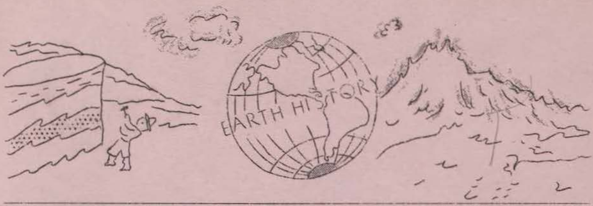


# THE MINNESOTA GEOLOGIST

## OFFICIAL BULLETIN OF THE GEOLOGICAL SOCIETY OF MINNESOTA

VOL. III. MAY 1946 NO 3

contents

# G E O L O G I C A L   S O C I E T Y   O F   M I N N E S O T A

831 SECOND AVENUE SOUTH
MINNEAPOLIS 2, MINNESOTA

Our Society is devoted to the study of GEOLOGY and MINERALOGY for their cultural value.

## O F F I C E R S



## FOUNDER

Edward P. Burch

## PAST PRESIDENTS

Junior F. Hayden
Alger R. Syme
Charles H. Preston
Joseph W. Zalusky

MEETINGS: OCTOBER to MAY inclusive our Society meets every MONDAY evening, not a holiday, in the large auditorium on the 4th floor of the Public Library at Hennepin Avenue and 10th Street, Minneapolis, Minnesota, at 7:30 o'clock P.M.

FIELD TRIPS: JUNE until SEPTEMBER, inclusive, we have a program of field trips. Visitors are very welcome, always.

ANNUAL DUES: Residents of Hennepin and Ramsey Counties $3.00 plus $1.00 additional for your wife, husband, or dependent family members; for students and those residing elsewhere, $1.00.

YEAR END: The lecture on May 5, marked the close of the 1945-46 lecture course. Most people will agree that it was one of our most successful years. Dr. Schwartz' course of 16 lectures on "Structural Geology" was exceptionally well received as was also Dr. Thiel's "short course" on Petroleum. We had 27 lectures during the year, and an average weekly attendance of 82. The Society closed the year with $535.00 cash in the Treasury, and all bills paid. Certainly these facts are evidence of success. The President, Officers, and Directors are to be congratulated, as is also the Society itself. We have every reason to believe that next year will be equally successful.

NEW PRESIDENT: The Board of Directors has elected Dr. Edward H. Mandell as President of the Society for next year. Dr. Mandell has been an earnest and conscientious member since coming to Minneapolis, as well as an ardent "field tripper." Dr. Mandell will have, of course, the full cooperation of the Board of Directors and the membership in his leadership of the Society throughout the next year, and we all hope that with him, we can do bigger and better things.

FIELD TRIPS: In this issue, you will find an announcement of the various field trips the Committee has arranged for this summer. This is an interesting field trip program and with tires and gasoline restrictions off, we hope no one will miss a trip unless absolutely necessary. Each of these places has interesting geological features you should know about. The trips are all scouted so that the leader is able to take you at once to the points of interest. It is an excellent idea for one to go on these trips, have the specific spots pointed out to you, and then sometime go back alone and examine them at your leisure. A trip makes an ideal outing for yourself and family, and also your guests. Once you start going, you will not stop except for unusually important reasons. Those who do not take the trips will miss a large share of their geology education. It is an interesting fact that practically the same group go on all trips. That is because those who go learn to fully appreciate the value of the trips, and are anxious to go on the next one.

FIRST FIELD TRIP: The first field trip of our present trip program is now a past event. 28 of us started off, the ground covered with snow, and cold weather and rain threatening to ruin the day. Mr. Hawley, however, predicted clear weather and that the snow would disappear by noon. So nothing daunted, we proceeded to Red Wing. Upon reaching Hastings, we found we had left the snow behind and the day remained bright and clear. Mrs. Lupient, as leader, did a fine job and a good time was had by all.

FUTURE EVENTS: The prospective trip to the Grand Canyon is a pretentious undertaking and will require considerable ground work. If you have any thought of going, make your decision as soon as possible and notify Past President Charles H. Preston, who is the originator and leader of the project. This fall, probably about October 1, we expect to entertain the Mid West Federation of Geological Societies. It will be a two-day session consisting of lectures and short field trips. There will be a banquet which will also be the start of our own lecture program for the 1946-47 season. You will receive an announcement in due time. We have made tentative arrangements with Dr. Schwartz for a course of lectures on "Economic Geology" to be given next year, provided time available to him will permit. Perhaps also the Society can do something about placing markers, with a geological description of certain points of interest in and arround Minneapolis, notably Minnehaha Park, as suggested by Dr. Thiel. And not least, perhaps we can persuade the Library management to let us construct that room we have long wanted in which to preserve our models, specimens, books, maps, etc.

