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DWIGHT H. GREEN, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
FRANK G. THOMPSON, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
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CIRCULAR NO. 140

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COVERING OLD AND NEW GROUND

BY

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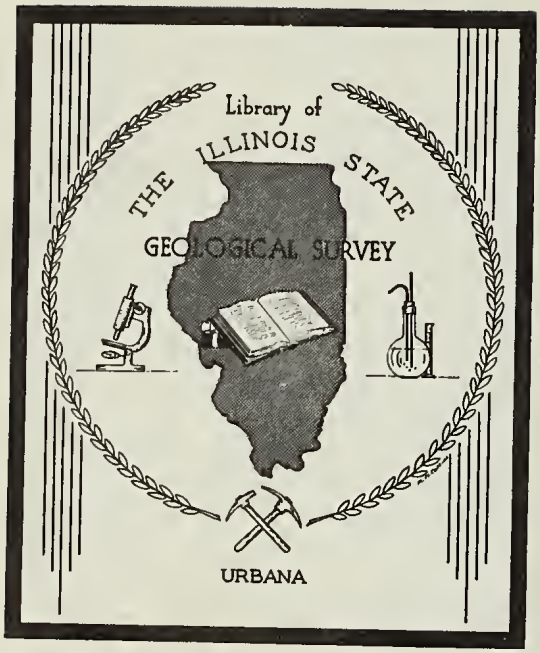

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COVERING OLD AND NEW GROUND*

M. M. Leighton
Chief, Illinois State Geological Survey, Urbana, Illinois

Ladies and Gentlemen of my radio audience: Geology is one of the great sciences devoted to the study of the nature of the world and of man. It concerns itself with the origin of the earth, the changes through which it has gone, the constitution and structure of the earth, its surface features, the history of life, and the geological resources that are useful to man.

All science is rooted in the dim and distant past. Man has always been interested in nature and has given thought to it since the day he became a reasoning creature. In the beginning the world was a mystery to him, and his gifts of perception and his fund of knowledge grew very slowly through thousands of years. Science as we know it today is of recent origin. Just as we speak of the new physics and the new chemistry, so we can speak of the new geology, the new botany, the new zoology, and the new other sciences. Every new discovery in one science has its effect upon the development of the related sciences. Thus science is dynamic and ever-changing.

Geology began to emerge and take form as a science in its own right less than two hundred years ago. It is primarily a nature science. Its body of information must come from studies intelligently made in the field, supplemented by more detailed physical and chemical studies in the laboratory. For fifty years after the Revolutionary War, false concepts progressively gave way to sound concepts, and information on the geology of the eastern half of the continent increased rapidly. Immediately following the Civil War geological explorations were extended into the western part of the continent. Universities and colleges began to establish departments of geology early in the nineteenth century, state geological surveys began to be organized about 1830, and the United States Geological Survey was founded in 1879. During the past thirty years the number of geologists has increased enormously due to the need for them by the petroleum industry, mining, engineering, and other fields. At present there are something like ten thousand geologists engaged in the science, indicating its importance today.

Geology has become a great science in even more important respects than the size of the profession. It now comprises many subdivisions, in each of which there is high specialization. There is, for example,

* Radio address presented over KODI, Cody, Wyoming, Thursday, August 7, 1947, on the occasion of the Geological Field Conference in the Big Horn Basin, under the sponsorship of the University of Wyoming, Wyoming Geological Association, and the Yellowstone-Big Horn Research Association, and with the Fellows of the Geological Society of America as special guests.

the special field of physiography which is a study of the surface features of the earth. Recently, Dr. Eliot Blackwelder, a distinguished American geologist, spoke to us over the radio about the face of our continent as you and I would survey it from an airplane enroute from Washington to San Francisco. On this imaginary airplane trip he took us across the Appalachian ranges and pointed out their parallel ridges alternating with valleys, with large rivers winding through many of the valleys. He pointed out that the rivers were the agencies which carved out these valleys and that the valleys came to be where they are because the rocks there are soft whereas the rocks in the ridges are hard, and that they occur in belts because the layers of rock had been uplifted from the sea and corrugated into parallel folds.

