MEMOIR

OF

JOHN LAWRENCE SMITH.

1818-1883.

BY

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BIOGRAPHICAL MEMOIR OF JOHN LAWRENCE SMITH.

THE Academy mourns the death in the past year of Alexander, Guyot, Engelmann, Humphreys, John L. LeConte, Norton, and Smith.

The sad but grateful duty has been assigned to the writer to speak of the life and labors of Smith, with whom he had the happiness to maintain an uninterrupted and life-long friendship.

JOHN LAWRENCE SMITH

was born near the city of Charleston, South Carolina, December 17th, 1818, where he received the best training offered by the private schools of that city. "Even as a child of four years, and before he could read," says his friend, Dr. Marvin, "he was familiar with the operations of simple arithmetic; at eight he was prepared for the study of algebra, and at thirteen was studying the calculus." This mathematical taste he retained through life, although circumstances later led him into different paths. His taste for physical phenomena and for scientific pursuits led him to elect at the University of Virginia, where we find him before he was yet seventeen years of age, the branches of chemistry, natural philosophy, and civil engineering, to which he devoted two years. Chemistry he followed under Prof. John P. Emmet, natural philosophy under Prof. William B. Rogers, civil engineering and mathematics under Prof. Chas. Bonnycastle.

By the plan of study adopted at the University of Virginia at that time the subject of civil engineering was divided under eight distinct heads between the professors of mathematics and natural philosophy, viz: I. Graphical mathematics. II. Theory of levelling and surveying. III. Theory of roads, railroads, canals, and bridges. IV. Theoretical mechanics, hydrostatics, hydrodynamics, &c. V. Laws of heat, steam, and steam-engine. VI. Geology and mineralogy. VII. Field practice in surveying. VIII. Plan drawing, plotting, topographical plans, &c. The six first named were divided between the chairs of physics and mathematics.

Such were the subjects to which Smith devoted the two years of his life at the University of Virginia, and under the stimulus of such teachers as Emmet, Bonnycastle, and Rogers we cannot doubt that his early preference for these studies was deepened and confirmed.

The writer now recalls the vivid impression made upon his own mind by a lecture which he heard from Mr. W. B. Rogers, in the autumn of the year 1836, at the University of Virginia, on the Resultant of Forces. It was in that year Smith entered this university, and there is no evidence that he attended any of the classical or literary courses of the institution. Whatever attention he bestowed on literary studies must have been in his preparatory schools in Charleston.

The year immediately following his residence at the University of Virginia he devoted to the duties of assistant engineer upon the railroad line between Charleston and Cincinnati. This pursuit proved to be uncongenial to his taste, and was abandoned for the study of medicine.

The Medical College of the State of South Carolina was at that time distinguished by the presence of a very able body of teachers, and here Smith took his medical degree in 1840, submitting as his graduation thesis an essay upon the "Compound Nature of Nitrogen."[1]

The now venerable Professor Chas. Upham Shepard, who was Smith's chemical teacher, at Charleston, in his medical course, in reply to my inquiry respecting Smith's early life, writes as follows, March 4, 1884:

"I regret not being able to furnish you with the particulars you desire concerning the life of Dr. J. Lawrence Smith farther than that he was a diligent student of our Medical College, especially in the department of chemistry, and that on graduation he submitted a very ingenious thesis, entitled '*The Compound Nature of Nitrogen.*' He was known to be very fond of chemistry, but I am inclined to believe that his time was chiefly devoted to other branches of the medical profession, as he was then looking forward to the practice of medicine in his native city. I think it possible, however, that

[1] A silver goblet, still in the possession of Mrs. Smith, was presented to Dr. Smith in honor of this thesis by the Faculty of the Medical College of the State of South Carolina, 1840.

his taste for mineralogy may have been promoted at this period of his career.

"After finishing his studies in Europe and commencing practice here he gave a course of lectures on toxicology before our students, which was highly approved. He was then much occupied with chemical analysis of the limestones, marls, and soils of this vicinity, and contributed valuable results to the agricultural journals of this place.

"His leading aim at simplifying processes in analysis was most apparent—a field in which he afterwards achieved his chief distinction."

Dr. Smith's father was a merchant in Charleston of sufficient fortune to enable his son to prosecute his studies beyond the curriculum of the medical school of his native city. Immediately after taking his medical degree, therefore, Smith went to Paris to follow the most distinguished teachers in medicine and other departments of science. With Dumas he followed chemistry pure and applied, and with Orfila toxicology; with Poulliet, Desprez, and Ed. Becquerel he followed physics, and with Dufrenoy and Elie de Beaumont mineralogy and geology.

During one of his summer excursions he found himself at the door of Liebig's laboratory at Giessen. This accidental circumstance turned the whole course of his life into the channel from which it was never afterwards diverted.

He became a zealous and enthusiastic student of chemistry under the inspiration of Liebig. He appears to have divided his time between Giessen in the summer and Paris in the winter. This result was foreshadowed, as we have seen by his early tastes.

While yet a student in Charleston, South Carolina, his maiden communication to the American Journal of Science was on "Chromate of Potassa—a reagent for distinguishing between the salts of baryta and strontia."[1]

In this paper he first made known to chemists this very delicate and now very familiar test for baryta, and determined its quantitative value. This paper is interesting as the first evidence of Smith's acumen in devising new analytic methods in chemistry. In the same year he published a second paper—"On a new method of making permanent artificial magnets by galvanism."[2]

[1] Am. Jour., [i] xxxvi, 183. 1839.

[2] Am. Jour., xxxvi, 335. 1839.

Soon after his arrival in Paris Dr. Smith opened a correspondence with the writer, which continued during life.

In 1842 he thus transmitted to the American Journal of Science his first important chemical research on "The composition and products of distillation of spermaceti, &c."[1] This paper is dated Paris, April 29, 1842. It is an elaborate research, embracing many ultimate organic analyses from which the true composition of spermaceti was first made known. He set aside the views of Chevereul—that spermaceti was a fat, and reached the conclusion that it was a compound of ethal, and that by its distillation a molecule of ethalic hydrate and cetine was produced.

Organic chemistry was at that time without the powerful aid of a comprehensive classification, and the theory of the compound ethers had not been developed; otherwise the work which Smith accomplished so well would have led him to the conclusion that spermaceti was *cetyl palmitate* (cetine)—a view with which his analytical results accurately corresponded.

At the time when this research was made probably no American chemist had done any work in organic chemistry of so elaborate a character as we find in this investigation. This paper was reproduced in the *Annales de Ch. et Phys.* of Paris, in *Liebig's Annalen*, in *Sturgeon's Journal*, and in *Majocchi's Jour. Fis.*, &c.

In a subsequent paper on the action of potash on cholestrine[2] he shows that this body, usually considered by physiologists as a fat, was, in reality, as then judged, nearly related to spermaceti. This paper, he states, was intended as an appendix to his more elaborate research upon spermaceti.

Shortly after Dr. Smith reached Paris he found the whole of France agitated by one of the most interesting criminal processes upon record—that of Madame La Farge. This case involved the question of the normal existence of arsenic in the human body, and of its presence in hydrated peroxide of iron, used as an antidote. Dr. Smith reviews these and other questions in a paper entitled "On the means of detecting arsenic in the animal body, and of counteracting its effects."[3] The date of the paper is Paris, December 6th, 1840. He was then a student of Orfila, but he does not

[1] Am. Jour., [i] xliii, 301.

[2] Am. Jour. Sci., [i] xliv. 1843.

[3] Am. Jour. Sci., [i] xl, 278-293. 1841.

hesitate to expose the errors of his distinguished professor in this celebrated case—errors afterward acknowledged by Orfila himself.

He follows up this subject by a second paper of date June 28th, 1841, entitled "Continuation of remarks made upon arsenic, considered in a medico-legal point of view,"[1] in which he described the method of Danger and Flandin for destroying animal matter in toxical examinations, and also the then new form of Marsh's apparatus; and he still further reviews the ground for rejecting the opinion that arsenic is ever a normal constituent of the animal body, supporting his statements by evidence from his own original work.