NOTE, substitution of article on Petroleum for "Geological Column", mentioned in INDEX.

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| May 12 | RED WING, Minnesota; LEADER, Mary Lupient. PURPOSE - to study the contact of Oneota and Jordan formations, collect trilobites, examine fault, land slides, and other features. |
| May 26 | HUDSON, Wisconsin; LEADERS, Mrs. Henry S. Sommers and Linda Bennitt. PURPOSE - to study the Afton Anticline, collect trilobites, examine certain Ordovician and Cambrian formations. |
| June 9 | TAYLORS FALLS, Wisconsin; LEADERS, Dr. and Mrs. Edward H. Mandell. PURPOSE - to study geology of the area, Pot Holes, Abandon Gorge, two drifts, Basalt flows, etc. |
| June 22 | MORTON and NEW ULM, Minnesota; LEADER, Chas. B. Howard. PURPOSE - to study the Pre-Cambrian Morton Gneiss, unconformity at top, Dakota formation of Cretaceous age, some other Pre-Cambrian outcrops, deeply weathered Pre-Cambrian granite surfaces at Red Wood Falls. |
| July 4, 5, 6 | JAY COOKE PARK; LEADER, not selected. PURPOSE - to study Thomson slates, character of area, intrusions by the Duluth Gabbro, structural geology, folding, bedding, jointing, etc. |
| July 21 | NOERENBERG'S RESIDENCE at Lake Minnetonka. PURPOSE - general get together. Lecture by Chas. H. Preston. Subject to be selected. |
| August 3, 4 | LITTLE FALLS, Minnesota; LEADER, Elmer H. Brown. PURPOSE - to study the contacts of the shists and granite, find staurolites, examine Algoman granite, etc. |
| August 18 | PRESTON HOME, Lake Minnetonka; LECTURE by Edward W. Hawley on "The Wonders of the Heavens." |
| September 1, 2, 3 | GRAND CANYON, Arizona; LEADER, Chas. H. Preston. PURPOSE - to visit and study the Grand Canyon. Dates are approximate only. |
| September 1, 2, 3 | WAVERLY and CEDAR RAPIDS, Iowa; LEADER, Dr. Wesley R. Hiller. PURPOSE - to study various Ordovician and Devonian formations, secure geodes and fossils. |
| September 14, 15 | SPRING VALLEY, (Minnesota), PRESTON, LANESBORO and VICINITY; LEADER, Alger R. Syme. PURPOSE - to study the Oneota, Shakopee and Root Valley formations of southeastern Minnesota, the geology of Root Valley, iron formation of Spring Valley, and the contacts of each. |
| September 29 | DENHAM, Minnesota; LEADERS, Mr. and Mrs. Lawrence W. King. PURPOSE - to study the metamorphism of the southern exposure of the Thomson formation, intrusions thereof by the Algoman granite, and other interesting and unusual features of the contact. |

# PROTEROZOIC SUBMERGENCES AND LAND FEATURES OF THE UNITED STATES

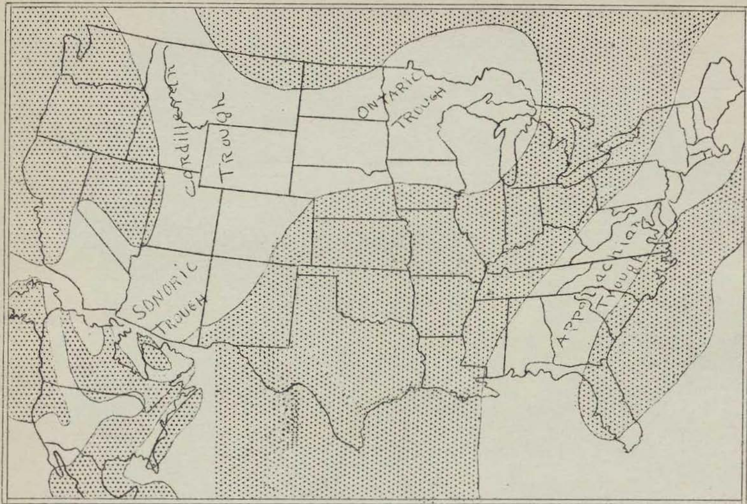
Because of their great age and complexity, due to intensive metamorphism extending over a period of hundreds of millions of years, the history of the Pre-Cambrian rocks is most difficult to read, and yet, the geologists are able to tell us considerable about the geography and topography of that time. The Proterozoic Era probably covered a period of at least 400 million years, and closed approximately 800 million years ago. This era covered the Lower, Middle and Upper Huronian and Keweenawan periods. This era is of particular importance to us because the great Mesabi iron formations were deposited during this period, and we live so close to it.

