MEMOIR

OF

FREDERICK AUGUSTUS GENTH.

1820-1893.

BY

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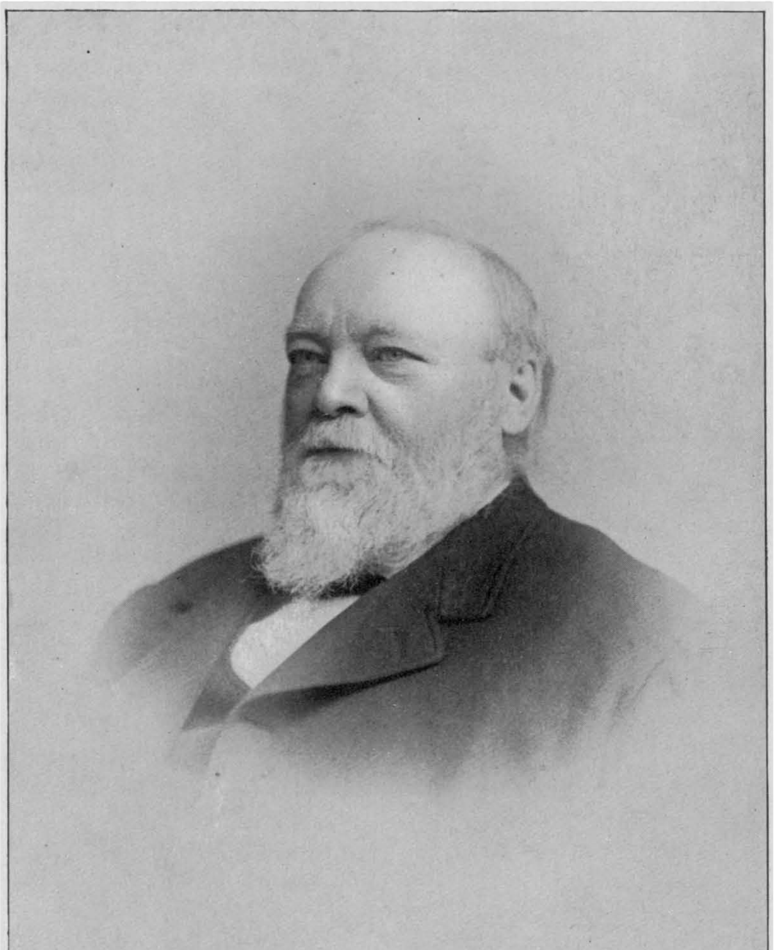
READ BEFORE THE NATIONAL ACADEMY, NOVEMBER 12, 1901.



FREDERICK AUGUSTUS GENTH.

BIOGRAPHICAL MEMOIR OF FREDERICK AUGUSTUS GENTH.

The pure sciences are sometimes classified as independent and dependent sciences—*i. e.*, as resting upon data solely their own or upon data borrowed from other sciences. Mathematics, physics, and chemistry may be adduced as instances of the former class of sciences; astronomy, mineralogy, and biology as instances of the latter class. Without the fundamental principles of mathematics and physics, for example, neither mathematical nor physical astronomy is possible. Moreover, the properties of minerals are classified either by their chemical composition, by their crystalline form, or by their optical properties; so that mineralogy as a science is dependent mainly upon physics and chemistry, and to some extent also upon mathematics; so botany and zoölogy, except in so far as they are classificatory, are based upon the chemical and physical characteristics of the organisms they investigate and the forms they classify. Our eminent associate who is the subject of the present memoir took a high rank as an investigator in each of these divisions. His researches in chemistry are equaled in importance only by those which he made in mineralogy. Both were of the highest order, and secured for him a very prominent position among men of science.

FRIEDRICH AUGUST LUDWIG KARL WILHELM GENTH was born in the village of Waechtersbach, in Hesse, on the 17th of May, 1820. On his father's side his family was an old Hesse-Nassau family, living for the most part in the neighborhood of Wiesbaden. He was the son of Georg Friedrich, high warden of forests to Prince Issenbourg, and of Karoline Amalie Genth. His mother's maiden name was Freyin von Schwartzenau, and she was a native of Darmstadt.

From his earliest childhood young Genth was thoroughly trained by his father, especial care being taken in the cultivation of his powers of observation; so that very early in life he is reported to have taken a great interest in the natural sciences, and particularly in mineralogy, botany, and conchology. When he had attained his sixteenth year he entered the gymnasium at Hanau, at that time under the direction of Dr. Schuppius. There he remained until the 26th of September, 1839, when, in his nineteenth year, he was graduated from that institution fully prepared for his entrance into the university. The report which Dr. Schuppius made at this time calls especial attention to his great interest in natural history and geography, and speaks in the highest terms of his exceptional diligence and ability as a student during all the time while he was at the gymnasium.

Young Genth entered the University of Heidelberg on the 11th of November, 1839. He came into contact with men such as Bischoff in botany, Blum and Leonhard in geography, geology, and mineralogy, and Gmelin in chemistry, all eminent in the sciences which he had already cultivated, and whose instruction he highly valued. On the 21st of August, 1841, however, he left Heidelberg, and in the following November entered the University of Giessen, where he remained until April, 1843, studying chemistry under the direction of Fresenius, of Kopp, and especially of Liebig. The stimulating influence of such teachers as these left an impression upon his mind which largely contributed to determine his subsequent career. Unfortunately his health at this time gave way, and this, added to the pressure of other calls upon him, necessitated his retirement from active study for something more than a year. In May, 1844, he entered the University of Marburg, where he continued his chemical studies under Bunsen and his work in physics under Gerling. In the month of January, 1845, he presented his thesis to the faculty of the university and passed his examination for the degree of Doctor of Philosophy. The subject of his dissertation was "Beiträge zur Kenntniss des Kupferschieferhüttenprocesses, erläutert durch die Untersuchung der auf der Friedrichshütte bei Riechelsdorf gewonnenen Producte." He was soon thereafter appointed a privat-docent in the university, and subsequently chemical assistant to Professor Bunsen. This position he held about three years, resigning it in the spring of 1848. About the middle of that year he sailed for Baltimore and soon afterward established an analytical laboratory in Philadelphia. In the fall of 1849 he was offered the position of superintendent of the Washington (now

Silver Hill) mine, in Davidson county, North Carolina. This he accepted, giving up his laboratory in Philadelphia and removing to Davidson county. He remained in this position until August, 1850, when he resigned it and returned again to Philadelphia, reopening his analytical laboratory and devoting himself principally to research, to commercial analysis, and to the instruction of special students in chemistry. He continued here his work of investigation and of professional analysis until 1872, when, upon the death of Professor Wetherill, he was tendered the position of the professorship of chemistry in the University of Pennsylvania, then just entering upon the new era of prosperity consequent upon its removal to West Philadelphia. This position he accepted, though at considerable pecuniary sacrifice, continuing to hold it with credit to himself and satisfaction to his colleagues until the fall of 1888, when he severed his connection with the university and for the third time returned to his private laboratory and to his professional and research work.

It has already been mentioned that Dr. Genth, even at the outset of his career, owing without doubt to his father's early training, took a great interest in the natural sciences, especially geology. His earliest paper, published while he was yet a student in the University of Giessen, shows the influence upon his mind of Leonhard, with whom he had studied at Heidelberg. It was entitled " Binnenconchylien lebender Arten im Kalktuff von Ahlersbach," and appeared in *Leonhard & Bronn's Jahrbuch* for 1842. The same year he published a second geological paper, entitled "Alter verschiedener Zechsteine," and in 1848 two further similar papers, " Eocene Schichten mit Beschreibung der Petrefacten " and " Miocene Geognosis des Mainzer Beckens," all appearing in the *Jahrbuch.*

In Giessen, however, under the influence of Liebig, of Kopp, and of Fresenius, and particularly in Marburg, where he received his chemistry directly from Bunsen, his mind was turned strongly in the direction of chemical science, together with its associate science, mineralogy. Even before taking his doctor's degree in 1845 he published papers on " Prehnite, a Pseudomorph after Analcime," on the " Chemical Examination of Masopin, a New Gum Resin," and on the "Analyses of Various Refined Coppers." Soon after graduating he published two manuals, the first a "Tabular Review of the Most Important Reactions of Bases," and the second a similar one on the acids.