Flying on westward, he pointed out the great Central Plains extending from Ohio to Colorado, a country not characterized by long belts of ridges and valleys but by dendritic drainage systems corresponding in form to the veins of a leaf. Below the soil of this rich farming country, he informed us, the rocks lie nearly flat as they were originally laid down in the ancient seas. Thus, when they were uplifted above sea-level, the drainage that developed on the rocks of approximately equal hardness took on a branching pattern. This drainage of the interior plains is in striking contrast to the trellised drainage of the parallel valleys and ridges of the folded Appalachians.

Approaching Denver, Dr. Blackwelder pointed out the Front Range of the Rocky Mountains, rising like a wall. This mountain block—once a part of the plain—was bent up sharply so that the erosion and stripping off of the overlying soft strata were accelerated and the underlying granite and other hard rocks have been gradually uncovered. They have been cut by streams into a most interesting and scenic complex of canyons and ridges to form the rugged Rockies.

Winging farther westward, Dr. Blackwelder carried us over the sage-brush steppes and the mountains of Utah and Nevada to California. And, to quote him, "There the Sierra Nevada rises above timberline with the sharp rocky peaks that indicate the former presence of glaciers upon their sides." Beyond them lies the great California Valley, formerly a bay of the Pacific Ocean, now a plain built up by the streams which descend and carry debris from the bordering mountains. The Coast Ranges bordering the Pacific are low mountains now being slowly folded and uplifted at the rate of inches per century but more rapidly than erosion can destroy them. Therefore we have a measure of how slowly and unobtrusively, yet invincibly, Nature works. Already the Coast Ranges are high enough to affect the rainfall to the east and the plant and animal kingdoms of the California Valley.

Anyone can take up the study of the physiography of the earth or

of his continent and gain an acquaintance with the ways of Nature that will revolutionize his intellectual state, give him poise in his philosophy of the world, and make him a better parent and companion.

Historical geology is another division of geology that would help to satisfy one's curiosity and desire to become more fully acquainted with Nature. By historical geology, I mean the history of the earth and its inhabitants—the animals and plants. Let me suggest that you start with the origin of the earth and learn how it is harmoniously related to the other planets of our solar family, why it appears that the earth was once a growing body but is now contracting, and how it is learned that the oldest known rocks are nearly two billion years old. Then follow the successive eras and learn why we believe that the great segments of the earth—the continental masses and the oceanic basins—have been permanent but that various parts of the continents have been repeatedly submerged by broad shallow arms of the oceans; how the history of these great earth events is determined, and how the relative ages of the various mountain ranges can be told; how we can interpret the past climates of the earth and why there is reason to believe that there have been some changes in the composition of the atmosphere; how the record of life from the earliest ages is read and what a marvelous record it has been. These facts give stability to one's thinking and become guideposts by which one can judge all sorts of philosophic speculations, ideas, and religious creeds. Above all, they teach humility, love of truth, and respect for the forces of Nature and behind Nature. You may recall the expression of Edwin M. Stanton, Secretary of War, at the death-bed of Lincoln: "Now he belongs to the Ages." One who is conscious of what geologic time means and of the infinite economy of Nature in both the spiritual and material sense knows the great significance of that statement.

A third subdivision of geology which might well fascinate you is structural geology. If you were to follow this subject there would be two possible diversions of interest: one, the structure of the earth's interior which would be especially attractive to those of you who have a bent for physics and chemistry, and the other, the structure of the earth's crust including the lofty monntain ranges, the great basins, the high plateaus, the low subdued plains, and the ocean basins. I should perhaps extend the note of warning that whichever you were to choose—the earth's interior or the earth's crust—you would soon find that the division is wholly arbitrary and unnatural and that the two have genetic relationships that you would want to follow through. If you were to start with mountains and basins there is no better point to launch your inquiry than right here in the Big Horn Basin, where the features that hold such scenic interest for you and your

guests from far away places possess a source of knowledge and inspiration for you that we from the plains look upon with genuine envy. Before you have gone far in your avocation you will have found such a feast for the mind, such a new outlook upon the world, such a thankfulness that you are able to view Nature in its true light, that you will declare with the psalmist, "I will lift up mine eyes unto the hills, from whence cometh my help."