Due to the great value of the iron deposits, the rocks of this era in Minnestoa, Wisconsin and Michigan have been studied very intensively. On the basis of the rock sequence and their character, here and elsewhere, it is a fair assumption that the Proterozoic Era was characterized by four great troughs of deposition. These are named on the accompanying map. Thousands of feet of sand, clay and mud were piled into these troughs until they obtained a thickness of some 5 to 12 thousand feet. Diastrophism, during and at the close of the period, made great changes in the physiography of the respective areas. At the end of these revolutions, the land areas previously occupied by the troughs were completely emerged from the sea. The great accumulations of sediments became great mountain ranges as indicated on the accompanying map. This is illustrated in the Ontaric trough area where the presence of a great mountain system a thousand miles long, extending from Kansas to Ontario, is shown. It is known as the Penokee revolution. The same processes operated to produce the same results in the other troughs. The result of this deposition and orogeny was the complete destruction of the troughs. This diastrophism marked the close of a great Era. The continent, at this time, was completely emerged.

The rocks formed in the Ontaric trough constitute the area now referred to as the Lake Superior Upland. The area includes part of Ontario, and all of Minnesota, Wisconsin and upper Michigan. It is part of the Canadian shield. In it are included the following Minnesota formations: Ogishke Conglomerates, Knife Lake Slates, Algoman Granites, Biwabik Iron Formation, Thomson Slates, the Duluth Gabbro, and the Hinkley and Fond du-lac Sandstone. These formations were deposited in this trough as sands, muds, and oozes. Their total thickness was in excess of 5,000 feet. During this period also in Minnesota occurred one of the greatest extrusions of lava known. Its volume is estimated to have been as great as 24,000 cubic miles.

The Piedmont Plateau and Blue Ridge Region indicates the same conditions prevailed during Proterozoic time as does also the Colorado Plateau and Northern Rocky Mountain areas. Exposed in the Grand Canyon two-thirds of the distance from the top is a tilted series of strata over-lying the Archeozoic shists, which indicate a normal marine deposition in excess of 12,000 feet. Most of the Proterozoic strata are characterized by extremely complex structures and thorough metamorphism. Conclusions should be drawn with great care because interpretation of conditions is difficult.

These stupendous facts challenge our imagination and are worthy of your continued study. If you wish to pursue this subject further and in greater detail, read "Fundamentals of Historical Geology" by Dr. Carl E. Dutton, formerly of the University of Minnesota, from which the foregoing facts and the maps have been taken.




PALEOGEOGRAPHIC SERIES II; (46) PROTEROZOIC ERA; Shaded area is land, white area is sea. Sketch shows area of total flooding.

Drawing by C.Schuchert.

PALEOGEOGRAPHIC SERIES II; (47) PROTEROZOIC ERA: Dominant surface features of the United States at end of period and the begining of the Paleozoic Era. Drawing made after C. Schuchert.

## INDUCED ATOMIC ACTION TECHNIQUE MAY REVEAL ORIGIN OF PETROLEUM

Condensed from the Oil Weekly

Utilizing atomic-age techniques, a group of Massachusetts Institute of Technology scientists are developing the hypothesis that oil is formed by the radioactive transformation of familiar organic substances.

M.I.T. has duplicated in the laboratory the radioactive process which may explain how nature, over a period of 10 million to 100 million years, accomplishes the conversion of protoplasm, proteins, fats and other complex materials into oil.

The research, sponsored by The American Petroleum Institute, has shown that by bombardment in a cyclotron fatty acids isolated from ocean-bottom mud can be turned into hydrocarbons of the type making up the bulk of the world's petroleum resources. Radon, a gas formed when radium spontaneously disintegrates, was used as the source of the alpha particles with which the fatty acids were bombarded.

Early research indicated that most petroleum originates in the remains of plants and animals which have been deposited on the ocean bottom and which have then been buried by layers of mud or sand. High temperatures and pressures were originally thought to contribute the energy required to convert this material into oil. Investigations about ten years ago proved, however, that oil is formed at temperatures too low to permit this conversion.

Recently, it has been proposed that bacterial action or the energy from the high-speed particles released by radioactivity may play an important role in converting protoplasm, proteins, fats, and other complex substances into the constituents of crude oils. Research by the Geology Department at M.I.T. has shown that there may be sufficient radioactivity in the materials of oil fields to effect this conversion over a period of 10 million to 100 million years.