We have already alluded to Dr. Smith's arrival, in the summer of 1841, at the laboratory of Liebig at Giessen. In November of that year he sent to this country from Giessen a translation of Will and Varrentrapp's method of determining nitrogen in organic compounds, then unknown in this country, accompanying it with notes of his own. This paper he supplemented in 1843, after his return to this country, with a notice of M. Reizet's criticisms upon the limits of accuracy of this method.[2]

It is pretty evident, from his scientific work while in Paris, that the study of medicine was subordinate to his interest in chemical research, and we are, therefore, prepared to find, after his return to this country, that medical practice offered few attractions for him. He indeed commenced practice, but found time to prepare and deliver courses of lectures, like that already mentioned by Prof. Shepard, before the Medical College on toxicology.

He also, in 1846, inaugurated the Medical and Surgical Journal of South Carolina, associated with Dr. Sinclair. He remained in this editorial work only one year before he went to Turkey. Before this time he had done some important work in chemical analysis and in the improvement of analytical methods; thus determining the action of alkaline salts on sulphate of lead; the composition of fossil bones from near Charleston, and the origin of the fluorine found in them; the action of solutions of the neutral phosphates upon carbonate of lime, and the composition of marl from Ashly River, South Carolina. A summary of these researches is contained in a paper published in October, 1844.[3]

[1] Am. Jour. Sci., [i] xlii, 75–81. 1842.
[2] Am. Jour. Sci., [i] xlv, 267. 1843.
[3] Am. Jour. Sci., [i] xlviii, 97–104.

He also turned his attention to the operations of the high iron furnace in two papers on this subject, and contributed abstracts of the researches of European chemists to the American Journal of Science (1845).[1]

These papers on agricultural chemistry—the composition of soils, the value of the marls and fossil bones of the Ashly River, &c.—undoubtedly led to his selection by Secretary (later President) Buchanan as a suitable person to meet the call from the Sultan of Turkey for scientific aid in introducing into that kingdom American methods in the culture of cotton—a subject with which he was also familiar.

This appointment marks an important epoch in Smith's career. It opened to him a new and virgin field of research, and offered him an opportunity to use his acquirements in a way different, indeed, from his expectations, but not the less important, Finding, on his arrival in Turkey, that an associate proposed to inaugurate the cultivation of cotton on a plan doomed to failure, he was about returning to America, when he received from the Turkish government a commission to explore her mineral resources. He entered at once, with his customary zeal and intelligence, upon this work, and in the four years of his residence in the Sultan's dominions, in spite of many vexatious restrictions, he opened up natural resources which have ever since added an important item to the revenues of the Porte.

His memoir on emery was equally important, both from a scientific and economic stand-point. Before his observations "On the geology and mineralogy of emery, made in Asia Minor," little was known of the mode of occurrence of this useful mineral. The Island of Naxos had long been almost the only locality, and the supply from this source was limited and the price excessive, and no geologist had found an opportunity of studying the mineral associations of emery or its relations to corundum. Smith's sagacity as an observer; his originality in discussing new methods of examination; his patience and conscientious fidelity in executing his work, are all conspicuous to the student of this memoir. From the study of the mineralogical associations in which he found the emery of Asia Minor he felt convinced that the search for like associations elsewhere would be rewarded by the discovery of emery or corundum.

[1] Some of his work at this time is found in the Reports of Tuomey on the Geological Survey of South Carolina, *q. v.*

With this view he addressed the present writer, requesting him to test the correctness of his observations upon known localities of corundum in the United States. The associate minerals were immediately found and reported. Later on, after his return to America, Smith had the opportunity of seeing the accuracy of his views demonstrated at the emery mine of Chester, in Hampden county, Massachusetts, which Dr. Charles T. Jackson had discovered by use of the key of its associate minerals, as suggested by Smith, the locality having been before regarded only as an iron mine. This mine is the subject of a special memoir by Smith, which will be found, pp. 42–53 of his volume of memoirs, 1873.[1]

Dr. Smith's memoir on the Turkish emery was presented to the French Academy in 1850, and was, at the recommendation of a special commission, of which Dufrenoy was the reporter, ordered to be inserted in the "*Recueil du Mémoires des Savantes Etrangers.*" It will also be found in the American Journal.[2]

In a letter to the writer, dated Paris, September 3d, 1850, Smith says he sends by a private hand the full translation of the first part of his paper on emery, and suggests, if no time is lost in its publication, it would first appear in full in America. It was, in fact, published simultaneously. He adds: "The second part I think you will like better than the first, and I shall set to work to translate it immediately. Please correct any little Gallicisms that you may find in the paper."

This last injunction is a tacit acknowledgment of the fact that the French idioms had a strong hold upon his literary style. We all were quite accustomed to this peculiarity, and found it not always easy to correct all the "little Gallicisms" without an almost new translation.

"I am now engaged," he adds in the same letter, "on the urinary calculi of the Museum of Dupuytren. This will be finished in about ten days. I shall then complete some odds and ends that I have in hand and leave for home about the first of October (1850). I shall give you more matter for the journal next year than you want from

[1] Mineralogy and Chemistry. Original researches by Prof. J. Lawrence Smith, of Louisville. 8vo, p. 401. 1873. A new edition of this volume of memoirs is now in course of printing by Dr. J. B. Marvin, of Louisville, which will contain a more complete collection of Dr. Smith's papers, brought down to the date of his death.

[2] [2], vol. x, 354–369.

any one indvidual. I did not visit your annual association, as much from diffidence as anything else."

His results on the urinary calculi above alluded to, I suspect, were never published, and he never carried out his purpose to describe his methods of analysis devised for this research. I only learn incidentally from a subsequent letter that two hundred calculi were examined.

Many other researches, scientific and economic, on coal, chromite, magnesite, &c., were prosecuted by Dr. Smith while in the service of the Ottoman government, several of which will be found in the volume cited, to which reference must be had for details. Of these his memoirs on thermal waters of Asia Minor is too important to be passed without mention (1849).[1]

Very soon after the Morse system of telegraphy was developed in the United States Smith applied to the present writer to send him as complete an apparatus as could then be had, with conductors sufficient to connect the Sultan's palace at Constantinople with the Bosphorus, and when all was ready the Sultan was invited to witness the operation of the first electric telegraph erected in his dominions, and was moved, as a consequence of the unselfish advice of our friend, to confer upon Prof. Morse a high decoration in recognition of his important invention. The Sultan was so impressed with the value of Dr. Smith's services in developing the resources of his dominions that he conferred on him substantial favors and honorable decorations in recognition of his esteem and friendship. He found his residence in the Sultan's dominions by no means agreeable to a man of his active temperament and to one impatient of diplomatic restraint. In a letter dated June 6, 1848, he says:

"And what do you think of my proposed plan of returning to America? Here I feel like a caged bird, being prevented from making those examinations of the country that my situation would so well enable me to do. But no! they must keep me at Constantinople the most of the time, because they *might want me*, and when I do go it is always with a troop of lazy, ignorant scoundrels, who are sent rather to watch my movements than to afford any assistance. The people are both suspicious and ignorant, and they believe an honest man exists only in the wildest dreams of philosophers. My last discovery was that of chromate of iron near

[1] Comptes Rendus du seances, de l'Academie des Sciences. Oct. 28, 1850.

Broussia. Nature, in placing all these mineral riches here, only threw 'pearls before swine.'"

In a former letter (May 27th) he says:

"I am becoming more and more disgusted with this country and its people, and have my hands tied by their stupidity and ignorance. You must recollect the coal mine I discovered about a year and a half ago, of which I made a detailed report to the government, giving the best manner of working it, &c. To this they appeared to pay great attention, and a few months ago got out a collier from England for the purpose of commencing the working of it. No sooner are all the preparations made than the government says it must not be worked; and why? Because the Sultan's mother and some of the great Pachas do not wish it, they owning mines on the Black Sea. This is done when there are hundreds of thousands of tons of coal brought from England every year. Comments are useless. They fear to go to the slightest expense in opening a new mine; consequently their great mineral treasures are useless to them."

