be destroyed by telluric agencies, of which water was the most potent, he would have shown how the new world, fit for the support of vegetable and animal life, was created from the ashes of the older rocks. No writer could have told the story as he did, for his intellectual equipment consisted not only of profound and curious chemical knowledge, won as much from laboratory work as from books, but of more than an amateur's acquaintance with the laws of physics. His study of geology, both stratigraphical and chemical, was coëval with his employment as a youth by the Canadian Geological Society. He was, moreover, a good mathematician, and what is an equally important qualification in a student of the chemistry of the universe, and of the development of the globe, a poet. But death, kept at bay for several years by his determination to live and complete his mineralogy, at length conquered, and his vision of the earth's birth and growth remained written only in fragments. It is impossible to assign to every thinker his due share of the world's intellectual progress. Few claim, and to still fewer is assigned by universal consent, the discoveries of any of nature's great secrets, or the formulation of one of nature's universal laws. Whether Hunt's law, that the volume of all species, whether liquid, gaseous or solid, is constant, and that "the integral weight varies directly as the density," is really one of nature's laws, posterity will determine. But one of the greatest living mineralogists, speaking of Hunt's system, expressed to me the firm conviction that it would receive wider and heartier recognition in the future than had been accorded to it in the past. As a system depending on intrinsic rather than superficial differences, it commends itself slowly to the working student. Moreover, as it came from Hunt's hands it was encumbered by a somewhat clumsy and repellant nomenclature. But while there may be errors in fact and statement and faults of style, his systematic mineralogy will rank high among the hermeneutic books of science.

The earliest and latest of Hunt's literary productions dealt with chemistry and mineralogy, or with geology from a chemical point of view. But after leaving the Canadian Geological Survey, he came to doubt the correctness of the positions assigned to certain groups of the crystalline rocks, by his old chief, Sir W. Logan, and he embodied his views in his address as Vice-President before the American Association in 1871, "On the Progress of the Appalachian System." He distributed the crystalline rocks overlying what he considered as the ancient floor of granitic gneiss, of Laurentian age, into groups which he named the Norian, Huronian, Montalban, Taconian and Keeweenian, thus confining to limited area the wider range assigned by Sir W. Logan to the Huronian.

His conclusions were based on geogenic as well as geognostic considerations, but they gave great offense to his old colleagues in the Canadian Geological Survey, and led to a regretable controversy with his old friend, Prof. Dana. But to Hunt truth as he saw it was truth, and to compromise with truth was a crime. And to him, as to many another scientist, all sense of proportion was lost as to what is essential and what non-essential, and trifling differences in opinion about the position of palæozoic strata were discussed with as much vehemence as though life and death depended on the issue. But whether his stratigraphical distribution of rocks comes to be generally accepted or not, no geologist brought to bear on the study of the older rocks a wider range of observation, or a greater wealth of chemical knowledge, and his facts and reasonings will always prove a storehouse of information to the student, even if his conclusions be ultimately contradicted. He took little interest in palæontology, and devoted but little attention to the newer rocks, one reason being, that his earlier geological studies in Canada were confined to the azoic and the lowest members of the palæozoic series; another being, that the crystalline rocks stimulated his speculations on the chemistry of the primeval earth more acutely than did the later sedimentary deposits.

Another geological subject upon which he felt and expressed himself warmly was Sir Robert Murchison's erasure of the word Cambrian from his Silurian system, whereby he not only, as Hunt then considered, "committed a stratigraphical and palæological error, but cast a slight upon the venerable author of the name, Adam Sedgwick." He became the champion of Sedgwick's views and Sedgwick's rights, and espoused his cause in one of his longest monographs, "History of the Names Cambrian and Silurian in Geology," translated in full by Dewalque of Liege in 1875. One of the last letters of the noble old geologist, who linked the last century with even the latter third of the present, was one of thanks to Hunt. All the old fervor and enthusiasm of his earlier days when he first traced the succession of these oldest palæozoic strata returns. The letter is worth quoting:

"TRINITY COLLEGE, CAMBRIDGE,
"November 14, 1872.

"*My Dear Professor:*—My infirmity of sight compels me to dictate this letter to one whose writing will be more easy to read than my own. I am, however, now in my best state of health and my hand is unusually steady, but my eyes forbid the use of it. I read your letter which reached me this morning with very deep interest, and after a very careful reperusal sent it to Dr. Cookson, whose name will appear in my Preface as a friend to our museum, and to all matters of Silieval administration. I entreat you not to think me of such a pettish character as to take offense at anything you may write on your own judgment and that of your scientific friends. I feel grateful to you for what you have done in opening questions connected with the best arrangement of the great paleozoic group both of America and of England. I recollect asking Prof. Henry Rogers whether the difference between the faunas above and below what I may call the great Cambrian break of continuity was as complete as he expected, after his visit to Wales. He replied, if I mistake not, that it was quite as great and perhaps greater. And is it not strange that the break in your great paleozoic segments takes place very nearly on the same horizon? This I make out from your letter, and I think I had heard the same stated by the two Prof. Rogers. Give my kind regards to Prof. William Rogers; the other professor has also been called away. You have, I believe, the grandest paleozoic succession in the world, but is not ours also a beautiful succession, exhibited on such a scale that you may cross nearly the whole of it in a stout walk of a couple of days? England may be called a geological microcosm in which nearly all the formations of the world are nicely packed as if on purpose for human study. With all my heart I wish you success and honor at your institute of technology, but also what terrible news has reached us of your great fire, a calamity which is even now acting upon the feelings and interest of the public bodies of England. It will, I fear, have interrupted your course of lectures, but have your scientific buildings escaped its ravages? I trust you will inform me on this point, as I cannot but feel some anxiety about your person and your scientific prospects in your institute. Dr. Cookson, a man of cautious and gentle temper, advised me to modify some of the statements in my Preface to the new catalogue, and I have complied with his wishes, and my new version of the Preface is actually now in the press, so that I hope the catalogue will be out in the course of the next week or ten days. A great German historian had a motto which greatly took my fancy, 'With truth and love,' or perhaps it would sound better in English, 'With truth and gentleness.' Shakespeare's maxim is through the mouth of Hotspur, 'Tell truth and shame the Devil.' The weather now is pestiferous, windy, wet and cold, but I rather think that the great 'storm wave' of November has not yet reached this part of Europe. Strange to tell, I am unusually well at this time. Generally speaking, I sink in spirits and undergo a kind of collapse during wet weather. I have your photograph in my book, and if you would like to possess it, I would send you mine, but I have no copy of a reasonable size at this moment.

"I think I may fight my way through this winter, but I shall have a hard battle to fight next spring if I live so long. The event is in my Maker's hands.

"I remain, my dear professor,
in truth and good will,
faithfully and gratefully yours,
"ADAM SEDGWICK."

But death won the fight, for Adam Sedgwick died in January following, eighty-eight years old.

Though the variety and volume of his literary productions denote his untiring industry, they by no means express the full measure of his activity. For many years, as already stated, after his connection with the Canadian Geological Survey, he spent several months of every year in the field, often with his chief, Sir W. Logan. Sir William had attained prominence as a stratigraphical geologist, but was not learned in chemistry and mineralogy. Hunt's familiarity with these sciences, therefore, supplemented Sir William's deficiency, and as long as Sir William remained at the head of the Survey, Hunt was rather his collaborator than his subordinate, and when Sir William from old age resigned, Hunt was made co-director with Sir William's successor, Dr. Selwyn.

That he was not appointed head was due to Sir William's knowledge of his lack of tact and of his irritability under business worries. His fitness to direct the technical operations of the Survey was beyond question, inasmuch as for twenty years he had been an active worker, and for part of the time the most influential member of the staff; but no one knew better than Sir William how intolerant of contradiction he was, and how impolitic were his comments on political leaders upon whose good will the votes for the support of the Survey depended. His decision, therefore, not to recommend Hunt as business director was an act of kindness to his old colleague.

During his connection with the Survey as chemist and mineralogist he had to investigate officially many technical subjects. The results are embodied in the regular annual reports in the general summary up to that date, published in 1863, and in special reports. The most important of the latter class was "On the Gold Mines of Canada, and the Manner of Working Them in 1863," "On Petroleum in Gaspé in 1865," "On the Gold Regions of Lower Canada in 1866," and of Hastings, Ont., in 1867, and of Nova Scotia in

1868, and "On the Goderich Salt Region and Iron Ores in 1870." But apart from such work growing out of his official duties, he was consulted frequently on points, generally very trivial, but sometimes the reverse, requiring technical knowledge and betimes protracted and tedious experiments. As the result of the inquiries of Mr. Workman, of the City Bank of Montreal, for an ink to be used in banknote printing which would be proof against photographic reproduction, Hunt invented the *greenback*. He suggested the use of sesquioxide of chromium and made the experiments necessary to prove its resistance to all ordinary chemical reagents; but Mr. George Mathews, in whose name the patent was taken, and his partner, Mr. Burland, used their practical knowledge, as banknote printers, in making a suitable ink with this coloring substance. Hunt read a paper on the subject before the A. A. at their Montreal meeting in August, 1857. He received a small sum for the use of his invention in the United States, and continued for years to draw royalty from Burland & Co., in Canada. The United States patent was bought by Mr. Tracy R. Edson, as member of the firm of Rawden, Wright, Hutch and Edson, by whom it was transferred to the American Banknote Company. The United States patent became very valuable on the breaking out of the war, due to the issue of the immense volume of greenbacks. Hunt, however, derived but little benefit from his invention, and even his name is now forgotten in connection with the subject.

Writing to a friend August 4, 1857: "I have perhaps told you that I have made a fortunate discovery of a process for printing banknotes which is likely to yield me a good deal of money. It is a green ink which cannot be effaced nor copied by photography. I got a small sum for it in the United States, but a permanent right and interest in the patent in Canada. The invention is not, however, in my name, but as 'Mathews Banknote Trust.'"

But in the following year he has to tell the same friend the usual inventor's story of disappointment: "You ask about my, or rather Mathews' green tint. It is largely used in the United States, but I sold it there for a trifle, and here our large banks move slowly, but have all adopted it, so in a year they will have it in use, and pay me something. I hope to sell it in England, but nothing definite has as yet come about, and have offered it to the Russian government through a friend. As yet it has been rather more trouble than profit.''

The following letters are historically interesting as the *Canada banknote printing tint* was the parent of the *greenback:*

"CITY BANK, MONTREAL,
"March 2, 1857.

"T. STERRY HUNT, ESQ.,
"*Chemist to the Geological Survey:*

"*Sir:*—The attention of the Board of this institution having been directed to the necessity of some further protection against the possibility of counterfeiting, altering or photographing banknotes, I beg most respectfully to ask your opinion as to the various tints, colors, and chemical agents which have been and are now employed, as a means of protection against these frauds.

