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THE ECONOMIC AND CULTURAL VALUE OF  
GEOLOGY<sup>1</sup>

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The title, The Economic and Cultural Value of Geology, is very inclusive. It is certainly a sufficiently broad one upon which to make an address of twice the length of the ordinary presidential address without exhausting the subject although the members of the Academy might find themselves completely exhausted. It is with much hesitation that I begin this address before an Academy with so diversified a membership as this one of ours. I can sense a feeling that some are thinking that the President is advertising his own field in a loud and unseemly manner. If any feel that way, I am sure they shall enjoy at some future date a presidential address by some one who is in their own field of endeavor or some closely allied one. The office of president passes annually to a member from another section of the State who has different interests.

The broadest definition of geology is the history of the earth. In the attempt to unravel the history of the globe, geologists have used information gathered by all the sciences from Astronomy to Zoology with one or more sciences representing each of the remaining twenty-four letters of the alphabet. This use of information from other fields of endeavor has been so generous that many persons have asked, "What has geology contributed to the sum total of knowledge?" "Is it not a composite subject resulting from the assembling of the data obtained in other fields?" The proposers of such questions are thoroughly justified in asking them although they reveal at the same time a certain ignorance. It is true that geology does depend upon the other sciences for data and ideas, but geologists have taken knowledge obtained in the laboratory and have applied it to the earth. Moreover, Geology has contributed ideas of its own. The concept of the duration of time and consequently that small forces working over a

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<sup>1</sup>Address of the retiring president of the Tennessee Academy of Science, presented at the annual meeting, Nashville, November 29, 1935.

long period of time can produce enormous changes, and the idea of superposition of strata are distinctly geological contributions. Prior to the beginning of the nineteenth century most educated persons accepted without question a relatively short period of time to account for the phenomena of the terrestrial globe. Indeed, the problems of the relative age of strata did not concern them although Steno (1631-1687) had published his ideas concerning the superposition of strata. With more thorough study of the history of the earth, a clearer concept of the length of time developed and with it an appreciation of the slowness with which major changes in the surface of the earth take place. The idea that one undisturbed stratum resting upon another undisturbed one must be younger than the underlying one has gradually taken hold upon the minds of most people. Upon the ideas of the lapse of time and superposition of strata has developed much of the basic philosophy of the science.

Geology is a relatively recent science, the name being first used about a century and half ago; but, if it is an outgrowth of geography, as many contend, it is a very old subject. In fact, descriptions of parts of the earth's surface as well as accounts of mineral products of value to ancient man doubtless ante-dated written history, and constituted not only folklore and tradition, but the working information of travelers and traders. The name geography was first used by the Greeks. It is reported that a geography written by Herodotus (c 484-425 B. C.) is still intelligible and interesting. Although some of his descriptions are not considered to be very accurate, still they are descriptions of eye-witnesses. At least, his reference to the delta of the Nile is of great value in indicating that men at that early date had fairly clear ideas of the origin of the great delta. Of course, Herodotus's known world was much smaller than ours. Since that time progress of geography has been slow with numerous interruptions and serious setbacks, but through the persistence of explorers, magnificent discoveries have been made which have added enormous areas. Some of the new lands, like the Americas, have been colonized by Europeans. It may have been the impetus of these discoveries and the consequent increase in material wealth that afforded opportunity for study as well as travel which enabled geographers to develop the descriptive and exploratory branches of the subject to the point where the human mind naturally began to inquisitively ask searching questions about the origin of the phenomena which were observed and to demand a reasonable explanation of them in the light of existing knowledge. In other words, to develop that branch of the science called physical geography. Geography has repeatedly developed branches that have grown so important that they have been set up as separate domains. Since the setting up of geology as a separate science, more than one hundred and fifty years ago, its progress has been amazing in spite of the fact that many controversies have raged over and around it. In spite of opposition the subject has grown; and, like many sciences, it covers such an enormous field no one man

