



THE MINNESOTA GEOLOGIST

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OF
THE GEOLOGICAL SOCIETY OF MINNESOTA

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No. 1

A GEOLOGICAL WALK

We followed the path a glacier took
Over a meadow, down a brook,
And saw its scratches on every stone.
One great boulder, overgrown,
Had come south from Saskatchewan.
No telling where the rest had gone.

We sat for lunch on a windy plain
On top of a terminal moraine,
On top of a miscellaneous mass
Of dirt and rocks subdued by grass,
Dour travelers with no relation
Except their means of transportation.

Out of a field of ice-borne stones
We chose two smooth striated ones
High on the side of a ravine
Tourists of the Pleistocene,
And brought them home. Here they will stop
Till the next glacier picks them up.

Betty Bridgman, Minneapolis

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THE MINNESOTA GEOLOGIST

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MEETINGS: October to May, inclusive, 7:30 p.m., every second and fourth Monday,
at 55 Ford Hall, University of Minnesota, 17th and Washington Avenue
S.E. Visitors welcome.

FIELD TRIPS: May until October, inclusive.

ANNUAL DUES: Residents in a 50 mile radius of the Twin Cities, \$5.00, plus
\$2.00 additional for husband, wife, or dependent family members.
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AFFILIATE MEMBER OF: Midwest Federation of Mineralogical and Geological Societies

and

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Mailing address for Exchange Bulletins until further notice:

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COMING EVENTS

The 28th Annual Banquet of the Geological
Society of Minnesota will be held at
Bethany Lutheran Church Basement
2511 East Franklin Avenue, Minneapolis
on Monday evening, April 24, 1967
Social Hour 5:30 P.M. -- Dinner 6:30 P.M.

The Minnesota Mineral Club will have its
Annual Show on April 22 and 23, 1967, at Brookdale Center

The Midwest Federation Annual Meeting is to be held in conjunction with the 1967 Midwest Convention and Show in Davenport, Iowa, and Rock Island, Illinois, on July 27, 28, 29 and 30, 1967. The Annual Business Meeting will be held on Saturday, July 20th at the Blackhawk Hotel, Davenport, Iowa, beginning promptly at 9 A.M.

Mr. E. J. Kloft, Show Chairman

A MESSAGE FROM YOUR PRESIDENT

The Geological Society is a cooperative venture in adult education. The earth and its atmosphere is the all-important subject that is of particular interest. "All-important" is the appropriate term because it is the fortunate interaction of earth and atmosphere energized by a nearby star that permits life to develop and maintain itself on the surface of this lonely little planet. It makes it possible for you and me to live here. Our Society tries to supply the means of understanding some of the answers to questions concerning this subject and, hopefully, to whet a curiosity for still further inquiry. This is the sort of knowledge that is good for its own sake.

However, though we may not be active geologists, there is a practical side to our inquiry that should be of interest to everyone. As population densities increase, changes in the earth's surface may be engineered in one place that adversely affect other more distant localities. An illustration may be that of a farmer draining his land at the expense of a distant community, which must then finance and pay for higher levees to ward off an increased water flow.

We are often asked why we do not systemize our lectures into something like a class in geology. The answer is that we do not have the hours available that are necessary for such a program. Instead, we try to use our lectures to bring out the latest information of general interest related to geology. For those members who desire to study geology on their own time as a supplement to our lectures, we recommend periodic visits to the bookshops on or adjacent to the campus where new or used current texts may be purchased. In this way a comprehensive bookshelf on geology can gradually be developed. However, such bookshops should never be visited at the beginning of the quarter because they are crowded with students, and it is impossible to browse. Some of the shops have an excellent assortment of inexpensive paperbacks.

We emphasize the word cooperation because it is the very essence of our Society. We invite and encourage individuals within the membership to offer their services in helping us develop the Society into an even more meaningful educational activity. We need people who can help us with publicity, who can act as leaders on our field trips, and who can suggest improvements in our program.

Information concerning our summer field trip program will be issued as soon as details are available. Only a tentative outline is submitted in this bulletin. However, our program concerning the trip to Flin Flon in west central Manitoba will not be available until the end of May because much of the area to be covered has only recently been opened to extensive tourist travel. It is impossible to get proper information without first scouting the projected route. We hope to do so early in May or as soon as the ice goes out.

Fred W. Hallberg

He who has learned to disagree without being disagreeable
has discovered the most valuable secret of a diplomat.

IN MEMORIAM

John Orval Engen, a long time member and director of our Society, passed away on March 12, 1967, after a long illness. We were saddened by his passing for we have lost a faithful and dedicated member, who was always ready and willing to help in the formulation of policies of our organization, making plans for field trips and finding many other ways in which he could be of service.

Being a Science teacher, he was very much interested in Earth Science and Geology. History was also a favorite subject on which he was very well informed. Often on a field trip he would narrate events of history in the area where we were travelling, thus adding interest to the trip. A genial, friendly person, he will certainly be missed by all who had occasion to work with him.

Mr. Engen was born in Elk River, Minnesota, on June 21, 1907. He taught in Badger, Howard Lake, and Fergus Falls, Minnesota, before coming to Edina where he had taught science for 25 years at the time of his death. He taught at Wooddale School for many years, and he had taught at South View Junior High School since its opening. He belonged to the Edina Education Association, the Minnesota Education Association, and the National Education Association.