"As your deep research in all that pertains to chemistry and your high reputation as a chemist will give to your opinions on this important subject a character for reliability, which cannot fail to be valuable on public grounds, may I beg the favor of your consideration of this matter at your early convenience?

"Yours very respectfully,
"WILLIAM WORKMAN, *President.*"

"MONTREAL, July 1, 1857.

"WILLIAM WORKMAN, ESQ.,
"*President of the City Bank.*

"*Sir:*—I have, agreeably to your request in your letter of the 2d March, made a series of inquiries, relative to the counterfeiting and alteration of banknotes, particularly with reference to the dangers to be apprehended from photography, and I have now the honor to state the results of my investigation.

" The various modes heretofore adopted, to render impracticable the copying of notes by photography, are based upon the use, in conjunction with black, of various colored inks, and consist in printing, with one of those colors, a design on the back of the note, or letters or figures on its face, or finally in covering with colored lines the face of the note.

" These plans are all ineffectual from the fact that the colored inks may be effaced by chemical agents. I have convinced myself by experiment that all the red and yellow tints, hitherto proposed, *may be destroyed* without injury to the paper, or to the ordinary black printing ink, which, having a basis of carbon, is insoluble and indestructible. The blue tints which have been employed are equally fugitive, and besides, as this color reflects the chemical rays of light, it is valueless as a protection against photographic copying.

" Another method has recently been introduced which consists in covering the paper with a ground of red or yellow color, and then upon the surface thus prepared printing the note with a peculiar black ink of a nature so fugitive that it is effaced by any attempt to remove by chemical agents the colored ground. Fugitive black inks employed this way offer a complete protection against photographic copying, but they at the same time present great facilities for alteration and render its detection difficult; their use should therefore be rejected.

" The only effectual method free from objection is, in my opinion, to be found in the use of a color which shall absorb the chemical rays of light, and be like the black carbon ink, indestructible and indifferent to all chemical agents. A note printed with the ordinary black ink, and having its surface previously tinted with lines of an ink prepared with such a color, will be protected against the possibility of copying by photography, by anastatic printing, lithographic transfer or kindred processes, while it cannot be altered by any chemical means. Such a color has hitherto been wanting, but is, in my opinion, now supplied by the green ink recently patented by Mr. George Mathews, engraver of this city, called the Canada Banknote Printing Tint. The green pigment which forms the basis of this ink resists all acids, alkalies and other agents, which can be applied to the paper. It is the most permanent of colors, and as indestructible as the carbon of the ordinary black printing ink. I have the honor to be, sir, Your most obedient servant,

"THOMAS STERRY HUNT."

Subsequently Hunt took out a patent for an ink made from stannic acid with small proportions of oxide of chromium, forming what he called Mineral Lake, but neither this nor any of his patents yielded him much revenue. While scrupulously honest in all pecuniary transactions, he did not possess the money-making instinct.

To the metallurgy of copper he was introduced by his friend, J. D. Whelpley, well known as one of the brilliant men on the staff of the first Pennsylvania Survey. Mr. Whelpley, in company with Col. Storer, had devised a wet method for treating copper ores, which was to be carried out by the employment of a number of novel mechanical devices. Hunt worked out the chemical reactions, and reduced them to formulæ. The method never came into practical use. It was while endeavoring to apply it that Hunt and I patented in 1869 the use of chloride of iron in connection with common salt as a solvent of cupric and cuprous oxide, and subsequently in 1871 our investigations and the inadequacy of our previous method to the treatment of silver-bearing ores, led us to patent a method in which the copper is separated from its chloridized solution as insoluble subchloride, through the action of sulphurous acid. On the elucidation of such technical subjects, he brought to bear his intimate knowledge of chemical reactions and his habits of careful research, and therefore his papers on such subjects have scientific value apart from their technical bearings.

The rules of the Geological Survey laid down by Sir William Logan strictly forbade any employée to engage in mining operations in Canada or to report on mining properties, and the rule was obeyed with commendable fidelity. But when Hunt left the employ of the government of Canada, he devoted not a little time to expert work. He made a report on the Ore Knob copper mines and other mining properties, but the enterprise to which he devoted himself with all the energy and enthusiasm of his restless nature was the development of the coal and iron resources of southern Ohio, and particularly of the Hocking Valley. He published in 1874 a volume of seventy-eight pages, "On the Hocking Valley Coal Fields and Its Iron Ores, with Notices of Furnace Coals and Iron Smelting, followed by a Survey of the Coal Trade of the West." Again in 1881 he published a still more comprehensive volume of 152 pages, "On the Mineral Resources of the Hocking Valley," in which, besides tracing the identity of the coal beds of the district, he collected all the information and analysis hitherto published bearing on the iron ore of the district, which previous to his former report had been regarded as of little value. He supplemented his treatise with a section on the latest improvements in the metallurgy of iron, giving one of the first descriptions of the Thomas-Gilchrist method, and with a clear but concise summary of the railroad communications of his favorite region with the coal-producing and consuming centres of the North and West. Without doubt his exertions between 1874 and 1881, and his insistence on the suitability of the dry non-coking, Hocking coal for use in blast furnaces, materially contributed to the increase in the coal and iron production of southern Ohio;—for the coal production in 1874 of somewhat over 1,000,000 tons rose in 1880 to 1,750,000 tons, and the production of iron in the Hocking Valley increased from *nil* in 1874 to 90,000 tons in 1880. The ultimate results have, however, not realized Hunt's very sanguine, too sanguine, hopes, expressed in the concluding paragraphs of both reports.

"The bituminous coal of southeastern Ohio may, in its geographical, commercial and industrial relations, be compared to the anthracite of Pennsylvania. The latter, occupying an area of 470 square miles, placed on the eastern border of the broad Appalachian basin, has before it to the north and east the rich and populous but coalless States of New York and New Jersey, with those of New England, which look to it for their chief supply of fuel. Moreover, in New York, in New Jersey and in eastern Pennsylvania are immense deposits of rich iron ores which find in the anthracite the fuels necessary for their reduction and manufacture.

"If now we turn to the West, we find on the opposite border of the Appalachian basin the coal region of eastern Ohio, and particularly the Hocking Valley coal field, with its 250 square miles of superior and easily mined coal, sustaining similar relations to the rich and populous States to the north and west which must in time to come look to it for the supply of a great portion of their fuel. In addition to this, we have as a further resemblance, the vast amount of iron ores, not only those of southern Ohio itself, but those of Lake Superior, which, with the rapidly increasing export trade in coal from this region, will find their way thither in larger quantities to be smelted and manufactured. In view of all these facts, we may with confidence expect to see this coal field and its vicinity the seat of a metallurgical industry comparable to that of the Lehigh Valley and of Pittsburgh."

The qualities of mind which conduce to make a man eminent in science are not those, it would seem, which constitute the mental equipment of a successful merchant, for the two characters are rarely united in the same person. But factors, whose influence Hunt could not foresee in 1874 or 1880, have come into play to frustrate not only his calculations, but the plans of much astuter minds than his It is true that in 1870 Michigan was producing 700,000 tons of ore, but no one dreamt that the production of the Lake Superior mines could, within twenty-five years, reach 10,000,000 tons a year, or that between then and now those unsuspected deposits would, by throwing into the market 100,000,000 tons, help to gradually reduce the cost of iron-making in this country to below the lowest European standard. Nor would the wildest enthusiast in 1874, when Birmingham, Ala., had only just been born and named a town, have ventured to predict that before the close of the century, pig iron would there be sold more cheaply than even in the Middlesboro district of England. Against such forces many of the old-established districts have had to recede, and therefore a new region, even with the advantages which Hunt believed to reside in the coal and iron of Hocking Valley, had little chance of forcing itself into the prominent position Hunt fondly assigned to it. His professional work in coal was also extended into Kentucky.

In another sphere of extra-collegiate work, Hunt attained considerable renown—as an expert in court. He was occasionally employed to give evidence in cases in the East, involving chemical or metallurgical questions, but the trial which brought out his forensic capacity into greatest prominence was the famous ***Eureka vs. Richmond*** case. By stipulation of both parties the case was tried in San Francisco before Justice Field.

In no one of the innumerable trials which are unavoidably growing out of the ambiguities and absurdities of the mining law of 1872, and for which its irrational provisions give an excuse, was exhibited a more brilliant display of legal and expert testimony. The case was one involving the meaning of the term lode, under the law, where no lode under the old acceptation of the term really existed, and where therefore expert testimony was really essential to an elucidation of the points at issue. These involved questions in stratigraphical geology as well as in the genesis and alteration of ores. Hunt's calm and clear statement of the geological facts of the case, and his lucid explanation of the dynamic forces by which certain rock strata were shattered and became the channels for the infiltration of mineral solutions, thus constituting these strata a lode; and further of the subsequent changes by which the original sulphides were altered into the oxidized minerals, then constituting the wealth of the territory and ore bodies in dispute, was so free from bias as almost to escape interruption from the opposing counsel, and so wonderfully explicit and convincingly reasonable that neither bench nor bar failed to understand his explanation of such difficult and obscure technical subjects. His marvelous faculty of extemporaneous discussion of a scientific topic was never more strikingly displayed than in the long lecture which he gave as a witness in this case, and which was listened to with such admiration that it has remained a tradition in the San Francisco courts.

He threw into this as into all his work such earnestness that no doubt of his sincerity could for a moment be entertained, and the knowledge of the subject on which he was giving testimony was so varied and profound, and his self-possession so supreme, that it was impossible in cross-examination to entangle him in his thoughts or his speech.

His fame brought him other work of the same description in the West, but he was then growing old and suffering from bodily ailments, which made such fatigue as was involved in faithful mining work, on the surface and below ground, arduous.

Another piece of expert work worthy of note was his report to the Corporators of the Hoosac Tunnel in October, 1874 (Massachusetts, House Document No. 9, January, 1875). Trouble from caving had occurred in the tunnel, and he and other geologists were employed to report on the cause. They found deep-seated rock decay at that portion of the western base of the range pierced by the tunnel, though glacial action had stripped the range elsewhere of its softened shell. This examination fell in aptly with the study he had been making of the decomposition of the rocks of the Appalachian chain in the Southern States, and gave him additional facts with which to support his argument.

Hunt was also one of a committee of which Hon. C. Francis Adams was chairman, which drafted a scheme for a scientific geological survey of the State of Massachusetts (House Document 266, April, 1874).

