ACCEPTANCE OF THE ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Paul Niggli,
Eidgenössische Technische Hochschule, Zürich, Switzerland.

The Roebling Medal, which The Mineralogical Society of America has been pleased to confer upon me, is indeed a unique distinction for a mineralogist. This presentation marks the second time the Medal has gone overseas and the first time to go to Switzerland. Professor Kraus has referred to the work of the Swiss mineralogists and geologists and to me in most flattering terms. Small wonder, then, that at this moment I should feel not only thankful to you, who have thus honored me, but embarrassed as well. I cannot but think that individual effort, when it shows a certain continuity and springs from real pleasure in the subject, may easily be overrated.

And so I should like on this so memorable an occasion for me to define in some measure what seems to me the special charm of the science we all serve. Some 40 years ago when I decided to take up the study of mineralogy, men who knew that I liked to grapple with a problem asked me why I had not chosen one of the so-called fundamental sciences, such as chemistry or physics. Minerals were, they said, for the most part already well known, and the general knowledge of the lithosphere was so far advanced as only to leave routine work to be done. The development of our science during the last 40 years has amply shown how far amiss such opinions were. And yet even today, and in spite of the rapid advance of crystal chemistry as a new connecting link between different sciences, mineralogy seems to lie off the road, since "speed," "actuality," "rationalization" are the order of the day. Perhaps this is because a comparatively tranquil atmosphere has surrounded our work. To understand the essential difference between our style of research and that prevailing in other sciences, we must define more clearly the very nature of the latter.

The progress of chemistry and physics has been made possible by observation, analysis, and experimental and mathematical treatment of natural phenomena. But happenings in nature, such as thunderstorms or avalanches in the spring time, were divided into a number of separate processes, each of which could be satisfactorily studied in the laboratory under precisely defined conditions. Thus separated from their natural context, they provided the basis of chapters in Electricity, Mechanics, and Physical Chemistry.

If a chemist or physicist is asked today about the details of the formation of a rock or mineral paragenesis, he will indicate some general laws, but at the same time point out that the influencing factors are far too

Paul Niggli, Recipient of the Roebling Medal of The Mineralogical Society of America numerous and the prevailing conditions too vague for an exact answer. He feels little interest in the intricate natural combination of processes which he for his part is accustomed to study separately, or at least to combine according to his own desire. The laboratory study has become for him the surroundings in which he receives the impetus and inspiration for his work.

These sciences have often been called the exact ones because they endeavor so to simplify and generalize the problems so that comparatively unequivocal deductions can be made. Research that is directed toward the unaltered conditions found in Nature (in the lithosphere, for example) that strives to give these conditions a scientific formulation and to understand them as the result of certain processes, is generally called a descriptive science. This is because axioms and definitions are replaced by descriptions of what Nature provides. But it is certainly not true to say that such descriptions exhaust the scope of our science. To the same extent as in physics or chemistry, it studies processes and properties and strives to understand the present state of things as derived or still in process of derivation from former states. But what is characteristic of the so-called descriptive sciences is their constantly maintained effort to reach an understanding of the natural phenomena as a whole, influenced and guided as they are by a multiplicity of factors.

The mineralogist and petrographer can never approach his problems from a one-sided standpoint. As a geologist, geophysicist, and geochemist, he must study the sites chosen by Nature for forming minerals and mineral deposits. What concerns him most is the question how this product of Nature came to be, what ultimate causes (irrespective of chemistry and physics) gave it its peculiar aspect and relationship to other occurrences. The physicist and chemist who is only interested in certain fundamental phenomena runs the risk of undue specialization. On the other hand, the mineralogist, petrologist, geologist, and biologist, for whom every natural factor is of importance and who should, therefore, be accurately informed about all of them, can, very often, not meet the requirements made upon him. Much that he needs for his synthesis must be accepted by hearsay, which easily leads to dilettantism.

Thus, both lines of research have their danger, though of course, the fundamental differences that have been sketched by no means coincide with an aptitude for any one subject or line of teaching. Many highly meritorious teachers and researchers in mineralogy and petrography have restricted themselves to very narrow fields and have never felt the urge to apply themselves to any particular occurrence in Nature. On the other hand, there have been physicists and chemists who never lost sight of the natural interrelations. But on the whole, the fact remains that the work of the mineralogist and petrologist starts from a study of Nature and is an attempt to apply the teachings of all fundamental sciences to his own very special problems. And this seems to me at least the peculiar, in fact, incomparable, attraction of the earth-sciences.

In some remote valley of the Alps and among the steep rocks we find signs of mineral fissures formed during the period of compression of the earth's crust and of mountain building. Carefully opened, the interior of the fissure displays a maze of crystals, wonderfully regular in shape. We attempt to unravel the laws governing the structure of these products of Nature, structures which require magnifications of a hundred million times to be made visible. And with their help the processes of crystallization and the development of crystal forms are made accessible to our understanding. Other questions arise which go beyond the formation of the individual occurrence and relate to mineral paragenesis in general, for instance the source of the solutions from which the crystals have separated according to physical-chemical laws. These in turn lead to a study of the rocks in which the mineral fissures were formed and further to the rock-forming processes and geochemical laws which many millions of years ago led to the formation of this part of the lithosphere that during the course of the Earth's history has again and again undergone changes and entered into characteristic reactions with the exterior forces.

Immense vistas thus appear before us, as soon as we attempt to comprehend in its historic significance even so small a portion of the inorganic world around us. Surely this task of reconstruction must always seem a fascinating one, even though we are aware that the picture we construct carries no certainty with it but merely a probable or possible sequence of events. Our activities may be compared with those of an artist who from many separate impressions creates a painting in which form and color are but parts of a whole, but whose harmony conveys an essential truth.

The stress, thus laid on the historical and artistic aspects of our science, may perhaps evoke the question whether such activities are of any practical value. Personally, I consider this question misplaced. The urge toward understanding the world around us is not one that can be judged by material values and from the point of view of its usefulness. The times in which we live have made it doubtful whether the progress of technical science has been well or badly applied. But it is clear that every scientific achievement must have an influence on our daily lives and that it would be absurd not to make use of the results of our labors in shaping the pattern of the surroundings in which we live. Our sciences are no exceptions in this respect. Nor do they merely show us where our raw materials are to be obtained. The increasing importance of complicated building and construction materials calls for widely comprehensive viewpoints that are essential to the mineralogist and petrographer. It does not suffice to classify an industrial material according to its chemical composition or physical behavior under simple conditions. Internal structure, micro- and macro-structures, behavior under influence of variously combined factors in tests of short and long duration, all these and many other details must be given conscientious consideration before a useful characterization can be arrived at.

The mineralogical style of research is beginning to make headway in these connections and, as in medicine, so also in the study of materials, scientists with a broad outlook are increasingly being called upon to supplement the work of the specialists. The value of correlations based on a knowledge of the constitution as a whole is thus becoming increasingly appreciated.

The aims man sets for himself are ideals he can never achieve. That, of course, is true also for mineralogical and petrographic reserach. How gratifying is it, then, when the striving for truth finds recognition, notwithstanding the errors that have crept in. Thus, it is, I feel, not through what I have achieved, but at most by loyalty to what I consider to be the fundamental principles of our science that I can in any way merit the honor you have bestowed on me, which moves me so deeply. For such time as may still be given me, the Roebling Medal will always be an incentive to further research.

I extend to you my heartfelt thanks, and my thanks go also to our common inexhaustible Science, which even in the darkest days of our history has never failed to enrich us.