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THE FUTURE OF MINERALOGY IN AMERICA[1]

INTRODUCTION

THIS meeting is the culmination of repeated efforts extending over a period of more than one hundred years to band the mineralogists of America together and to maintain a journal devoted primarily to mineralogy and cognate sciences. Although our colleagues in England and France organized over forty years ago, in 1876 and 1878, respectively, we were unable to do so until a year ago. The past year has been primarily one of adjustment and development and of bringing the need of such an organization more strongly to the attention of those interested. It has also been a period during which our ideas of what the society should be have become somewhat clarified. The progress made has been most gratifying. We are now a going concern with some very tangible assets, and there are already strong assurances of a most influential future. As retiring president, I desire to discuss briefly some of the important phases in the development of mineralogy in America, and the various efforts made to organize a national society, and to found a journal; also to interpret, if possible, the function of mineralogy in our present-day educational and scientific programs and to indicate some probable lines of future development.

THE PERIOD OF EARLY DEVELOPMENT, 1785–1850

The earliest published papers dealing with the mineralogy of America were apparently those which appeared in the *Memoirs of the American Academy of Arts and Sciences,* in 1785. These were followed two years later by

[1] Address of the retiring president of the Mineralogical Society of America, Chicago, December 29, 1920.

what Merrill characterizes as the first work on American geology although its title was distinctly mineralogical. I refer to Schoepf's *Beitraege zur Mineralogischen Kenntniss von des Oestlichen Theils von Nord Amerika und seine Gebirge,* which was published in Germany.

An event of far-reaching importance upon the development of our science was the appointment in 1802 of Benjamin Silliman as professor of chemistry, mineralogy, and so forth in Yale University. This appears to have been the first college appointment for mineralogy in America. Silliman began his lectures at Yale in the fall of 1804, and two years later wrote a sketch of the "Mineralogy of New Haven," which was published in 1810 in the *Transactions of the Connecticut Academy of Sciences.* In those days mineralogy and geology had not been sharply differentiated, and mineralogy was commonly used as the more comprehensive term. Accordingly, this contribution by Silliman is commonly recognized as the first attempt at a geological description of a region. Mention must also be made here of the "Mineralogical Observations made in the Environs of Boston in 1807 and 1808," by S. Godon, and which were published in the *Memoirs* of the American Academy of Arts and Sciences.

Interest in the subject was increasing rapidly so that in January, 1810, Dr. Archibald Bruce established the *American Mineralogical Journal,* the first American publication designed primarily for mineralogists and geologists. He was a native of New York City, having been born there in February, 1777. Although a physician by profession, Dr. Bruce was vitally interested in mineralogy. After completing his medical studies at the University of Edinburgh in 1800, he spent two years visiting important mineral localities and collections in England, France, Switzerland and Italy, so that when he returned to New York in the fall of 1803 to take up the practise of medicine he brought with him a mineral collection of great value.

Dr. Bruce's biographer tells us that

> the ruling passion in Dr. Bruce's mind was love of natural science and especially of mineralogy. Toward the study of this science, he produced in his own country a strong impulse, and he gave it no small degree of eclat. His cabinet, composed of very select and well characterized specimens; purchased by himself, or collected in his own pedestrian or other tours in Europe, or, in many instances, presented to him by distinguished mineralogists abroad; and both in its extent, and in relation to the then state of this country, very valuable, soon became an object of much attention. That of the late B. B. Perkins, which, at about the same time had been formed by Mr. Perkins in Europe, and imported by him into this country, was also placed in New York and both cabinets contributed more than any causes had ever done before to excite in the public mind an active interest in the science of mineralogy.