can be master in all branches. One of the branches is Economic Geology and its progress has been amazing. Thousands of ore deposits have been discovered, developed, and exhausted in all parts of the world without any scientific study. However, during the past century, more and more attention has been paid to the study of deposits of economic value. Only a hundred years ago the use of geology was limited to finding coal and building stone, particularly in England. England's forests were exhausted and fuel had to be sought. In America forests were numerous and coal was not eagerly sought until a later date. Wood was so abundant that building stone was used only where it was available locally, or a handsome edifice was planned. Although the desirability of stone was appreciated, the factor of cost kept down its use. Soon after the dawn of the nineteenth century, the city of Washington was in the process of development and some of the more important structures were planned. Due to a lack of knowledge of building materials, a rather friable sandstone was selected which would not stand the rigors of the climate of Washington. Most of the structures built of it have disappeared. The White House was erected out of this material, and it was necessary to paint the stone to prevent disintegration as well as to cover up the smoke and grime of the fire of 1814. Without paint this structure would not be left as an example of the use of improper building stone. In the years that have passed since the beginning of the nineteenth century discoveries have crowded close upon one another. The original narrow field of economic geology has broadened until now there are few developments in the fuels, metallics or non-metallics in which geology does not play an important part. In the fuels, petroleum, natural gas, and coal, geology has been in the forefront. One has only to refer to the literature to learn the number of pages that have been printed. Literally thousands of men are engaged in every country searching for these valuable necessities of modern civilization. In the past several years the fuels have been overdeveloped and prices have tumbled. In the field of metals the geologists by their contribution of old and new prospecting methods have opened up enormous deposits. In the development of non-metallic deposits the geologists have played a most conspicuous part. A number of minerals, formerly only of academic interest, have been developed by technologists in other fields until workable deposits of them have been sought. In finding these the geologist has played a most conspicuous part. The most spectacular is the finding of sillimanite in California for use in the manufacture of spark plugs, so essential in the gasoline engine. Without doubt, geologists, along with others, have contributed to the depression by making available to world markets enormous tonnages of raw materials over and above the world's present capacity to consume. However, when consumption again overtakes production, the world will again be howling for geologists to search once more for mineral deposits of economic value.

One can continue the list of economic products from beginning to end and not exhaust the list, for new uses arise both for minerals employed for years, and for minerals never before used. Gold, silver, tin, lead, mercury, copper, iron and combinations or alloys of them have been used for centuries. In fact, their discovery ante-dates history, but they are still sought. In times of stress, gold is in greatest demand and the search for new deposits continues with increased energy. It has long been the material upon which many members of the human race have placed the highest value. The search for gold has been a striking force behind many of the world's most productive explorations. The search for silver and the common metals has usually followed behind gold. The demand for all of them has increased with the increasing complexity of civilization. Alloys of them have been developed for special purposes, but in modern times metals unknown to the ancients have been discovered and produced in enormous tonnages. Zinc and aluminum, to name only two, have added much to life. Manganese, cobalt, nickel, and chromium have been discovered and numerous uses have been developed. Alloys of the several metals have been developed that are wonderfully useful for formerly unheard of purposes. The problem from the economic side has been complicated by the salvage value of the metals in use. The reclaimed metal that annually comes on the market materially affects the price of the virgin metal with the exception of gold. In the field of the non-metallics, gems have the highest value per unit of weight. They are usually sought for purposes of human adornment, yet an increasing percentage is used in industry. Gems are usually carefully guarded and, unless accidents befall them are not destroyed. Those on hand are actually a threat to the existing market except in times of prosperity. In lean periods necessity may get the better of sentiment and they may be put on the market. Such forced sales always depress the market. The most eagerly sought gem today is probably the diamond. Man has long prized this stone and has paid dearly for it. Today it is probably the most carefully marketed product in the world. Most of the product is controlled by the Diamond Syndicate and marketed with great care. The history of diamonds is a long one. In the Middle Ages, India produced the majority of the stones; soon after 1700, Brazil produced the majority of stones from river gravels; in 1867, diamonds were discovered in South Africa. A few years later they were found in place in igneous plugs at Kimberly and other localities. In spite of numerous discoveries of diamonds in Africa, both alluvial and in igneous plugs, the syndicate continues to control the market. Younger members of the academy who are planning purchases of diamonds might keep in mind these remarks and think of them when they pay a large price.

As mentioned previously it is impossible to exhaust the possibilities of this part of the address, in spite of the fact that this is a group of scientists. There is a group of Tennesseans who are mostly of "Scotch" descent. Consequently they are interested in the word

"economic" particularly when that word is connected with the industry, mining; the products of which are valued in the billions of dollars and the employees and dependents are numbered by the millions. On the other hand the approach to the other part of the title is somewhat more difficult. In the first place, the term cultural must be defined and ideas must be presented. It must be admitted that in our present civilization that an enormous weight is given to the dollar value of ideas and thoughts as well as to material things. It is very difficult to evaluate in money the cultural side of Geology, yet enormous amounts of capital have been tied up with earth features such as scenery, glaciers, and geysers, and enormous revenues derived from persons enjoying those features.

No one person has defined cultural in a satisfactory manner. Obviously it is related to the noun culture. One of the dictionaries defines cultural "of or pertaining to culture." The problem is one of defining culture. The dictionary gives a number of meanings such as "cultivation, tillage; growing of micro-organisms; the act of improving or developing by education and discipline; the enlightenment and discipline acquired by mental and moral training; refinement; the characteristic attainments of a people or social order." Only a few of the several meanings of the word need be considered in this discussion. The word as defining a state of development or civilization of man is widely accepted, but in the other definitions there is less agreement. Yet everyone has some idea when either culture or cultural are used. I hope my remarks will fit approximately the average of such ideas or concepts.