Dr. Genth's purely chemical papers number thirty-one in all. In 1845, in a letter to Liebig, he called his attention to an allotropic modification of nickelous oxide NiO;β. He had noticed on certain disks of refined copper from Riechelsdorf, a layer of small, almost microscopic crystals, which at first he mistook for cuprous oxide. But, unlike this substance, they were left behind on dissolving the copper in nitric acid. Under a magnifier they were recognized as regular octahedrons. They were grayish black in color, giving a brownish streak. They were opake, were not magnetic, and possessed a metallic luster. They were quite brittle and had a hardness between calcite and fluorite, and a specific gravity of 5.745. They were insoluble in nitric, hydrochloric, and sulphuric acids in the cold, but dissolved in the latter acid on boiling. They were not altered by fusion with carbonates, but borax and phosphorus-salt dissolved them, giving a nickel bead. On fusing with acid potassium sulphate the solution gave on evaporation crystals of potassium nickel sulphate and reacted like nickelous oxide. On reduction with hydrogen, 5.5780 grams gave 4.3905 grams nickel, showing it to be a pure nickelous oxide. In 1853 he described in the *American Journal of Science* a similar compound of cobalt in iron-black brilliant microscopic octahedrons with a submetallic luster.

In 1848 Dr. Genth published in *Liebig's Annalen* a paper giving analyses of the lavas from Hecla which were collected by Bunsen in his journey to Iceland. This investigation is remarkable as the first ever made upon the products yielded by an active volcano with a view to determine whether those products agree with each other in composition at different eruptive periods. The lavas analyzed were those of Thjorsá, Háls, Efrahvolshraun, and that of 1845, named in the order of eruption. Besides these, an analysis of volcanic dust from the eruption of 1845 is given, the dust having been collected from a clean surface of snow. The Thjorsá lava consisted of a grayish-black mass filled with cavities containing, besides crystals of scapolite, a new mineral which he called thjorsaite. The Háls lava was found to resemble Laurent's wichtisite. The author finds (1) that these lavas differ from those of Vesuvius and Ætna, (*a*) in that they contain no material gelatinizing with hydrochloric acid, and (*b*) that they are insoluble in this acid, excepting traces of magnetite; (2) that they all contain a single essential constituent, forming substantially the entire mass, which has the same composition as wichtisite, and (3) that the variation from wichtisite of the elemental ratio is due to the presence of thjorsaite, chrysolite, orthoclase (?), and magnetic iron in different proportions.

In *Erdmann's Journal für praktische Chemie* for 1846 an elaborate paper was published by Dr. Genth on a "Chemical Examination of the Products obtained in the Metallurgy of Copper Schists," the special works studied being the Friedrichs plant at Riechelsdorf. This paper, which covers 48 pages, is substantially his inaugural dissertation at Marburg. The immediate occasion of the investigation was the sending to Professor Bunsen for analysis of various samples of Norwegian and Swedish refined copper, together with two specimens from the Riechelsdorf works, by the Kurfürstliche Ober-Berg und Salzwerks-Direction of Cassel. The examination of these coppers was given in charge to Dr. Genth, and the great differences observed in the content of nickel and silver in these specimens led him to undertake a more general investigation into the products of the Riechelsdorf plant. During this research he improved many analytical methods and devised some new ones. He observed that the precipitation of barium sulphate in presence of hydrochloric acid caused the precipitate to become granular; so that the filtrate was clear and not turbid, except in presence of acetates. He proposed methods for detecting minute quantities of nickel in presence of cobalt and for separating manganese from zinc by igniting the carbonates with access of air and subsequent extraction with dilute acetic acid. It was during this investigation that he discovered the allotropism of nickelous oxide already mentioned. The paper is divided into six sections. The first gives a general review of the Riechelsdorf process for working the copper schists. In the second the analytical methods which he employed are described. The third considers the Friedrich's products and gives their physical properties and chemical composition. The fourth gives the results of analyses of other coppers—Japanese, Avista, Norwegian, Gustav, Carlsburg, Dillenburg, and a cement copper from Westphalia. In the fifth is given a tabular statement of all the products which were analyzed, and the sixth states some chemico-technological conclusions. The value of this research was recognized by a letter of thanks from the direction, and was followed by some material changes in the processes used at the Friedrich works, due to the results of the analytical work which had been done.

In December, 1852, Dr. Genth read before the Academy of Natural Sciences a paper on a supposed new element which he had detected in certain small white grains associated with iridosmine and platinum from California. On treatment with hydrochloric acid two of the metallic particles began to dissolve with the evolution of hydrogen. They were at once removed, washed, and examined with a magnifier, when they were shown to be mixed with gold. In color they were between tin white and steel, were malleable, but harder than tin, and dissolved in nitric acid, yielding a crystalline salt. The solution gave a brown precipitate with hydrogen sulphide. Before the blow-pipe, on charcoal, the metal fused readily, but became soon covered with a black oxide. It gave no incrustation. With borax in the outer flame, it dissolved, giving a colorless bead, which became opalescent on cooling. While the new metal somewhat resembles tin, it is distinguished from it (1) by its complete solubility in nitric acid, (2) by its brown precipitate with hydrogen sulphide, and (3) by its not being readily oxidized into a white oxide before the blow-pipe.

But the chemical research by which Dr. Genth is best known is undoubtedly that on the ammonia-cobalt bases, which, as developed jointly with Dr. Wolcott Gibbs, was published as a monograph by the Smithsonian Institution.

Doctor Genth's original memoir was published in Philadelphia in 1851, in *Keller & Tiedemann's* "*Nordamerikanischer Monatsbericht für Natur und Heilkunde*," under the title "Vorläufige Notiz über Gepaarte Kobalt verbindungen." This paper contained the first distinct recognition of the existence of perfectly well-defined and crystallized salts of the ammonia-cobalt bases. Indeed, it would appear that no trace exists in any earlier publication of even the idea of such a class of compounds. The results given in the paper were first obtained by the author, in Marburg, in 1847, while chemical assistant to Professor Bunsen, during the latter's absence in Iceland. They were freely communicated verbally to others, and a suite of the salts obtained were deposited at the time in the Giessen laboratory. In this early memoir Dr. Genth describes two series of salts in which cobalt oxide, paired with ammonia, acts as a base. To prepare these bases ammonium chloride is added to a solution either of cobaltous chloride or sulphate, and the solution is saturated with ammonia. After standing four or five weeks in the air, and the excess of ammonia has evaporated, hydrochloric acid is added to acid reaction and the solution is boiled. After some time a crystalline heavy carmine-red powder is deposited, a further quantity of which is obtained by further evaporation of the solution. This carmine-red salt is with difficulty soluble in cold water, easily in boiling water. If no free acid is present, the aqueous solution is decomposed on boiling or even on long standing in the air. The presence of acetic or hydrochloric acid prevents this decomposition, and from this solution the pure salt can be obtained by crystallization. The crystals are small octahedrons, peach-blossom carmine-purple red to black in color. On analysis they gave the empirical formula $Co_2O_3(NH_4)_3$ Cl.; hence they must be considered the chloride of the paired compound $Co_2O_3(NH_4)_3$, which plays the part of a metal. From this chloride, by double decomposition, not only the base itself, but a beautiful series of salts may be obtained. The base is described in the paper, and also the carbonate, sulphate, nitrate, chromate, and molybdate, as well as the compounds formed with mercuric, stannic, and platinic chlorides. In the mother liquor from which the carmine-red compound was prepared an orange-yellow cobalt compound was obtained by further evaporation, it being more soluble than the red salt. Its crystals were rhombic or klinorhomboidal. The phosphate crystallizes in gold-yellow, brilliant needles. "Though the analyses here given were from necessity not sufficiently complete and extended to fix the constitution of the bases in question, yet the fact is indisputable that this memoir contained not merely the first announcement of the existence of ammonia-cobalt bases, but also a scarcely less accurate and complete description of two of these bases than any which has since appeared." The foregoing memoir was called by Dr. Genth a preliminary notice, but, since circumstances prevented a resumption and continuation of this subject, the field was entered by others. Claudet in 1851 described with some detail the properties of purpureo-cobalt chloride, and later in the same year Fremy communicated to the French Academy two preliminary notices, claiming as his own the discovery of a class of bases containing cobalt and ammonia produced by the oxidation of ammoniacal solutions of cobaltous salts, his complete memoir not appearing until the following year. He appears not to be aware that the two bases which he describes had been already described by Genth, in a manner but little less complete than his own, in a paper published two years before.