And further,

> Dr. Bruce manifested a strong desire to aid in bringing to light the neglected mineral treasures of the United States. He soon became a focus of information on these subjects. Specimens were sent to him from many and distant parts of the country, both as donations and for his opinion respecting their nature. In relation to mineralogy he conversed, he corresponded extensively, both with Europe and America; he performed mineralogical tours; he sought out and encouraged the young mineralogists of his own country, and often expressed a wish to see a journal of American mineralogy upon the plan of that of the School of Mines at Paris. This object, as is well known, he accomplished, and in 1810, published the first number of this work. Owing to extraneous causes, it was never carried beyond one volume; but it demonstrated the possibility of sustaining such a work in the United States, and will always be mentioned in the history of American science, as the earliest original purely scientific journal in America.

It is to be sincerely regretted that the failing health and early death of Bruce caused this journal to be so short-lived. Its continuation would have permitted the mineralogists of this country to have looked with pride upon the achievements of our early workers in this direction, for in Europe much progress in the founding of mineralogical journals had already been made. In France there was the *Journal des Mines,* founded in

1795 and which became the *Annales des Mines* in 1816. In Germany the *Taschenbuch fuer die gesammte Mineralogie mit Hinsicht auf die neuesten Endeckungen* was established in 1806, which subsequently was superseded by the *Zeitschrift fuer Mineralogie*. This journal in turn gave way to the *Jahrbuch fuer Mineralogie, Geognosie, Geologie, und Petrefaktenkunde* in 1830, which with but slight modifications in the title has continued down to the present day and is recognized as a most powerful influence in the development of the early sciences, especially in Europe.

The first comprehensive work on mineralogy in America was Parker Cleaveland's "Elementary Treatise on Mineralogy and Geology," a volume of 668 pages with numerous crystal drawings and a colored geological map of the eastern portion of the United States, which appeared in 1816. In writing this text it obviously was necessary for Cleaveland, who was professor of mathematics and natural philosophy, and lecturer on chemistry and mineralogy in Bowdoin College, to which position he had been appointed in 1805, to draw freely upon European writers, especially English, French and German. The incorporation of American localities was an arduous task, for Cleaveland indicates that Bruce's *Mineralogical Journal,* a paper by S. Godon in the *Memoirs of the American Academy,* and another by Dr. Adam Seybert, of Philadelphia, in the *Medical Museum* were almost the only printed authorities which he employed.

In his introduction, Cleaveland stresses the importance of mineralogy in the following manner:

> It may also be remarked that several arts and manufactures depend upon mineralogy for their existence; and that improvements and discoveries in the latter can not fail of extending their beneficial efforts to the aforementioned employments. In fine the study of mineralogy, whether it be viewed as tending to increase individual wealth, to improve and multiply arts and manufactures and thus promote the public good; or as affording a pleasant subject for scientific research, recommends itself to the attention of the citizen and scholar.

Also,

> But whatever progress may hitherto have been made in mineralogical pursuits, every new advance has opened a wider and more interesting prospect. The science is still in its infancy, and in many of its paths can only proceed with a faltering and uncertain step.

In reviewing this pioneer text, Professor Silliman in 1818 said:

> In our opinion, this work does honor to our country and will greatly promote the knowledge of mineralogy and geology, besides aiding in the great work of disseminating a taste for science generally. . . . The method of execution is masterly. Discrimination, perspicuity, judicious selection of characters and facts, a style chaste, manly, and comprehensive, are among the attributes of Professor Cleaveland's performance. . . . In our opinion, Professor Cleaveland's work ought to be introduced in all our schools of mineralogy and ought to be the travelling companion of every American mineralogist.

The text was received with great favor, a second edition in two volumes being issued in 1822. Although later a third edition became necessary, it was never prepared on account of the failing health of the author.

In 1825 Samuel Robinson published an elaborate list of American mineral localities, entitled "A catalogue of American minerals with their localities." The following year Emmon's "Manual of Mineralogy and Geology" was issued. This was a text of 230 pages. The part dealing with mineralogy was the second general treatise on mineralogy published in America. Little attention was given to crystallography. Descriptive mineralogy was emphasized and 297 minerals were described.