His many varied interests were expressed in the diversified organizations to which he belonged. He was a charter member of the Minnesota Academy of Science, as well as a member of the Hennepin County, Ramsey County, and Minnesota Historical Societies. He served as treasurer for the Geological Society of Minnesota and was on its board of directors. He also belonged to the South Minneapolis Chapter of the Izaak Walton League, the Natural History Society, the Edina Astronomy Club, and the American Camping Association.

Active in Boy Scout work, Mr. Engen was a Boy Scout Leader and on the Boy Scout Committee at Lake of the Isles Lutheran Church. He was one of the deans of merit badge counselors in the city of Minneapolis, and up to one week before his death he served as a counselor for Conservation and Wild Life. Photography was one of his hobbies, and he served as counselor and camp photographer at Camp Lincoln for Boys for several years.

At Lake of the Isles Lutheran Church he taught Sunday School and was an active member of Lutheran Church Men.

Surviving him are his widow, Frances, one son, Clement, two daughters--Ruth (Mrs. James Lee) and Eleanor (Mrs. Donald Holmquist), and a sister, Miss Evelyn Engen.

It is with great regret that we close the record of his fine service to our organization. Our deepest sympathy is extended to Mrs. Engen and all other members of his family.

Members of the Society were sorry to hear, shortly after Mr. Engen's death, that his mother, Mrs. Nicholas Engen, passed away on Monday, March 27, 1967. We would also like to extend our condolences to the family who have suffered this loss.

Mrs. John Orval Engen and family would like to express their thanks to the members of the Society for flowers, cards, and acts of thoughtfulness during Mr. Engen's illness and at the time of his death. These things are deeply appreciated and remembered as indications of true friendship and concern.

Fossils once collected can be used in a variety of studies. Closely related trilobites or brachiopods from successive beds 20 feet or so apart can frequently be used to demonstrate evolutionary changes. Fossil ecological communities are frequently easier to recognize than modern communities; the differences between the nearly contemporary Platteville, Decorah and Galena communities are due mainly to the single factor of original sea bottom sediment type. A comparison of the upper Platteville fossils with those of the descendant community from the Dubuque formation will demonstrate that similar sediments often have similar communities, and will also demonstrate many examples of evolution.

Comparison of the fossils from several localities will be of more use than the collection and study of fossils from just one locality.

The best places to search for fossils are in roadcuts along highways, in natural exposures along creeks and rivers and in quarries or clay pits. Safety precautions ought to be obvious -- rocks falling ten feet or more are dangerous and must be guarded against. The easiest mode of protection is to make sure no student is collecting directly up hill from another. Cars must be parked safely on the shoulder of the road and students should leave the car by the off-road doors. Fossils should not be hunted on private land without the landowners' permission.

While fossils may generally be found at most exposures of the bedrock in southeastern Minnesota, they are more common in some formations than others. The buff and green sandstones of the 200 foot thick Franconia Formation are the oldest exposed rocks in Minnesota with abundant fossils. The six inch thick layers or units of sandstone that can be split into thin beds afford the best possibilities for fossil collecting. Those that are riddled with tube like structures have no fossils except the tubes. The vertical tubes or spikes of harder sandstone are fossil worm burrows. Not all such beds will have fossils in them, but any gully or roadcut with 20 feet or more of this rock unit exposed will have at least one such bed. The fossils will be molds of trilobite parts, heads, tails and thorax segments in sand. The fossils are frequently stained rusty red when compared with the surrounding sand grains and rock surfaces. They may be seen best in glancing light.

The Jordan Sandstone (100 feet thick) occasionally contains fossils, but only rarely are they really of satisfactory preservation.

The Oneota Dolomite, New Richmond Sandstone, and Shakopee Dolomite are the major subdivisions of the 150 to 250 foot thick Prairie du Chien Formation. Poor quality snails are common in the Oneota in most quarries and roadcuts as are worm trails and burrows (called fucoids). Winona travertine is a particularly well borrowed architectural variety of Oneota Dolomite. The best fossils in the Oneota are those to be found in residual chert or flint nodules at or near the crest of hills in Winona and Huston Counties. One such locality is in the road ditches at the crest of a hill just above the town of Dresbach. These flint boulders must be cracked to find the fossil, a four pound or heavier hammer is necessary. Farther north in Goodhue and Lakota Counties, these chert nodules frequently have amethyst lined cavities.

The St. Peter Sandstone is 100 feet thick and nonfossiliferous except for one small area in South St. Paul. It is a medium grained quartz sandstone with frosted, well-rounded sand grains, that has been used for glass making.

FOSSIL HUNTING IN MINNESOTA -- Con't.

The Glenwood Shale, Platteville Limestone and Decorah Shale are all relatively thin units 15 to 40 feet in thickness and all exposed close together over large areas. These are the most readily collected fossiliferous units in Minnesota. Common species of fossils to be found in the Platteville Limestone and Decorah Shale have been discovered both in the Twin City area and throughout southern Minnesota. Descendants of many of these fossils can be found in the Galena, Dubuque and Maquoketa Formations of Fillmore County.

Platteville quarries can be found throughout the outcrop areas of St. Paul. A brief reconnaissance will usually locate at least one such quarry near at hand. The Decorah Shale, on the other hand, is usually best exposed in roadcuts along gravel county roads. The most widely searched localities for these formations are Shadow Falls at the end of Summit Avenue and Mississippi River Road, and Hidden Falls Park just south of the Ford Motor Company Plant, both in St. Paul, and the Twin City Brick and Tile Company clay pit in Cherokee Heights south of the Mississippi River but still in St. Paul. This last can be dangerous after a rain and should never be entered without permission or with a large group.