The only important field work Hunt did after leaving the Canadian Survey was in southeastern Pennsylvania between

1875 and 1878. He wrote for the Second Geological Survey of Pennsylvania a special report on the "Trap Dykes and Azoic Rocks of Southeastern Pennsylvania." He completed only the first part, a volume of 253 pages, consisting in the main of the historical introduction. The director, Dr. J. P. Lesley, in his letter to the commissioners of the Survey, after explaining the work done by three of the geologists of the regular corps, adds: "In support of the assiduous studies of those gentlemen of the azoic rocks in their respective districts, and to further the success upon which they can already congratulate themselves, it was unquestionably desirable to compare their observations and conclusions with those made and reached by geologists outside of the State, in the azoic regions of New Jersey, New York, New England, and especially Canada. No better plan could have been adopted to reach this end than to invite so distinguished a student of azoic geology as Dr. Hunt to visit those districts of our survey which seemed to correspond with those in the North, among which he has spent the best part of his laborious and successful life, and no book could be more useful than one in which he should collate all the known, supposed and suspected facts of American azoic geology, with all the accepted conclusions, and proposed hypotheses, published on the subject by the most eminent geologists of the last half century in Europe and America.

"We owe, therefore, a debt of gratitude to Dr. Hunt for this historical monograph which will supply a deeply felt deficiency in the literature of our science. It is a treasury of notes and suggestions, of the greatest value to the geologists of Pennsylvania and of other States, working in such districts as are occupied at the surface or are underlaid at moderate depths by the Cambrian and sub-Cambrian formations, although no final demonstration has been accomplished by the author of these problems of superposition, unconformability and identification at which so many geologists are still half despairingly at work. But his opinion of the probable final solutions of these problems will reinforce their own, when they agree, and lead to discussions when they disagree." Prof. Lesley exhibits nice delicacy in thus expressing his dissent from some of Hunt's conclusions.

As a lecturer he attained well-deserved fame. He never indulged in bursts of eloquence, and in speaking, as well as in writing, he eschewed fine language, but his conceptions were always clear, his thoughts well arranged, and his memory stored with an inexhaustible magazine of facts and illustrations. An ample vocabulary of words, though not a redundant one, was always at his command.

In private it was a great pleasure to listen to his conversation, or rather his monologue, for like all good talkers he monopolized the subject, and one of the charms of his public utterances was that he delivered them with all the ease of a personal address. His attitudes were never awkward, and he never indulged in violent gestures, but his voice was musical and flexible and his manner earnest.

His first professorship was at the Laval University of Quebec, of which he was one of the original staff, from its organization in 1856. He continued to give a course in chemistry every spring, between that date and 1862, speaking French, in which language he could express himself not only fluently, but with eloquence and accuracy. He also lectured for several years at McGill University, Montreal. But it was not till he severed his connection with the Canadian Survey that professorial work was not only his chief occupation but his source of salary. He left Canada to fill the Chair of Geology in the Massachusetts Institute of Technology, which post he occupied from 1872 to 1878. But teaching was not congenial, perhaps because he had not those genial qualities which attract and endear students to some professors. It was also disagreeable to him to discuss details and devote time to geological periods which were outside the range of his chosen studies. Lecturing upon his favorite themes, or when he could choose the subject, was stimulating and very grateful, but the routine work of the college class was distinctly and avowedly distasteful. It was fortunate, therefore, that in 1866, despite the high recommendations from Lyell, Murchison, the Rogers, Dana, Silliman and others with which he backed his application, that he was rejected in favor of Newberry for the Chair of Geology in Columbia College. And a sense to a certain extent of his unfitness, owing to his aversion to mere collegiate teaching and academic administration, induced him to refuse a better position than the one he occupied at the Institute of Technology. Though he never wrote in full a lecture or even a scientific paper before its delivery, he never appeared before an audience, even the most uncritical and uneducated, without careful preparation and until he had written out ample notes. He rarely looked at these notes, but nevertheless he followed them sufficiently closely to avoid wandering from the train of argument he had mapped out, and so enlarging on any section of the subject that his lecture lacked an appropriate peroration, when the allotted time had expired. His lecture notes are valuable, not only on account of their contents, but as models. A correct list of his single unpublished lectures and courses out of college it would be difficult to make, but the appended list is approximately complete. The following notes of a lecture "On the Chemistry of the Sea" afford a good sample of his method of preparation:

"*Chemistry of the Sea.*—Aphrodite life and beauty and fertility true and more than true. A vast history. Some pages from it. Decipher some lines of the inscription by the fingers of the sea. We must go back to when sea was not; look forward to the time when it shall have disappeared. All things are of the sea, the sands, the clays, the gravels, solid rocks, great granite hills, foundations laid in the sea. In its earliest form of life, or at least, earliest preserved. The secret of our mineral wealth is all there; its history is that of the building of a world. Origin of the sea, time when no sea was, primeval ocean, first-formed rocks, our land has all been beneath the ocean. Compos. of the early sea—limestone, clay, salt, carbonic acid; their relation; purification of the early atmosphere; progressive changes of air and climate

Origin of clays and sands, filling up of basins. Our American sea basin. Subsiding bottom. Climate. Evaporation and rainfall. Closed basins, limestone (animal life), magnesian rocks, gypsum salt, potash, salts. Mediterranean, Dead Sea, Salt Lake of Utah. Story of ancient climate in records of the sea. Sea constantly changing in compos. like air and soil. Evidence from mineral springs—their history and origin. Saratoga diluted and modified early sea water. Contains all soluble matters. Meteoric waters fall on land; superficial springs add continually new ingredients. Terrestrial circulation, blood, vitalizing fluid circulates. Air, earth and water great system. Take a single sample, phosphorus, relation to life, in all soils and plants, in all products of decay, drainage water (soil retains). In the sea growing plants, seaweeds, animals, fishes, bones and muscle, come up as food for man. Birds of prey. Guano. The sea restores its phosphorus. Still another way, ooze retains it. Uplifted bottom soil for new generations. Potash in like manner.

"Metals in primitive sea. So the wash carries them down. Iron, copper, silver and gold. Precious metals of the sea. Silver sea-weeds. Gold. Late experiments, 1 gr. (?) to the ton; a thousandfold more than all now in circulation. Iodine, precious agent, the solvent the great aërator of the sea water.

"Laws of separation and accumulation of these in beds and veins a subject apart and distinct, full of rare instances of nature's chemistry.

"Another circulation besides that by evap. and condensation. Temperature and earth's rotation. N. E. and S. W. currents; great circuits of hot and cold water more than all a vertical circulation. Cold current over the ocean's bottom. Relation to ocean life. Depths of Mediter. Barren waste; exception not the rule; stagnant water. Atlantic to great depths full of life. Descending waters carry the oxygen down and thus supply life. Rapidly multiplying creatures and abundant life; lime also to form their shells. Makes limestone possible in deep water. Rises to moderate tropic heats.

" Some of these phases of chemical history of the sea ; its future ; we speak of it as unchanging. The image of eternity comparatively so. Land rises and falls. Here rolls the deep. The sound of streams that swift or slow draw down Eonian Hills. In this struggle the land seemingly succumbs, but really conquers its foe ; slowly, mechanically and chemically it feeds upon the sea ; 5 to 20 per cent. of modern rocks is water ; ¼ the ocean. Process still goes on. Cooling globe also ; pores will absorb water ; little by little it will fail, and the time will come when there shall be no more sea. A sealess, waterless continent, from which life is absent. A waste spot in the great creation. Such fate awaits our earth, and all the bodies of our solar system sooner or later, when the sun itself shall have been extinguished and cooled in its turn. Such a period in the process of ages must come, but is not final ; 'tis but a follow season in the eternal years of God, and the forces of His universe can again call from out the darkened chaos a new heaven and a new earth. Man, too, how great is that divine gift by which he reads the lesson of creation and destruction, and can, as in Campbell's grand vision, look on the dying seer."

Hunt had charge of the Canadian Geological collection at several of the great exhibitions, and his fame and perfect command of the French language led to his appointment to the International Jury at both the Paris Exhibitions of 1855 and 1867. He occupied the same honorable position in London in 1862, and in Philadelphia in 1876. With him jury duty was no mere honorary and perfunctory service, but a task to which he devoted himself with such intentness that he was blind to all else in the exhibition but what it was within his province to study. His official position in Paris in 1855 first opened to him the portals of the great world, and he entered it with all the ardor and high hopes of his impulsive and enthusiastic nature. Some extracts from a letter to an old Norwich friend, written from Paris in September, 1855, are interesting biographically as expressing his simple unconscious vanity, and historically as they refer to men and events now becoming obscure and misty in the hazy past, which yet is so little distant from us: "Since I am here I have been so busied with the duties of juror (for I was appointed member of the International Jury) that I have really been a slave. You may judge when I tell you that, although the Palace of Fine Arts is but a few rods from my lodging, I have only been there once, and then on duty and for an hour only, and I have been once to the Louvre for two hours. I am tired of it; I shall leave in three or four days for the Rhine. I have need of this to rest me and prepare me for further labors of the Jury in October, when the recompenses will all be fixed for the different exposants. I have had the objects of the first-class minerals, metallurgical processes and all that concerns raw materials of this class. A vast amount of material is collected from France, Prussia, Austria, Spain, etc., but England sends very little, and the United States almost nothing. The associations of the Jury have been very valuable for me; our President is Elie de Beaumont, who is justly regarded as the patriarch of geology in France; besides we have Dufrénoy, Callon and de Chancourtors of the Imperial School of Mines; Leplay, who is at the same time Commissionary-General of the Exposition, and some foreign members of more or less distinction. My intercourse with them has been very agreeable. M. de Beaumont has been particularly kind in his marks of attention toward me and his high position in the scientific world and as Senator has made his patronage very useful to me. Dumas has also interested himself for me, has brought me before the Academy of Sciences, and presented me the other day to Prince Napoleon in a most public and flattering manner. The Prince received me with great kindness. The presentation was the more flattering as it was unsolicited, and as M. Dumas said things about my scientific merit that I will not repeat. I dined at Dumas' house, and met among other chemists, Mess. Balard and Wurtz. M. Dumas was much pleased with some novelties in the way of theories which I showed him, and begged me to let him give them to the

Academy in my name ; I thanked him for the honor he did me, and he replied that anything coming from me would always be presented by him with great pleasure. I shall give him my notes when I return from the Rhine. Meanwhile he has presented one paper from me on atomic volumes, and de Beaumont another on the hypersthene rocks, besides I have read two papers before the Academy myself, one on the acid springs and gypsum of Canada, and one on its saline waters. These were referred to a committee of Dumas, Boussingault and de Lenarmond, and both are published in the *Comptes Rendus* of the Academy, where I have thus published four memoires, besides one in the bulletin of the Geological Society, on the magnesium rocks, serpentines, etc., of Canada. All my memoires have been very well received and much talked of; they seem to have been very fortunate. I shall bring you copies of them. I am very fortunate in being able to write and speak French. We had a meeting of the Society last week, and made several excursions about Paris. I bring you some *aluminium* with a little note from Ste. Claire Deville, the discoverer. As for aluminium, it is still very rare, perhaps 100 pounds have been made by Deville for the emperor, who has defrayed from his own purse the experiments. Rousseau, the greatest fabricant of rare chemicals in France, sells it, however, at three and a half cents a grain, the price of gold, and everybody buys specimens of it at that price, so that he can hardly supply the demand. I send you a bit in this letter from Deville himself, for you, but his autograph I will keep till I see you."