The next work on mineralogy by an American was the first part of the "Treatise on Mineralogy," published in 1832, by Professor C. U. Shepard, who at that time was an assistant to Professor Silliman at Yale University. It was based on the work of Mohs and was a small volume of 256 pages. This was followed in 1835 by Part Two consisting of two volumes of 630 pages. A second edition was published in 1844.

The year 1837 is memorable in the annals of American mineralogy on account of the publication in that year of Dana's "System of Mineralogy." While this work, consisting of 580 pages, was based to a considerable extent on the writings of European mineralogists, notably Haüy, Mohs, and Naumann, it was not devoid of originality. This is especially true of the section on mathematical crystallography and of the elaborate classification of minerals based upon the systems in use in botany and zoology. As it is well known, this system of classification gave way in the fourth edition, in 1854, to a chemical classification which has continued in quite general use down to the present time. Dana's "System of Mineralogy" was received with great favor, and the first edition was succeeded by others as follows: second in 1844, third in 1850, fourth in 1854, and fifth in 1868. The last edition, which is the sixth by E. S. Dana in 1892, with its various appendixes, is the standard reference work the world over on descriptive mineralogy.

As already indicated, in 1810 Bruce founded *The American Mineralogical Journal* which was discontinued after the publication of but one volume. Although but short-lived, it had demonstrated the great need of a strictly scientific journal. Consequently in 1817 Colonel George Gibbs, one of the most enthusiastic devotees of mineralogy and the possessor of perhaps the largest and most notable mineral collection in America at that time, which was purchased by Yale University in 1825, suggested to Professor Benjamin Silliman that a general scientific journal be established. This led to the founding of the *American Journal of Science* in 1818 under the editorship of Silliman. While its scope was intended "to embrace the circle of the physical sciences and their application to the arts, and to every useful purpose," the *American Journal of Science* has from the beginning published most of the important contributions on mineralogical subjects by American writers.

The decade 1810 to 1820 is an extremely important one to us, for during that period there were founded the *American Mineralogical Journal* and the *American Journal of Science*. There was also published Cleaveland's *Mineralogy*. However, it yet remains to call attention to the fact that in 1819 there was organized at Yale College the *American Geological Society*. Many of the members of this society can be characterized as mineralogists, and mention may be made in this connection of Gibbs, Silliman, Cleaveland and Godon. This organization continued until 1828, when it went out of existence. During this period, however, it did much to stimulate American workers in geology and mineralogy.

This organization was followed in 1840 by the *Association of American Geologists*, which held its first meeting in Philadelphia on April 2, 1840. Meetings were held annually and in 1843 the *Transactions of the Association of American Geologists and Naturalists* appeared. However, in 1847 this organization became the *American Association for the Advancement of Science*. It is thus seen that the American Association with which practically all the important scientific societies are now affiliated, was according to Alexander Winchell "in its incipiency a body of geologists, and its first constitution was prepared by geologists assembled in Boston, in 1847."

In the development of American higher education in the period prior to 1850, the fact must not be overlooked that no college or university considered itself adequately equipped unless it possessed a representative collection of minerals. Indeed in the case of some institutions mineral collections, or cabinets as they were commonly called, were usually among the first purchases authorized by the governing bodies of the institutions. Such was, for example, the case at the University of Michigan, which was founded on March 18, 1837, but was not formally opened for instruction until 1841. In the meantime, however, the well-selected mineral collection of Baron L. Lederer, of New York City, consisting of 2,600 specimens, mostly from foreign localities, was purchased. This admirable collection was moreover quickly augmented, so that when the university opened

its doors to students a collection of approximately 5,000 entries was available.

It will also be recalled that in 1807 Yale University acquired the Perkins collection, and that in 1825 the Gibbs collection also became the property of that institution. In discussing the growth of mineralogy in this country from 1818 to 1918, Ford says,

> There is no doubt but that the presence at this early date of this large and unusual mineral collection had a great influence upon the development of mineralogical science at Yale and in the country at large.