PROJECT "MOHOLE"

Although man has sent his probes far out into space, he has pushed only a short distance through the crust of the earth on which he lives. Project Mohole is designed to penetrate deeper into the earth than man has ever gone before....beyond the crust and into the earth's mantle.

The earth's crust is a relatively thin skin of rock which varies in thickness. Beneath that is the mantle which composes more than 80 per cent of the earth's mass. The boundary between the crust and mantle is called the "Moho" after the Yugoslav scientist, Mohorovicic (Mo-hor'o-veech-ic), who discovered it. No one knows much about the mysterious Moho, and no one knows for certain about the mantle. To find out what's down there, a hole must be dug . . . a "Mohole".

The earth's crust is thicker beneath the land than it is below the seas. Like icebergs, the land pushes its "roots" deep below the average level of the bottom of the crust. Under the seas the crust is thinnest, and the Moho may be no more than four miles below the ocean floor. Therefore, surveys searching for a spot to dig are taking place at sea, and the hole to the interior of the earth will use techniques developed by the petroleum industry in its search for offshore oil.

The Vol. 1, No. 7 issue of Horizons of Science is an exclusive report on Project Mohole's first oceanographic survey in search of a possible drilling site 200 miles north of Puerto Rico.

Geologists at sea are using three basic methods of learning about the ocean floor and the earth's structure:

PROJECT "MOHOLE" -- Con't.

1. South waves are bounced off the ocean floor at precise intervals, and the time needed for the echo to return is automatically recorded, drawing a profile of the bottom far below. This is the sonar technique.
2. A coring pipe is dropped through miles of water to sample the sedimentary layers of the ocean floor. Many of these cores, which can reveal a history of centuries of deep-sea life, are being obtained and studied.
3. High explosives are set off under water, producing tremendous amounts of sound energy. By making seismic recordings of the reflected sound waves with supersensitive microphones called hydrophones, it is possible to calculate the thickness of the layers of rock beneath the ocean floor and to determine the distance to the Moho.

Gathering scientific evidence at sea is tough, adventurous, sometimes hazardous work, as the film shows. Full interpretation of the evidence will take time. When sufficient information has accumulated, the final dramatic step will be taken . . . a seagoing rig will drill through the sediments to the Moho, giving us our first comprehensive picture of the history of the earth and our first direct knowledge of the earth's interior.

Much that we know about the structure of the earth's outer layers is only theoretical -- it is based on inferences from many different kinds of measurements and determinations that have been made. The only way to get clear, direct evidence is to examine actual specimens of the earth's mantle. And the only way to get these samples is to drill -- perhaps more than 30,000 feet -- down from the surface. Other valuable evidence should come to light at the same time. Much remains to be learned about the progress of evolution of life on earth. Only direct fossil evidence will give us answers to the questions that remain. We may learn about shifts which have taken place in the earth's magnetic poles or in the temperature of the oceans during past geologic ages. We may find clues as to the age of the ocean and its rate of growth. Still another factor to be considered is that there is a chance that Project Mohole will turn up some great unexpected discovery. If we turn to the history of science, we find many instances in which unpredicted discoveries have upset accepted theories. These are some of the most valuable results of venturing into the unknown.

This article and film which we viewed were produced in association with Educational Testing Service and the National Science Foundation.

CLAY MINERALS OF MINNESOTA

Dr. Walter Parham

Clays are common natural substances composed primarily of a group of silicate minerals, sheet-like in structure. Chemically, clays may be classed as hydrous aluminum silicates. In addition to water, aluminum, and silicon, clays often contain varying amounts of magnesium, potassium, iron, calcium or sodium. Those clays high in aluminum and low in the latter elements have a high melting point

CLAY MINERALS OF MINNESOTA -- Con't.

and a white fired color and as such are used in the manufacture of fine china, insulators, fire brick and other refractory products. Clays with high contents of iron and potassium, on the other hand, will melt at much lower temperatures and commonly have fired colors of red or brown. These clays are more common and are suitable for the manufacture of brick and other structural clay products.

Identification of specific clay minerals can only be accomplished with special laboratory tools because of the clay minerals' size. Most occur as particles of 1/500 mm in diameter or smaller, far too small for identification by the hand lens or light microscope. Identification of specific clay minerals can be accomplished rapidly by X-ray diffraction techniques; however, information concerning the particle's shape is only obtained by examination with an electron microscope. Magnifications of 100,000 times are readily obtained with today's modern equipment.

The most common clay mineral types are kaolinite, halloysite, illite, chlorite, and montmorillonite. Kaolinite and halloysite are high aluminum clay minerals of similar composition but have quite distinctive shapes. Kaolinite occurs as poorly formed to well formed hexagonal plates, whereas halloysite occurs as thin tubes and less commonly as hollow spheres. Illite is a potassium bearing clay mineral usually having a platy shape of irregular outline. It may occur as hexagonal plates also. Chlorite is a magnesium rich clay of platy form irregular in outline. Montmorillonite is a very thin, platy clay mineral often containing calcium or sodium. The plates have the unique property of being able to expand or contract as the amount of available water increases or decreases.

Industry has taken advantage of the wide variety of unique physical properties possessed by clay minerals in developing products and industrial techniques of advantage to us all. Most of today's glossy, white paper used in magazines similar to Life or Look is composed of approximately one-third kaolinite. Kaolinite's white, flat particles are used as filler in the paper fiber and as a coating on both surfaces. The paper industry is one of the major consumers of kaolin clays.