The honor he expected was conferred. He was made Chevalier of the Legion of Honor, and subsequently raised to the rank of Officer. After the congress of Bologna, King Humbert of Italy decorated him with the order of St. Mauritius and St. Lazarus. Literary honors were also showered on him, and when elected a fellow of the Royal Society in 1859, he enjoyed the distinction of being the youngest of that generation entitled to add F.R.S. to his name. Early in his career Harvard conferred on him the degree of M.A., but his own University of Yale, on account of some youthful escapade, never enrolled him on her honor list. The University of Laval, of which he was a member of the first Senatus Academicus, conferred on him the degree of LL.D., and in 1881 the University of Cambridge, England, honored him with the same degree, assigning him as his chambers, while its guest, quarters in Trinity College, near the rooms occupied by Newton. It was there under the inspiration, as he felt, of the great philosopher's presence, that he wrote his splendid essay, "On Celestial Chemistry from the Time of Newton." Hunt was one of the founders of the Geological Congresses which have been held at intervals of three or four years since the first assembled in Paris in 1878. The idea was originally broached at a meeting in Büffalo of the American Association for the Advancement of Science in 1876, when it was resolved that a committee of the Association be appointed to consider the propriety of holding an international congress of geologists at Paris during the International Exhibition of 1878, for the purpose of getting together, comparative collections, maps and sections for the settling of many obscure points, relating to geological classifications and nomenclature. The committee consisted of seven eminent American geologists, of whom Hunt was one, and to the committee were added Huxley, Terrill and Hamhauser, who were present at the meeting. Subsequently James Hall was elected President, and Hunt, Secretary, and it was to his efforts as Secretary that the successful organization of the Congress was largely due, for, as was afterwards shown, this was not the first attempt to induce the geologists of the world to assemble for discussion and conference, Capellini had in 1874 unsuccessfully made similar proposals. At the Nashville meeting in 1877, Hunt presented the committee's report, and he, with Lesley, Hall, Cope, Chambertin and Selwyn, attended the First Congress at Paris. Hunt was elected one of the Vice-Presidents. He took part in the opening session, was prominent as a debater throughout the Congress, and was appointed one of the International Committee on Unification and Geological Nomenclature.

He attended the Second Congress at Bologna, which opened on September 26, 1881, under the presidency of the distinguished statesman and geologist, Quintino Sella. He participated actively in committee work, and in the discussions, but though he communicated no important paper to the Congress, his eminence was so conspicuous that, as already stated, King Humbert conferred on him the order of St. Mauritius and St. Lazarus.

His health was already beginning to fail. He did not attend the Congress held in Berlin, in 1885, but his name was placed on the Committee for the Unification of Geological Nomenclature. But he was able to attend and participate actively in the Fourth Congress held in London in September, 1888. He communicated a paper in French on "Crystalline Schists," and took a warm part in the resulting discussion on the crystalline rocks. It was the last occasion on which he visited Europe, and when the Congress met in Washington in August, 1892, he was too ill to attend.

Another organization in whose inauguration and subsequent welfare he took a deep interest was the Royal Society of Canada. It was created in 1882, and Hunt was the first President of the Mathematical, Physical and Chemical Sections, and was President for the years of 1884–5. The bibliography is evidence of the industry with which he worked for the Society.

Two other societies whose meetings he attended with laudable punctuality and to whose publications he contributed largely were the American Association for the Advancement of Science and the American Institute of Mining Engineers. He was active Vice-President of the former in the absence of its President in 1871, and was President of the Institute in 1877. The last paper which he contributed to its transactions was a very comprehensive, yet concise summary of the geological relations of the iron ores of the United States, presented at the joint meeting of the Iron and Steel Institute (of England) and the American Institute of Mining Engineers in 1891. The paper was written while confined to his room by his fatal illness, and the material was drawn from the resources of his well-stocked memory.

In 1873 he was created a member of the National Academy of Science, and for many years attended its sessions in Washington, even when so doing involved not a little inconvenience.

The last two years of his life he spent either in St. Luke's Hospital or confined to his room in the Park Avenue Hotel, New York, but they were by no means years of idleness. He wrote most of his *Systematic Mineralogy* when suffering from a complication of diseases, which would have been a valid excuse to any other man for physical and mental rest; and up to the day before his death, which took place on February 12, 1892, he spent hours at his desk, at work on a new book. He died sitting on his bed, fully dressed, his head leaning on the table, fighting the grim enemy to the very last. His sole pleasure, during those dreary months of confinement, was tending his plants and flowers, for he loved them, not only as a well-trained botanist, but with keen sympathy, as if they had been sentient beings. They never offended his taste or acute sense of smell or irritated him as animals did. For them he had almost a dislike.

Apart from science Hunt wrote little or nothing. In his youth he for a time believed himself a poet, and he composed a short epic and translated Latin hymns. The following verses express the mystical tendency of his mind at that period:

"PREËXISTENCE."

"Dreams that steal o'er me in my waking hours
Tell of another life than that of earth,
For ante-natal memories sometimes come
O'er the dark flood my spirit crossed at birth.

"Visions of other scenes in other lands,
Strange glimpses of a life now mine no more;
Thoughts, too, that tell me that what is has been,
Forms I have known on some forgotten shore.

"Friends that were mine before I crossed the flood
Which darkly hides that vanished life from view;
Wakening my love, as only brothers could
Tell me that all these memories are true.

"This world is but one scene on life's great stage;
My soul, to whom these visions now are given,
Passing beyond the darkening flood of death
Shall wake to fuller vision in high heaven."

His temperament was always distinctly religious. He went to Canada as a high-strung imaginative boy, who had been brought up in the strictest school of Connecticut Congregationalism. In Montreal he was at once admitted into the inner circle of the French Canadian Society, which retained much of the culture and grace of the *Ancien Regime*, was devoutly Catholic, and was controlled by French ecclesiastics of great suavity, tact and intellectual acuteness. Under these influences Hunt adopted the Roman Catholic faith, and remained a devout son of the Church till after the breaking out of the war of the Rebellion, when he abandoned the Church as openly and with the same courage and sincerity as he had shown in entering it, though in so doing he alienated some of his dearest friends. Whatever may have been his faults, cowardice and duplicity were not among them.

He remained a bachelor till 1877, living during the previous thirty years almost always alone, but devoting a very large portion of his salary to the support of his mother, whom he loved and reverenced till her death, and of his two sisters.

Marrying so late in life, after his habits had become rigid, and when so many years of solitude had made it difficult to bend to the elastic requirements of domesticity, marriage was not congenial. It interfered with his studies, and his wife and he wisely decided to live apart.

But though a hermit in his habits, he formed many warm friendships, and was fond of occasional social intercourse. Like all emotional natures, he was subject to periods of great elation and corresponding depression, and in his estimate of men was inclined to idealize his friend, and to hold and express unduly derogatory opinions of those he was not in sympathy with. During his long and eminent scientific career he knew and corresponded with nearly all of the world's great chemists and geologists, and of course his acquaintance was intimate with the scientists of this country and Canada, who lived during the latter half of the century. When adopted into the Society of the Lynx, a very exclusive Roman body, the members of which are known under the pseudonym of some departed scientist, he took the name of Sir Humphrey Davy, but Faraday was his model and example. Faraday's unselfish devotion to science and his voluntary surrender of gain and of a life of ease and wealth, which would have rewarded the pursuit of technical chemistry and physics, in order that he might devote himself without distraction to the investigation of pure science, excited Hunt's emulation. At the same time, the beautiful serenity of Faraday's disposition and the purity and steadfastness of his religious convictions appealed strongly to Hunt's deeper feelings. Hunt was a guest at Dumas' breakfast table, when a letter from Faraday was delivered, which, as it was written in English, none but Hunt could read and interpret. It was the acceptance by Faraday of the highest honor the Emperor Napoleon could bestow on him, the Commandership of the Legion of Honor, a distinction conferred rarely except for distinguished military services. Napoleon when he was an exile in England had known intimately and admired profoundly the single-minded philosopher, and now through Dumas, the greatest French chemist and a Senator, he thus expressed his appreciation of his work and character. Faraday's reply was couched in the most respectful though almost affectionate language, and ended with a devout wish, that the Almighty would guide his old friend amidst the difficulties which now beset his path—such a prayer as he might have uttered in the little Sandimanian conventicle which he frequented.

Faraday was Hunt's hero of science, and Newton its prophet. Therefore the calm philosophical spirit which actuated both men must have been to him a constant reproach; for Hunt's vehemence too often took the place of simple earnestness, and his keenly impressionable and irritable nature prevented his always judicially weighing both sides of the many debatable questions on which he nevertheless held decided views.

He was not lacking in candor. If he believed himself in the wrong he was willing to admit his error. But at the same time he was bigoted in his adherence to any position he had assumed, and when forced to abandon it, he was very ingenious in finding good reasons for his change of base.

The controversial character of so much of his writings and the constant reiteration of his claim of priority as I have already remarked, obscure unfortunately to some extent the brilliancy of his original work, and have created, it is to be feared, a false impression of his character, which was essentially chivalrous and generous. Those who came most intimately into contact with him were those who admired him most. His faults and foibles were not skillfully concealed. They were only too patent.

Hunt set before himself high ideals. He did not always realize them. But he none the less strove to live up to them, and he did attain to no small measure of success and self-conquest. The heroism of his declining years ~~were~~ was magnificent, as he worked patiently and perseveringly under the strain of failing health and with a speedy death staring him constantly in the face and threatening with inevitable certainty to soon cut the thread of life.

BIBLIOGRAPHY.

ABBREVIATIONS.

A.A.P.—American Academy Proceedings.
A.C.—American Chemist.
A.N.—American Naturalist.
B.A.R.—British Association Reports.
C. & G.E.—Hunt's Chemical and Geological Essays.
C.G.S.—Canadian Geological Survey.

C.J.—Canadian Journal.
C.N.—Canadian Naturalist.
C. News.—Chemical News.
C.R.—Comptes Rendus, Paris.
D.G.S.J.—Dublin Geological Society Journal.
Erd.J.P.C.—Erdmann Jour. Prakt. Chem.
G.S.J.—Geological Society Journal.
I.M.E.—American Institute of Mining Engineers Transaction.
M.P. & P.—Hunt's Mineral Physiology and Physiography.
P.A.A.—Proceedings of American Association.
P.M.—Philosophical Magazine.
R.S.P.—Royal Social Proceedings.
S.J.—Silliman Journal—American Journal of Science.

1846.

On the Meteoric Iron of Texas and Lockport. G. B. Silliman Jr., and T. S. H. S. J., ii, p. 370.