From the foregoing discussion it is quite obvious that mineralogy played a very important rôle in the development of higher education during the first half of the nineteenth century. It was one of the first sciences to find a place in the curricula of our colleges and universities. Its devotees founded the first general scientific journals, one of which has continued uninterruptedly up to the present time and is held in high esteem the world over. Mineralogists were also among the first to recognize the need and value of national organizations, and were important factors in the founding of our most general scientific society, the *American Association for the Advancement of Science.*

THE PERIOD OF EXPANSION, 1850–1900

The second half of the nineteenth century was a period of rapid development in higher education. Colleges and universities sprang up all over the United States in quick succession, especially in the mid and far west. It was also a period in which mineralogy and geology were applied practically on a very large scale by the federal and state surveys. The demand for competent geologists became very great, so that more emphasis was now placed upon geology than upon mineralogy by the institutions of higher learning. However, during the last two decades of the century the need of specialization became imperative and the number of scientifically trained mineralogists increased materially. It was during this period also that petrography and economic geology began to be recognized as independent disciplines.

Not only did the expansion of our surveys and the development of our vast mineral resources, but also the fostering of graduate work by our older and larger universities, demand adequately trained specialists. It will be recalled that during the eighties and early nineties comparatively large numbers of Americans went to Europe and especially to Germany, to acquire the latest methods in petrography and mineralogy.

After the *Association of American Geologists and Naturalists* in 1847 voted to resolve that organization into the *American Association for the Advancement of Science,* geology participated along with other sciences in the activities of the association, and with geography formed what is known as Section E. Although at first the *American Association* served the interests of the geologists rather satisfactorily, nevertheless with the rapid growth of the *Association* the opportunities for meetings of a strictly scientific character became fewer and the need of a separate organization began to be felt. According to Alexander Winchell an independent organization was first openly agitated by the geologists assembled at the meeting of the *American Association* at Cincinnati in 1881. Although a committee was appointed, which canvassed the situation and reported favorably upon the organization of a separate society and the establishment of a geological magazine, no definite action was taken at the next meeting.

However, this question continued to be considered quite regularly at successive annual meetings of the *Association* and the publication of the *American Geologist* was begun in Minneapolis in January, 1888. Again on August 14, 1888, in Cleveland, it was resolved that the formation of an *American Geological Society* was desirable, and organization plans were made. The first meeting was held in Ithaca on December 27, 1889, with a membership of 137. This organization, officially known as the *Geological Society of America,* was from the beginning independent and in no way subor-

dinate to the *American Association*. It at once became a great stimulus to American geology and has exerted profound influence upon its development.

During the last two decades of the nineteenth century the movement to band those interested in minerals together in local organizations manifested itself in several of our large cities. Thus in 1886 the *New York Mineralogical Club* was organized to "develop and maintain an interest in mineralogy, especially in the minerals and rocks of Manhattan Island, New York City, through collecting and the study and comparison of existing collections." The club has been successful in stimulating interest in mineralogy in New York City and its environs. It has also acquired the Chamberlain collection of minerals which is now deposited in the American Museum of Natural History. Reference must also be made of the fact that in 1892, what is known as the *Philadelphia Mineralogical Society*, was organized, its purpose being similar to that of the New York Club. From time to time similar organizations had been founded in other localities, all of which have done much to stimulate interest in minerals and especially of those of the region immediately surrounding the location of the society.

It was also during this period that a journal devoted to the interests of the lover of minerals was founded in 1885 by Mr. Arthur Chamberlain. It was first called the *Exchangers' Monthly* but was subsequently changed to the *Mineralogists' Monthly*. In 1892 *Goldthwaite's Minerals* was published. For two years both of these publications appeared but in 1894 they were merged into the *Mineral Collector*, which continued to appear regularly until March 1909 when it was discontinued.