Montmorillonite from Wyoming and the Dakotas serves as the binder in Minnesota's taconite pellets. Its thinness and ability to expand are properties desirable for bonding clays. It is used with foundry sands as a binder also. Large quantities of montmorillonite are used by the petroleum industry as drilling mud. During oil well drilling it seals off pores in the rocks preventing the escape of drilling fluids.

Recently, it has been discovered that illite is effective in trapping radioactive cesium, a common ingredient in radioactive waste products, and as such is used in the treatment of radioactive waste. When cesium comes into contact with illite it is firmly fixed to the illite particle. The clays and radioactive cesium can be collected and more easily handled than the original liquid waste.

These are but a few uses of clay minerals. A complete list of uses would be too long to include here. Instead, let's consider Minnesota's developed and undeveloped clay resources.

The youngest clays of the State are those deposited in the Pleistocene glacial lakes. These cover large areas of northern Minnesota but at present are only being used at one locality for pottery production. These clays are composed

of a mixture of clay mineral types and large amounts of non-clay minerals. These fine-size materials were originally carried into the region by glaciers and were later washed into lakes where they were deposited. As a result, they are a mixture of all the materials picked up by the advancing glaciers and therefore are not sought after at present as some of the purer clays.

The Decorah Shale and Glenwood Shale, both Ordovician age sediments, are of marine origin. These units are found in the southeast part of Minnesota, and at present only the Decorah Shale serves as the raw material for brick production at one plant. Their clay-size fraction is composed of illite in the eastern areas, but both units become richer in kaolinite in Minnesota further west.

There are impure Cretaceous kaolinitic clays in Goodhue County used for the manufacture of sewer pipe. Illite normally occurs in these sediments as a minor component. Other occurrences of Cretaceous clays and shales are found on the Mesabi Range, near St. Cloud, New Ulm, Morton and at Springfield. Only at Springfield and Morton are these clays and shales being mined by industry. Here they are used for the manufacture of brick and lightweight aggregate. The clay mineral composition of these sediments varies regionally and stratigraphically. Many times they are rich in kaolinite, however, it is equally common to find them rich in illite and montmorillonite.

Underlying the glacial deposits and Cretaceous sediments of most of western Minnesota is a thick section of decomposed Precambrian granites and gneisses, composed of kaolinite to a large extent. The weathered rocks crop out nearby north of St. Cloud and are well-exposed along the valley walls of the Minnesota River between Fort Ridgley and Redwood Falls. The weathered zone in places reaches thicknesses in excess of 100 feet. Most of the clay in the weathered zone is kaolinite, but tubular halloysite and montmorillonite may occur in small amounts also. Today, none of the residual weathered kaolins is being used by industry. Currently, however, there is interest in these materials by some kaolin clay companies. Test drilling has been carried on over the past several years in the Redwood Falls region with the hope of finding kaolinite satisfactory for use as filler and coating clays for the paper industries. Testing and exploration is continuing, but at present there is no active mining of kaolin for paper usage in Minnesota.

Work at the Minnesota Geological Survey is continuing on the State's clay resources. Basic geologic and mineralogic information on the various clays is being collected, cataloged, and interpreted for future publication.

Take time to work, it is the price of success.
Take time to think, it is the source of power.
Take time to play, it is the secret of youth.
Take time to read, it is the foundation of knowledge.
Take time to worship, it is the highway of reverence.
Take time for friendship, it is the secret of happiness.
Take time to love, it is the one sacrament of life.

Anonymous

Minnesota Prehistoric Archaeology

Dr. Eldon Johnson
State Archaeologist

The evidence for human occupation of what is now Minnesota extends back to the terminal phases of the Wisconsin glaciation some 10,000 years ago. Archaeological research conducted over the past 35 years has produced a wealth of data on the sequences of cultural development and change within this region and four broad cultural categories have been defined.

The earliest occupation is associated with what is usually called Paleo-eastern or the Big Game Hunting Complex. This late glacial and early post-glacial occupation by small bands of hunting peoples is known in Minnesota primarily from scattered surface finds of chipped stone projectile points, most of which fall into the type known as Folsom fluted. The Browns Valley burial with the associated finely flaked projectile points is the only excavated site of this very early complex. Though numerous finds of late Pleistocene mammoth are known from Minnesota, none of these to date have any indication of human associations, though we know from other areas that the mammoth was one of the principal mammals sought by these early hunters.

The second major cultural complex in Minnesota is one characterized by ground stone axes and other working tools, and in Minnesota and Wisconsin, by the utilization of native copper for tool production. This complex is called the Eastern Archaic and is characterized by small groups of hunting, fishing and gathering peoples changing their culture to exploit more effectively the variant environmental zones developing in the post-glacial period. One of the earliest of these Archaic sites in Minnesota is the Nicollet Creek bison site in Itasca Park, excavated recently by C. T. Shay of the University under a grant from the Hill Family Foundation of St. Paul. Bones of the extinct Bison occidentalis were excavated from a peat deposit together with some of the projectile points and skin dressing tools used by the peoples who ambushed the bison at the site some 8,000 years ago.

Late Archaic cultures in Minnesota include those which show the use of native copper as a raw material for tool manufacture. Recent excavations at Petaga Point in the New Mille Lacs-Kathic State Park have produced an occupation zone now occupied by these peoples, probably about 1,500 B.C.