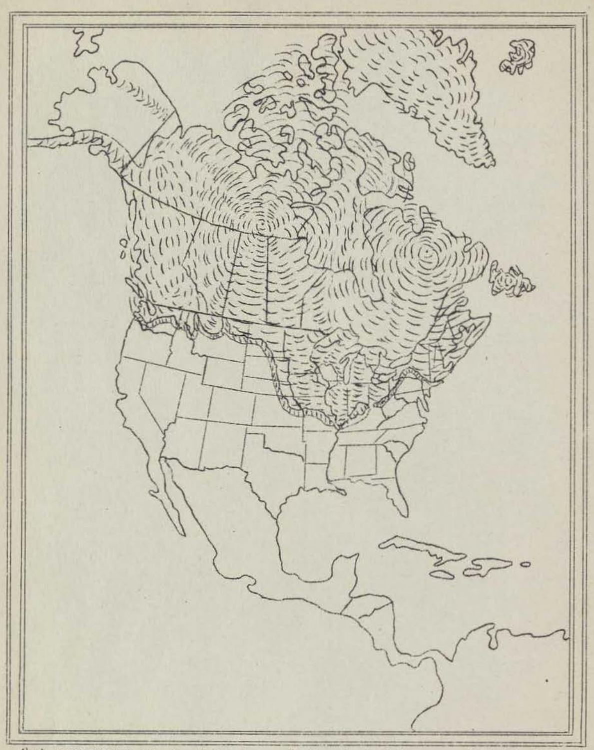
Among the compounds isolated from ocean bottom muds have been a number of fatty acids, so named because they can be obtained by chemical treatment of fats. When certain of these acids were exposed to bombardment by alpha particles from radioactive disintegration in the laboratory, they were converted into straight chain hydrocarbons which make up the greatest proportion of naturally occurring petroleum.

Radon, a gas formed when radium spontaneously disintegrates, was used as the source of alpha particles for the bombardment of the fatty acids.

In order to increase the yield of conversion products experiments were carried out with the large, controlled source of fast particles in the M.I.T. cyclotron. Comparison showed that the gas evolved when the cyclic acid used in this work was bombarded by alpha particles from radon or by deuterons in the cyclotron had nearly the same analysis. This research, therefore, indicated that the high speed deuterons produced in the cyclotron have the same chemical effect as the natural alpha particles from the radioactive element radon.

After other investigations and physical calculations had confirmed this conclusion, it was decided to run further bombardments of the acid in the cyclotron. As a result of such irradiation the acid group was found to be removed from the cyclic portion of the molecule, thus producing a mixture of cyclic hydrocarbons, one of which is widely distributed in fairly large quantities in petroleum.

Work is now in progress to determine the manner in which complex organic substances are transformed by means of radioactivity. These changes in organic compounds have been brought about by bombardment or radiation under laboratory conditions. Whether similar conversions may take place in the organic material present in oil fields to form appreciable quantities of petroleum is as yet unknown. The radioactivity of earth materials is now being measured and in time, as this study progresses, some definite idea will be obtained as to the quantitative importance of radioactivity in the formation of crude oil.



(45) PLEISTOCENE- The Great Ice Age. (U.S.Geological Survey, modified by Miller)

When life began, it appeared in the sea. Ages before there were trees or flowers, tiny plants lived in salt water. As ages passed they became larger and more varied, so that when the first animals came into being, they crawled and swam among green banks of algae.

Like the earliest plants, these animals were small--but they also began to grow. Some became worms and other shellfish, while less active sorts turned into corals and sponges. When they grew large enough to leave many fossils, they had formed most of the groups we now know and a number that have become extinct.

To see what these early creatures were like, let us visit an ancient sea. We shall find it high on a mountain side near the railroad town of Field, British Columbia, where a quarry was opened in 1909 by Dr. Charles D. Walcott of Washington. Discovering some rare specimens, he brought workmen and tools, and began to dig. In the fifteen summers of collecting that followed, he secured some of the most perfect fossils that anyone ever has found. Though only black films on slabs of dark shale, they show the shapes and internal organs of creatures that lived during Cambrian times, four hundred million years ago.

To collect at the Walcott quarry, we must camp a thousand feet down the mountain, where we have wood, shelter and a spring. Here we put up a small tent, cook lunch and watch the antics of ground squirrels that bob up from their holes to watch us, and to steal food even while we were eating. Then we climb to the quarry, and with hammer and chisel split the hard shale, searching each piece for fossils. When we find them, we wrap them carefully in paper and put them in a knapsack to be carried back to camp in the evening.