In the joint monograph of Gibbs and Genth, published by the Smithsonian Institution in 1856, the nomenclature of Fremy is substantially adopted, though somewhat modified. Instead of "roseocobaltiaque" and "luteocobaltiaque," as Fremy proposed, roseocobalt and luteocobalt are used for the two bases originally discovered by Genth; purpureocobalt for the base discovered by Claudet; xanthocobalt for that of Gibbs, and fuscocobalt for Fremy's base. The colors of these substances are referred to the chromatic scale of Chevreul, as suggested by Fremy, and the crystallographic measurements given were made by J. D. Dana. After describing the methods of analysis, the monograph goes on to state at length the mode of preparation and the properties of the salts of roseocobalt, purpureocobalt, luteocobalt, and xanthocobalt, together with the results of their analysis. It concludes with a theoretical discussion of the rational structure of these bases. Considering them as conjugated compounds of sesquioxide, sesquichloride, etc., of cobalt, the five or six equivalents of ammonia or of ammonia and nitrogen dioxide are viewed as forming the conjunct and serving to give to the sesqui-compound of cobalt the degree of stability which it possesses in this class of bodies. Hence the chloride of luteocobalt is written $(\mathrm{NH}_3)_6\frown\mathrm{Co}_2.\mathrm{Cl}_3$, employing the connecting circumflex as a symbol of conjugation, as suggested by Kolbe. Adopting this view, we have the following conjugate radicals, which we assume as existing in the ammonia-cobalt bases, precisely in the same sense in which we assume Co_2 as existing in the sesquichloride and the sesquioxide of cobalt:

Roseocobalt........	$(\mathrm{NH}_3)_5\frown\mathrm{Co}_2$	Luteocobalt........	$(\mathrm{NH}_3)_6\frown\mathrm{Co}_2$
Purpureocobalt.....	$(\mathrm{NH}_3)_5\frown\mathrm{Co}_2$	Xanthocobalt...	$\mathrm{NO}_2\frown(\mathrm{NH}_3)_5\frown\mathrm{Co}_2$

But while two of these bases are triacid bases, the other two are diacid, one of these, purpureocobalt, even forming acid compounds with four equivalents of acid. In order to explain this condition of things, the authors assume in these latter the existence of secondary radicals containing oxygen; these secondary radicals being in purpurecobalt $(\mathrm{NH_3})_5{\frown}\mathrm{Co_2O}$ and in xanthocobalt $\mathrm{NO_2(NH_3)_5Co_2O}$. A tabular view is given of the rational formulas of all the salts examined upon the above assumption.

Thus roseocobalt chloride is	$(\mathrm{NH_3})_5{\frown}\mathrm{Co_2.Cl_3.H_2O}$
purpureocobalt chloride	$(\mathrm{NH_3})_5{\frown}\mathrm{Co_2Cl.Cl_2}$
luteocobalt chloride	$(\mathrm{NH_3})_6{\frown}\mathrm{Co_2.Cl_3}$
xanthocobalt chloride	$\mathrm{NO_2.}(\mathrm{NH_3})_5{\frown}\mathrm{Co_2O.Cl_2}$

This elaborate and extended research has always stood among the finest chemical investigations ever made in this country. Several years were required to complete it, the analytical portion of the work being as difficult as it was protracted.

In 1858, also in conjunction with Dr. Gibbs, Dr. Genth published a preliminary notice of a new base containing osmium and the elements of ammonia. In consequence of their joint research on the ammonia-cobalt bases, the authors were led to investigate the production of analogous compounds with other metals. For this purpose they studied the action of the mixed nitrogen oxides upon ammoniacal solutions of the platinum metals, and discovered the fact that a well characterized base is formed by osmium with ammonia, the salts of which crystallize well. The chloride of this base is a yellow crystalline salt, which was first noticed by Fremy in 1844 and called osmiamide. The authors found, however, that the rational formula he assigned to it was erroneous, and that it is a true chloride, yielding a beautiful salt with platinic chloride and giving, on double decomposition with salts of silver, a well characterized sulphate, oxalate, nitrate, etc. The salts of this new base have a beautiful orange-yellow color, are nearly insoluble in cold water, but more soluble in hot. The solutions decompose easily, however, evolving osmic acid. The authors attribute to the chloride the formula $(\mathrm{NH_3})_2{\frown}\mathrm{OsO_2.Cl}$.

The chief chemical investigations of Dr. Genth, however, and those which will cause his work ever to be most highly valued, are the investigations which he made in connection with mineralogy. As early as 1842 he published a paper in *Leonhard & Bronn's Jahrbuch* on a pseudomorph of prehnite after analcime, and in 1848 he gave a mineralogical paper in *Liebig's Annalen*, containing analyses of baulite from Krabla, of phillipsite from Stempel, of chabasite from Annerode, of iron-mould from the Alte-Birke mine, and of speiss-cobalt from Riechelsdorf. In 1851 he announced in *Keller & Tiedemann's Monatsbericht* the discovery of traces of platinum in Lancaster county, Pennsylvania, of tetradymite in North Carolina, and of a magnetic pyrite, containing 2.9 per cent. of nickel, in the Gap mine of Lancaster county. This pyrite has since been made the basis of a considerable nickel industry. Later he described a mineral from Texas, Pennsylvania, which he considered to be a gymnite in which a part of the magnesia is replaced by the isomorphous nickelous oxide. To this mineral he gave the name nickel-gymnite; but Dana subsequently called it genthite.

A series of valuable papers entitled "Contributions to Mineralogy" were published by Dr. Genth from time to time for several years. These papers were fifty-four in number and contained descriptions of two hundred and fifteen mineral species, in most cases accompanied by analyses. Most of these appeared in the *American Journal of Science*, although some were published in the *Proceedings of the American Philosophical Society* and in other serials. In several of the later "Contributions" he was associated with Professor Penfield, who furnished the notes on crystallography. Besides these comprehensive papers, Dr. Genth was the author of twenty-three minor contributions to chemical mineralogy, many of which contained descriptions of new minerals. He was the discoverer of twenty-four new mineral species, all of which were so thoroughly individualized, both by chemical and by physical methods, that they took at once a position in the science which they have ever since maintained.

In 1854 he described a new meteoric iron from New Mexico, given him by Professor Henry, and labeled "native iron." On analysis it afforded: iron, 96.17; nickel, 3.07; cobalt, 0.42, and 0.57 of insoluble matter, consisting of iron, nickel, and titanium. This insoluble portion was a steel-colored powder in microscopic crystals. The next year he published the analysis of a fragment of one of the meteoric irons of Tucson, Mexico, presented to the Academy of Natural Sciences by Dr. Herrmann. This analysis showed the meteorite to consist of iron, copper, cobalt, nickel, chromium, alumina, magnesia, lime, soda, potash, phosphorus, and silica, together with a feldspathic mineral supposed to be labradorite. It agreed substantially with the analyses by J. L. Smith of a fragment cut from one of the huge masses in that region by Lieut. John G. Parke, U. S. Engineers. In 1886 he described a new meteorite from East Tennessee.