A major shift in the nature of the archaeological evidence occurs about 1,000 B.C. with the advent of Woodland Culture. Earth mounds for the burial of the dead began to be used, and hand made pottery of fired clay was added to the cultural inventory. Still basically a hunting-fishing-gathering series of people, their habitation and burial sites show significant cultural variation both through time and also within the various vegetation providences of Minnesota at any one time period. Most important for the archaeologist in attempting to define the series of cultures within the Woodland complex is pottery, which through different techniques of decoration and stylistic changes often provides the best clues.

The final cultural complex in this broad view of Minnesota prehistory is called Mississippian and is intrusive into the southern parts of the state about 1,000 A.D. Cultures within this complex show a considerably different adaptation and economy in that the peoples practiced maize agriculture and lived in fairly permanent villages. North of an east-west line through the Twin Cities,

MINNESOTA PREHISTORIC ARCHAEOLOGY -- Con't.

Woodland culture persisted along with the Mississippian to the south. Climatic and soil factors prevented the spread of maize agriculture north of that line and limited the northward movement of Mississippian people. The Woodland peoples to the north did shift their economy, however, for the archaeological evidence indicates that during this late prehistoric period they began the intensive utilization of wild rice as a staple vegetable food.

The intrusion of French and then British fur traders in the 17th and 18th centuries marks the end of the prehistoric period and the beginning of drastic cultural changes for the Indian populations in Minnesota. The prehistorian and the historic site archaeologist are both interested in this period of change in early historic times, and like the prehistoric period, broad outlines are known, but much research remains to be done.

GLACIAL HISTORY OF THE MINNEAPOLIS-ST. PAUL AREA, MINNESOTA

Dr. John E. Stone

The geologic history of the Minneapolis-St. Paul area during the Quaternary Period, which began about 1.5 million years ago, unquestionably has been extremely complex, for the area has been covered by continental ice sheets during each of the four main glacial ages of the Pleistocene Epoch and has been subjected to erosion during the long interglacial ages that separated them. Unfortunately, however, few details are known about most of these events; most of the geologic evidence either has been destroyed by erosion or is deeply buried by younger deposits and, therefore, is inaccessible. Only the deposits and surface features of the last major glaciation, the Wisconsinan glaciation, are well preserved and relatively well exposed. Thus, the account that follows is really a history of only the end of the last glaciation that has affected the Twin Cities area.

About 13,200 years ago the Superior Lobe of the Wisconsinan glacier, which was pushing down the Lake Superior lowland, terminated in the Twin Cities area, building the St. Croix Moraine in an area around the eastern, southern, and western sides of the metropolitan area; and in front of the moraine was built a large outwash plain which is spectacularly developed in the Rosemount area in Dakota County. Then the Superior Lobe retreated. The meltwaters of the retreating glacier deposited a thick sand unit (recently named the Hillside Sand) behind the St. Croix Moraine.

Then about 12,700 years ago the Des Moines Lobe which was flowing down the Red River Valley lowland and the Minnesota Valley lowland sent the Grantsburg Sublobe eastward and northeastward into the Minneapolis-St. Paul area where it rode up onto the back side of the older St. Croix Moraine and there terminated. Shortly thereafter the Grantsburg Sublobe began to retreat in a stepwise fashion, halting five times before it retreated from the immediate Twin Cities area. Each halt is documented by such features as end moraines, outwash plains, and ice-marginal lake deposits, though none of these features is as large and as spectacular as the St. Croix Moraine and its associated outwash plain.

Finally, the Grantsburg Sublobe retreated entirely to its parent, the Des Moines Lobe, which, in turn, began a halting retreat, the meltwater from the wasting Des Moines ice sheet being funnelled down both the Mississippi and Minnesota River Valleys to produce a broad valley train at the 850-880 foot level. 1/ This episode is well represented today by the Osseo Terrace, which is particularly well developed at Osseo.

At some time after the Des Moines Lobe had retreated, blocks of ice which had been trapped in the glacial debris deposited by the Superior and Des Moines Lobes began to melt, producing many thousands of depressions called kettle holes. Many kettleholes are small, merely contributing to the irregularity of the topography. Many others, however, today contain the hundreds of peat bogs and lakes in the area. It is interesting to note that most of the largest lakes in the area are aligned above buried bedrock valleys of which there are several up to 500 feet deep and up to 1.5 miles wide. Evidently, there was a particular tendency for large blocks of glacial ice to be deposited in the bedrock valleys.

After the valley train had been stabilized at the 850-880 foot level (the Osseo Terrace), some event, as yet unknown, caused downcutting along the Mississippi and the Minnesota Rivers so that the valley train was established at the 820-850 foot level and was considerably less wider than it had been. These rivers were still flowing at a high elevation, however, and were cutting entirely within glacial deposits. Both streams were carrying so much load that most of their energy was devoted to load carrying rather than to downcutting.

