Geology, Its Place in Science and the School Curriculum*

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This title of the subject upon which I have elected to speak opens up a wide field of approach. Geology may be defined as the science which treats with the history of the earth and its inhabitants, as recorded in the earth's crust. More specifically, it is concerned with the composition, character, and architecture of the earth and with the natural agencies and processes which continually have been and are now altering it. We study those substances, both within and on the earth, that compose its body. We study the character that the earth has in respect to other heavenly bodies—how it reacts to outside influences and how it behaves inwardly and on its surface. The term architecture, as here used, pertains to the rock framework of the earth and to the natural forces which are constantly acting upon this structure.

The natural agencies that influence and alter the earth's crust are wind, water, and ice. For instance, we have all seen streams running over the surface and carrying tremendous loads of rock and soil. They are, as you can see, affecting the rocks of the crust when they transport this material from one place to another. Geologic processes refer to a multitude of features. I might cite the action of volcanoes as one example; another is the occurrence and propagation of earthquakes. Indeed, there are many other natural geologic phenomena.

Geology is a big subject. As we strive for the full answer to questions about the earth, we enlist and use all of the other natural sciences. Although geology is not an exact science in the strict sense of the word, it has been called rightfully the broadest of all natural sciences in that it enlists and chooses what it will from the collaboratory fields of biology, zoology, chemistry, physics, mechanics, and so on. Geology is a fascinating subject since it includes not only a study of the physical conditions and history of the earth from the time of its beginning, but it deals with the orderly appearance and development of all life on the earth as well. The procedure we follow in an attempt to answer these questions which arise, is to observe conditions and happenings as they occur day by day on the earth's crust. We then use the observations as a key with which to unlock the secrets of the past that are recorded and waiting for translation in the great volume of the rocks. For example, studies of the present volcanic activity on Hawaii give us a clue or key as to what occurred over much of Idaho and the Pacific Northwest thousands and thousands of years ago, as is now evidenced in the rocks of this region.

There are two fundamental reasons why we make these studies of the earth. They are, namely, (1) for the economic advantages we may gain through having a knowledge of geologic principles. A geologist is called upon to not only classify minerals and rocks, but to locate valuable mineral deposits and to direct their exploration. He gives counsel regarding dam sites, tunnels, foundations, irrigation systems, the control of floods, and of other engineering projects; (2) for purposes of increasing our general knowledge of the earth upon which we walk and to become familiar with the natural wonders we see on every hand. By such familiarity with the grandeur of nature, we must necessarily become better people with whom to live.

It is my purpose to consider the science of geology from its aspect as a true economic science and also quite fully from the cultural and popular standpoint. The growth of science to its

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present substantial proportions is largely the result of the intellectual curiosity of the human mind, but the practical problems and commercial aspects of geologic principles have tremendously stimulated the growth of the science.

A geologist, highly trained in the profession of geology, is a specialist in his chosen field. He is a technical man whose efforts directly or indirectly are devoted toward the goal of greater economic wealth. The school curriculum is so designed that such professional attainment may be secured in the various specialized phases of the science. At the same time, however, every geologist is well-versed in the fundamental principles of geology and its related sciences through his school efforts. Some men, upon graduation, go out into commercial enterprises well-equipped and trained to apply the principles, facts, and theories which have a bearing on the distribution, mode of occurrence, and economics of our natural mineral resources. Others, still geologists in every sense of the word, elect to bend their efforts along research and instructional trends. Each must have met the requirements of a comprehensive course of study in geology before he reaches his objective. Indeed, it is upon graduation that the trends of special interest really begin to diverge. The man of commercial bent thereupon begins to visualize things largely from the practical standpoint whereas the researcher is still delving and probing into the subject in the more academic manner. The trained man in the field undertakes to carry on the analysis of the distribution and occurrence of valuable mineral deposits of lead, zinc, copper, gold, phosphate, cement, clay, etc. He is better able to reach the heights of his endeavors by having had the theory of geology as presented in our schools and universities. The unschooled man, by virtue of this fact, can never reach the higher level, regardless of his innate ability and judgment. The day of going out and discovering a mine which will yield ore from the grass roots down is essentially gone forever. Today, in the discovery of new mineral wealth, we must apply, as working tools, the theories and principles of our science.

The unschooled man can never, of course, in this day of extreme specialization, reach the heights attained by a specialist in research. The researcher is often working in science for science's sake, and also to the end that his findings will be of value to the man who has taken the other trail of strictly commercial practice. Although at the time the scientist discovers new principles there may not appear to be any direct commercial application, one usually soon develops and the practical man can thereby more readily search out the hidden riches of the earth.