Description and Analysis of a New Mineral Species Containing Titanium, with Some Remarks on the Constitution of Titaniferous Minerals. S. J., ii, p. 30.

On Ozone. S. J., ii, p. 103.

1847.

On the Artificial Formation of Specular Iron. S. J., iii (?), p. 411.

Review of the Organic Chemistry of M. Charles Gerhardt. S. J., iv, p. 93.

On the Relations of Glycocoll and Alcargene. S. J., iv, p. 108.

On the Action of Sulphuretted Hydrogen upon Nitric Acetene. S. J., iv, p. 350.

Analysis of Minerals in Third Annual Report of C. B. Adams of the Geological Survey of Vermont.

1848.

On the Analysis of Chromic Iron. S. J., v, p. 418–419.

On the Chemical Constitution of Gelatine and its Transformation. S. J., v, p. 74.

Seven Reviews in the Scientific Intelligence, and One Analysis of Chromic Iron. S. J., v, p. 418.

On the Anomalies presented in the Atomic Volumes of Sulphur and Nitrogen, with Remarks on Chemical Classification and a Notice of M. Laurent's Theory of Binary Molecules. S. J., vi, p. 170. Republished as "Theory of Types in Chemistry" in C. & G. E.

On the Chemical Nature of Gelatine. S. J., v, p. 259.

Geological Survey of Canada (1847–1849), April, 1848. Report on the Rocks and Minerals of the Ottawa—especially Epatite and Analysis of Mineral Rocks. Pp. 125–165.

1849.

Note to a Paper on the Chemical Nature of Gelatine. S. J., vi, pp. 259, 260.

On the Acid Springs and Gypsum Deposits of the Onondaga Salt Group. S. J., vii, pp. 175–178; Edinb. New Phil. Jour., xlvii, pp. 50–53.

On Some Principles to be Considered in Chemical Classifications. S. J., vii, pp. 89–95; viii, pp. 89–95 (?).

Chemical Examination of Algerite, a New Mineral Species. S. J., viii, pp. 103-108; also B. J. N. H., vi, 1857, pp. 118–123.

Chemical Examination of the Water of the Tuscarora Sour Spring, and of Some Other Waters of Western Canada. S. J., vii, pp. 364-372.

On the Decomposition of Aniline by Nitrous Acid. S. J., viii, pp. 372–375.

On the Geology of Canada. P. A. A. S., ii, pp. 325–334.

On a New Mineral Algerite, Boston, Proc. Nat. His. Soc., iii, 1848–1851, pp. 259, 260.

Leucine and Its Homologous Relations, with some Critical Remarks upon the late Researches of Mr. Würtz. A. A. A. S., pp. 231-233; also S. J., ix, 1850, pp. 63–67.

Report on Limestones, Assatite, and Mineral Waters. C. G. S., pp. 47–65.

1850.

Geology of Canada (1849). S. J., ix, p. 12–19.

Leucine and Its Homologous Relations, with Some Critical Remarks on the Late Researches of Mr. Würtz. S. J , ix, p. 63.

Chemical Examination of the Waters of Some of the Mineral Springs of Canada. S. J., ix, pp. 266-275.

Research upon some Derivations of the Benzoic Series of Chural. S. J., p. 275; and other note in the Scientific Intelligence.

On Some Saline Springs Containing Baryta and Strontia. P. A. A., pp. 153, 154.

On the Taconic System. P. A. A., pp. 202-204.

On the Determination of Phosphoric Acid. P. A. A., p. 338.

Analysis of Soils and Ashes of Peat. P. A. S., p. 222 (not received).

Canadian Localities of Minerals. P. A. S , p. 311 (not received).

On Magnisite. P. A. S. p. 352 (not received).

Locality of Asphaltum. P. A. S. p. 357 (not received).

Malate of Lime in Sugar Maple. P. A. S., p. 389 (not received).

Report on Soils of Canada East and Mineral Springs. C. G. S., p. 73–106.

1851.

On the Mineral Springs of Canada. S. J., xi, pp. 174–181.

On the Chemical Constitution of the Mineral Warwickite. S. J., xii, pp. 352–356.

Description and Analysis of Loganite. P. M., ii, pp. 65–67.
Examination of Some Canadian Minerals. P. M., i, pp. 322–328.
Remarks on the Lithological and Palæontological Characters of the Potsdam Sandstone. P. A. A., pp. 271–273.
On the Homologies of the Alcohols and their Derivatives. P. A. A., pp. 216, 217.
Columbite of Haddam. P. A. S., p. 243.
Octahedral Peroxide of Iron. P. A. S. p. 242 (not received).
Economical Use of the Skin of the White Porpoise. P. A. S., p. 386.
Report—North Shore of St. Lawrence below Quebec. C. G. S., pp. 37–54.

1852.

On the Compound Ammonias and the Bodies of the Cacodyle Series. S. J., xiii, pp. 206-211.
On the Octahedral Oligist Iron. S. J., xiii, 370–373.
Examination of Some American Minerals. S. J., xiv, pp. 340–346.
Examination of the Phosphatic Matter and Supposed Bones and Coprolites Occurring in the Lower Silurian Rocks of Canada. G. S. Q. J., viii, pp. 209, 210.
Report (on Chemical Work). G. S. C. (report of progress), pp. 93-121.
Remarks on the Lithological and Palæontological Characters of the Potsdam Sandstone. P. A. A., vi, pp. 271–273.

1853.

On Atomic Volumes. S. J., xv, p. 116.
On the Theory of Chemical Change and on Equivalent Volumes. S. J., xv, 226–234. Reprinted in C. & G. E.
On the Constitution and Equivalent Volume of some Mineral Species. S. J., xvi, pp. 203–218. Reprinted in C. & G. E.
Report—Mineral Waters of Canada. C. G. S., pp. 152–179.

1854.

On the Theoretical Relations of Water and Hydrogen. S. J., xvii, pp. 194–199.
On the Chemical Compositions and Remarks on the Mineral Species of Algerite. S. J., xvii, pp. 351–352.
Description of Parophite, xvii, p. 127.
On Some of the Crystalline Limestones of North America. S. J., xviii, pp. 193–200.
Illustrations of Chemical Homology. P. A. A., pp. 237-247, and S. J., xviii, pp. 269-271.
On the Composition and Metamorphoses of Some Sedimentary Rocks. P. M., vii, pp. 233–238; Erd. J. P. C., lxii, p. 174.
On Phosphatic Organic Remains in the Palæozoic Rocks. P. A. S. (no copy furnished for pub.).
On a Number of Mineral Species. P. A. S. (not furnished for pub.).

Report for the Year 1854. Triclinic Feldspars.
Silurian Rocks. C. G. S., pp. 373–388.

1855.

Thoughts on Solution and the Chemical Process. S. J., xix, pp. 100–103. Reprinted in C. & G. E.

On the Equivalents of Some Species. S. J., xix, pp. 416–418.

On the So-called Talcose Slates of the Green Mountains. S. J., xix, p. 417.

Sur les roches magnésiennes du groupe de la revière Hudson au Canada. Paris, Lex. Géol. Bull., xii, 1854, 1855, pp. 1029–1031.

Note sur les sources acides et les gypses de Haut-Canada. Paris, Comptes Rendus, xl, pp. 1348–1351.

Sur les volumes atomiques. Paris, Comptes Rendus, xli, pp. 77–81.

Recherches sur les eaux minerales du Canada. Paris, Comptes Rendus, xli, pp. 300–304.

Sur les rapports entre quelque composes différant par H_2 et par O_2. Paris Comptes Rendus, xli, pp. 1167–1169.

Examinations of Some Felspathic Rocks. P. M., ix, pp. 354-363 ; Erd. J. P. C., lxvi, pp. 149–154.

1856.

On the Serpentines of Canada and their Associated Rocks. R. S. P., viii, pp. 423–425.

On the Parts which the Silicates of the Alkalies, may play in the Metamorphism of Rocks. R. S. P., viii, pp. 458–461 ; also P. M., xv, in 1858, and S. J., xxv, pp. 278–287, in 1858.

1857.

On the Origin and Metamorphosis of Some Sedimentary Rocks. C. S. ii, pp. 355–357.

On the Chemical Composition of the Waters of the St. Lawrence and Ottawa Rivers. P. M., xiii, pp. 239–245.

On the Reactions of the Alkaline Silicates. S. J., xxiii, pp. 437, 438.

Note on the Cherokine of C. U. Shepard. S. J., pp. xxvi, 27–50.

On the Probable Origin of Some Magnesian Rocks. R. S. P., ix, 1857-1859, pp. 159–164 ; S. J., xxiv, pp. 272, 273.

Report of Chemist and Mineralogist of the Geological Survey of Canada for the Year 1853 on Mineral Waters and Laurentian Limestones. C. G. S.

Ditto, ditto, for 1854, "On Triclinic Felspars of the Laurentian Series," and "On Silurian Rocks."

Ditto, ditto, for 1855 "On Iron Ores and Metallurgy of Iron," "On Extraction of Salt," "On Magnesian Mortars," "On Plumbago," "On Peat and Its Products."

Ditto, ditto, for 1856, "On Parallelism of the Metamorphic Silurian and Laurentian Rocks."

All the above in Report of Progress, published in 1857. Abstracts of above were published in C. N., iii, 91–97, and in S. J., second series, xvx, pp. 217–226, and xxvi, pp. 234–240, under the title, "Contributions to the History of Ophiolites," with additions, "On Serpentines and Some of its Uses." C. N., ii, pp. 28–34.

Chemical Report and "On Dolomites and their Formation." C. G. S. (report of progress), 1857, pp. 193–329 ; Laurents, 58.

Mineral Waters and Origin of Magnesian Rocks. C. N., ii, p. 258.

1858.

On the Theory of Igneous Rocks and Volcanos. C. J., iii, pp. 201–208 ; C. N., iii, pp. 194–201, and republished in C. & G. E.

On the Chemistry of the Primeval Earth. S. J., xxv, pp. 102, 103.

Contributions to the History of Ophiolites. S. J., xxv, pp. 217–226 ; xxvi, pp. 234–240 ; Erd. J. P. C., lxxv, pp. 457, 458.

On the Extraction of Salts from Sea Water. S. J., xxv, pp. 361–371 ; C. N., iii, pp. 97–110.

On the Origin of Feldspars and on Some Points of Chemical Lithology. S. J., xxv, pp. 435–437.

On Euphotide and Saussurite. S. J., xxv, p. 437.

On Some Reactions of the Salts of Lime and Magnesia. S. J., xxvi, pp 109, 110.

1859.

Contributions to the History of Gypsum and Magnesian Rocks. P. A. S., pp. 227–247 (1860) ; C. N., iv, pp. 294, 295. Reprinted in C. & G. E.