THE MODERN PERIOD, 1900–1920

The first two decades of the twentieth century have been a period of enormous development in higher education. Attendance upon our colleges and universities has increased by leaps and bounds. The physical plants of these institutions were greatly extended. The older departments of instruction were materially expanded by the giving of more advanced and specialized courses, and many new departments were added. Our graduate work developed rapidly. Even before the outbreak of the World War, fewer and fewer students each year found it necessary to go to Europe, as had been the custom during the nineteenth century, for they were now able to secure the instruction desired in our universities. Indeed, this instruction could be obtained from equally competent men and in more modern laboratories with superior facilities than were to be found abroad. The many contributions by the various governmental bureaus and the establishment of the Geo-physical Laboratory in 1907 gave a great impetus to many branches of science in America. Industrial corporations also recognized the imperative need of adequately equipped laboratories and competent investigators.

During this period, the development of science was indeed marvelous. This statement applies to no science more than it does to mineralogy, by which term we obviously include what may be readily interpreted as the broader field, namely crystallography. Moreover, it was during the war that the preeminent position of the United States in the production of minerals and mineral products, and the vastness of our mineral resources were brought most forcibly to the attention of the general public. Mineralogical methods had to be resorted to in the solving of many special problems imposed by the war, when it became necessary for us to establish our scientific independence. Hence, at present the value of mineralogy is appreciated as never before. On account of its basic value in the training of the geologist, chemist, pharmacist, forester, mining engineer, ceramist, and many other specialized engineers and technologists, mineralogy has become in some of our larger and more progressive institutions what may be designated as a "service" science. Furthermore, it is no longer merely a descriptive science but by virtue of the development of many quantitative methods and especially as the re-

sult of the epoch-making discoveries in the field of crystal structure it is now an exact science of fundamental importance.

THE MINERALOGICAL SOCIETY OF AMERICA

During the first fifteen years of the existence of the *Geological Society of America,* comparatively few of its members were primarily interested in mineralogy. However, beginning with the latter half of the first decade of the twentieth century the number of professional mineralogists who became members of the society increased rapidly. This group, however, soon felt that aside from the social aspect of the meetings, the society offered them but little in their own field. Accordingly in January, 1913, Professor Alexander N. Winchell, of the University of Wisconsin, in a letter addressed to those especially interested in mineralogy and petrography, raised the question as to the advisability of organizing a *National Association of Mineralogists and Petrographers.* The responses were, however, of such a character that a postponement of a separate organization was decided upon. This question, however, would not be downed and it came up annually at the meetings of the *Geological Society of America,* so that finally at the Albany meeting, December, 1916, a small group consisting of Phillips, Van Horn, Walker, Wherry, Whitlock, and the speaker, decided to launch an active campaign looking toward the formation of the *Mineralogical Society of America.* A circular letter, signed by the above-named committee, was sent out to those most vitally interested and the replies received clearly indicated the great desirability of such an organization. However, the United States entered the World War in the following April, and consequently plans for organization were held in abeyance. But in the meantime, there had been much correspondence among those taking a lively interest in the organization, and in the fall of 1919 the new society was again actively agitated. A call was issued for an organization meeting to be held at the time of the meeting of the *Geological Society of America* in Boston, and on December 30, 1919, a group of 28 mineralogists met in the Mineralogical Museum of Harvard University and organized the society under whose auspices we are meeting to-day, and adopted a provisional constitution.

At this meeting arrangements were made whereby the lists of charter fellows and members would remain open for one year. The question of affiliation with the *Geological Society of America* was discussed and it is indeed gratifying to know that during the year this has been accomplished. On December 20, the *Mineralogical Society* had 55 fellows and 126 members. There were in addition 139 subscribers to the *American Mineralogist.* The most enthusiastic advocates of an independent mineralogical society never expected that such widespread interest could be stimulated during the organization year.

