# ACCEPTANCE OF THE ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA

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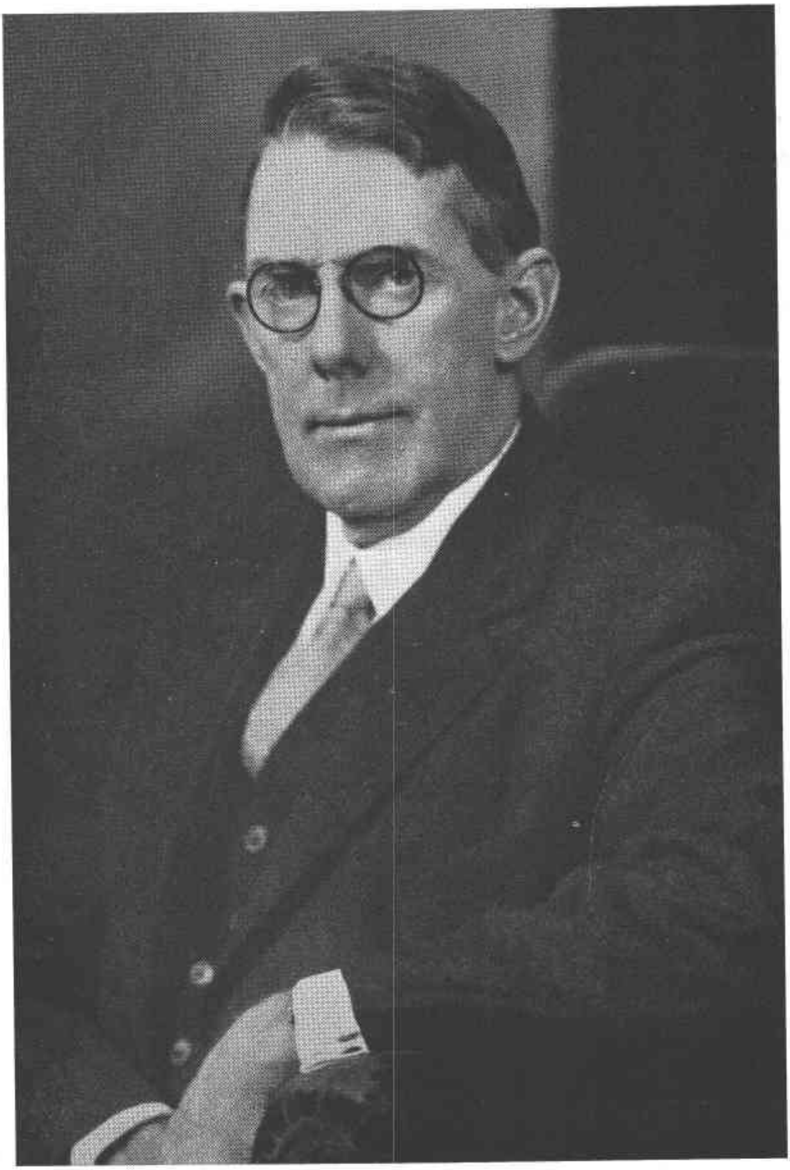
The Mineralogical Society of America bestows a very great honor when it calls one whose interest has been with minerals before its membership to receive the Roebling medal. Therefore, it is with sincere appreciation that I accept the Roebling medal of this Society from the hand of my friend and colleague, Waldemar T. Schaller. In casting over the names of those who have received this medal in the past there is a very deep sense of gratitude for all that it implies. Anything I can say will but inadequately express my heartfelt thanks, for there are times when spoken words are very ineffective, and this is such a time. There has also grown up the custom of an address by the recipient, perhaps to enforce a proper sense of humility. In response to this custom I have chosen to speak of some of the possible research problems in mineralogy, of some of the things yet to be learned. We also may consider how we can present mineralogic information known, or yet to be known, in a manner and with a completeness which will make it fully useful to mineralogists, geologists, and to the world. Even when the final volume of the new edition of Dana becomes available there will still remain fields of mineralogic information which will not have been covered, or which require fuller treatment.

The science of mineralogy is now blessed with effective methods of research and there is a very urgent need to fulfill the opportunities thus presented. These methods and techniques include the use of *x*-rays with their several modes of approach; the spectrograph, old in theory but now available with great refinement of equipment; perfected methods for differential thermal analysis; the improved methods for mineral separation; and the systematic determination of optical properties, particularly the more accurate determination of numerical values of indices of refraction. Of fundamental importance is the only partially developed study of paragenetic relationships. These methods were preceded by chemical analyses; measurement of crystal angles, studies of morphology; visual recognition, and mineral synthesis, an old but constantly developing method of study.