On the Formation of Magnesian Limestone. C. J., iv, pp. 185, 186.

Fish Manure. C. N., iv, pp. 13–23.

Formation of Siliceous Rocks. C. N., iv, pp. 295, 296.

(Report as Chemist and Mineralogist.) On Intrusive Rocks of Montreal and Grenville, Minerals from Silurian Rocks and History of Dolomites. C. G. S. (report of progress, 1858), pp. 171–218. Reprinted in part in C. J , v, new series, pp. 426–442. Abstract in S. J., second series, xxxi, p. 124.

Contributions to the History of Euphotide and Saussurite. S. J., xxvii, pp. 336–349 ; Erd. J. P. S., lxxx, 1860, pp.333–336.

On Some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsum and Magnesian Rocks. S. J., xxviii, pp. 170–187, 365–383.

Notes on Some Points in Chemical Geology. B. A. R., 1860 (Part 2), pp. 83, 84 ; C. N., iv, 1859, pp. 414–425 ; G. S. J., xv, pp. 488–496 ; S. J., xxx, 1860, pp. 133, 137. Republished in C. & G. E.

1860.

Analysis of Canadian Wolfram. C. J., v, p. 103.

On the Intrusive Rocks of the District of Montreal. C. J. v, pp. 426–442.

On the Titananiferous Iron Ores of Canada. C. N., ii, pp. 41, 42.

On the Formation of Gypsums and Dolomites. G. S. J., xvi, pp. 152–154.

Sur les relations entre les matieres amyloïdes et albuminoïdes. Paris, C. R., l, pp. 1186, 1187; Jour. de Pharm., xxxviii, pp. 122, 123.

On Some of the Igneous Rocks of Canada. S. J., xxix, pp. 282–284.

Notes on the Dolomites of the Paris Basin. S. J., xxix, pp. 284–286.

Review of Some Points in the Geology of the Alps. (Memoire sur les terrains liassique et keuperion de la Savoie par Alphonse Favre). J. S., (second series), xxix, pp. 118–124.

1861.

Note on Chloritoid from Canada. S. J., xxxi, pp. 442, 443.

On Ozone, Nitrous Acid and Nitrogen. S. J., xxxii, pp. 109, 110.

On the Taconic System of Dr. Emmons. S. J. (second series), xxxii, pp. 427–430; xxxiii, pp. 135, 136.

On Some Points in Chemical Geology. B. A. R.

On the Theory of Types in Chemistry. C. J., vi, pp. 120–129; C. R., lii, 247–250; P. M., xxii, pp. 15–23; S. J., xxxi, pp. 256–264.

On Some Points in American Geology. C. N., vi, pp. 81–106; S. J., xxxi, pp. 392–414. Reprinted in part as "The Origin of Mountains" in C. & G. E.

On the Origin of Some Magnesian and Aluminous Rocks. C. N., vi, pp. 180–184; S. J., xxxii, p. 286; C. News, vi, 1862, pp. 158–160.

Notes on the History of Petroleum or Rock Oil. C. N., vi, pp. 241–255; C. News, vi, 1862, pp. 5, 6, 16–19, 35, 36.

Mr. Barrande on the Primordial Zone in North America, and on the Taconic System of Emmons. C. N., vi, pp. 374–383.

1862.

Considerations sur la chemie du globe. C. R., liv, pp. 1190–1195; C. N., vii, pp. 201–205.

Note on the Taconic System of Emmons. C N., vii, pp. 78–80; S. J., xxxiii, p. 138.

Note on the Occurrence of Glauconite in the Lower Silurian Rocks. S. J. (second series), xxxiii, pp. 277, 278.

On the Chemistry of the Earth. C. N., vii, pp. 201–205; C. R., June 9, 1862.

Descriptive Catalogue of Collection of Economic Minerals of Canada, and of its Crystalline Rocks sent to the London Exhibition of 1862. C. G. S., pp. 61–63.

Note on the Various Theoretical Views Regarding the Origin of the Primitive Formations. By C. F. Naumann. C. N., vii, pp. 262, 263.

1863.

Note sur la nature de l'azote et la théorie de la nitrification. C. R., lv, pp. 460–462. P. M., xxv, pp. 27–29.

On the Chemical and Mineralogical Relations of Metamorphic Rocks. C. N., x, pp. 195-208; D. G. S. J., x, 1864, pp. 85-95; S. J., xxxvi, p. 214. Republished in C. & G. A.

On the Earth's Climate in Palæozoic Times. C. N., viii, pp. 323-328. S. J., xxxvi, p. 396.

Sur la nature du jade. C. R., lvi, pp. 1255-1257; S. J., xxxvi, p. 426.

Contributions to the Chemical and Geological History of Bitumens and of Pyroschists or Bituminous Shales. S. J., xxxv, 157-171.

On the Gold Mines of Canada and the Manner of Working Them. C. N., viii, pp. 13-19.

1864.

Contributions to Lithology. 1. Theoretical Notions. 2. Classification and Nomenclature. S. J., xxxvii, pp. 248-266; C. N., i, pp. 16-36, 161-189.

Laurentian Rhizopods of Canada. S. J., xxxvii, p. 431.

Contributions to Lithology. 3. On Some Eruptive Rocks. 4. Local Metamorphism. S. J., xxxviii, pp. 91-104, 174-185.

Notes on the Silicifications of Fossils. C. N., i, pp. 46-50.

On Peat and Its Uses. C. N., i, pp. 426-441.

On Organic Remains in the Laurentian Rock of Canada. B. A. R.

1865.

Vorkommen des Apatits in Canada. Neues Yahrb. Mineral, p. 845; Halle, Zeitschr. Gesammt, Naturwiss., xxv, p. 297.

Contributions to the Chemistry of Natural Waters. S. J., xxxix, pp. 176-193; C. N., ii, p. 1-21, 161-183, 276-299. Reprint in C. & G. E.

On the Mineralogy of Eozoon-Canadense. C. N., ii, pp. 120-127.

A Geographical Sketch of Canada. C. N., ii, pp. 356-363.

On the Mineralogy of Certain Organic Remains from the Laurentian Rocks of Canada (1864). G. S. Quart. J., xxi, pp. 67-71; P. M., xxix, pp. 76, 77.

Petroleum, Its Geological Relations, with Special Reference to Its Occurrence in Gaspé, with map. Montreal. Pp. 19.

1866.

On Petroleum. P. A. A., xv, pp. 29, 30. C. N., iii, pp. 121-123.

On the Metallurgical System of Messrs. Whelpley and Storer. P. A. A., xv, pp. 30-34.

On the Primeval Atmosphere. P. A. A. S., pp. xv, 34-37; C. N., iii, pp. 117-120.

On the Laurentian Limestones and their Mineralogy. P. A. A., xv, pp. 54-57; C. N., iii, pp. 123-125.

Further Contributions to the History of Lime and Magnesia Salts. S. J., xlv, pp. 49-67.

Report "On Geology and Mineralogy of the Laurentian Limestones," "On the Geology of Petroleum and Salt," "Porosity of Rocks," "Peat." C. G. S., Report of Progress for 1863-66, pp. 181-291. Ottawa.

Report on the Gold Region of Lower Canada. C. G S., Report of Progress fr. 1863 to 1866, pp. 79-90.

1867.

On the Objects and Method of Mineralogy. S. J., xliii, pp. 203-207. A. A. P., vii, pp. 238-242. Reprinted in C. & G. E.

On the Mineralogy of Crystalline Limestones. Geol. Mag., iv, pp. 357-369, 432-477, 478; Les Mondes, xv, pp. 17-24; Archives Sci. Phys. Nat., xxxi, 1868, pp.5-14; C. N., iii, 1868, pp. 225-234; Roy. Instit. Proc., v, 1869, pp.178-185; Smithsonian Reports, 1869, pp. 182-207.

Sur la formation des gypses et des dolomites. C. R., lxiv, pp. 815-817.

Sur quelques réactions de silo magnésiens et sur les roches magnésifères. C. R., lxiv, pp. 846-849.

Sur les pétroles de l'Amérique, du Nord. Paris, Bull. Soc. Géol., xxiv, pp. 570-573.

Terrains anciens de l'Amérique du Nord. Bull. Soc. Géol., xxiv, pp. 664-669.

Sur la théorie de l'Origine des montagues. Bull. Soc. Géol., xxiv, 687-689.

Description géologique du Canada Equisse Géologique du Canada, pp. 3-35.

Report on the Gold Region of Hastings. C. G. S., pp. 3-6.

1868.

On Some Points in the Geology of Vermont. S. J., xlvi, pp. 222-229.

Notes on the Geology of Southwestern Ontario. S. J., xliv, pp. 355-362; C. N., iv, 1869, pp. 11-20.

A Notice of the Chemical Geology of Mr. D. Forbes. Geol. Mag., v, 49-59.

On the Chemistry of the Primeval Earth. C. N. (new series), iii, pp. 225-234. Read to the Roy. Inst. Great Britain, London, May, 1867. Repub. in C. & G. E.

On the Gold Region of Nova Scotia. C. G. S., pp. 38.

On the Chemical and Geological Relations of Metals. P. A. A. (paper read, not printed).

1869.

Volcanoes and Earthquakes. C. N., iv, pp. 387-397.

The Magnetic Iron Sands of Canada. C. N., iv, pp. 467-469.

On the Probable Seat of Volcanic Action. Geol. Mag., vi, pp. 245-251; C. N., iv, pp. 166-173; S. J., l, 1870, pp. 21-28. Reprinted in C. & G. E.

Études chimiques sur le cuirre. C. R., lxix, pp. 1357-1360; C. N., iv, p. 324; S. J., xlix, 1870, pp. 153-157.

Oesterreich. Zeitschr. Bergwesen, xviii, 1870, pp. 157-159.

Geological Features in Vicinity of Belœil Mountain. C. N. (new series), iv, pp. 218-224.

Borings for Oil in Southwestern Ontario Region. Read to A. A. A. S.; Abstract Am. Nat., ii, p. 388 (⅛ p.).

The Goderich Salt Region—Iron and Iron Ores. C. G. S., pp. 211-304.

On Ancient Erosions in the St. Lawrence Valley. Paper read A. A. A. S. (not printed).

On the Geology of Northeastern America. Paper read A. A. A. S. (not printed).

1870.

On American Iron Sands. P. A. A., xix, pp. 131, 132.

The Oil-bearing Limestone of Chicago. P. A. A., xix, pp. 157-159; S. J., i (1871), pp. 420-424; Am. Chemist, ii (1872), pp. 27-29; C. N., vi, (1872), pp. 54-59. Reprinted in C. & G. E.

Notes on Granite Rocks. P. A. A., xix, pp. 159-161; C. N., v, 388-406; S. J., i (1871), pp. 82-89, 182-191; iii (1872), pp. 115-125.