Mention has already been made of Dr. Smith's very liberal and unselfish efforts to secure a proper recognition of the services of Prof. Morse in telegraphy. In his letter of November 7th, 1849, he says:

"You make allusion to Prof. Morse's decoration, about which I do not know that I have said anything to you. The fact is, I did not know that it had reached him until four or five months ago, when I came across an old American newspaper speaking of Prof. Morse's magnificent diamond broach. I do not know that you are aware that it was from a wish upon my part that the decoration was sent to Prof. Morse. The sole honor I expected to have in the matter was to transmit the decoration to him as the Sultan had ordered. But our minister thought proper to do otherwise, and, after a very long delay, he forwarded it himself. The fact is, after the decoration was accorded to Morse it would not have been given, had I not pushed the matter and proved, in a document sent to the Minister of Foreign Affairs, that Prof. Morse was entitled to the invention, that some English intriguers here wished to deprive him of. However, I send you a note written to me some time ago by the dragoman of the legation, who is the only one beside myself who is acquainted with the whole affair.

"Excuse me for writing to you about an affair which turned a loss to me without my obtaining the little honor that I coveted—that of exhibiting my esteem for the merits of Prof. Morse." * * *

He concludes this letter thus:

"I have been trying for some time past to conclude my arrangements with the Turks, and have at last succeeded. To remain here any longer is very much against my wishes, for my occupations interest me but little, and are of no general utility. Could I travel about as I wish, I could remain here ten years.

"In leaving his service the Sultan has thought proper to express his satisfaction at the service I have rendered him, and to present me with an elegant gold snuff-box set with diamonds. He has also ordered an official expression of the satisfaction of government to be given to me by the grand vizier, &c. So ends my career in Turkey. I leave in a day or two for Syria and Egypt, and after visiting these countries shall return to America by way of France."

Notwithstanding Dr. Smith's regrets over the folly of the Turks in hampering his movements, and so limiting his discoveries and researches, the fact remains that he managed, in spite of annoying restrictions, to reap a rich harvest of good work in the Ottoman Empire, at the record of a part only of which we have glanced.

He reached Paris in the early spring of 1850, and remained there until the following October, occupied with scientific work relating chiefly to the researches on emery and its associate minerals, and the presentation of his two memoirs on this subject to the Institut. He also found time to project his inverted microscope, which he matured after his return to America.

We have seen also that he took in hand the analysis of the urinary calculi of the Musée Dupreytren.

Many matters of chiefly mineralogical interest are found in his letters written during this period, but as the facts have long since found their proper place in the records of science, the letters now possess only a personal and historic interest.

After his return from his Turkish and European residence Dr. Smith passed almost immediately to New Orleans, where he remained about two years, having accepted an invitation to deliver courses of lectures on science before a lyceum or scientific society.

While there he was also elected to a chair in the scientific depart-

ment of the University of New Orleans, "which," he writes, in December, 1850, "at present exists but in name." Nevertheless we find at the head of his papers, prepared at this time, he uses the title of professor of chemistry in the University of Louisiana. Here he completed researches commenced abroad, as, for example, the description of the inverted microscope,[1] of which I find a pretty full notice in a private letter, with a figure, of date December 21, 1850, within a month after his arrival in New Orleans. Here he felt keenly, and deplores, the want of a laboratory as greatly hampering his researches. But he found occupation in a variety of work which he could accomplish with the limited means at hand, and I find him, in January, 1851, projecting an excursion to Arkansas, up the Mississippi to Missouri, and to Kentucky. This plan he carried out later. In a letter of October 9th, 1851, from Charleston, where he then was on a visit, he expresses his regrets that he had not yet a permanent place of residence. "I often regret," he says, "that I am not more permanently established, for my concentration on scientific labor can never be made advantageous until I have a well-mounted laboratory of my own. All my scientific labors have as yet been carried on in the Gipsey style. * * * In fact I have been literally a sort of peripatetic philosopher, carrying my own hammer and anvil and doing a little wherever I could get a place to work in. It would no doubt surprise you to see in my baggage a box of platinum, from a pint capacity down; bottles of pure carbonate soda, bisulphate of soda, fluor-spar, potash, carbonate of lime, &c.; in fact, my essentials that I am only satisfied of as to purity when they come from my own stock."

This habit of keeping a stock of pure chemical reagents in his baggage he retained for a long time, even after he was permanently settled in Louisville.

In 1852, June 24th, he married a daughter of the Hon. James Guthrie, of Louisville. This happy marriage decided the future course of his life. Cheered and sustained by the genial companionship of a wise and devoted wife, who took an intelligent interest in his pursuits, and was his constant companion during his frequent journeys at home and abroad, under her influence we find the opening out of a side of Dr. Smith's character which in his migratory life had little opportunity for expression. His tender human nature

[1] Am. Jour. Sci., [2] xiv, 233. Sept., 1852.

now found opportunity for development in works of charity and religion and in graceful hospitality. Louisville was destined hereafter to be his home, but not immediately. He was turning his mind toward the chemical chair in the University of Virginia, lately vacated by the transfer of Dr. Robert E. Rogers to Philadelphia, and to this place he succeeded in the autumn of 1852. He held this chair for only one year, but it was a year of great scientific activity, in which, aided by the efficient assistance of Mr. Brush, he was able to accomplish a very important amount of original investigation in the department of chemical mineralogy and in perfecting his new method of analyzing the alkaline silicates.

This subject had engaged his attention before he left Paris, but it was only after commencing work at the University of Virginia that he put it in form for publication.

In a letter, of date January 7, 1853, addressed to the writer at Louisville, after passing an encomium upon Brush, he adds:

"My method of analyzing the alkaline silicates is now complete, and will appear in the next number of the journal. This method of decomposing silicates for the alkalies is quite as easy as a carbonate of soda fusion, which latter, however, is an insignificant decomposing agent along side of it. Zircon and kyanite yield to it at a light red heat in an open furnace. Carbonate of lime is the agent. You will learn how to use it for this purpose by referring to the forthcoming paper."

This paper, which appeared in March, 1853,[1] was a very valuable contribution to analytical methods, and Smith's process for decomposing the alkaline silicates, by the use of calcium carbonate and chloride, is now the generally accepted method.

The researches on American minerals, carried on jointly by Smith and Brush, were made in 1853, and have long since passed into the records of science. They settled many doubtful points, and relegated into obscurity many worthless species, while clearly establishing others.

It may be asked why so prosperous a commencement of professional life at the University of Virginia should not have been continued beyond the period of one year? At this time Mrs. Smith's

[1] Am. Jour. Sci., [2] xv, 234–243. Completed in Part II, July 1, 1853. [2] xvi, 53–61.

father, the Hon. James Guthrie, was Secretary of the Treasury of the United States, residing at Washington, and it was no doubt his wish to reunite his family in that city, which was largely instrumental in deciding Dr. Smith's resignation at the close of his first year at Charlottesville.

The Smithsonian Institution offered him a convenient and agreeable place for prosecuting his researches, and there he spent the following winter, as well as several subsequent summers; and while there he also worked in the department of agricultural chemistry for the United States Department of Agriculture. I am favored by Prof. F. H. Smith, of the physical chair at the University of Virginia, who was there when Dr. J. Lawrence Smith commenced his labors, with an interesting reply to my inquiry as to Dr. Smith's success as a teacher. He says, in a letter of date March 12, 1884:

"His course of lectures were remarkable in several particulars—

"1st. The freshness and thoroughness of his chemical knowledge as given to the class. He appeared fully abreast and even in advance of the general status of the science. He spoke as a master. His experiments were often novel and, I believe, generally successful, as well as striking, partly owing to the efficient aid he had from George J. Brush, now professor at Yale College, but then his private assistant and student.

"2d. The fact that he confined his lectures to chemistry proper, leaving physics to the professor in charge of that branch. This he did, I believe, of set purpose, with the result of his giving more chemistry in eight months than his predecessors had done, nominally, in nine, but really in six.

"3d. The awkwardness and unrhetorical form of his address, and his inattention to, if not contempt for, all mere graces of style, and this in an institution where the graces of style were greatly valued, as evinced in the shining example of William B. Rogers, John B. Minor, John Stager Davis, and others. The contrast was a matter of general comment. But I am not sure that, in the end, it at all diminished the instructiveness of Dr. Smith's teachings, and did not, in fact, increase the impression they made. I heard one or two of his lectures myself, and certainly had no feeling but one of admiration for the excellence of his treatment of his theme and the admirable experiments with which he illustrated it.