Then, about 10,000 years ago the Des Moines Lobe retreated into the Red River lowland and Lake Agassiz came into existence and drained down the Minnesota Valley. Lake Agassiz was the largest fresh-water lake known to all geological history, and the Minnesota River (known at this time as Glacial River Warren) was indeed formidable. It was flowing so rapidly that it swept along every loose object it encountered, from clay - and sand - size particles to boulders several feet across. River Warren had energy to spare, and it quickly cut down through the unconsolidated glacial deposits of the area until it encountered the resistant Platteville dolomites at an elevation of 800 feet above present-day sea level. At downtown St. Paul, however, the rushing torrent encountered an old preglacial or interglacial bedrock valley, and this it quickly cleared of its glacial filling down to bedrock at an elevation of 500 feet. Thus, Warren Falls, plunging 300 feet from the top of the Platteville Formation to the bottom of the old bedrock valley in a torrent one-half mile wide, was formed. Warren Falls began to retreat by hydraulically undermining the soft St. Peter Sandstone, which underlies the Platteville. With the St. Peter Sandstone removed, the unsupported Platteville dropped to the base of the Falls. The retreat of Warren Falls accounts for the straightness and steep-sidedness of the Mississippi Valley from downtown St. Paul southward to Fort Snelling. Blocks of displaced Platteville Formation can be seen at the north end of the High Bridge in St. Paul. The falls also retreated up the Minnesota Valley until it encountered another buried bedrock valley and suddenly ceased to exist. At Fort Snelling, however, the falls had left a hanging valley on the Mississippi. This produced St. Anthony Falls (about 180 feet high) which also began to retreat. It has retreated to its present position in downtown Minneapolis where it is only 50 feet high. As it retreated, it left a number of

1/ The Grantsburg Sublobe had blocked the Mississippi Valley in the Twin Cities area, diverting the Mississippi River eastward to the St. Croix Valley.

small hanging valleys and the water falls dropping from these began to retreat in turn. The best known of these Falls is Minnehaha Falls.

After a while Lake Agassiz ceased to drain down the Minnesota Valley because an outlet was opened to Lake Superior and River Warren was no more. Sedimentation became somewhat more like that along the Mississippi and Minnesota Rivers today, and the valley began to be filled in until the present-day flood plain was established at 700 feet.

The terrain in the Twin Cities area is largely related to the events outlined above. The last several thousand years have seen few changes until the arrival of Man, who is busily changing the landscape.

TO EACH HIS OWN

Her pots and pans look bright and new
And proudly hang for all to view -
She ponders long which paints to blend
Lest colors in yon drapes offend.

She buys her books with great dispatch
Insistent that the bindings match -
She serves the guests in her abode
To gourmet treats on lustrous Spode.

A modern fence was built to hide
These eerie folks she can't abide
Those neighbors with their piles of stones
Their thunder-eggs and bits of bone,
And, mystified, she tells Miss Fox,

"My dear, their house is full of rocks!"

From Mesabi Media
Vol. V, No. 5

MINUTES OF GOLD

Two or three minutes -- two or three hours,
What do they mean in this life of ours?
Not very much if but counted as time,
But minutes of gold and hours sublime,
If only we'll use them once in a while
To make someone happy -- make someone smile.
A minute may dry a little lad's tears,
An hour sweep aside trouble of years.
Minutes of my time may bring to an end
Hopelessness somewhere, and bring me a friend.

Author Unknown.

CONTINENTAL DRIFT

Dr. J. C. Craddock

Within the past few years many interesting theories have been advanced in support of drifting continents.

There is a distinction between continents and other portions of the earth's surface. The continents are seven in number and vary in composition. Oceanic islands are more uniform in composition, being erupted volcanic material, consisting mainly of olivine basalt and superficial deposits of calcium carbonate. Continents are more complex in structure. The basal rocks are typically plutonic, Precambrian in age, made up of very complicated forms along with granite and metamorphic and sedimentary rocks.

Certain igneous and metamorphic rocks are typical of continents. If we were to consider the thickness of the earth's crust, we would find it to be a thin outer shell. The thickness below the continents is 25 miles, but under the ocean basins the base of the crust is about six miles below sea level.

The earth is four and one-half billions of years old. Rocks go back from three to three and one-half billions of years.

It is possible that continents have not always been as they are today. It was thought that continents were permanent, but in 1912 Alfred Wegener published some new ideas on continental drift. In 1937 Alexander Du Toit wrote on wandering continents. A super continent called Gondwana Land, fragmented into the present southern continents beginning in the late Mesozoic period.

There are nine major types of evidence that continents have drifted:

- | | |
|--------------------------|---|
| 1. Physiographic - | Remarkably parallel shape of coast lines; also the edge of the continental shelf is remarkably similar. |
| 2. Stratigraphic - | Stratigraphy of Mesozoic and Paleozoic rocks. Points in Africa, South America and Australia show remarkable similarity. |
| 3. Tectonic - | Relating to structure in continuity of structural trends, such as fold belts. |
| 4. Extensive Volcanism - | Vast out pourings of lava during the Jurassic period in several southern continents. |
| 5. Paleoclimatology - | Deposits show different paleo temperatures. Climatic conditions were different in the past. There were glacial deposits in equatorial areas, coal in polar regions. |
| 6. Evidence of Fossils - | Animal and plant fossils. Certain common animals which could not swim across the ocean. Plants of India and Antarctica similar in great proportion. |
| 7. Geodetic - | Possible changes of position in continents. Greenland appears to be moving westward. |

CONTINENTAL DRIFT -- Con't.

8. Paleomagnetism - Fossil magnetic field and changes and reversals in magnetic field can be interpreted to show relative movement of continents.
9. Ages of Rock in Ocean Basins - Atlantic Ocean basin, for instance, shows no rocks older than Cretaceous.

Evidence cited compels attention but is open to interpretation. Fossil evidence may be interpreted either for or against drifts.