As we find fossil after fossil, we begin to picture this country as it was when these specimens were alive. Instead of mountains, we find a sea on which a few greenish weeds are drifting. Dropping down through the water, we find that our feet stand in soft, black mud. Thousands of little shells either lie still on it or wave gently on stalks of flesh. Here and there small cones shoot through the water, driven by fins that look like wings. Among the seaweeds, worms are crawling. Not earthworms or caterpillars, which cannot live in water, but beautiful sea worms dressed in shining scales and plumes of gold, silver or purple.

The biggest thing we see looks a bit like a lobster. Yet it has no claws or pincers, and when frightened it crawls and wriggles, as no lobster ever does. From its large head, shaped like a half moon, two solemn greenish eyes look upward, and a pair of long, jointed antennae wave. The flattened body is made up of jointed pieces or segments, which partly cover the many pairs of legs by means of which the creature is crawling. The tail is only a small, flat button which finishes the tapering body.

This queer fellow is a trilobite, whose special name is Neolenus. He belongs to a class from which crabs, lobsters and scorpions will develop; and though only a few inches long, he is the leading inhabitant of this Cambrian sea. Only one of his neighbors is able to harm him--and this is a crab-like second cousin whose pincers can break even a trilobite's shell.

Neolenus has just the habits we expect from his clumsy, flattened form. When very young, he floats in the water; as he grows he settles down to life on the sea floor, where he eats defenceless or dead bodies that he finds while crawling about on the mud. His antennae help him discover such food, and his many legs take him to it promptly. Around some piles of rubbish a dozen trilobites are feeding, each busily eating all that he can take away from his neighbors.

Like his descendent, the crayfish, Neolenus grows only now and then. Month after month he crawls about in a hard, shiny shell. One day, that shell breaks along the head--and with much wriggling and twisting, Neolenus sheds it. Each twist removes more of the hard cover, and at last he comes out as a larger but soft-shelled trilobite, which must hide among the seaweeds and sponges until his coat has time to harden.

As he crawls about on the muddy bottom, Neolenus meets a number of relatives. The commonest are small, smooth creatures less than half an inch in length, with heads no larger than their tails and only two body segments. Some have tiny eyes; other are quite blind, and spend their lives burrowing among rubbish or plowing through mud for something to eat. They are the smallest and most specialized of their kind--and their differences from Neolenus show how much trilobites had varied (or evolved) before they grew the hard shells which today we find and call fossils.

Have we seen enough of these creatures? Then let's look at other sea beds, or formations, to see how great the trilobites became. In late Cambrian sandstones of Minnesota, there are heads and tails of kinds much longer than Neolenus, with habits like those of the modern king crab, so common along the Atlantic sea coast. They crawled and fed in sandy shallows, and when they had nothing better to do, lay partly buried by the sand. When they died, and the sand hardened to stone, their shalls left prints in the rock before they decayed. Those prints also are fossils, although they tell less about the creatures that made them than do the remains at Dr. Walcott's quarry.

During the Ordovician period, trilobites became even more varied. Though named because its rocks were found in the country of a tribe called Ordovices by the Romans, the Ordovician seas covered a great deal of North America. In the shales and limestones that they left, trilobites are common; and so are the shells of less active animals whose ancestors lay on the Cambrian muds. These Ordovician descendants had grown much larger, with thick shells like those of clams. We call them brachiopods or "lamp shells," and find them in abundance when we climb the hills above Cincinnati, or break layers of shale and limestone beside some of the creeks in eastern New York.

Among the brachiopods are some very large trilobites, as well as others that were small and thick shelled. When danger threatened they rolled into balls, their bodies encased in ribbed armor that discouraged every enemy.

Most large trilobites were smooth, yet one which lived in Devonian seas developed a marvelous set of spines. His large head bore knobs, points and spikes; more spikes stuck upward from his back, while his tail was set with knobs, spines and hooks. A perfect porcupine of the sea, he commanded a clear right-of-way the moment his bristling shell appeared. Other denizens of the ancient deep left him severely alone.

Smaller species with prickly armor were little more than clusters of spines. Others had no spines at all. There are crustaceans like that today--and crustaceans are cousins of trilobites. Some smooth forms lived more simply. Digging down with their spade-shaped tails, they buried most of their bodies in mud and lay with their mouths just at the surface, waiting for something to eat. Unwilling to burrow or to hunt, they took just what drifted by. Theirs was the truly simple life, with nothing risked, little lost, and leisure through every day and year.

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