One of the most important and also one of the most extended of Dr. Genth's mineralogical investigations, however, was that made upon "Corundum, its alterations and associated minerals," the results of which were communicated to the American Philosophical Society in 1873. This paper occupies forty-six pages of the *Proceedings*. He had exhibited to the society, in the spring of 1871, several peculiar crystals of corundum, altered either wholly or partly into other mineral species. "Further chemical investigation of these crystals and of others similar to them gave results leading to conclusions which seemed to possess interest, not only for the chemist and mineralogist, but in connection with their paragenesis, to the geologist also." The largest deposits of corundum in the world are in a chromiferous serpentine or chrysolite formation and in the rocks adjoining thereto. Localities of this mineral have been developed all the way from Massachusetts to Alabama, and it will always be an interesting question by what agencies such enormous quantities of alumina could have been precipitated to form it. Especially so since by its subsequent alteration it has given rise to many of the most widely distributed minerals and rocks. The most important eastern corundum deposit is that at Chester, Massachusetts, discovered by C. T. Jackson and mineralogically described by C. U. Shepard and J. L. Smith. The deposit of this locality consists of crystalline corundum contained in a fine scaly chlorite, and of a peculiar mixture of granular and crystallized corundum with magnetite intermixed with more or less of a chloritic mineral. The deposit traverses two mountains for about four miles, having an average thickness of four feet, lying in a talcose slate and serpentine between gneiss and mica slate in the center of the Green Mountains. The gneiss itself contains no corundum; but the talcose rock has grains of emery, of corundum, and of magnetite distributed through it. The corundum occurs either in small brownish crystals or in very fine grains. Sapphire in pyramidal crystals is sometimes met with. Pinkish margarite, diaspore, and corundophilite invest frequently the corundum or emery, associated with tourmaline, cyanite, chloritoid, ilmenite, rulite, etc. At Litchfield, Connecticut, corundum is found in balls of cyanite associated with talc and diaspore. At Unionville, Chester county, Pennsylvania, crystals of corundum are frequently met with in the soil, large boulders of it being not unusual. The bed whence these came showed a mass of almost solid corundum thirty feet long, five to ten feet thick, and about fifteen feet deep. The corundum itself is granular in structure, brownish gray in color, and shows a gradual change into other minerals, among which Dr. Genth observed diaspore, gibbsite, damourite, margarite, soda-margarite, euphyllite, zoisite, tourmaline, chlorite, lesleyite, and pattersonite.

By far the most numerous localities of corundum, however, many of them of great scientific interest, occur in North Carolina, the most easterly locality being in Guilford county. Here the corundum is a true emery, being granular and mixed with magnetite and associated with a chloritic mineral. The corundum belt, which stretches, with occasional interruptions, southwesterly from Madison county, North Carolina, through Georgia into Tallapoosa county, Alabama, a distance of at least 250 miles, was discovered by the Rev. C. D. Smith. The first large mass of corundum was found in 1847, on the French Broad river, near Marshall, Madison county. It was dark blue in color and was associated with chlorite and margarite. In all probability it came from the great chrysolitic belt. Dr. Genth had already suggested that the chromiferous and nickeliferous serpentines and talc slates owe their existence to the decomposition of chrysolite rocks, an opinion proved later to be correct. The outcrop of the Culsagee mine, near Franklin, Macon county, North Carolina, extends over thirty acres, the strata which are there developed, according to C. U. Shepard, being (1) chrysolite rock mixed with anthophyllite, (2) micaceous rock, (3) a seam of chalcedony, (4) a stratum of chloritic rock (ripidolite), and (5) a similar layer through which the corundum is irregularly diffused. According to J. Willcox, the chlorite schist is much decomposed, even to a depth of fifty or sixty feet, the corundum itself falling easily into fragments. At right angles to the chlorite schist a vein of chlorite several feet wide was found, containing large crystals of corundum, which also fell readily into fragments. About twenty miles southwest of this mine is the so-called Cullakenee mine, the outcrop of the chrysolite rock here covering an area of about 300 acres. In many places corundum is found in boulders. The chrysolite contains the usual associates of serpentine, such as actinolite, picrolite, etc., and is already partly changed into serpentine. Near the middle of the chrysolite bed is an outcrop of a very peculiar rock resembling omphacite and consisting of green smaragdite, a white triclinic feldspar, and highly colored grains of ruby intermixed with cyanite and chromite in small quantities. The corundum here is generally of a grayish-white or pale ash-gray color, with specks of sapphire occasionally. Sometimes, however, it is of a beautiful pink color, associated with andesite, zoisite, margarite, hornblende, and rarely with chlorite, spinel, and tourmaline. Ten miles southeast of Cullakenee, corundum again occurs, and for five or six miles, extending into Georgia, it is often found associated with chlorite and probably smaragdite, the chrysolite lying between beds of hornblendic gneiss. The Georgia locality resembles that at Culsagee. Near Gainesville a very peculiar corundum occurs. It exists as a nucleus in irregular kidney-shaped masses of margarite or with a peculiar earthy mineral of a color between isabel and flesh red, frequently intersected by veins of a fine scaly or massive margarite. Quite similar to these occurrences of corundum are those of the Ural, as described by G. Rose, and of Asia Minor, as given by J. L. Smith.

After this general survey of the geological conditions attending the occurrence of corundum, Dr. Genth proceeds to discuss the minerals which are found to be associated with it.

I. *Spinel.*—Corundum altered into spinel occurs in many localities, the most interesting variety coming from Hindostan. The surface of the corundum crystals is rough, and to many of them reddish orthoclase and a dark mica are attached, showing their matrix to have been granite. Most of the crystals are from half an inch to two inches in size. Many are completely altered, but most of them show that the alteration began at the surface and has penetrated irregularly the crystals toward the center, leaving frequently a nucleus of brownish gray, cleavable corundum. The spinel, the result of this alteration, is black in color, has a granular crystalline structure and a vitreous to submetallic luster. Material from seven other localities is described and their analyses given. These show that the spinel is pseudomorphous after corundum, the specimens from Hindostan and a green spinel from Culsagee being mixtures of the spinel varieties pleonaste and hercynite, while the other spinels from Culsagee contain in addition an admixture of the variety picotite.

II. *Diaspore.*—Although this mineral has been observed in many places as the result of the hydration of corundum, it does not appear that a real pseudomorph has ever been met with. Though J. L. Smith notes that all the corundum he had examined contained from 0.68 to 3.74 per cent. of water, yet he was not able to detect diaspore. Dr. Genth suggests that it may be so minutely distributed through the corundum that even careful microscopic examination fails to detect it, as is the case sometimes with spinel. Diaspore is abundant and of rare beauty in Chester, Massachusetts. Dr. Isaac Lea found it at Unionville in beautiful crystals and J. C. Trautwine noticed it in cavities of massive corundum from the Culsagee mine.

III. *Beauxite.*—This aluminum hydrate, mixed with ferric hydrate and a hydrous aluminum silicate, and inclosing grains of corundum, occurs abundantly in the south of France. T. S. Hunt has suggested that since beauxite can be converted into corundum by intense heat, the same change may have taken place in this locality at ordinary temperatures. Dr. Genth, however, not knowing of a single instance of the production of corundum under these conditions, infers that the reaction must have been in the inverse direction, and that the beauxite has resulted from the hydration of the corundum, some grains of which still remain unconverted.

IV. *Gibbsite.*—This rare aluminum hydrate has been noticed only twice in contact with corundum—once in Asia Minor, by J. L. Smith, and once at Unionville, Pennsylvania, by T. F. Seal.

V. *Quartz.*—This mineral is mentioned by Sillem as occurring as a pseudomorph after corundum.

VI. *Opal.*—Dr. Genth observed the variety hyalite in connection with corundum and the minerals resulting from its alteration, first at Culsagee mine, where it occurs rarely in beautiful colorless and white botryoidal incrustations on foliated chlorite and on corundum, and again at Dudleyville, Alabama.

VII. *Smaragdite.*—The peculiar rock formed by a feldspathic mineral, supposed to be smaragdite, and grains of pink and even deep ruby corundum at the Cullakenee mine, has already been mentioned. The smaragdite grains are very indistinct in form, frequently showing an obtuse angle like that of an amphibole. Their color is emerald to grass green, passing into grayish green. An analysis by Chatard, in Dr. Genth's laboratory, gives an atomic ratio of 4 : 1 : 4, agreeing exactly with that of kokscharoffite. Other varieties of amphibole are in some localities associated with corundum and even penetrate its mass. A black or brownish black hornblende occurs in the andesite of Cullakenee and a dark-green variety, often associated with zoisite, is found with and in the corundum of the same locality.