"As a man he impressed me as one of thorough, conscientious loyalty to truth and duty. I have never met him since without a feeling of pleasure, based upon profound respect for him personally as well as professionally."

In 1854 Dr. Smith accepted the chair of medical chemistry and toxicology in the University of Louisville, then made vacant by the resignation of the writer. This chair was retained by Dr. Smith until the spring of 1866, when he resigned. Possessed now of an ample fortune, and frequently called, in the way of his profession, to visit Europe, he found the restraints of a professorship in an institution no longer prosperous, distasteful, and naturally preferred to devote himself to the more congenial researches which he had recently commenced in the department of aerolites, to the collection and study of which he gave great attention during the remainder of his life. His first memoir on this subject was his description of five new meteoric irons in 1854, forming part of his memoir on meteorites, read before the American Association for the Advancement of Science in April, 1854, at Washington, but not published until the following year.[1]

This memoir is also reproduced in his volume of Scientific Researches. In this paper Dr. Smith appears for the first time as the author of a general theoretical discussion of cosmical or astronomical considerations as to the origin of meteorites. His views are expressed with force and clearness. He antagonizes the notion that meteorites, as we know them from fragments which reach the earth, are large, solid cosmical bodies, passing through the earth's atmosphere with planetary velocity, and dropping small portions of their mass in their flight. He advocates strongly the lunar origin of meteorites as the most probable theory yet advanced. This view he sustains with the courage of his convictions, and illustrates by citing many interesting facts, which, in his view, go far to establish the lunar theory. It is not now the time to follow this discussion, but it is interesting to note the fact that, from the time Smith took up the discussion of this subject, the study of meteorites became almost the exclusive theme which occupied his attention. Thus, if we turn to the list of his papers in the Royal Society catalogue, we find, out of seventy-eight titles, down to 1873, there are twenty-two upon

[1] Am. Jour. Sci., [2], xix, 153–332.

meteoric subjects, all subsequent to 1854, and of these seventeen papers were printed between 1864 and 1873, the date of the publication of his volume of papers already cited, and in this volume of four hundred pages one hundred are devoted to meteorites. In the ten years succeeding there are seventeen additional meteoric papers and many on other subjects, chiefly mineralogical. The list of Dr. Smith's papers appended to this notice of his life embraces the full titles.

The last paper printed by Dr. Smith, in the June issue of the American Journal of Sciences, 1883, was "On the peculiar concretions in meteoric iron." At the close of this paper he says he shall continue the research, "if," he adds, "my health permits." It was his last work.

Dr. Smith's collection of meteorites was commenced by his purchase of the collection of the late Dr. G. Troost, of Nashville University, who was fortunate in securing a number of large iron meteorites from Tennessee, but Smith added constantly to this collection from all parts of the world, and especially of irons from Mexico, as well as from the United States, and of stones from such falls as those of New Concord, Ohio, in May, 1860, and from the great fall of Iowa in February, 1875; Nash county, North Carolina, 1872; Warren county, Missouri, January 7, 1877, and others. He sold a number of his larger iron masses in 1862 to Prof. C. U. Shepard in London, and of the Mexican irons to the museum of the Garden of Plants in Paris (1879).

Fortunately for science this fine meteoric collection has passed entire, by purchase, into the possession of Harvard College. It is a memorable circumstance that the news of the completion of this sale was communicated by telegraph to our lamented associate, greatly to his joy, on the last day of his life! It was Dr. Smith's ardent wish that his collection should be kept together, and having failed in accomplishing this object with a local institution, in the permanency of which he had lost confidence, he was only too happy to contemplate its secure position in the cabinet at Harvard College.

Prior to 1862 it had been less an object with Dr. Smith to amass a large collection of meteorites than to use those he had already described, as a means of procuring others, which were new to science. Hence his collection has been largely gathered since that date, after which time he decided to make his collection as complete as possible.

Prof. Cooke, of Harvard, informs me that the Smith collection

represents about two hundred and fifty falls, and a total weight of about twenty-five hundred pounds, making the Harvard collection, including what they had before, represent in all about two hundred and seventy falls.

In the British Museum there are now represented about three hundred and fifty falls, and in the Garden of Plants, now second only to the British Museum, a few over three hundred falls. The Harvard-Smith collection will soon be commemorated in a complete catalogue. This collection is inferior to that of London and Paris in the number of stones, but is said to be quite equal to that of the British Museum in the irons.

It will be interesting to see a complete catalogue of all the meteoric collections in the United States, some of which exceed the Harvard collection in the weight, if not in the number, of falls reported.

Dr. Smith's collection is, in a sense, a monumental one, memorial of the life-work of a devoted student in this very interesting department of cosmical chemistry and mineralogy.

Dr. Smith was in 1872 elected a member of this Academy, and in 1879 corresponding member of the Academy of Sciences of the Institut of France, succeeding Sir Charles Lyell. Few Americans have received more academic honors, abroad and at home, than Dr. Smith.[1] He was chevalier of the Legion d'Honneur, and in 1874 was president of the American Association for the Advancement of Science.

Although Dr. Smith felt at home in Louisville, where his family ties and numerous friendships bound him and where he preferred to remain, he was at the same time isolated in all his scientific work. He had built an ample house, where he was surrounded with the interesting memorials of a lifetime, and in which he also provided space and accommodations for his private laboratory on the upper floors, where he could pursue his researches uninterrupted.

He acted as commissioner at the Paris exposition of 1867, and prepared the report on the chemical industries, entitled "The progress and condition of several departments of industrial chemistry." This document formed part of volume II of the official reports of the United States commissioners, published at Washington in 1869 in six volumes and edited by W. P. Blake. Dr. Smith

[1] A full list of his memberships and decorations is appended.

served in the same capacity at the Vienna exposition in 1873. I have never seen his report of the work done there. I know that he prepared an elaborate report on the petroleum production and industry of the United States, for which I furnished him material, but I understand this was sent to Dr. Hofmann, and was published in German, but has not been reproduced in English.[1]

It was in 1873 that Dr. Smith went to St. Petersburg with Prof. Daubrée to attend the centennial of the Chemical Society, and in 1879 he again spent a year in Europe, with his wife, visiting Sweden and Norway, going as far as the North Cape, and there celebrating the Fourth of July under the midnight sun.

His elaborate paper on the so-called meteoric irons of Greenland and the basalts was presented to the Institut of France in 1879, and is published at length in the *Comptes Rendus* of that year. The title is given in the list of his papers appended to this notice.

Unfortunately, many of Dr. Smith's valuable notes and manuscripts were burnt in transit from Charleston to the University of Virginia in 1853, and he was always too much occupied with new work to reproduce them.

His fondness for practical work led him to accept the charge of the gas-works at Louisville, for which he acted as president for several years. He also established a laboratory for the production of chemical reagents and of the rarer pharmaceutical preparations, in which enterprise he associated himself with Dr. E. R. Squibb, whose fame as a successful worker in pharmaceutical chemistry is well known.

In reply to my inquiry, Dr. Squibb wrote me a letter, from which the following sentence is extracted, which is interesting as shedding light upon a side of Dr. Smith's character which is little known:

"During the year and a half that I was there so closely associated with him I learned to respect and esteem him more highly than ever before, and have always regretted that after we separated I could see so little of him. For many years, however, he made me annual visits, usually spending most of the day in looking into mechanical devices and adaptations, in which he was always very much interested.

[1] I have failed to secure a copy of this memoir, the title of which I am, therefore, unable to add to the list of Smith's papers. B. S.

"He was a man of great ability and of great integrity of character."

Dr. Smith's personal character possessed a charm which won all who came within the sunshine of his genial nature. His sturdy manliness and integrity was combined with an almost feminine gentleness.

During the years of the civil war, while his affiliations and life-long associations were inseparably united with his native South, he deplored the sad conflict with a spirit bowed as under a personal sorrow. I never heard a word from him on the subject which partook of bitterness or animosity, and no shadow passed across the path of his old friendships.