There is a testing corollary in study of rocks in Antarctica. Rocks in Ellsworth Mountains similar to those in Africa and in South America. Discovery of three Triassic fold belts in South America, Africa, and Antarctica is strange considering present geography, but all may be a part of one belt if drift occurred.

Dr. J. Campbell Craddock, Antarctic explorer and associate professor of geology at the University of Minnesota, has resigned to take a post at the University of Wisconsin. He joined the university in 1956.

Dr. Craddock will go to Madison as a full professor of geology, where they have an active program of polar research. We have heard Dr. Craddock lecture on his polar explorations, and understand that his interest lies in that field.

We extend our best wishes for his happiness and success in his new assignment.

ROCKHOUND ROUND-UP

If you are interested in trading some of your rock collection or adding to it, the following round-up seems to offer a fine opportunity.

WISCONSIN ROCKHOUND ROUND-Up, Sponsored by the Rib Mountain Gem and Mineral Society of Wausau, Wisconsin.

July 22 & 23, 1967

Saturday 10:00 to 8:00

Sunday 10:00 to 5:00

Swap---Buy---Sell---Trade---Wholesale---Retail

The better material you bring to swap the better you will take home. Bring your own tables and chairs and lots of rocks. Reserve space. No charge of any kind to anyone.

To be held at Rothschild Pavilion south of Wausau in Rothschild Park. Plenty of parking space. Food served in the building.

A silent auction will be held both days to help defray expenses. Any material donated will be appreciated.

ONLY A FLOWER

"Only a Flower!" Yet it tells me more of God
Than sages have. Has shown me His footprints on the sod;
Has often pointed to His writing on the grass,
And said to me, "He ever comes, but does not pass."

"Only a Flower!" Still its calyx dost unfold
A beauty, too marvelous, -- almost, -- to behold!
And lo! I see its gleaming petal written o'er
With messages, that pale the deepest Grecian lore.

"Only a Flower!" Yet the sky no fairer tint
Derives from the Far Empirian Orient.
No bright Eastern Star the wanderers' way did guide
More truly, than this flower does my way decide.

If the beauty of the form is sculptured by thought,
Oh, what strength of soul! What future the flower's lot!
Ah, if I surely knew, there was an "Elysian Bower",
I would not fear to go, with "Only a Flower"!

Dr. L. O. Dart

Dr. Leslie O. Dart was born on June 3, 1868, in Meeker County, Minnesota, and attended public grade and high schools there. He took some of his academic work at Columbia University, but later transferred to the University of Minnesota, where he took medicine, graduating in 1901. For 18 years Dr. Dart was a member of the faculty of the Medical School at the University of Minnesota, teaching Internal and Clinical Medicine.

Dr. Dart was born with a keen observation and abiding interest in nature. As a boy, he closely observed and investigated natural phenomena, and at the age of 14 was conducting scientific correspondence with Dr. Elliot Coues, Secretary of the U. S. Geological Survey, a great naturalist and traveler. He was a personal friend of President Theodore Roosevelt, with whom he became acquainted while the former president was ranching in North Dakota, and was invited by the ex-president to accompany him on his trip to Africa.

Dr. Dart made nine or ten trips to South and Central America in the interest of science, and had many thrilling and exciting adventures while in pursuit of scientific facts. On one occasion, while investigating the Mayan Civilization remains, he stumbled into a pit, having a single opening at the top, there to find himself and a large boa constrictor sole occupants of the pit. He was rescued by his companions who lowered strong vines to him.

While exploring the Delta of the Orinoco, he collected many varieties of mosses. When these were scientifically identified, it was found that more than 50 varieties had been previously unknown to science.

He was a versatile and entertaining conversationalist, and a man of broad views and tremendous tolerance for the faults of others. In his travels he developed a great interest in geology, and he has been an active and enthusiastic member of our group to the end. He passed away on November 22, 1962. His poem shows how sensitive he was to the beauty of a flower.

1967 Field Trips* (Tentative)

- 1967
May 14 Twin City Brick Yard at St. Paul -- Fossils
One day -- Leader --
- June 11 Red Wing -- Faulting -- Fossils
One day -- Leader -- Elmer H. Brown
- July 1-10 Flin Flon, Manitoba, Canada
One of the richest ore mines in the world. Value of production
to date in excess of one billion dollars. Several Canadian provincial
parks may be visited en route.
- Aug. 6 Annual Picnic
Home of the Kings on the St. Croix
- Aug. Osseo Gravel Pits -- Agates, petrified wood, etc.
One day -- Leader --
(Permission yet to be obtained)
- Sept. 16 Ortonville, Milbank, South Dakota -- Granite
17 & 18 Browns Valley, Lake Traverse (Tri-State Conservancy District)
Mud Lake, Wheaton, Lake Agassiz Beaches, Alexandria, Wadena, Douglas
Lodge at Itasca Park, Brainerd. Then to archeological excavation
at the south end of Lake Mille Lacs.
3 days -- Leaders -- Dr. Bert Carlson and Elmer H. Brown
- Oct. 7-8 Soudan
Duluth, Virginia, Ely, Little Marais -- Trip into the Soudan Iron
Mines to the 27th level.
2 days -- Leader

* Dates and locations are approximate and subject to change.

Field trips are an important part of the program offered by the Geological Society of Minnesota. The real purpose of the field trip is to make the lecture information more tangible and better understood. Members have an opportunity to study the material of which the earth is composed in its mantle, in road cuts and outcrops. There is always something new to be found and learned on every trip. In addition to its educational value, members are given an opportunity for a pleasant outing at nominal cost in new scenic areas with a friendly and cooperative group. Bring your friends who are interested in geology and join us for an interesting experience. Field trips are by chartered bus.