A survey of these various methods of mineralogic research indicates that the trained mineralogist of today should make use of analytical chemistry, of physical chemistry, of *x*-rays. He should be skilled in crystal optics, have a wide and intimate knowledge of the literature of mineralogy; be able to determine in the field the mode of occurrence and relationships of minerals; have a knack for the manipulation of the tools of



Clarence S. Ross, Recipient of the Roebling Medal of the Mineralogical Society of America.

research and the design of new ones. Of course, few of us can hope to be all of these, but the research mineralogist must be skilled in several of these fields, and should know the applicability of all of them to problems in hand. Thus, almost the entire range of the physical sciences is placed at the disposal of the mineralogist. This means that mineralogy, like all the other sciences, must depend more and more upon the efforts of a group; but of necessity a group, the members of which can see the problem as a whole, and understand the roles that other lines of effort are to play. What is the range of the opportunities thus presented, and what are some of the most urgent problems that await attention?

Of all the methods of mineralogical research, the most neglected today is chemical analysis, the oldest of the truly rigorous methods. This is not said to belittle the others, *x*-rays, for instance, but because the others can not be effectively applied until more and better chemical analyses are available. Thus chemical analysis is, as since the beginnings of mineralogy, the foundation stone of mineral studies. How often do we see the use of old analyses, which may themselves be good, but whose correlation with the material under investigation is open to question, or which may have been made on impure materials? How often has the study of a mineral been handicapped because the mineralogist had to shop around to secure an accurate analysis? If this is true for single minerals it is all the more true where the study of mineral groups is involved. In a search of the literature for analyses of particular minerals one is commonly surprised to find how few are available, or that no recent analyses have been made.

Chemical analysis may become mere routine, but analytical work takes on new interest when the chemist learns to use petrographic or other methods of mineral research. He may thus come to feel that he is a full partner in a research group. These and other means must be provided to interest and recruit able chemists, so that analytical chemistry may play its fundamental role in mineralogic research.

Members of the Geological Survey and associates outside the Survey have recently been engaged in a canvass of the problems involved in a systematic study of the mica groups and this indicates that at least a hundred new analyses are needed for such a study. The newer methods, *x*-rays, spectrograph, or differential thermal analysis may often speedily identify a mineral and thus make a routine analysis unnecessary, but they do not remove the need for analysis as a part of a research program. New discoveries have a thrill for all of us, but enthusiasm for a new method too often leads to disregard of older but vital methods. The *x*-ray helps the chemist in the selection of materials, determinations of impurities, and even suggests procedures by indicating relationships. Likewise, the spectrograph has become so much a part of every wellequipped laboratory that all rocks and minerals should be examined by this means before analysis. This will show the major elements which must be determined by chemical means and at the same time the minor ones present as traces, which may be determined better by spectrograph than by analysis. Differential thermal analysis may indicate the approximate proportions of gibbsite present in bauxites, and so the chemist will need to analyze only the high grade and more promising materials. These techniques are helpful supplements, but not substitutes for careful chemical analyses. By their means the chemist may be relieved of much routine work, and allowed to concentrate on the constructive research required if we are to understand mineral relationships and mineral groups.

The systematic study of mineral groups is probably the largest single line of research to which mineralogists may now devote their efforts. Important work along these lines is being done and within recent years we have come to have a far better knowledge of a number of mineral groups, but a large number of others await attack.

We may revert to the aforementioned mica group to illustrate some of the problems in the study of mineral groups; but in so doing there is no suggestion that they are uniquely important. Such a systematic study requires many additional analyses: in particular, of the various types of micas separated from igneous rocks. In general, the representation of rock-forming minerals is discouragingly small among available analyses. A systematic study of rock forming micas for instance will add not only to our knowledge of this mineral group, but also indicate much about the reciprocal relationships between the component minerals and the gross composition of the enclosing rock, and about paragenesis. Some of the more important minerals for which further study seems needful, are the amphiboles, the epidote group, the tourmalines, the hydrous magnesian silicates, including serpentine and all related materials, and many of the non-silicate mineral groups.

The separation of minerals for chemical analysis is one of the necessary, but most laborious duties connected with mineralogic research. It requires careful selection of suitable materials, patience, and ingenuity in the use of all available techniques for mineral separation—heavy solutions, the electromagnet; long hours of tedious hand picking; flotation; centrifuging, and at times special chemical treatment, involving knowledge of the chemical reactions which will leave the desired mineral unaffected. Routine treatments are rarely adequate, and each rock or mineral may present new problems. The suitability and purity of the separated material must be constantly controlled by petrographic study, *x*-ray, or spectrograph, and commonly by all of these methods.

The methods for determining optical properties under the petrographic microscope, particularly since the first appearance of Larsen's tables, has become so standardized and widely accepted that further advocacy of their usefulness is hardly needed among mineralogists. Optical properties however do not attain their greatest significance until they have been correlated with differences in chemical composition. Unfortunately, the optical methods have not been fully applied in some other branches of science which would be greatly benefited by the systematic use of the petrographic microscope, and the techniques which it makes possible.

The application of *x*-ray methods to the study of crystalline materials has been the greatest single contribution to mineralogy since the development of the polarizing microscope. A detailed discussion of the greatly refined techniques now available would be outside the limits of this address. However, a knowledge of the many ways by which *x*-rays may assist in mineralogic research should be familiar to all mineralogists. These include the identification of minerals, especially of fine grained aggregates and opaque minerals, the determination of mineral relations by means of similarities in their space lattice, and very exact determination of the lattice structure.