He had no children, but he had founded an orphan home in Louisville, and amply endowed it in connection with the Baptist denomination, of which he was for many years a devoted member.

For two or three years before the end of his life he had been in delicate health from a chronic affection of the liver. He was seldom confined to his house, but on the first of August, 1883, a severe attack of the disease compelled him to take to his bed, from which he never arose again. Without acute suffering he passed peacefully away on Friday, October 12th, at three in the afternoon.

By his directions his funeral was of the most simple character, and without an eulogy. His life closed as he had lived, peacefully, with uncomplaining endurance of suffering. His last words were: "Life has been very sweet to me; it comforts me. How I pity those to whom memory brings no pleasure."

He was warmly attached to the National Academy of Sciences, and was always in full sympathy with its objects and with his fellow members. His memory is dear to us, and we rejoice that though dead he yet lives, and that the work he loved so well will be perpetuated, under the auspices of the Academy, by a noble endowment bestowed *in memoriam* by his devoted wife.

Sic itur ad astra!

NOTE, JULY 1ST, 1884.—The endowment mentioned in the closing sentence of the foregoing notice has been completed by a deed of trust from Mrs. Dr. Smith, conveying to the National Academy of Sciences the sum of $8,000 as a fund, the interest of which is to promote, by original investigation, the study of meteoric bodies, to which a large part of Dr. Smith's life was successfully devoted. At the discretion of the Academy a gold medal, of the value of $200, is to be awarded, not oftener than once in two years, to the person, of whatever nationality, who, within the previous two years, has made the most important advances in this line of investigation; or the income may, if the Academy so decide, be awarded from time to time in aid of such researches, but in this case only to citizens of the United States. The dies for this medal, by the celebrated artist CHAPLAIN, of Paris, are also provided by Mrs. Smith at her own expense. The medal will carry on the obverse the head of Dr. Smith in profile, the bust in a classic toga, and on the reverse the legend in Latin—*J. Lawrence Smith medal for researches in meteoric bodies*, with the name of the Academy and of the person to whom it is awarded.

It is interesting to know that this fund represents the sum paid by Harvard College for the meteoric collection of Dr. Smith, the purchase of which by that institution is mentioned in the foregoing notice.

B. S.

JOHN LAWRENCE SMITH, M. D.,

Member of the American National Academy of Sciences; Membre correspondant de l'Institut de France (Academie des Sciences); Member of the Chemical Society of Berlin; of the Chemical Society of Paris; of the Chemical Society of London; of the Société d'Encouragement pour l'Industrie Nationale; of the Imperial Mineralogical Society of St. Petersburg. Corresponding Member of the Boston Society of Natural History; of the American Academy of Arts and Sciences; of the American Philosophical Society; American Bureau of Mines; the Société des Sciences et des Arts de Hainaut, Royal Society of Göttingen, Polytechnic Society of Kentucky, etc.

Chevalier de la Legion d'Honneur; Member of the Order of Nichan Iftabar of Turkey; Member of the Order of Medjidiah of Turkey; Chevalier of the Imperial Order of St. Stanislas of Russia.

List of scientific papers published by Dr. J. LAWRENCE SMITH, arranged in chronological order, with references to the place of publication:*

1. Chromate of Potassa—a reagent for distinguishing between the salts of Baryta and Strontia. Sill. Journ., xxxvi, 1839, pp. 183–184.

2. A new method of making permanent artificial magnets by galvanism. Sill. Journ., xxxvi, 1839, pp. 335–337.

3. On the means of detecting arsenic in the animal body, and of counteracting its effects. Sill. Journ., xl, 1841, pp. 278–293; xlii, 1842, pp. 75–81; Sturgeon's Ann. Electr., vii, 1841, pp. 65–77.

4. The composition and products of distillation of spermaceti, with some few remarks upon its oxidation by nitric acid. Sill. Journ., xliii, 1842, pp. 301–321; Annal. de Chimie, vi, 1842, pp. 40–62; Journ. de Pharm., ii, 1842, pp. 169–179; Liebig Annal., xlii, 1842, pp. 241–254; Majocchi Ann. Fis. Chim., x, 1843, pp. 18–32; Sturgeon's Ann. Electr., x, 1843, pp. 28–44.

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*The Royal Society's catalogue to 1873 enumerates seventy-eight papers by Dr. Smith. The present list has been compiled by a careful comparison of the various journals and transactions cited, and nearly all the cross-references have been verified by the originals.

5. A short notice of the action of potash upon chloesterine. Sill. Journ., xliv, 1843, pp. 60–63.

*6. A review of the researches upon the dilatation of gases by M. V. Regnault. Amer. Journ. Sci, xliv, 1843, pp. 63–69.

7. A new instrument for estimating the quantity of carbonate of lime present in calcareous substances. Sill. Journ., xlv, 1843, pp. 262–266.

8. On the method of Drs. Varrentrapp and Will for estimating nitrogen in organic compounds. Sill. Journ., xlv, 1843, pp. 267–269; Sturgeon's Ann. Electr., xi, 1843, pp. 22–28.

9. Action of some of the alkaline salts upon the sulphate of lead. Sill. Journ., lxvii, 1844, pp. 81–84.

10. Actions of solutions of the neutral phosphates of the alkalies upon the carbonates of lime and some other insoluble carbonates. Source of fluorine in fossil bones. Composition of the marl from Ashley River, South Carolina, with an extract from a letter written by Prof. Bailey, of West Point. Existence of the oxide of cobalt in South Carolina. Sill. Journ., lxviii, 1845, pp. 97–104; Bibl. Univ., lvii, 1845, pp. 378–380.

11. A few remarks on the hygienic properties of ice, with an account of a new method of freezing water in a vacuum. Charleston, South. Journ. Med., i, 1846, pp. 149–156.

12. Observations on the more recent researches concerning the operations of the blast furnace in the manufacture of iron. Sill. Journ., i, 1846, pp. 170–178.

13. Freezing of water by the air-pump without the aid of sulphuric acid or any other desiccating agent. Sill. Journ., i, 1846, pp. 265–266.

14. Observations on the more recent researches in the manufacture of iron. Sill. Journ., ii, 1846, pp. 95–102.

*15. Oxide of cobalt and magnesian opal. 1846. "Sci. Researches" by J. Lawrence Smith, 1873.

16. On the annular eclipse of the sun, October, 1847. Sill. Journ., v, 1848, pp. 283–285.

17. Two new minerals—medjidite (sulphate of uranium and lime), liebigite (carbonate of uranium and lime). Sill. Journ., v, 1848, pp. 336–338; Liebig Annal., lxvi, 1848, pp. 253–256.

18. Emery formation of Asia Minor. Sill. Journ., vii, 1849, pp. 283–285.

19. Chrome and meerschaum of Asia Minor. Sill. Journ., vii, 1849, pp. 285–286; Ann. Sci. Disc., 1850, pp. 265–266; 1852, p. 293.

20. A list of the minerals associated with the emery of Asia Minor. Sill. Journ., ix, 1850, p. 289.

21. Memoir on emery: Part I—On the geology and mineralogy of emery, from observations made in Asia Minor. Sill. Journ., x, 1850, pp. 354–369;

*Numerous intercalations have necessitated a departure from the numbering in the Royal Society's catalogue. The intercalated papers, which are from American sources, are starred.

Annal. des Mines, xviii, 1850, pp. 259–307; Comptes Rendus, xxxi, 1850, pp. 48–50.

22. Notice of a magnesian opal from near Harmanjick, Asia Minor. Amer. Assoc. Proc., vi, 1851, p. 242.

23. On the geology and general character of the meerschaum in the plains of Eski-Shehi (Asia Minor). Amer. Assoc. Proc., vi, 1851, p. 270.

24. On the geology of emery and corundum. Amer. Assoc. Proc., vi, 1851, p. 274.

25. Causes and prevention of the explosion of steam boilers. Journ. Franklin Inst., xxi, 1851, pp. 407-414.

26 Memoir on emery: Part II—On the minerals associated with emery: corundum, hydrargillite, diaspore, zinc-spinel, pholerite, ephesite (a new species), emerylite (a new species), muscovite, chloritoid (a new variety), black tourmaline, chlorite, magnetic oxide of iron, oligiste iron, hydrated oxide of iron, iron pyrites, rutile, ilmenite, and titaniferous iron. [1850.] Sill. Journ., xi, 1851, pp. 53–66. Compt. Rend., xxxi, 1850, pp. 191–193.