On Laurentian Rocks in Eastern Massachusetts (1869). S. J., xlix, pp. 75-78; C. N., v, pp. 31-38.

On Norite or Labradorite Rock. S. J., xlix, pp. 180-186; C. N., pp. 198-205.

On the Geology of Eastern New England. S. J., l (1870), pp. 83-90; C. N., pp. 198-205.

On Laurentian Rocks of Nova Scotia. S. J., l. pp. 132-134.

On a Mineral Silicate Injecting Paleozoic Crinoids. C. N., v, pp. 449-451; S. J., i, (1871), pp. 379-380.

The Liquefaction of Rocks. G. Mag., vii, pp. 60, 61.

On Astronomy and Geology. C. N. (new series), v, pp. 460-462

Labradorite Rocks at Marblehead, Mass. S. J. (second series), xlix, p. 389 (¼ p.).

Description of the New England Granite Formation. Essex Inst. Bull., i, pp. 106-107 (½ p.)

On the Salt Deposit of Western Ontario. Paper read A. A. A. S. (not printed).

1871.

Address before the American Association, delivered at Indianapolis. 1. Geognosy of the Appalachian System. 2. The Origin of Crystalline Rocks. P. A. A., xx, pp. 1-59; A. N., v, pp. 451-509; Geol. Mag., ix (1872), pp. 76-78. Reprinted in C. & G. E.

Notes on the Hunt and Douglas New Process for the Extraction of Copper from Its Ores. A. C., i, pp. 199-200.

Mineral Silicates in Fossils. S. J., ii, pp. 57-58.

On the Oil Wells of Terre Haute, Ind. A. M. N., v, pp. 576, 577. Reprinted in C. & G. E.

On the Chemistry of the Earth. Smithsonian Report for 1869, pp. 182–207.

Analysis of Coals and Crystalline Rocks from Vancouver Island. P. A. A., pp. 98–100.

The Origin of Crystalline Rocks. P. A. A., xx, p. 35; Am. Nat., v, p. 470; S. J., ii (third series), 205.

Notes on Granite Rocks. S. J., i (third series), pp. 82–182, and iii, p. 115; C. N., v, p. 388. Reprinted in C. & G. E.

1872.

The Origin of Crystalline Rocks. [1871], A. C., ii, pp. 291, 292. Reprinted in C. & G. E.

On Alpine Geology. S. J., iii, pp. 1–15. Reprinted in C. & G. E.

Remarks on the Late Criticisms of Prof. Dana in Reference to My Theory on the Origin of Crystalline Rocks. S. J., iv, pp. 41–52.

Geological History of the Mountain of Montarville. C. N., vi, pp. 224–226.

History of the Names Cambrian and Silurian in Geology. C. N., vi, pp. 281–311, 417–448. Reprinted in C. & G. E.

Osservazioni intorus alla geologia del gruppo del Monte Bianco. Transl. Firenze, Ball. Com. Geol. Ital., iii, pp. 131–140.

On Prophyries of the Coast of Mass. Essex. Inst. Bull., iii, pp. 53, 54.

On Labradorite Rocks in New Hampshire and Colorado. G. S. New Hampshire, report of progress during 1871, pp. 13, 14.

On the Geology of the Vicinity of Boston. Boston Soc. Nat. His. Proc., xiv, pp. 45–49.

Remarks on the Extraction of Bismuth from Certain Ores. I. M. E., i, pp. 260, 261.

Origin of Metalliferous Deposits. Lecture delivered before the American Institute of New York and published in C. & G. E.

1873.

The Geognostical History of the Metals. I. M. E , i, pp. 331–346.

Remarks on an Occurrence of Tin Ore at Winslow, Me. I. M. E., i, pp. 373, 374.

The Origin of Metalliferous Deposits. I. M. E., i, pp. 413–426.

Notes on the Geology and Economic Mineralogy of the Southeastern Appalachians.

The Metamorphism of Rocks

Geology of Southern New Brunswick.

Breaks in the Americal Paleozoic Series. P. A. A., xxii, pp 113–119.

Remarks on Prof. Newberry's Paper—"On Circles of Deposition." P. A. A., xxii, 196–198.

Some Points in Dynamical Geology. S. J., third series, v, pp. 264–270. Reprinted in C. & G. E.

On the Copper Deposits of the Blue Ridge. S. J., vi, 305–308.

Palæography of the North American Continent. (1872), A. G. Soc., J., iv, pp. 416–431.
On the Theory of Volcanos. (1872), Boston Soc. Nat. His. Proc., xv, pp. 250–252.
On the Crystalline Schists of the Green and White Mountain Series. Boston Soc. Nat. His. Proc., xv, pp. 309, 310.
On the Eozoon Canadense. (1870), Irish Acad. Proc., i, 1873–74, pp. 123–127.
On Concentric Lamination in Rocks. Boston Soc. Nat. His. Proc., xv, pp. 261, 262. Remarks by Kunland.

1874.

On the Crystalline Rocks of the Blue Ridge Southwest of Lynchburg, Va. (1873), Boston Soc. Nat. His. Proc., xvi, pp. 116, 117.
Geology of the North Shore of Lake Superior. I. M. E., ii, p. 58.
The Ore Knob Copper Mine and Some Related Deposits. I. M. E., ii, pp. 123–131.
Remarks on Position of Magnetic Iron Ores of Northern New York. I. M. E., i, 370.
On the Cement of Some Natural and Artificial Stones. P. A. A., xxiii, pp. 106, 107.
The Disintegration of Rocks and Its Geological Significance (abstract). P. A. A., xxiii, pp. 396.
The Sewage Question Chemically Considered (abstract). P. A. A., xxii, pp. 107–109.
On Wet Processes of Copper Extraction (abstract). P. A. A., xxii, pp. 78(b), 79.
On the Decayed Rocks of the Hoosac Mountains. I. M. E., iii, pp. 187, 188.
The Coals of the Hocking Valley, Ohio. I. M. E., ii, p. 273.
Magnetic Iron Ores of New Jersey. I. M. E., ii, pp. 234, 235.
Occurrences of Glauconite and Fossil Resins. Boston Soc. Nat. His. Proc., xvi, pp. 301, 302.
Remarks on the Stratification of Rock Masses. Boston Soc. Nat. His. Proc.. xvi, pp. 237–239.
The Deposition of Clays. Boston Soc. Nat. His. Proc., xvi, pp. 302–304.
On Dr. Genth's Researches on Corundum and Its Associated Minerals. Boston Soc. Nat. His. Proc., xvi, March 4.
Breaks in the American Paleozoic Series. P. A. A., xxii, pp. 117.

1875.

Celestial Chemistry, v. Popular Science Monthly.
Deposition of Sediment. A. J. S., ix, pp. 61, 62. Boston Soc. Nat. His. Proc.
Report on Hoosac Tunnel. House Doc. No. 9, 1875, Mass.
Chemical and Geological Essays. Boston. Pp. 489.

The Geological Survey of Missouri. Amer. Nat., ix, pp. 240–245.

Remarks on Hematite Iron Ores, Eastern United States. I. M. E., iii, pp. 417–422.

On the Boston Artesian Well and Its Waters. Boston Soc. Nat. His. Proc , xvii, pp. 486–488.

Remarks on the Relations of Primordial and Crystalline Works in New England and Elsewhere. Boston Soc. Nat. His. Proc., xvii, pp. 508–510.

1876.

The Cornwall Iron Mine and Some Related Deposits in Pennsylvania. I. M. E., iv, pp. 319–325.

History of Crystalline and Stratified Rocks. P. A. A., xxv, p. 205.

Geology of Eastern Pennsylvania. P. A. A., xxv, pp. 208–212.

On the Petrosilex Porphyrus of N. Carolina. P. A. A., xxv. Read, not printed.

A New Ore of Copper and Its Metallurgy. I. M. E., pp. 325–328.

The Development of Our Mineral Resources. Being the Fifth Paper of the First Contrib. of the Repub. Series. Harper's Magazine.

1877.

The Goderich Salt Region. I. M. E.. v, pp. 538–560; S. J., third series, xiii, p. 231.

Older Rocks of Western North America.

J. D. Dana on the Alteration of Rocks. Boston Soc. Nat. His., xviii, pp. 108, 109.

The Decayed Gneiss of the Hoosac Mountain. Boston Soc. Nat. His., xviii, pp. 106–108.

1878.

International Geological Congress. P. A. A., xv, p. 485.

Special Report on the Trap Dikes and Azoic Rocks of Southern Pennsylvania. Part I. Historical Introduction. II. Geol. Surv. Penna. Report E, p. 8–21; 253 pages. Harrisburg.

On the Geology of the Eozaic Rocks of North America. Boston Soc. Nat. His., xix, pp. 275–279.

The Quebec Group in Geology. Boston Soc. Nat. His., xix, pp. 2–4.

Introductory Remark at Phil. Meeting. I. M. E., vi, p. 18.

Remark on Nickel Deposit of Oxford, Canada. I. M. E., vi, p. 213.

Remarks on Origin of Clays. S. M. E., vi, p. 188.

On the Origin of Crystalline Rocks. B. A. R., p. 536.

On the Geological Relations of the Atmosphere. B. A. R., p. 544.

1879.

Coal and Iron of the Hocking Valley, O. I. M. E., vii, p. 313.

The History of Some Precambrian Rocks in America and Europe. P. A. A., xxvii, p. 279; S. J., xix, pp. 268–283; C. N., ix, p. 257.

Table of Geological Formations, p. 51 ; Eozoic, p. 10, and Dominion of Canada, pp. 52–55, in Macfarlane's Amer. Geological Railway Guide.

Remarks on the Position of Copper-bearing Rocks of Lake Superior and Pennsylvania. I. M. E., vii, p. 333.

On the Origin of Clays on the Atlantic Seaboard. I. M. E., vi, p. 188.

1880.

The Chemical and Geological Relations of the Atmosphere. S. J., xix, pp. 349–363. Reprinted in M. P. & P.

On the Recent Formation of Quartz and on Silification in California. S. J., xii, p. 371 ; C. E., ix, pp. 435, 1881.

The Genesis of Certain Iron Ores. Science (edited by Michels), i, p. 201 ; also read to A. A. A. S., 1880.

Letters and Notes on the Iron-bearing and Associated Rocks of the Marquette Region, and Comparisons with the Archean of Canada and of the Eastern United States (with comments by T. B. Brooks). Geology of Wisconsin Survey of 1873–79, vii, 1880.

Des terrains pré-Cambriens dans l'Amérique du Nord. Congrès Géol. International Compte Renda, Session of 1878, pp. 229–232, 1880.

Sur les limites du terrain Cambrian. Congrès Géol. Inter. C. R., Session 1878, p. 99, 1880.

On the Origin of Anthracite (abstract), Science, i, p. 303. Read to National Acad. of Sci.

1881.