When applied to the stage or state of civilization of man, the word is full of geologic significance. The Stone, Copper, Bronze, and Iron Ages all indicate that man had a keen interest in geology. When most of man's tools or implements were stone, he probably was a keener student of lithology than most of those who came later when the art of working metals had been discovered. When most of the food had to be killed with arrows, tipped with stone, it behooved him to know and to find those rocks which could be worked into arrow heads. Just as today, some men were better workmen than others. If you do not believe that statement, either collect arrow heads or inspect a collection of them. Arrow heads, remnants of the Stone Age, are very abundant in our state. They show an enormous variation in perfection as well as in materials from which they were made. Hard rocks and minerals were used for arrow and lance heads and other weapons. Softer materials were used for utensils. With the introduction of copper and other metals, the art of stone working fell from its position of major importance to its position of minor importance. Man today possibly uses more stone than ever for various purposes, but it is no longer the most important material for weapons and utensils. Copper and Bronze have had periods of ascendancy followed by decline and eclipse. Tools and utensils made of these materials are much more easily made than from stone. The age of

iron is still with us, although some people are suggesting that we are passing into an age of non-metallics. However, iron is still the foundation of our society. It might be said that we are in an age of alloys by the endless varieties of them in use; stainless steel, solder, and brass to name only a few of the commonest ones.

I feel that the word culture brings a concept to the mind which includes training and education to produce a human being who fits into the existing order with profit—in a spiritual sense rather than in a monetary way—to both society and the individual. If such a broad and inexact definition is acceptable then obviously a cultured person should know something about the globe upon which he spends some years. This is appreciated by most educators—may I use such a term?—and indicated by their efforts to lead the younger generation at a tender age into the field of geography. At times it appears that leading is done poorly, or it is done at the wrong stage of development so that the pupil is permanently repelled from the subject instead of being led to a proper appreciation of the globe upon which he or she resides. Can it be that geography might be introduced into the curriculum more profitably at a later stage? Of course such a proposal cannot be made without an understanding that our schools are designed for the greatest benefit for the largest number. If geography were introduced at a later date, a considerable percentage of the students would have left school without having studied geography. Possibly the problem might be better solved by having the major emphasis on the subject postponed to the high school period. A good knowledge of geography is an excellent background for the general science courses so widely used in the modern high schools. Of course, these general science courses leave much to be desired. Instructors of broad, general knowledge are needed to teach them successfully, but most instructors in such courses are poorly trained and of limited experience, or so thoroughly interested in one field that the other parts of the course are poorly taught and the students fail to get the maximum benefit. Physical geography or geology are often a part of the course, but due to a lack of knowledge, the instructors and students fail to derive much benefit from the brief chapters on the earth. Frequently the students do not recover from a course of that type and never show any interest in earth science, or any kind of science.

It will be readily admitted that a person who has even an elementary education should be interested in the phenomena of this earth. They are interested usually in explanations that are satisfying in the light of modern knowledge. Today both the newspapers and the radio spread news of striking geologic phenomena such as floods, earthquakes, volcanic eruptions, land slides, and similar happenings, usually called disasters, with amazing rapidity into homes not only in the city but in the remotest districts. Certainly the readers or listeners should know about the causes of these phenomena. Most of our superstitions are the result of a lack of knowledge. Teach the average man or

woman of our population something about our earth and most of the ancient superstitions will disappear.

With the advent of the railways, steamships, and subsequently the automobiles and good roads, the world is constantly on the move, particularly in America. The automobile has brought many of the remote spots within reach of nearly everyone. The result is that there are annually millions of visitors to see nature's wonders. The Federal Government has wisely set aside for public use many of the so-called "wonders of nature" as National Parks. Visitors flock to them. The National Park Service finds itself very busy in the field of adult education trying to explain the countless features of their parks. How much easier the task would be if the visitors had only a casual acquaintance with geology; how much more enjoyable the trip would be for the visitors? But millions traveling over our highways are going about their business, not bound on pleasure trips, yet they see landscapes that puzzle them. The rocks lie in different positions; sandstone, shale, limestone, unconsolidated sediments, and igneous rocks are encountered which arouse curiosity or are passed by in ignorance. Although it is unwise to make geologists out of all people, yet let us have an opportunity to acquaint the masses with some of the ordinary facts of this earth and they will be the happier for it.

The economic side of the subject does make a direct appeal to many persons, but the cultural side should appeal to a greater group. It is somewhat more difficult to present, but when presented so that the average person can comprehend the subject it will have just as great an appeal. Collecting minerals, rocks, and fossils is an excellent way to relieve surplus energy. In general the collections resist insect and other pests, only a few minerals disintegrating spontaneously. This is only another phase of the cultural side of the subject. One may go on presenting different parts of the subject, including the description of the specimens. Not only amateurs but professionals could improve their written discussions—most books and periodicals show that.

To bring this to a close: Think of geology not only in its economic appeal but in the cultural sense. There is room in this great subject not only for the professional but for the amateur. Hours spent on geology will yield much pleasure and possibly some profit.