27. Liebigite. Sill. Journ., xi, 1851, p. 259.

28. On some of the thermal waters of Asia Minor. Sill. Journ., xii, 1851, pp. 10–16, 366–377; Amer. Assoc. Proc., vi, 1851, pp. 260–261; Erdm. Journ. Prakt. Chem., lv, 1852, pp. 110–114.

29. The inverted microscope. A new form of microscope, with a description of a new eye-piece micrometer, and a new form of goniometer for measuring the angles of crystals under the microscope. Sill. Journ., xiv, 1852, pp. 233–241. Ann. Sci. Disc., 1852, p. 148; Amer. Assoc. Proc., vi, 1851, pp. 76–77.

30. Warwickite. A borotantalite. Amer. Assoc. Proc., 1853, vii, pp. 147, 148.

31. Danburite. A silico-borate of lime. Amer. Assoc. Proc., 1853, vii, pp. 148, 149.

32. A new method of getting rid of sal-ammoniac in analysis. Sill. Journ., xv, 1853, p. 94; Ann. Sci. Disc., 1853, pp. 261–262.

33. New and ready method of determining the alkalies in minerals: Part I—The quantitative determination of the alkalies in the siliceous minerals not soluble in acids, with a note on a new method of forming the protoxyd of nitrogen. Sill. Journ., xv, 1853, pp. 234–243; Erdm. Journ. Prakt. Chem., lix, 1853, pp. 159-160; Ann. Sci. Disc., 1854, pp. 271–274.

34. New and ready method of determining alkalies in minerals: Part II—Conversion of the sulphates into chlorids; qualitative determination of the mixed alkalies; separation of the alkaline chlorids from each other, with a more direct method of obtaining them from silicates not soluble in acids. Sill. Journ., xvi., 1853, pp. 53–61; Erdm. Journ. Prakt. Chem., lx, 1853, pp. 244–247.

35. On the supposed new element, thalia. Sill. Journ., xvi, 1853, p. 95.

36. On a native borotitanate. Sill. Journ., xvi, 1853, pp. 293-294.

37. Note 1—Action of nitric acid on the chlorids of potassium and sodium. 2—Action of oxalic acid on the nitrates and chlorids of the same, with a ready

method of converting them into the carbonates. 3—The presence of oxalic acid enabling zinc to decompose water. Sill. Journ., xvi, 1853, pp. 373–375.

38. Re-examination of American minerals: Part IV—Boltonite, iodide of silver, copiapita, owenite, xenotime, lanthanite, manganese alum, apophyllite, schreibersite, protosulphuret of iron, cuban. Sill. Journ., xviii, 1854, pp. 372–381; Erdm. Journ. Prakt. Chem., lxiii, 1854, pp. 455–462.

39. Re-examination of American minerals: Part V—The minerals of the Wheatley mine in Pennsylvania: Anglesite, cerusite, wulfenite, vanadate of lead, pyromorphite, mimetene, galena, copper, copper pyrites, malachite, azurite, blende, calamine, hematite, fluor-spar, calc-spar, sulphur, etc. Amer. Assoc. Proc., ix, 1855, pp. 190–204; Sill. Journ., xx, 1855, pp. 242–253; Erdm. Journ. Prakt. Chem., lxvi, 1855, pp. 432–437.

*40. Minerals and mineral waters of Chili. U. S. Astron. Exped. (Gillis's Report of), ii, 1854, pp. 85–107.

41. Memoir on meteorites. Description of five new meteoric irons, with some theoretical considerations on the origin of meteorites, based on their physical and chemical characters. Sill. Journ., xix, 1855, pp. 153–163, 322–342; Erdm. Journ. Prakt. Chem., lxvi, 1855, pp. 421–428.

42. Report on Dupont's artesian well at Louisville, Ky. Sill. Journ., xxvii, 1859, pp. 174–178.

43. Account of several meteoric stones which fell in Harrison county, Indiana, 28 March, 1859. Sill. Journ., xxviii, 1859, pp. 409–411.

44. Description of three new meteoric irons from Nelson county, Ky., Marshall county, Ky., and Madison county, North Carolina. Sill. Journ., xxx, 1860, p. 240.

45. The Guernsey county (Ohio) meteorites. A complete account of the phenomena attending their fall, with a chemical analysis of them. Sill. Journ., xxxi, 1861, pp. 87–98.

46. Description of three new meteorites: Lincoln county meteoric stone, which fell in August, 1855; Oldham county (Ky.) meteoric iron; Robertson county (Tenn.) meteoric iron. Sill. Journ., xxxi, 1861, pp. 264–266.

47. Smith, J. Lawrence and G. J. Brush. Re-examination of American minerals: Part I—Emerylite, euphyllite, Litchfield mica, unionite, kerolite, bowenite, williamsite, lancasterite, hydro-magnesite, magnesite. Sill. Journ., xv, 1853, pp. 207–215. 2—Re-examination of American minerals: Parts II and III—Chesterlite, loxoclase, Danbury feldspar, Haddam albite, Greenwood mica, biotite, margarodite, chesterlite, talc, rhodophyllite, cummingtonite, hydrous anthophyllite, monrolite, ozarkite, dysyntribite, gibbsite, emerald nickel, danburite, carrollite, thalite, hudsonite, jenkinsite, lazulite, kyanite, elæolite, spodumene, petalite. Sill. Journ., xvi, 1853, pp. 41–53, 365–373; Erdm. Journ. Prakt. Chem., lix, 1853, pp. 161–167, 274–282; lxi, 1854, pp. 172–179.

48. Chladnite of the Bishopville meteoric stone proved to be a magnesian pyroxene. Amer. Journ. Sci.,† xxxviii, 1864, pp. 225–226.

† The change of name from "Silliman's Journal" to "The American Journal of Arts and Sciences," which took place at this time, is followed by the Royal Society's Catalogue.

49. Analysis of a new meteoric iron from Wayne county, Ohio, and some remarks on the recently-described meteorite from Atacama, Chili. Amer. Journ. Sci., xxxviii, 1864, pp. 385–387.

50. A new meteorite from Newton county, Arkansas, containing on its surface carbonate of lime. Amer. Jour. Sci., xl, 1865, pp. 213–216.

51. On the use of the bisulphate of soda as a substitute for the bisulphate of potash in the decomposition of minerals, especially the aluminous minerals. Amer. Journ. Sci., xl, 1865, pp. 248–249.

52. On the emery mine of Chester, Hampden county, Mass., with remarks on the nature of emery and its associate minerals. Amer. Journ. Sci., xlii, 1866, pp. 83–93.

53. A new meteoric iron, "the Colorado meteorite," from Russel Gulch, Gilpin county, near Central City, Colorado Territory. Amer. Journ. Sci., xlii, 1866, pp. 218–219.

54. On Colorado meteorites. Russel Gulch meteoric iron and Bear Creek meteoric iron. Amer. Journ. Sci., xliii, 1867, pp. 66–67.

55. On a new locality of tetrahedrite, tennanite, and nacrite, with some account of the Kellogg mines of Arkansas. Amer. Journ. Sci., xliii, 1867, pp. 67–69.

56. A new meteoric iron from Mexico. Amer. Journ. Sci., xlv., 1868, p. 77; Amer. Phil. Soc. Proc., x, 1869, pp. 330–331.

57. A new meteoric iron (the Wisconsin meteorite), with some remarks on the Widmannstättian figures. Amer. Journ. Sci., xlvii, 1869, pp. 271–272; Compt. Rend., lxviii, 1869, pp. 620–621.

58. The Cohahuila meteoric irons of 1868, Mexico. Amer. Journ. Sci., xlvii, 1869, pp. 383–385.

59. On the descloizite of the Wheatley mine, Pennsylvania. Amer. Journ. Sci., xlviii, 1869, pp. 137–138.

60. On the lesleyite of Chester county, Penn., and its relations to the ephesite of the emery formation near Ephesus, Asia Minor. Amer. Journ. Sci., xlviii, 1869, pp. 254–255.