Some people love to collect and identify, and they become surprised with the educational values of such an adventure. To those of you who lean that way in the realm of nature, mineralogy holds a volume of interest and a multitude of ties with the world about us. One can run the whole gamut of minerals from graphite and talc to the metallic minerals and the gems and precious stones, their crystal forms and the laws that govern them. In the beginning, specimens of single minerals will be of chief interest but eventually and logically composite specimens of ore minerals in their natural relationships will come to your attention and also the rock-forming minerals and the great families of rocks. By this time you will be coupling mineralogy and petrology, the science of rocks. The Big Horn Basin and the adjacent areas of Yellowstone National Park and the Tetons are places where I suspect the Boy Scouts excel in their knowledge of minerals and rocks. Perhaps some of them have become amateur mineral economists or youthful statesmen on the national importance of mineral resources.

What has been said about mineralogy applies equally well to paleontology, the science of fossils, or better still, the science of past life. The region about Cody illustrates the well-known biblical quotation: "The low places shall be made high," for there are hosts of outcrops, in the basin and on many mountain slopes, of sedimentary layers originally laid down on ancient sea-bottoms, which contain many shells of marine forms that lived during those ages when Cody was not the Cody of today but a spot in the Jurassic sea or the Cretaceous sea. What fun it is to compare these fossils with forms that you will collect the next time you visit the seashore or exchange with a friend who lives there. Another fine interest in this connection is to trace some of the ancient life forms down to the present and get that breadth of view and understanding that comes from knowing how long it has taken Nature to produce the life of the present. In the case of the larger forms like the birds, the dinosaurs, and the mammals, a person can resort to collecting photographs from museum and other scientific publications. By all means, if your interest runs to life, do not pass up paleontology.

Now I have, up to this point, called the roll of most of the subdivisions of the modern science of geology—physiography, historical

geology, structural geology, mineralogy, petrology, and paleontology. There is one more division which if omitted would be to ignore the modern industrial life of America and our high standards of living—namely, economic geology. The veracity of this statement may be confirmed by a listing of its branches.

First, petroleum geology. The petroleum industry employs more than half of all the geologists in America, which reflects how important the scientific finding of oil has become. Moreover, America moves on wheels powered by oil and its products.

Second, mining geology. Nearly 20 percent of all of the geologists of this country are employed by mining companies and other industries. Our type of national economy has flowered because of the products of mines and quarries.

Third, engineering geology. Engineering geologists perform vital functions in seeing that dangerous features of foundations for dams for large reservoirs are eliminated to make them safe for life and property, that the problems of the occurrence of groundwater are understood, that the geological pitfalls of highway construction and maintenance are recognized and solved, and that other aspects of earth materials and conditions are understood before the engineer of design or construction completes his work.

The importance of economic geology is thus seen to have become highly essential to modern life.

The next few minutes we shall devote to the educational relationships of geology. The universities and colleges of this state and of this country are the torch-bearers of human knowledge from the generation that is passing to the generation that is coming. They also carry in large degree the responsibility, first, to conserve the sum of knowledge, and, second, to improve and extend it. The training of competent and inspiring teachers and of creative research men and writers is of the utmost importance to all branches of knowledge. As one of the great sciences, geology looks to a great future through the work of these institutions in training men.

Educators throughout the world consider this to be a time for introspection. They look upon that period between 1919 and 1939 as a period when a great victory was thrown away with a rapidity and a completeness unexampled in history. They are asking, is this an age without standards, an age without knowledge of the science of good and evil, an age without a goal towards which to set our course? Sir Richard Livingstone, the great English educator, reminds us that "human beings have bodies, mind and character," each of which is capable of "virtue" or "excellence"; that "education is a handmaid of the art of living"; and that "the true teacher develops the mind without weakening the character."

"University teachers," he continues, "are familiar with a type of boy who is well-educated in the conventional sense, but who has no clear philosophy of life, nothing to fall back on in the hours of stress, discouragement or indolence that all men experience: who is easily swept off his feet by current sophistries or the fashion of the hour, and the voyage of whose life, even if he escapes these, tends to be 'bound in shallows'."

Is it not possible that the omission in our secondary schools of fundamental subject matter dealing with the nature of the world and the history of life upon it and our relations to the great economy of things—material and spiritual— is an important factor in this lack of a clear philosophy of life and in man being "bound in shallows"?

I am reminded of Shakespeare's statement in "Measure for Measure": "The law hath not been dead, though it hath slept."