AMERICAN MINERALOGIST

As already indicated the *American Mineralogist,* which was founded in 1916, became the *Journal of the Mineralogical Society* under the editorship of one of the founders, Dr. E. T. Wherry. A board of associate editors was appointed by the council to assist Dr. Wherry. During the past year the *Journal* has appeared regularly, the earlier numbers being considerably larger in size than had previously been the case. However, on account of increased cost of paper and printing it was necessary to reduce the size of the later numbers. It is hoped that as a result of the general readjustment of prices the issuing of monthly numbers of from 24 to 32 pages each may soon become possible. The exact character of the *Journal* needs to receive the serious consideration of the council, inasmuch as it must serve the widely divergent interests of several groups of the society. We owe much to the energy, skill and unselfish devotion of our editor, who is constantly striving to make the *Journal* one of which American mineralogists may be justly proud. This, however, will require some little time and I trust that we may all be somewhat patient in this matter.

GENERAL OUTLOOK

As the result of a more general recognition of the basic importance of mineralogy in pure and applied science and in various branches of industry, and with a national society boasting of a membership including the progressive investigators and devotees of the subject, and with a well established and widely recognized official monthly publication, the future of mineralogy in America is assured. The problems of really fundamental significance requiring a comprehensive knowledge of crystallography and mineralogy are indeed many. The applications of the methods and truths of our science are constantly increasing and if America is to assume leadership in this great field it can be most speedily and advantageously accomplished through the friendly cooperation of the members of an organization such as this.

Edward H. Kraus

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SEX IN THE TREMATODE FAMILY SCHISTOSOMIDÆ[1]

The trematode family Schistosomidæ in addition to containing three species which produce important human diseases, viz., *Schistosoma hæmatobium, S. mansoni,* and *S. japonicum,* is interesting because it is the only group of the trematodes in which the sexes are separate in the adult stage, which lives in the vertebrate. In this stage there is an extreme sexual dimorphism, the structure of the male being adapted for grasping the female in the gynæcophoric canal during copulation and the female having a very long slender body. The complete life cycles of the three human species of this family have been worked out in the last seven years, making it now possible to attack the problems related to the determination of sex and the development of sexual dimorphism.

Just what is involved in these problems can perhaps be made clear by a brief outline of the life cycle of one of the human species of this family, *Schistosoma japonicum.* The adult of this species lives in the bloodvessels of the liver and mesenteries of man and other mammals in the far East. The adults are almost always found in copulation in the vessels of the hepatic portal system. The fertilized ovum develops into the miracidium within the egg shell before the egg escapes from the host. The miracidium hatches almost immediately when the egg is voided into the water and dies within a short time unless it comes in contact with a small species of snail, *Blanfordia nosophora* (Robson). It penetrates vigorously into this snail and metamorphoses into a sac-like structure known as the mother sporocyst. The germ cells of the miracidium are carried over directly into the mother sporocyst and develop by parthenogenesis into daughter sporocysts. A single mother sporocyst may live for a considerable period of time and produce several hundred daughter sporocysts. These daughter sporocysts also carry germ cells and produce by parthenogenesis cercariæ which are the larvæ of the diœcious vertebrate-dwelling adults. These cercariæ escape into the water and will penetrate directly through the skin of any suitable host with which they come in contact. From the skin they make their way to the blood vessels of the liver, where they develop to sexual maturity in about three to four weeks. In fact I have seen copulation in an experimentally infested mouse nineteen days after exposure to these cercariæ.

The first question which naturally arises in connection with the sex phenomena in this life cycle is how far back can the sexual dimorphism be traced in the development of the adult from the cercaria in the final host. In a recent series of studies on the development of *Schistosoma japonicum* in experimentally infested mice I have been able to distinguish males from females in specimens about 0.3 mm. in length. Since the body of the cercaria of this species is about 0.15 mm. to 0.20 mm. in length and the smallest sexually mature forms have a length of about

[1] From the department of medical zoology of the school of hygiene and public health of the Johns Hopkins University.