VIII. *Zoisite.*—G. Rose had already observed zoisite as an associate of corundum in the Urals, and B. Silliman described it, under the name unionite, as occurring with corundum at Unionville, Pennsylvania. The best locality for it, however, is at the Cullakenee mine, in North Carolina, where it occurs, often in crystals, though generally in compact and columnar masses easily cleavable, and from grayish to greenish and brownish white in color. Many of the specimens show distinctly that it is the result of the alteration of corundum, the pink corundum being often surrounded by a thin coating of white zoisite. Analyses are given of the mineral from this locality for comparison with that of unionite, by G. J. Brush.

IX. *Feldspars.*—Of the many varieties of feldspar occurring with corundum, Dr. Genth enumerated (1) a white grayish and reddish variety of anorthite, called indianite by Bournon, as the matrix of corundum in the Carnatic, associated with cyanite and garnet; (2) a snow-white massive granular feldspar, observed in the Ural by G. Rose, who gave it the name of barsowite; (3) a snow-white or bluish-white cleavable feldspar, associated with hornblende at the Cullakenee locality, together with a granular and very compact variety, having crystals of corundum disseminated through it; (4) a fine-grained and very friable variety from Cullakenee, resembling the oligoclase from Chester, but containing hornblende crystals through it in place of biotite; (5) soda-oligoclase from Unionville, analyzed by

Smith and Brush and also by Chatard; (6) a yellowish white granular feldspar from Mineral Hill, Pennsylvania, containing crystals of corundum altered into fibrolite and other minerals; it appears to be an oligoclase; (7) indianite from Chester, Massachusetts, proved by Jackson to be granular oligoclase; and (8) a white granular feldspar found on the road from Unionville to Kennett Square, and determined as albite by Brush and Weld. It is frequently the matrix of gray corundum associated with euphyllite (?). As to the question whether the feldspars found in connection with corundum are the result of the alteration of this mineral, Dr. Genth concludes that many more observations will be needed in order to answer it positively; but from what he has already seen he believes that there are cases where feldspars have been formed from corundum. Perhaps, at the same time, a portion of the alumina recrystallized as corundum, and is thus found imbedded in the feldspathic matrix.

X. *Tourmaline.*—This mineral is associated with corundum at most of the localities already mentioned. At Unionville black tourmaline occurs in irregular masses of different sizes, in the corundum itself as well as in the masses resulting from its alteration. Dr. Isaac Lea mentions the occurrence of a crystal of transparent green tourmaline passing through the middle of a prism of diaspore, the whole enveloped by lamellar crystals of pearly emerylite (damourite, Genth). At the Culsagee mine the association of tourmaline with corundum is of special interest. There are masses of black tourmaline containing crystals of white and yellowish-white corundum disseminated through them, the particles of tourmaline being intermixed with the corundum crystals and *vice versa*, though on the whole the tourmaline looks more like the matrix of the corundum. One specimen from this mine which was examined by Dr. Genth is a pseudomorph of tourmaline after corundum, showing three planes of the hexagonal prism and portions of one pyramidal plane.

XI. *Fibrolite.*—For a long time this mineral has been known to accompany corundum both in Europe and Asia. The variety which was used by the Celts in the stone age was obtained in the neighborhood of Chavagnac and Curouze, in France, where it is associated with mica, cyanite, and red and blue corundum.

At Norwich, Connecticut, the small crystals of sapphire are completely surrounded by fibrolite. Analyses are given of the mineral from Mineral Hill.

XII. *Cyanite.*—This mineral is a very common associate of corundum, rolled masses of it occurring in Litchfield and Washington, Connecticut, containing corundum and diaspore. An interesting specimen from Newton, Connecticut, received from G. J. Brush, consists of irregularly arranged bladed masses of gray bluish-white and blue color, a white or yellowish-white micaceous mineral occurring where the blades meet, imbedded in which is diaspore. In one place, in immediate contact with the cyanite, is a rounded fragment of a slightly pink corundum.

The list of these associated minerals is continued as follows: XIII, Staurolite; XIV, Pyrophyllite; XV, Damourite; XVI, Ephesite (Lesleyite); XVII, Paragonite; XVIII, Euphyllite; XIX, Jefferisite; XX, Chlorite; XXI, Kerrite (a new mineral); XXII, Maconite (a new mineral); XXIII, Willcoxite (a new mineral); XXIV, Pattersonite; XXV, Chloritoid; XXVI, Margarite; XXVII, an earthy mineral from Gainesville, Georgia; XXVIII, Dudleyite (a new species), and XXIX, Lazulite.

The conclusions reached by Dr. Genth, as the result of this extended investigation, are as follows: (1) at the great period when the chromiferous chrysolite beds were deposited, a large quantity of alumina was separated which formed beds of corundum; (2) this corundum has subsequently been acted on and in this way changed into various mineral species—spinel, fibrolite, cyanite, tourmaline, damourite, chlorite, and margarite, and perhaps also into some varieties of feldspar; (3) a part of the products of the alteration of corundum still exist in the form of large beds of mica (damourite) and chlorite slates or schists; (4) another part has been still farther altered and converted into other minerals and rocks, such as pyrophyllite, paragonite, beauxite, lazulite, etc.

In 1874 Dr. Genth was appointed by Professor Lesley, Director of the Second Geological Survey of Pennsylvania, to the position of chemist and mineralogist to the survey, and toward the close of that year he presented a Preliminary Report on the Mineralogy of Pennsylvania, which, together with an Appendix on Hydrocarbon Compounds, prepared by S. P. Sadtler, covers two hundred and sixty pages. The following year he published a Second Preliminary Report, covering thirty-one pages. He was also chemist to the Board of Agriculture of Pennsylvania, and did much by his investigations, especially by his analysis of fertilizers, to develop the agricultural industry of the State and to maintain a high standard of excellence in all farm products.

As a man of science, Dr. Genth stood among the first in this country. As a chemist, especially in analytical work, he was almost without a peer, being completely familiar, not only with the reactions and methods of determination and separation of the ordinary elemental and compound ions, but, what is more remarkable, of the rarer and less frequently occurring ones as well; but, more than this, his scientific work was characterized by a conscientiousness and fidelity to fact which was exceptional. No labor seemed to him too great if by it an added accuracy could be secured. His knowledge of minerals was complete. Not only did his acute vision aid his early training in recognizing them at a glance, but his skill in detecting their physical and chemical properties gave him remarkable power in recognizing new species. Moreover, his devotion to scientific accuracy was so great that most, if not all, of the discussions he had with others involved questions of fact rather than of opinion. Again, his mind had acquired great facility in grasping the relations of structural grouping, both in salts and minerals, and the rational formula of an ammonia-cobalt base or of a complex mineral species was at once clearly recognized from the empirical results of his analysis.

As a teacher, Dr. Genth was most successful. Apart from his complete command of the subject, he took a great interest in his good students and devoted himself assiduously to their advancement; but for those who were studiously indifferent and careless, to his credit be it said, he had but little regard. He was merciless upon evasive, and especially upon fraudulent, work, particularly in analysis. The reputation which he gave to his department in the university was deservedly high. The large amount of research work which he did was never allowed to interfere with his instruction, and those who were his students remained ever afterward among his best friends. His retirement was a great loss to the university, the more so since there is reason to believe that possibly it might have been avoided.

Professor Dr. Genth was everywhere recognized by his scientific associates as a man of rare talent. He was elected a member of the American Philosophical Society in January, 1854. He was one of the corporate members of the American Chemical Society, and was elected a Vice-President in 1876 and President in 1880. In 1872 he was elected a member of the National Academy of Sciences, and in 1875 a fellow of the American Academy of Arts and Sciences in Boston. The American Association for the Advancement of Science paid him, in 1888, the high compliment of election as one of the three honorary fellows of the association.

Doctor Genth's personality was most agreeable. He was cordial to his friends and associates, valued highly their society, and was ever ready to give them any assistance he could render out of the storehouse of his knowledge. He was twice married, first in Europe, in 1847, to Karolina Jaeger, the daughter of the librarian of Marburg University, by whom he had three children, two sons and a daughter, all of whom are yet living. In 1852 he married Fräulein Minna Paulina Fischer, of Silesian Prussia, whom he met in Cumberland, Maryland; nine children, four daughters and five sons, being the result of this second marriage. Of these four daughters and one son are still living.