61. Account of a fall of meteoric stones near Danville, Ala., with an analysis of the same. Amer. Journ. Sci., xlix, 1870, pp. 90–93; Cosmos, vii, 1870, pp. 232–234.

62. On the flight of a remarkable meteorite across the western portion of Ohio, near Forest, lat. 40° 50′ N. and long. 84° 40′ W. Amer. Journ. Sci., xlix, 1870, pp. 139–141.

63. Description and analysis of the Franklin county meteoric iron. Amer. Journ. Sci., xlix, 1870, pp. 331–336.

64. Remarks on the alkalies contained in the mineral leucite. Amer. Journ. Sci., xlix, 1870, pp. 335–336.

65. Description and analysis of a meteoric stone that fell in Stewart county, Ga. (Stewart county meteorite), on the 6th of October, 1869. Amer. Journ. Sci., l, 1870, pp. 339–341.

66. Some practical remarks on the use of flame-heat in the chemical laboratory, especially that upon burning gas without the aid of a blast. Amer. Journ. Sci., l, 1870, pp. 341–344.

67. On the precipitation of cæsium and rubidium salts with the insoluble salts of lime. Chemical News, xxii, 1870, pp. 150–151.

68. Phosphates of soda and potash. Amer. Assoc. Proc., xx, 1871, pp. 193-195. Amer. Chemist, ii, 1871, p. 207.

69. A regulator to maintain a constant level in the water-baths of a laboratory. Amer. Assoc. Proc., xx, 1871, pp. 195–197; Annal. Chem. Pharm., clxiii, 1872, pp. 191–192; Amer. Chemist, ii, 1876, p. 207.

70. The precise geographical position of the large masses of meteoric iron in North Mexico, with the description of a new mass—the San Gregorio meteorite. Amer. Assoc. Proc., xx, 1871, pp. 266–270; Amer. Journ. Sci., ii, 1871, pp. 335–338.

*71. A convenient form of specific gravity flask. Amer. Assoc. Proc., xx, 1871, p. 197; Amer. Chemist, ii, 1871, p. 200

*72. On bending glass tubes for fitting apparatus. Amer. Assoc. Proc., xx, 1871, p. 198; Amer. Chemist, ii, 1872, p. 244.

*73. A simple, clean, and convenient stand for filtrations. Amer. Assoc. Proc., xx, 1871, p. 198; Amer. Chemist, ii, 1872, p. 244.

74. Potash and its compounds. Amer. Chem., i, 1871, pp. 291–296.

75. Soda and salts of soda. Amer. Chem., i, 1871, pp. 339–345.

*76. The manufacture of sulphuric acid. Amer. Chemist, i, 1871, pp. 367-374.

77. On the determination of the alkalies in silicates by ignition with carbonate of lime and sal-ammoniac. Amer. Journ. Sci., i, 1871, pp. 269–275; Amer. Chem., i, 1871, pp. 404–407; Annal. Chem. Pharm., clix, 1871, pp. 82–92.

*78. Stearic acid industry. Amer. Chemist, i, 1871, pp. 414–420.

*79. Chlorine, fluorine, manganese, and carbonic acid. Amer. Chemist, i, 1871, pp. 442–448.

*80. Industrial production of oxygen, hydrogen, and other elements. Amer. Chemist, i, 1871, pp. 41–44.

81. Mineralogical and chemical composition of the stone that fell near Searsmont, Maine, 21 May, 1871. Amer. Journ. Sci., ii, 1871, pp. 200-201.

*82. Manufacture of illuminating gas from coal. Amer. Chemist, ii, 1871, pp. 11–17.

83. Ammonia, baryta, magnesia, and alumina. [1871.] Amer. Chem., ii, 1872, pp. 94–97.

*84. A new method for forming platinum black. Amer. Chemist, ii, 1872, p. 291.

85. Address delivered at the Portland meeting of the American Association, 1873. Amer. Assoc. Proc., xxii, 1873, pp. 1–26; American Naturalist, vii, 1873, pp. 577–602.

86. On getting rid of the accumulation of sal-ammoniac in mineral analysis. [1872.] Amer. Chem., iii, 1873, p. 201.

87. Conversion of the sulphates of the alkalies into the carbonates, tartrates, etc., in the moist way. Amer. Chem., iii, 1873, p. 241; Chem. News, xxvii, 1873, p. 316.

88. A description of the Victoria meteoric iron seen to fall in South Africa in 1862, with some notes on chladnite or enstatite. Amer. Journ. Sci., v, 1873, pp. 107–110; Compt. Rend., lxxvi, 1873, pp. 294–297.

89. Notes on the corundum of North Carolina, Georgia, and Montana, with a description of the gem variety of the corundum from these localities. Amer. Journ. Sci., vi, 1873, pp. 180–186; Compt. Rend., lxxvii, 1873, pp. 356–359, 439–442.

90. Masse de fer météorique découverte en creusant un fossé. Observations sur la structure moléculaire du fer météorique. Protochlorure solide de fer dans les météorites. Compt. Rend., lxxvii, 1873, pp. 1193–1197; Chem. News, xxix, 1874, p. 11.

91. On a mass of meteoric iron of Howard county, Ind., with some remarks on the molecular structure of meteoric iron and a notice concerning the presence of solid protochloride of iron in meteorites. Amer. Journ. Sci., vii, 1874, pp. 391–395; Annual Rec. Sci. and Indus.,† 1874, pp. 219-220.

92. Absolute alcohol. Amer. Assoc. Proc., xxiii, A, 1874, pp. 111–113; Annual Rec. Sci. and Indus., 1875, p. 538; Chem. News, xxx, 1874, p. 235; Amer. Chemist, v, 1874, p. 120.

93. Pure carbonate of soda. Amer. Assoc. Proc., xxxii, A, 1874, pp. 109–110; Chem. News, xxx, 1874, p. 234; Amer. Chemist, v, 1874, p. 119.

94. Pure carbonate of potash. Amer. Assoc. Proc., xxiii, A, 1874, pp. 110, 111; Chem. News, xxx, 1874, p. 235; Amer. Chemist, v, 1874, pp. 119–120.

95. Warwickite. Amer. Journ. Sci., viii, 1874, pp. 432–434; Annal. de Chim., iii, 1874, pp. 425–427; Compt. Rend., lxxix, 1874, pp. 696-697; Chem. News, xxx, 1874, pp. 217–218.

*96. The century's progress in industrial chemistry. Address delivered at "The Centennial of Chemistry." Amer. Chemist, v, 1874, pp. 61–70.

97. Curious association of garnet, idocrase, and datolite. Amer. Journ. Sci., iii, 1874, pp. 434–436; Compt. Rend., lxxix, 1874, pp. 813–814; Annal. de Chim., iii, 1874, pp. 428–430; Chem. News, xxx, 1874, pp. 241–242.

98. Laboratory notes: The limit of weighing; condensation of air on the surface of platinum; gold-lined capsules and crucibles; weighing on filters; a ready method of showing the absorption of hydrogen by palladium. Amer. Chemist, v, 1874, pp. 212–213; Chem. News, xxxi, 1875, pp. 55–56.

99. Analysis of ægirite from Hot Springs, Arkansas. Amer. Journ. Sci., x, 1875, p. 60.

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†Previously referred to as "The Annual of Scientific Discovery."

100. Description of the Nash county meteorite, which fell in May, 1874. Amer. Journ. Sci., x, 1875, pp. 147–148; Compt. Rend., lxxx, 1875, pp. 1453–1454.

101. Rapport sur la chute de deux pierres météoriques dans les États Unis. Compt. Rend., lxxx, 1875, pp. 1451–1454. (Included above.)

102. Anomalie magnétique du sesquioxyde de fer, préparé á l'aide de fer météorique. Compt. Rend., lxxx, 1875, pp. 301–304; Amer. Chemist, v, 1875, pp. 356–358; Chem. News, xxxi, 1875, pp. 210–212.