Historical Notes on Cosmic Physiology. P. A. A., xxx, p. 48.

The Taconic System in Geology. C. N. (new series), ix, p. 429(abstract) ; abstract, Am. Nat., xv, p. 494. Read Nat. Acad. Sci., 1880.

Remarks on Pre.-Cambrian Rocks of Great Britain. Bos. Soc. Nat. His., xx, pp. 104–141.

The Hydrometallurgy of Copper and its Separation from the Precious Metals. I. M. E., x, pp. 11–25.

Nature in Thought and Language. Lon., Edin. and Dub. Phil. Mag., 1881. Reprinted in M. P. & P.

1882.

Address of Welcome. A. A. A. S., Montreal C. Meeting, xxxi, p. 613.

Remarks and Notices. A. A. A. S., Montreal C. Meeting, xxxi, pp. 618–639.

The Eozoic Rocks of Central and Southern Europe. The Serpentines of Italy. P. A. A., xxxi.

Celestial Chemistry from the Time of Newton. Proc. Phil. Soc. of Cambridge, iv, p. 3 ; S. J., xxiii, pp. 123–133. Reprinted in M. P. & P.

The Relation of the Natural Sciences. Address before Royal Society of Canada. C. Nat., x, No. 5, and, with additions, Popular Science Monthly, xxii, p. 165.

1883.

Classification of the Natural Sciences. P. A. A., xxxii, p. 29. Reprinted in M. P. & P.

Pre-Cambrian Rocks of the Alps. P. A. A., xxxii, pp. 239–242; Am. Nat., xvii, pp. 1099–1102; abstract, Science, ii, pp. 322–333.

The Serpentine of Staten Island, N. Y. P. A. A., xxxii, p. 242; Am. Nat., xvii, p. 1037; Science, ii, p. 323.

The Decay of Rocks Geologically Considered. S. J., xxvi, p. 190; Science, i, p. 324; Am. Nat., xvii, pp. 645. Read to Nat. Acad. Sci., April 17. Reprinted in M. P. & P.

Coal and Iron in Alabama. I. M. E., xi, p. 236. Eng. & Mining J., xxxv, p. 113; abstracts, School of Mines, Quart. iv, p. 225; Science, i, p. 101.

On the Pre-Cambrian Rocks of Europe and America. C. N., x (new series), p. 126, 127.

The Geology of Port Henry, N. Y. C. N., ix, p. 420–422; Sci. Am. Supp., viii (No. 195), p. 3096. Read to Am. A. A. S., 1879.

Geology. Progress for 1882. Smithsonian Report for 1882, p. 126. In part in the Virginias, v, p. 141–161.

The Pre-Cambrian Rocks of Wales. Science, ii, p. 403.

The Geology of Lake Superior. Science, i, pp. 218, 219.

A Historical Account of the Tatonic Question in Geology, with a Discussion of the Relations of the Taconian Series to the Older Crystalline and to the Cambrian Rocks. Can. Royal Soc. Trans., i, sec. 4, pp. 417–427.

Relation of the Natural Sciences. Inaugural address. Can. Royal Soc. Trans., i, sec. 3, p. 1.

The Geological History of Serpentines, including Notes on Pre-Cambrian Rocks. Can. Royal Soc. Trans., i, sec. 4, pp. 165–215. Reprinted in M. P. & P.

Notes on Prof. James Hall's Address, on the Geological History of the American Continent. P. A. A., xxxi, p. 69–71.

Historical Account of the Taconic Question in Geology. Can. Royal Soc. Trans., i, p. 217. Reprinted in M. P. & P.

1884.

On the Chemistry of the Natural Silicates. B. A. R., p. 679.

The Origin of the Crystalline Rocks. Can. Royal Soc. Trans., ii (3), p. 1. Read before Royal Soc. of Canada. Abstract, S. J , xxviii, p. 73. Reprinted in M. P. & P.

The Apatite Deposits of Canada. I. M. E., xii, pp. 459–468; E. & M. J., xxxvii, p. 138.

Cambrian of North America. Read to Bos. Soc. Nat. His. Am N., xviii, p. 409; Canadian Rec. Sci., i, p. 77.

Note on Age of Rocks on Border of the Trias near the Iron Mines of Pennsylvania. A. Phil. Soc. Pro., xxi, p 458. Discussed by P. Frazer.

The Eozoic Rocks of North America (Abstract). Geol. Ency., i (third series), p. 506 ; Canadian Rec. Sci , i, p. 82 ; B. A. R., p. 727.

The Genesis of Crystalline Rocks. Am. Nat., xviii, p. 605. Abstract of paper read to Nat. Acad. Sci., April 15.

1885.

Biographical Notice of Prof. Benjamin Silliman. I. M. E., xiii, p. 782.

Remarks on Natural Gas in Canada. I. M. E., xiii, p. 782.

An Electrical Furnace for Reducing Refractory Ores. I. M. E., xiv, p. 492.

Note on the Apatite Region of Canada. I. M. E., xiv, p. 495 ; P. A. A. A., xxxiv, p. 199.

Geology (Progress of, for 1883). Smithsonian Report for 1883, p. 443, 1885.

Les Divisions du système Éozoique de l'Amérique de Nord. Soc. Géol. Belgique Annales, xii, p. 3.

The Geology of the Scottish Highlands. Science, v, p. 87.

An Historical Account of the Taconic Question in Geology, with a Discussion of the Relations of the Taconic Series to the Older Crystalline and to the Cambrian Rocks Second Part. Can. Royal Soc. Trans., ii, sec. 4, p. 125 ; abstract, Science, iii, p. 675. Reprinted in M. P. & P., Chemistry of Sea and Land, and Youth's Companion, June.

1886.

Apatite Deposits in Lawrentian Rocks. Abstract, P. A. A., xxxiv, p. 199.

A Natural System of Mineralogy with a Classification of Native Silicates. Can. Royal Soc. Trans., iii (3), p. 25 ; S. J. S., xxxii, p. 410. Reprinted in M. P. & P.

Mineral Physiology and Physiography. A Second Series of Chemical and Geological Essays, xvii, 710 pages, Boston. Review Am. Geol., viii, p. 110.

Note on the Apatite Region of Canada. I. M. E., xiv, p. 495 ; Canadian Rec. Sci., i, p. 65.

1887.

Remarks on Hocking Valley District. I. M. E., xv, p. 754.

Further Notes on the Hydrometallurgy of Copper. I. M. E., xvi, p. 80.

Elements of Primary Geology. Geol. Mag., third decade, iv, p. 493 ; abstract, E. & M. J., xxxiv, p. 219 ; Nature, xxxvi, p. 574 ; B. A. R., 1887, p. 704.

Gastaldi on Italian Geology and the Crystalline Rocks. Geol. Mag., third decade, iv, p. 531 ; abstract, B. A. R., p. 703.

The Genetic History of Crystalline Rocks. Can. Royal Soc. Trans., iv, sec. 3, p. 7. Reprinted in M. P. & P. Abstract Canadian Rec. Sci., i, p. 147.

The Taconic Question Restated. Am. Nat., xxi, p. 114. Reviewed by J. D. Dana. S. J., third series, xxxiii. p. 412.

Chemical Integration. S. J., xxxiv, p. 116.

A New Basis for Chemistry; A Chemical Philosophy. 165 pages, 8vo, Boston, S. E. Cassino. Supplément to Natural System in Mineralogy. Can. Royal Soc. Trans., iv (3), p. 63.

History of Pre-Cambrian Rocks, condensed from "Azoic Rocks," and published in M. P. & P., p. 402.

Integral Weights in Chemistry. B A. R., 637.

The Sonora Earthquake of May 3, 1887. B. A. R., p. 712.

1888.

On Subdivisions, Unconformities, Characteristics, etc., of the Lower Paleozoic Formations. International Cong. Geol. Am. Committee Reports, 1888 A., pp. 68, 69.

On the Study of Mineralogy. B. A. R., p. 627.

The Theory of Solution. B. A. R., p. 636.

Mineralogical Evolution. B. A. R., p. 682.

1889.

On Granet-veins of the Lawrentian Formation. I. M. E , xvii, p. 594. Classification and Nomenclature of Metalline Minerals. Can. Royal Soc. Trans., vi (3), p. 61.

1890.

Iron Ores of the United States. I. M. E., xix, p. 3.

Letter concerning Prof. Von Turner. I. M. E., xix, p. xxi.

Notes on Geology of Eastern New York. Macfarlane's Geol. Rev. Guide, second edition, p. 137.

The Geological History of the Quebec Group. Am Geol., v, p. 212.

1891.

Les Schistes Cristallins. Congrèss Gèol. International C. R., 4th sess. p. 65. Londres. Abstract, Nature, xxxviii, p. 519. 1888.

Systematic Mineralogy based on a Natural Classification. Published by Scientific Pub. Co., New York.

BOOKS WRITTEN BY DR. T. STERRY HUNT.

Chemical and Geological Essays:
- First Edition published in 1874.
- Second Edition with new Preface, 1878.
- Third Edition, 1890.
- Fourth Edition, 1891.

Mineral Physiology and Physiography.

A Second Series of Chemical and Geological Essays with a General Introduction:
First Edition published in 1886.
Second Edition with new Preface, 1890.

A New Basis for Chemistry: A Chemical Philosophy, 1887. Translated by Prof. W. Spring into French and published in Paris and Liege as Un Système Chèmique Nouveau, 1889.

Systematic Mineralogy based on a Natural Classification with a General Introduction, 1891.

Special Report on the Trap Dykes and Azoic Rocks of Southeastern Pennsylvania, 1878.

EXTRA LECTURES.

1866–1867. Lectures on Chemical and Physical Geography delivered before the Lowell Institute, Boston.

1872. Twenty lectures on Chemistry delivered before the Ladies' Educational Institute, Montreal.

1874. Six lectures on Chemistry of the Waters delivered before the Boston Society of Natural History, Boston.

1875. One lecture on the Constitution of Water as Related to Modern Chemistry and Physics, before Examiner Club.

1875. One lecture on the Glazier Period, delivered for the Lit. and His. Society of Quebec.

1875. Eighteen lectures on the Practical Geology of the U. S., Boston.

1876. Eighteen lectures on Elementary Geology.

1876. A Course on the Older Rocks before the Boston Society of Nat. History.

1876. The Building of the Earth, delivered in Salt Lake City.

1877. Chemical History of the Earth, before Chestnut Street Club.

1881. Coal.

1883. Twelve lectures on Mineral Physiology before Lowell Institute.

1884. The Manufacture of Iron, before Finance Club, Cambridge, Mass.

1885. On Arbor Day, Montreal.

1886. On Geology, Campobells.

1886. On the Alps, Liverpool, England.

1888. Theory of Volcanoes, Montreal.

1889. Goethe and Modern Science, The Concord School of Philosophy.