Doctor Genth was rather corpulent in his habit, and in his later years went about with some difficulty, being considerably troubled with asthma. He died at his home, in Philadelphia, on the 2d of February, 1893, from an attack of pneumonia, being in his seventy-third year.

NEW MINERALS ESTABLISHED BY F. A. GENTH.

Barnhardtite.
Whitneyite.
Rhombic tungstate of lime.
Melonite.
Calaverite.
Montanite.
Cosalite.
Kerrite.
Maconite.
Willcoxite.
Dudleyite.
Schirmerite.
Psittacinite.
Magnolite.
Endlichite.
Lansfordite.
Nesquehonite.
Aguilarite.
Ferrotellurite.
Phosphuranylite.
Penfieldite.
Coloradoite.
Nickelgymnite (genthite).

SCIENTIFIC PAPERS, ETC., PUBLISHED BY F. A. GENTH.

1842. 1. Binnenconchylien lebender Arten im Kalktuff von Ahlersbach in Leonhard-Bronn's N. Jahrbuch, pp. 229, 590.
1842. 2. Alter verschiedener Zechsteine. Leonhard-Bronn's N. Jahrbuch, pp. 707, 708.
1842. 3. Prehnit, Pseudomorph nach Analcim. Leonhard-Bronn's N. Jahrbuch, p. 707.
1843. 4. Chemische Untersuchung des Masopin's, eines neuen harzartigen Körpers. Liebig's Annalen, xlvi, pp. 124–128.
1844. 5. Analysen verschiedener Gaarkupfer. Notizenblatt des Goettingischen Vereins Bergmännischer Freunde No. 44.
1845. 6. Tabellarische Uebersicht der wichtigsten Reactionen, welche Basen in ihren Salzen zeigen. Bayrhoffer'sche Universität's Buchhandlung.
1845. 7. Tabellarische Uebersicht der wichtigsten Reactionen, welche Säuren in ihren Salzen zeigen. Bayrhoffer'sche Universität's Buchhandlung.
1845. 8. Allotropische Modification des Nickeloxyduls. Liebig's Annalen, liii, pp. 139–141.
1846. 9. Chemische Untersuchung der, beim Kupferschiefer-Hütten process fallenden Producte. Erdmann's Journ. für Praktische Chemie, xxxvii, pp. 193–240.
1848. 10. Untersuchung der Eruptions-producte des Hekla. Liebig's Annalen, lxvi, pp. 13–28.
1848. 11. Eocene Schichten mit Beschreibung der Petrefacten. Leonhard Bronn's N. Jahr., pp. 188–192.
1848. 12. Miocene Geognosie des Mainzer Beckens. Leonhard-Bronn's N. Jahr., pp. 192, etc.
1848. 13. Untersuchung einiger Mineralien. Liebig's Annalen, lxvi, pp. 270–280.
    1. Baulit vom Krabla.
    2. Phillipsit vom Stempel bei Marburg.
    3. Chabazit von Annerod bei Giessen.
    4. Eisenmulm von der Grube "Alte Birke" bei Siegen.
    5. Speisskobalt von Riechelsdorf.
    6. Uranit aus dem Siebengebirge.
1849. 14. Boden-Analyse. Liebig-Kopp's Jahresbericht, p. 656.
1851. 15. Vorläufige Notiz über Gepaarte Kobaltverbindungen. Keller-Tiedemann's Nordamerikanischer Monatsbericht, ii, pp. 8–12.
1851. 16. Chemisch-Mineralogische Notizen. Keller-Tiedemann's N. A. Monatsbericht, ii, pp. 249, 250.
    Platin in Pennsylvanien.
    Tetradymit von Nord Carolina.
    Magnetkies von der Gap Mine.

1851. 17. Aschenbestandtheile des Blutes von Limulus Cyclops. Keller-Tiedemann's N. A. Monatsbericht, iii, pp. 438–441.

1851. 18. Chemisch-Mineralogische Beiträge. Keller-Tiedemann's N. A. Monatsbericht, iii, pp. 486–488.
Henry Wurtz's Methode der Aufschliessung der Silicate.
Orthoclas von Nord Carolina.
Nickelgymnit von Texas, Lancaster Co., Pa.

1852. 19. Untersuchung des Mineralwassers von Bristol, Pa. Keller-Tiedemann's N. A. Monatsbericht iv, pp. 246, 247.

1852. 20. Ueber die Aschenbestandtheile des Blutes von Limulus Cyclops. Liebig's Annalen, lxxxi, pp. 68–73.

1852. 1853. 21. On some minerals which accompany gold in California. Proc. Phila. Ac. Nat. Sci., vi, pp. 113, 114.

1852. 1853. 22. On Strontiano-calcite, a new mineral. Proc. Phila. Ac. Nat. Sci., vi, p. 114.

1852. 1853. 23. On Rhodophyllite, a new mineral. Proc. Phila. Ac. Nat. Sci., vi, pp. 121–124; Am. Jour. Sci., xv, p. 438.

1852. 1853. 24. On a probably new element with Iridosmine and Platinum, in California. Proc. Phila. Ac. Nat. Sci., vi, pp. 209, 210; Am. Jour. Sci., xv, p. 246.

1852. 1853. 25. On a new variety of Gray Copper. Proc. Phila. Ac. Nat. Sci., vi, pp. 296, 297.

1852. 1853. 26. On Owenite, a new mineral. Proc. Phila. Ac. Nat. Sci., vi, pp. 297–299.

1853. 27. On the Allotropic modification of oxide of cobalt. Am. Jour. Sci. (2), xv, p. 120.

1853. 28. On Owen's New Earth, "Thalia." Am. Jour. Sci. (2), xvii, p. 130 (Proc. Ac. Nat. Sc.).

1853. 29. Contributions to Mineralogy. Am. Jour. Sci. (2), xvi, pp. 81–86.
Tetradymite. Apophyllite.
Gray copper. Allanite.

1853. 30. Contributions to Mineralogy. Am. Jour. Sci. (2), xvi, pp. 167–170.
Owenite. Emerald-nickel.
Kaemmererite.

1854. 31. On a new Meteorite from New Mexico. Am. Jour. Sci. (2), xvii, pp. 239, 240.

1854. 32. Contributions to Mineralogy. Am. Jour. Sci. (2), xviii, pp. 410, 411.
Pyrophyllite. Owenite (identical with Thuringite).
Chrysotile.
Scolecite.

1854. 1855. 33. Herrerite, identical with Smithsonite. Proc. Phila. Ac. Nat. Sci., vii, pp. 232, 233; Am. Jour. Sci. (2), xx, p. 118.

1854. 1855. 34. Analysis of Meteoric Iron from Tucson. Proc. Phila. Ac. Nat. Sci., vii, pp. 317, 318; Am. Jour. Sci. (2), xx, p. 119.

1855. 35. Contributions to Mineralogy. Am. Jour. Sci. (2), xix, pp. 15–23.

Tetradymite.
Bismuthine.
Aciculite.
Barnhardtite, a new mineral.
Gray Copper.
Geocronite.
Garnet.
Allanite.
Tungstates of North Carolina.
Scorodite.
Wavellite.

1856. 36. Researches on the Ammonia-Cobalt Bases, jointly with Wolcott Gibbs; Smithsonian Contributions. Am. Jour. Sci. (2), xxiii, pp. 234, 319, and xxiv, p. 86.

1857. 37. Contributions to Mineralogy. Am. Jour. Sci. (2), xxiii, pp. 415–427.

Bismuthine.
Harrisite (Shepard), a pseudomorph of copper glance after galena.
Cantonite (Pratt), a pseudomorph of covellite after galena.
Linnæite.
Enargite.
Coracite (Leconte) is Pitchblende.
Epistilbite.
Shepard's Plumboresinite is Cyanosite.
Cherokine (Shepard) is Pyromorphite.
Vivianite.
Wavellite.
Dufrenite.
Hitchcockite.
Lanthanite.
Bismuthite.

1857. 38. A few remarks in answer to Prof. C. U. Shepard's Reply. Am. Jour. Sci. (2), xxiv, p. 133.