As an illustration of this point, I might cite, as one example among many, the study of the paragenesis of metallic minerals. The economic geologist, working as a pure scientist in the beginning, and using his microscope and other laboratory facilities, early noted a certain uniformity and order in the sequence of deposition of many metallic minerals in nature. The commercial geologist, now that the day of discovering ore right at the earth's surface is largely gone, is employing these criteria more and more in his attempts to interpret and visualize sub-surface conditions of mining geology.

Inasmuch as geology is concerned chiefly with field interpretations and observations, it is frequently noted that the man who, through commercial experience, has cultivated a field technique, and can combine this experience with technical theoretical knowledge, not only then makes an outstanding research specialist, but, in addition, is often a splendid teacher. Students, who train under such an individual, tend to most readily grasp the interrelation of theory and practice and thereby can go on rapidly and steadily in later endeavors.

Here we note the close association of geography and geology. In fact, a geologist's education is not complete without

at least a fundamental training in geography and a knowledge of how the two studies may and do correlate and supplement each other. For example, what natural factors control our fertile soil areas, our natural boundaries, and economic mineral empires? What controls the occurrence and distribution of our watersheds and of our "dustbowl" areas? Certainly, the answers to these questions, together with many others which might be mentioned, are largely geographic in character but at the same time they are equally geologic. The processes involved have developed in and on the crust of the earth through the activity of natural geologic phenomena and agents. There is no question but that the occurrence of various geologic features closely parallel the geographic environment of man on the surface of the earth.

I am firmly convinced that true and total solution of our economic situation does not rest solely in the perfection of new geologic techniques nor in the discovery of new mineral deposits of oil, coal, silver, copper, lead, or phosphate. To a far greater degree it lies in our satisfactory solution of the current social problem. So it is with this thought in mind that I wish to present an analysis of the broader aspect of geology as we find it in the school curriculum. This is the phase which has to do with the natural inquisitiveness of the human mind and which sets man off as an animal apart from all others on the earth. Geologists have sometimes been called dreamers; it is said that they do not keep their feet on the ground and that they are prone to speculate and theorize too generally. If this be so, I claim it is a happy condition. For instance, Chamberlin and Moulton in developing their famous Planetismal hypothesis of Earth origin were parties, albeit unintentional perhaps, to such an order. Moulton, the physicist, and Chamberlin, the geologist, counterbalanced each other's efforts so that their work has become widely recognized. What happened? A true hypothesis is developed only through the correlation of facts and natural laws with imaginary ideas. It has been suggested that Chamberlin furnished many of the ideas. Moulton presented the physical facts with which they must agree. They are rightfully both entitled to equal credit for their achievement. I believe implicitly, and I am entirely sincere when I say that I think the solutions of material problems are not to be found in materialism, but are instead largely bound up in the appreciation and knowledge of the beauties of nature.

This is the appreciation that we gain from a study of the cultural phase of geology, and it is with this thought in mind that I suggest the ever widening adoption of the study of geology and geography in our secondary schools. The younger, more easily molded, mind is open and eager to grasp this study of our living sphere. For instance, the student observes and is brought to understand the devious but none the less controlled development of the wonders of nature on the earth's crust. We learn how and why the Grand Canyon of the Colorado River was formed, what Yellowstone, Craters of the Moon, Crater Lake, and other particular phenomena, mean in the earth scheme. We are romanticists in that we delve into the character of the center of the earth; how the earth originated, and how it fits into the infinite planetary system. We observe in fossils the wonderful evidence of past life on the earth, and we disturb and remove these forms from their burial ground of perhaps 500 thousand or 500 million years ago. In fact, we are in many cases the first creature that ever walked upon the face of the earth that has seen the fossilized animal since its burial day. We know why the dinosaurs no longer live upon the earth's surface — those tremendous beasts which grew so large that one form actually was forced to develop two nervous systems or brains so that his back legs and feet could keep coordinated and going in the same direction as his front limbs.

We speculate as to the former presence of land bridges joining two continents together. We study what makes our mountain ranges and why many of their highest peaks are now situated in areas which were formerly flooded by arms of the sea. We know that such is the case because we find fossils of marine animals trapped in the rocks of the mountain ranges. We know that the Salmon River, that famous "river of no return," was flowing over a land surface in its present direction and manner long before the present central mountain range of Idaho was uplifted. We observe the effects of glacial invasions and understand why peculiarities of such phenomena have resulted in the formation of an ideal locality for the Grand Coulee Dam.

In the study of geology, we lose ourselves not in the pursuit of material things to the degree that we do in the treatment of the awe-inspiring and magnificent wonders of the greatest history book of all, the earth's crust.

For this reason alone, and aside from the increase of our general knowledge, the geologist, or the person who merely studies geology as a natural science, are undoubtedly better men. The true geologist because economic enterprise and greed are tempered with the cultural aspects of the science, and the natural science student because he has been given an appreciation of the devious ways and grandeur of nature.