103. On the passage of two bolides, in 1872 and 1874, over Middle Kentucky. Amer. Journ. Sci., x, 1875, pp. 203–205.

104. A note in relation to the mass of meteoric iron that fell in Dickson county, Tenn., in 1835. Amer. Journ. Sci., x, 1875, pp. 349–352; Compt. Rend., lxxxi, 1875, pp. 84–87; Ann. Rec. Sci. and Indus., 1876, p. 225.

105. On troilite. Amer. Journ. Sci., xi, 1876, p. 68; Compt. Rend., lxxxi, 1875, pp. 976–978.

106. Sulfhydrocarbure cristallisé, venant de l'interieur d'un masse de fer météorique. Compt. Rend., lxxxi, 1875, pp. 1055–1056.

107. Researches on the solid carbon compounds in meteorites. Amer. Journ. Sci., xi, 1876, pp. 388–395, 433–442; Annal. de Chimie, ix, 1876, pp. 259–288; Compt. Rend., lxxxii, 1876, pp. 1042–1043.

108. On a bolide of January 31st that passed over Kentucky. Amer. Journ. Sci., xi, 1876, p. 458.

109. Sur l'arragonite observée á la surface d'un météorite. Compt. Rend., lxxxii, 1876, pp. 1505–1507.

110. Sur les combinaisons de carbone trouvées dans les météorites. Compt. Rend., lxxxii, 1876, p. 1507.

111. A new form of compensating pendulum. Amer. Journ. Sci., xii, 1876, pp. 106–107; Compt. Rend., lxxxiii, 1876, p. 202; Ann. Rec. Sci. and Indus., 1876, pp. xlvi–xlvii, Lond. Ed., and Dub. Phil. Mag. ii, 1876, pp. 237–238.

112. Aragonite on the surface of a meteoric iron, and a new mineral (daubréelite) in the concretions of the interior of the same. Amer. Journ. Sci., xii, 1876, pp. 107–110; Compt. Rend., lxxxiii, 1876, pp. 74–75.

113. An account of a new meteoric stone that fell on the 25th of March, 1865, in Wisconsin, identical with the Meno-meteorite. Amer. Journ. Sci., xii, 1876, pp. 207–209; Compt. Rend., lxxxiii, 1876, pp. 161–163.

114. Puits de gaz en Pensylvanie. Annal. de Chimie, viii, 1876, pp. 566–571.

115. Examination of the Waconda meteoric stone, Bates county meteoric iron, and Rockingham county meteoric iron. Amer. Journ. Sci., xiii, 1877, pp. 211–214.

116. Note on the new localities of the columbic acid minerals, and two new columbates. Amer. Journ. Sci., xiii, 1877, p. 234.

117. Note of the recent fall of three meteoric stones in Indiana, Missouri, and Kentucky. Amer. Journ. Sci., xiii, 1877, p. 243; Compt. Rend., lxxxiv, 1877, pp. 398, 399.

118. Examination of American minerals: No. 6—Description of columbic acid minerals from new localities in the United States, embracing a reclamation for the restoration of the name Columbium to the element now called *Niobium*. Description and analysis of columbite, samarskite, euxenite, and fergusonite, and the new species hatchettolite and rogersite. Amer. Journ. Sci., xiii, 1877, pp. 359–369; Annal. de Chim., xii, 1877, pp. 253–264.

119. Sur deux nouveaux niobates. Compt. Rend., lxxxiv, 1877, pp. 1036–1038.

120. A description of the Rochester, Warrenton, and Cynthiana meteoric stones which fell, respectively, December 21st, 1876, January 3d, 1877, and January 23d, 1877, with some remarks on the previous falls of meteorites in the same regions. Amer. Journ. Sci., xiv, 1877, pp. 219–229; Compt. Rend., lxxxv, 1877, pp. 678–683; Annal. de Chim., xiii, 1878, pp. 41–59.

121. Tantalite. Amer. Journ. Sci., xiv, 1877, p. 323.

122. The earths of the cerium group as found in the North Carolina samarskite. Amer. Journ. Sci., xiv, 1877, p. 509.

123. Tantalite from Coosa county, Alabama, its mode of occurrence and composition. Amer. Journ. Sci., xv, 1878, pp. 203–204.

124. On the composition of the new meteoric mineral *daubréelite*, and its frequent, if not universal, occurrence in meteoric irons. Amer. Journ. Sci., xvi, 1878, pp. 270–272; Compt. Rend., lxxxvii, 1878, pp. 338–340; Amer. Assoc. Proc., 1878, xxvii, pp. 147–150.

125. Le Mosandrum; un nouvel élément Compt. Rend., lxxxvii, 1878, pp. 148–151; [Note on same—Amer. Journ. Sci., xvi, 1878, p. 384;] Lond. Ed. and Dub. Phil. Mag., vi, 1878, pp. 238–240; Arch. des Sci., Phys. et Nat., lxiii, 1878, pp. 165–172.

126. A short account of the nature of the oxide of the new element, Mosandrum. Amer. Assoc. Proc., xxvii, 1878, pp. 143–147.

127. Lettre à M. Dumas sur les matières organiques et l'air produisant un mélange explosible. Explosion d'un moulin à farine. Annal. de Chim., xiv, 1878, p. 144.

128. Note sur une nouvelle terre du group du cerium et remarques sur une méthode d'analyse des columbates naturels. Compt. Rend., lxxxvii, 1878, pp. 146–148.

129. Sur le fer natif du Groënland et le basalte qui le renferme. Compt. Rend., lxxxvii, 1878, pp. 674–676; Ann. Rec. Sci. and Indus., 1878, p. 286.

130. Note au sujet l'élément appelé mosandrum. Compt. Rend., lxxxvii, 1878, pp. 831–834.

131. Note sur un remarquable spécimen de siliciure de fer. Compt. Rend., lxxxvii, 1878, pp. 926–929.

132. Memoire sur le fer natif du Groënland et sur la dolerite qui le renferme. Annal. de Chim., xvi, 1879, pp. 452–505; [Note on same—Amer. Journ. Sci., xviii, 1879, pp. 72–73.

133. Sur des cristaux extraits de la fonte de fer par l'téher ou le pétrole. Compt. Rend., lxxxviii, 1879, pp. 888–890.

134. Figures de Widmannstätten sur le fer artificiel. Compt. Rend., lxxxviii, 1879, pp. 1124–1125.

135. Sur le spectre du nitrate de didyme. Compt. Rend., lxxxviii, 1879, p. 1167.

136. Daubrée's experimental geology [review of]: Part II—Experimental study of meteorites, with reference to certain cosmical phenomena. Amer. Journ. Sci., xix, 1880, pp. 386–390.

137. Study of the Emmet county meteorite that fell near Estherville, Emmet county, Iowa, May 10, 1879. Amer. Journ. Sci., xix, 1880, pp. 459–463, 495.

138. A new meteoric mineral (Peckhamite), and some additional facts in connection with the fall of meteorites in Iowa, May 10th, 1879. Amer. Journ. Sci., xx, 1880, pp. 136–137.

139. Hiddenite. An emerald-green variety of spodumene. Amer. Journ. Sci., xxi, 1881, pp. 128–130.

140. Occurrence of a nodule of chromite in the interior of a compact meteoric iron from Cohahuila. Amer. Journ. Sci., xxi, 1881, pp. 461–462; Compt. Rend., xcii, 1881, pp. 991–992.

141. Anomalie magnétique du fer météorique de Sainte Catherine. Compt. Rend., xcii, 1881, pp. 843–844.

142. Note on the magnetic properties of nickeliferous iron. Amer. Journ. Sci., xxiii, 1882, p. 232.

143. On the determination of phosphorous in iron. Amer. Journ. Sci., xxiii, 1882, pp. 316–320.

144. On the peculiar concretions in meteoric irons. Amer. Journ. Sci., xxv, 1883, pp. 417–423.

145. Methods of analyzing samarskite and the other columbates containing earthy oxides by the agency of fluorhydric acid; and of dissolving columbite and tantalite by the same acid. On the separation of thoria from the other oxides. Quantitative estimation of dilymium-oxide in its mixtures with other earthy oxides. Privately printed, Louisville, Ky., 1881, pp. 17, 8vo.