1857. 39. Report of Experiments on the Value of Wood Gases, jointly with Wolcott Gibbs. Franklin Inst. Journal, 3d series, vol. 34, p. 126–130.

1858. 40. Analyses of Water from the Dead Sea, and of the Spring of Elisha near Jericho, and virgin soil from near Jerusalem. J. S. Osborn's Palestine, Past and Present.

1858. 41. Preliminary notice of a new base, containing Osmium and the elements of Ammonia, jointly with Wolcott Gibbs. Am. Jour. Sci. (2), xxv, p. 248.

1858. 42. Contributions to Metallurgy, No. 1, Analyses of Chinese coins. Franklin Inst. Journal, xxvi, pp. 261–266.

1859. 43. Contributions to Mineralogy. Am. Jour. Sci. (2), xxvii, p. 400.

Whitneyite, a new mineral.

1859. 44. Contributions to Mineralogy. Am. Jour. Sci. (2), xxviii, pp. 246–255.

Native iron.
Native bismuth.
Whitneyite.
Bernhardtite.
Ripidolite.
Pholerite.
Scheelite.
Rhombic tungstate of lime.

Gersdorffite.
Molybdate of Iron (Owen) is Molybdite.
Albite.
Wolfram.
A few observations on the occurrence of Gold.

1859. 44*a*. Analyse natürlich vorkommender Wasser u. von Erde aus Palästina. Liebig's Ann., cx, 1859, pp. 240, 241.

1860. 45. Reëxamination of Tetradymite from Field's Mine, Ga., and on a new modification of Wolfram. Mining Mag. and Jour. of Geology, i, pp. 358-360.

1861. 46. On Tetradymite; Reply to Dr. Chas. T. Jackson. Journal of Geology, ii, pp. 64-66.

1862. 47. Contributions to Mineralogy. Am. Jour. Sci. (2), xxxiii, pp. 190-206.

Gold, pseudomorphous after aikinite.
Antimonial Arsenic and Arsenolite.
Arsenides of Copper, Domeykite, Algodonite, Whitneyite.
Copper glance, pseudomorphous after galena.
Millerite.
Proustite.
Automolite.
Pyrope.
Lime-Epidote.
Leopardite, a true porphyry.
Staurolite.
Serpentine.
Kerolite.
Monazite.
Rammelsberg's Mineralchemie.

1862. 48. On the Analysis of Chrome Iron ores. Chemical News, vi, pp. 30-33.

1866. 49. On Chrysolite with Chromic Iron in Pennsylvania. Am. Jour. Sci. (2), xli, p. 120.

1868. 50. Contributions to Mineralogy, vii. Am. Jour. Sci. (2), xlv, pp. 305-321.

1. Whitneyite from Arizona.
2. American Tellurium Minerals.
    Petzite and Hessite.
    Altaite.
    Native Tellurium.
    Melonite, a new mineral.
    Calaverite, a new mineral.
    Tetradymite.
    Montanite, a new mineral.
3. Barnhardtite from Arizona.
4. Cosalite, a new mineral.
5. Boulangerite.
6. Tetrahedrite from Arizona.
7. Brochantite.

1868. 51. On the occurrence of cupriferous ores in Texas. Proc. Phila. Ac. Nat. Sci., October 20, 1868, pp. 227, 228.

1870. 52. On American Tin Ores. U. S. R. R. Gazette and Mining Register, May 4, 1870.

1870. 53. On Rhodium Gold from San Domingo and Gold Sands from soil of Phila. Proc. Am. Phil. Soc., xi, pp. 438, 439.

1870. 54. On native lead and iron in Gold Tailings from Montana. Proc. Am. Phil. Soc., xi, pp. 443, 444.

1871. 55. Minerals of North Carolina, December 15, 1871. Published as Appendix C, pp. 53-88, of W. C. Kerr's report on the Geology of North Carolina, i (1875).

1872. 56. Mineral resources of North Carolina. Franklin Inst. Jour., lxiii, pp. 48-61 and 114-130.

1873. 57. Corundum ; its alterations and associated minerals. Proc. Am. Phil. Soc., xiii, pp. 361–406, and in German, Ueber Korund, etc., in Jour. für Prak. Chem., 1874, ix, pp. 49–113.

1874. 58. Reply to Dr. T. Sterry Hunt. Proc. Am. Phil. Soc., July 17, 1874.

1874. 59. Investigation of Iron ores and Limestones from Center, Blair, and Huntingdon Counties, Pa. Proc. Am. Phil. Soc., February 6, 1874.

1874. 60. On American Tellurium and Bismuth Minerals. Proc. Am. Phil. Soc., August 21, 1874, and in German in Jour. für Prak. Chem., N. F., x, pp. 355–369.

Native Tellurium.
Tetradymite.
Altaite.
Hessite.
Petzite.
Sylvanite.
Calaverite.
Tellurate of Copper and Lead.
Bismuthine.
Schirmerite, a new mineral.

1875. 61. Preliminary Report on the Mineralogy of Pennsylvania, "B," of the Second Geological Survey of Pennsylvania, 206 pages.

1875. 62. Second Preliminary Report on the Mineralogy of Pennsylvania, pp. 207–238.

1876. 63. On some American Vanadium Minerals. Am. Jour. Sci. (3), xii, pp. 32–36.

Roscoelite.
Psittacinite, a new mineral.

1877. 64. On some Tellurium and Vanadium Minerals. Proc. Am. Phil. Soc., August 17, 1877, and in German, in Groth's Zeitschrift für Krystallographie, ii, p. 1.

Native Tellurium.
Hessite.
Coloradoite, a new mineral.
Calaverite.
Tellurite.
Magnolite, a new mineral.
Ferrotellurite, a new mineral.
Roscoelite.
Green Mineral from Colorado (Aluminous Roscoelite).
Volborthite.

1877. 65. Report on Fertilizers, in First Annual Report of the Pennsylvania Board of Agriculture for 1877, pp. 77–103, with 17 analyses.

1879. 66. On Pyrophyllite from Schuylkill County, Pa. Proc. Am. Phil. Soc., July 18, 1879, pp. 279-280.

1879. 67. South Cārolina Phosphates, in Third Annual Report of the Pennsylvania Board of Agriculture for 1879, pp. 20-26.

1879. 68. Examination of North Carolina Uranium Minerals. Am. Chem. Journal, i, pp. 87-93.

Uranotil. Phosphuranylite, a new mineral.

Gummite.

1880. 69. Analyses of Fertilizers, in Fourth Annual Report of the Pennsylvania Board of Agriculture for 1880, pp. 60-73, Nos. 1-62.

1881. 70. On the Valuation of Fertilizers, in Fifth Annual Report of the Pennsylvania Board of Agriculture for 1881, pp. 45-49.

1881. 71. Analyses of Fertilizers, in Fifth Annual Report of the Pennsylvania Board of Agriculture for 1881, pp. 301-304, Nos. 63-191.

1881. 72. Analyses of Minerals and Rocks from Bucks, Montgomery, and Philadelphia Counties, by F. A. Genth and F. A. Genth, Jr., in Report C-6, Second Geological Survey of Pennsylvania, pp. 94-136.

1881. 73. Minerals and Mineral Localities of North Carolina, by F. A. Genth (and W. C. Kerr). Chapter 1 of volume ii of Geology of North Carolina, 1881, 122 pages.

1881. 74. In "Egyptian Obelisks," by Henry Gorringe:

Analysis of the Plagioclase from the Granite of the obelisk, p. 162.

Analysis of the Cement attached to the Pyramidion obelisk, pp. 169, 170.

Analysis of the Bronze from the Crabs of the obelisk, p. 173.

Analysis of the paints on images about 4,000 years old; Yellow and Gilt paint, Black paint, Red paint, pp. 173-175.

1882. 75. On Ensilage, in Sixth Annual Report of the Pennsylvania Board of Agriculture for 1882, pp. 107-109.

1882. 76. Analyses of Fertilizers, Annual Report of the Pennsylvania Board of Agriculture for 1882, pp. 392-394, Nos. 183-301.