The study of the opaque minerals long lagged behind that of the other branches of mineralogy. These minerals presented unusual problems, since they were very difficult to identify by the older methods; mineral varieties were imperfectly known; analyses were at times correlated with the wrong mineral and mixtures had been unwittingly analyzed. Modern studies of the opaque minerals have applied *x*-rays, etch tests, microchemical techniques, hardness tests, color comparisons including spectrophotometry, polarized reflected light, and the spectrograph; as well as the older methods of chemical analysis, and crystallography. The electron microscope and in particular the replica film process will no doubt help in the understanding of these minerals. Research is being done on the greater refinement of all these methods, and polishing methods are being perfected. The significance of the physical relations of these minerals, and their paragentic history are expanding subjects of investigation. All this intensive work is rapidly extending our knowledge of the opaque minerals, but much remains to be done.

The electron microscope has interested mineralogists as it has those in other branches of science. It has given us a knowledge of the physical habit of some of the minerals, which like the clay minerals, are capable of extreme dispersion, and hence, come within the range of its magnifications and its limited powers of penetration. Electron diffraction has supplemented *x*-ray diffraction and the use of the replica film process on polished surfaces has been mentioned.

The method of differential thermal analysis first devised by LeChatelier, but recently reintroduced by Norton, has proved to be especially useful in studies of the clay minerals, bauxites, carbonates, and the hydrous magnesium silicates. In studies of minerals of the montmorillonite group, it even indicates whether the exchangeable base is sodium or calcium, and it has been especially useful in the preliminary evaluation of bauxite deposits.

The Data of Geochemistry compiled by Clarke went through many editions. Few books pertaining to any branch of the geologic sciences have ever had so wide an acceptance in Europe as well as in America, and about 46 thousand copies have been printed. More than 20 years have passed since the last edition appeared, but the need for some source of similar data has grown with the years, and the Geological Survey hopes to prepare such a revised and modern edition. The scope and practical limits of such a proposed new volume have not been fully determined. However we may briefly consider the various types of data which would be desirable in a fully monographic presentation of mineralogic information; perhaps constituting a more inclusive and voluminous series of publications than would be possible in even a greatly enlarged edition of the Data of Geochemistry.

One method of presentation might be by mineral groups, and an entire volume could easily be devoted to some of these. Obviously such a detailed presentation would need to be the joint product of a large group of specialists and would require years of preparation. The first parts might need revision by the time the later ones were finished, and so would represent continuing contributions. Doubtless all this can be only an objective for the time being, for during the war period the immediate need has been the chore of all of us, and a backlog of problems has accumulated, which must be cleared up before new projects are undertaken. Therefore the proposed outline is one of ideals, but ideals, even when not fully realizable, will help to orient our plans and activities. Ideals may eventually become realities. We must ever look forward, envisioning new projects, new plans, new expectations, for these are the very life breath of science.

If such a series of papers were to be realized, the chemical data should be very complete, and should return to the usage of Edward S. Dana in presenting an ample list of analyses of minerals, selected so far as possible to illustrate the different types, the various regions from which they have been reported, and the different genetic environments under which they are known to have formed. Rare elements, including those present only in traces, so far as these are known, should be listed, and their relation to environment and association should be discussed. The information gained from mineral synthesis should be included, together with the phase relations. The different modes of formation as revealed by field relations should be presented, together with the indicated physical conditions, and the physical chemistry which favors the different modes of formation. The outstanding studies and regions where these modes of formation are best exemplified should be summarized. A list of the important minerals which commonly accompany each distinct genetic occurrence, and of the alteration products, would be an essential part of any such treatise. References to published studies along all these lines should be very exhaustive.

The part of the foregoing outline which would prove to be the most sketchy, and which would most forcibly present the magnitude of the mineralogic work yet to be done, would undoubtedly be that of genetic relations. It would, however, be the handbook for all those engaged in carrying forward studies of mineral paragenesis, and so be of immense help to all those interested in trying to discover how minerals form. This no doubt leads mineralogy far into the realm of geology, but some geologic problems must be attacked by a mineralogic approach, and both geology and mineralogy benefit thereby.

The lines of research here suggested may not all be of the best; certainly some of you will favor others; and avenues will no doubt open before us which none can foresee. However, all will agree that we have awaiting us problems, opportunities, duties, for all of which we can be immensely thankful. Mineralogy is among the very oldest of the sciences, but it still is young, for it grows and hopes and plans. Colonel Roebling, in whose honor this medal was named, indicated his faith in the future of mineralogy through his generous endowment of our Society, and we, being endowed with so great an opportunity, can help to justify his faith.

This medal is a very beautiful thing in itself, but to me its greatest values will be its symbolism of the science we all love and serve and as a reminder of the heartfelt gratitude I owe to the Mineralogical Society, and to you, my many friends, who are its representatives here today.