We are not surprised at the geologist's report
that the world is shrinking. Anything that stays
so long in hot water is bound to shrink.

Wall Street Journal

GEOLOGICAL SOCIETY OF MINNESOTA

New Members -- 1967

Anderson, Miss Joyce M.	619 11th Avenue S.E.	Minneapolis	55414	331-2857
Black, Miss Carol F.	Route 3, Box 19	Forest Lake	55025	
Blake, Mrs. Robert H.	Box 226 Ft. Steilacoom,	Washington	98332	
Blake, Martin A.	721 East 3rd Street	Altoona, Wisc.	54720	835-2087
Elegen, Douglas P.	16925 Linden Drive	Minnetonka	55343	473-5281
Bryck, Miss Cindy	128 Lamplight Circle	St. Paul	55119	739-0794
Dahlstrom, Mr. & Mrs. Irvin J.	309 Ontario Street S.E.	Minneapolis	55414	331-5137
Eginton, Mrs. Dorothy	1808 Beechwood Avenue	St. Paul	55116	699-5473
Frohn, Roger	588 N. Lexington Pkwy.	St. Paul	55104	644-0312
Gates, Stephen O.	1200 "B" Zenium Lane No.	Minneapolis	55427	545-6563
Holman, Mr. & Mrs. Don	3848 Quail Avenue No.	Minneapolis	55422	537-9014
Jackson, Miss Betty	2030 Skillman Avenue W.	St. Paul	55113	631-2199
Johnson, Mr. & Mrs. Robert G.	3704 So. Arbor Lane	Minnetonka	55343	938-5854
Nelson, Mrs. Donald F.	2727 N. E. Buchanan	Minneapolis	55418	781-9011
Schwartz, Dr. & Mrs. Geo. M.	237 Bedford Street S.E.	Minneapolis	55414	336-6576
Osborn, Mrs. Mildred I.	701 County Rd. 73 So.	Minnetonka	55343	545-7752
Trutna, Mr. & Mrs. Roger	1299 Ryan Avenue	St. Paul	55113	645-4975
Vacanti, Kimberly	8941 10th Avenue So.	Minneapolis	55420	888-4240

Martha M. Peterson
Membership Chairman

NEWS NOTES

After several months in the Veterans Hospital, Mr. Edgar K. Randall has returned home where he is convalescing. He says he hopes to attend our meetings in the fall. We extend our best wishes for his complete recovery and happiness through the year.

Miss Bernice Bursley was hospitalized for about three weeks. Her recovery was noted by her return to meetings, and we hope that she will continue in happiness and good health.

It was recently learned that Elsie Hinchley fell and broke two ribs, necessitating her hospitalization in Bethesda Hospital, St. Paul. We extend our best wishes for her early recovery and hope to see her at the banquet on April 24.

GEOLOGY BOOK LIST

By Elsie J. Sacia

<u>The How and Why of Picking Agates</u>	Robert R. and Hazel C. Minton	\$ 1.50
<u>A Field Guide to Rocks and Minerals</u>	Frederick H. Pough	4.95
<u>Dictionary of Geological Terms</u>	7,500 items, (paper back)	1.95
<u>Collecting Rocks, Minerals, Gems and Fossils</u>	Russell P. Macfall	3.95
<u>Rocks and Minerals</u>	Richard M. Pearl	1.95
<u>My Hobby is Collecting Rocks and Minerals</u>	David E. Jensen	3.95
<u>Treasures of the Earth</u>	Fred Reinfeld	3.95
<u>The Agates of North America</u>	Hugh Leiper	2.00
<u>Rocks, Rivers and Changing Earth</u>	Herman and Nina Schneider	3.95
<u>Field Book of Common Rocks & Minerals</u>	F. B. Loomis	3.95
<u>1,001 Questions Answered About Earth Science</u>	Richard M. Pearl	6.00
<u>The Rock Book</u>	Carroll and Mildred Fenton	8.95
<u>Guide to the Study of Rocks</u>	L. E. Spock	8.75
<u>The Rock Hunter's Field Manual</u>	D. K. Fritzen	3.50
<u>Gemstones and Minerals</u>	John Sinkankas	8.95
<u>1,001 Questions Answered about the Mineral Kingdom</u>	Richard M. Pearl	6.00
<u>Nature's Hidden Rainbows</u>	Robert M. Jones, Jr.	2.95
<u>The Story of Fluorescence</u>	Rayteck Equipment Co.	1.25
<u>The Fossil Book</u>	Carroll and Mildred Fenton	15.00
<u>The Story of Rocks</u>	Dorothy Shuttlesworth	2.95
<u>Midwest Gem Trails</u>	June Culp Zeitner (Minn. Wisc. Ia. N. & S. Dak.)	2.00
<u>The Rock Hunter's Range Guide</u>	J. Ellis Ransom	4.95
<u>Ultra-Violet Guide to Minerals</u>	Sterling Gleason	7.95
<u>Rocks and Minerals</u>	Herman C. Zim & Paul R. Shaffer (Hard & Paper cover)	3.95 1.00
<u>How to Know the Rocks & Minerals</u> (The Answer to the Question: "What Kind a Rockizzit?")	Richard M. Pearl	5.75

GEOLOGICAL SOCIETY OF MINNESOTA
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