1882. 77. Analysis of the Emerald-green Spodumene, "Hiddenite," from North Carolina. Am. Jour. Sci. (3), xxiii, p. 68.

1882. 78. Contributions to Mineralogy. Proc. Am. Phil. Soc., August 18, 1882.

I. 1. Corundum altered into Spinel.
2. Corundum altered into Zoisite.
3. Corundum altered into Feldspar and Mica.
4. Corundum altered into Margarite
5. Corundum altered into Fibrolite.
6. Corundum altered into Cyanite.
7. When were the corundum alterations formed?

II. Alteration of Orthoclase into Albite.
III. Alteration of Talc into Anthophyllite.
IV. Talc, pseudomorph after Magnetite.
V. Gahnite from Mitchell county, N. C.; from Cotopaxi, Col.; by H. F. Keller.
VI. Rutile and Zircon from the Itacolumite of Edge Hill, Bucks county, Pa.
VII. Sphalerite and Prehnite from Cornwall, Lebanon county, Pa.
VIII. Pyrophyllite in Anthracite.
IX. Beryl from Alexander county, N. C.
X. Niccolite from Colorado.
XI. Artificial Alisonite.

1883. 79. On Robert Wilhelm Bunsen in Encyclopædia Americana, i, pp. 675–677.

1883. 80. Analyses of Fertilizers in Seventh Annual Report of Pennsylvania Board of Agriculture for 1883, pp. 365–374, Nos. 300–518 and 86–295.

1884. 81. On Herderite. Proc. Am. Phil. Soc., October 17, 1884.

1885. 82. On the Vanadates and Iodyrite from Lake Valley, N. M., by F. A. Genth and Gerhard vom Rath. Am. Phil. Soc., April 17, 1885, xxii, A, pp. 363–375.

Vanadinite.	Descloizite.
Endlichite, a new species.	Iodyrite.

1885. 83. Über Vanadate & Jodsilber von Lake Valley, N. M., von F. A. Genth and G. vom Rath. Groth's Zeitschrift, x, 5, pp. 458–487.

1885. 84. Contributions to Mineralogy. Proc. Am. Phil. Soc., October 2, 1885, xxiii, pp. 30–47.

1. Tin and associated minerals.
2. Joseite and Tetradymite.
3. Seleniferous Galenobismutite.
4. Argentobismutite.
5. Cosalite.
6. Schirmerite and Beegerite.
7. Tetrahedrite—Sylvanite.
8. Polybasite.
9. Arsenopyrite and Scorodite.
10. Alteration of Magnesian Limestones from Berks County, Pa.
11. Ilmenite from Carter's Mine, N. C.; Oligoclase.
12. Topaz from Stoneham, Me.
13. Orthoclase from French Creek, Chester County, Pa.
14. Muscovite after Nephelite.
15. Stilpnomelane pseudomorphs—Ankerite.
16. Calamine.

  17. Titanite.
  18. Vanadinite.
  19. Annabergite.
  20. Dr. Clemens Winkler & Herderite.

1886. 85. Analysis of pseudomorph from Magnet Cove, Ark., in Geo. F. Kunz Mineralogical Notes. Am. Jour. Sci. (3), xxxi, p. 74, January, 1886.

1886. 86. On an undescribed meteoric Iron from East Tennessee, with two photographic plates. Proc. Ac. Nat. Sci., December 28, 1886.

1887. 87. Contributions to Mineralogy, No. 24. Proc. Am. Phil. Soc., March 18, 1887, with 1 phototype plate and 3 wood cuts.

  I. Occurrence of Tin ores in Mexico.
    1. On Cassiterite—*a*, C. red variety; *b*, C. yellow variety; *c*, C. pseudomorphs after hematite; *d*, C. pseudomorphs after magnetite.
    2. Hematite.
    3. Mimetite and M. pseudomorphos after anglesite.
  II. Vanadinite and Descloizite.
  III. Pyrite pseudomorphous after pyrrhotite.
  IV. Hessite.
  V. Tapalpite.
  VI. Allanite.
  VII. Willemite.
  VIII. Hisingerite pseudomorphous after calcite.

1888. 88. On Lansfordite, a new mineral. Groth's Zeitschrift.

1889. 89. On Two Minerals from Delaware County, Pa. Proc. Ac. Nat. Sci., 1889, pp. 50-52, with one wood cut.

  1. Gahnite.
  2. Columbite.

1889. 90. Contributions to Mineralogy, No. 44. Am. Jour. Sci. (3), September, xxxviii, pp. 198–203.

  1. Gadolinite from Texas.
  2. Cacoclasite.
  3. Monazite from Villeneuve, Canada.

1890. 91. Jarosite from Utah. Am. Jour. Sci. (3), xxxix, p. 73, January, 1890.

1890. 92. Contributions to Mineralogy, No. 46. Am. Jour. Sci., xxxix, pp. 47–50; Am. Jour. Sci., January, 1890.

  On a new occurrence of corundum in Patrick County, Va.
    Corundum.
    Andalusite.
    Cyanite and Rhætizite
    Muscovite.
    Margarite in part.
    Chloritoid.

1890. 93. On Lansfordite, Nesquehonite, and Pseudomorphs of Nesquehonite, after Lansfordite. By F. A. Genth and S. L. Penfield. Am. Jour. Sci., xxxix, pp. 121–137, February, 1890.

1890. 94. Contributions to Mineralogy, No. 48. Am. Jour. Sci., xl, pp. 114–120.
  1. Tetradymite.
  2. Pyrite.
  3. Quartz, pseudomorphous after Stibnite.
  4. Gold in Turquois from Los Cerillos, N. M.
  5. Zircon.
  6. Scapolite.
  7. Garnet.
  8. Titaniferous Garnet.
  9. Allanite.
  10. Lettsomite from Arizona and Utah.

1890. 95. Contributions to Mineralogy, No. 49. With crystallographic notes by S. L. Penfield. Am. Jour. Sci., xl, pp. 199–207.
  1. Amarantite.
  2. Sideronatrite.
  3. Ferronatrite.
  4. Utahite.
  5. Picropharmacolite from Joplin, Mo.
  6. Pitticite.
  7. The so-called Gibbsite from Chester County, Pa., a phosphate.
  8. Atacamite.

1891. 96. Contributions to Mineralogy, No. 50. With crystallographic notes by S. L. Penfield and L. V. Pirsson. Am. Jour. Sci., May, 1891, xli, pp. 394–400.
  1. Three new varieties of Axinite: *a*, from Franklin, N. J.; *b*, Guadalcazar, Mexico; *c*, McKay's Brook, Northumberland County, N. S.
  2. Eudialyte from Magnet Cove, Ark.
  3. Titanite from Magnet Cove, Ark.
  4. Monticellite from Magnet Cove, Ark.

1891. 97. Contributions to Mineralogy, No. 51. Am. Jour. Sci., May, 1891 (3), xli, pp. 401–403.
  1. Aguilarite, a new species.
  2. Seleniferous Bismuthinite and Guanajuatite.

1891. 98. Minerals of North Carolina. Bulletin No. 74, U. S. Geological Survey.

1891. 99. Contributions to Mineralogy, No. 52. By F. A. Genth, with crystallographic notes by S. L. Penfield. Am. Jour. Sci., xliii, pp. 184–189.
  1. Hübnerite.
  2. Hessite from Mexico.
  3. Bismutite.
  4. Natrolite.

1891. 100. On Penfieldite, a new mineral, No. 53, September, 1892. Am. Jour. Sci., xliv, p. 260 (No. 53).

1891. 101. Contributions to Mineralogy, No. 54, November, 1892. Am. Jour. Sci., xliv, pp. 381–389. With crystallographic notes by S. L. Penfield.

1. Aguilarite.
2. Metacinnabarite.
3. Löllingite.
4. Rutile.
5. Quartz resulting from the alteration of Orthoclase, from W. Cheyenne.
6. Danalite.
7. Yttrium-Calcium Fluoride.
8. Altered Zircon or Cyrtolite.
9. Lepidolite.
10. Fuchsite.

1891. 102. On Anglesite, associated with Boléite, No. 55, January, 1893, Am. Jour. Sci., xlv, pp. 32–33.