



THE MINNESOTA GEOLOGIST

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OF
THE GEOLOGICAL SOCIETY OF MINNESOTA

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NO. 1



ANNOUNCEMENT

DENVER TRIP

June 12-20th, 1948

The time has come when we must know definitely how many plan to go on the Denver Field Trip. It has already been necessary to make an advance payment to assure us of accommodations in Denver, and it will soon be necessary to make other deposits and commitments.

The bus will leave Minneapolis, Saturday Morning, June 12th, stopping at Grand Island, Nebraska, the first night. We will arrive in Denver Sunday evening, June 13th, where reservations have been made in a modern Auto Court. Monday morning we will leave for Colorado Springs, Garden of the Gods, Pikes Peak and vicinity, Cripple Creek area, and the Royal Gorge, stopping at Canon City, Monday night. We will return to Denver Tuesday evening, remaining there all day Wednesday and Wednesday night. Opportunity will be afforded the group to see the excellent Denver Museum and to attend some of the sessions of the First Annual Convention of the American Federation of Mineralogical Societies, including a noon luncheon arranged for members of the Midwest Federation, and the evening banquet. Thursday morning we will leave for the Rocky Mountain National Park, stopping at Estes Park for the night and returning to our rooms in Denver Friday evening. Saturday morning we will start for home, arriving there Sunday evening, June 20th.

The cost of the entire trip should be between \$65.00 and \$80.00, depending upon your budget, which is estimated as follows:-

Bus Fare (Round Trip)	\$27.00 to \$30.00	(Depending upon the
Rooms (8 Nights)	16.00 to 20.00	number going)
Meals	22.00 to 30.00	
Total Expense	\$65.00 to \$80.00	

Extras are a matter of your choice. This trip affords a wonderful opportunity to study the Front Range of the Rocky Mountains and to attend the first annual convention of the American Federation of Mineralogical Societies. The number of passengers on the bus will be limited to 33. Reservations will be made in the order in which they are received, when accompanied with a deposit of \$10.00.

Please fill out and return the following questionnaire by return mail. It will greatly facilitate the work of the Committee and will help you as well.

CHARLES H. PRESTON, Trip Leader
610 Plymouth Building
Minneapolis 2, Minnesota

GEOLOGICAL SOCIETY OF MINNESOTA

831 SECOND AVENUE SOUTH
MINNEAPOLIS 2, MINNESOTA

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

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MEETINGS: October to May inclusive, 7:30 P.M. every Monday,
not a holiday, large auditorium, 4th floor, Public Library,
Hennepin Avenue and 10th Street, Minneapolis, Minnesota.

FIELD TRIPS: June until September inclusive.

ANNUAL DUES: Residents of Hennepin and Ramsey Counties \$3.00
plus \$1.00 additional for husband, wife, or dependent fam-
ily members; for students and non-residents, \$1.00.

Member

MIDWEST FEDERATION OF GEOLOGICAL SOCIETIES



WE'RE OFF AGAIN, on another one of those super de luxe field trips, for which some of us live from year to year. This time it is to Denver, Garden of the Gods, Pikes Peak, Royal Gorge, Cripple Creek, Estes Park, Rocky Mountain National Park, and last, but not at all least, the first biennial national convention of the American Federation of Mineralogical Societies. The leader is Past President Charles E. Preston, experienced--trip to the Grand Canyon two years ago and to the Black Hills last year --and able. The caravan will leave Minneapolis Saturday, June 12th, arrive in Denver Sunday night, June 13th, and return to Minneapolis on Sunday, June 20th. "LET'S GO".

PHD'S. The better acquainted we become with the members of the University of Minnesota Geology Faculty, and others who enjoy a Ph.D. in Geology, the greater becomes our admiration and respect for this degree. We are fully convinced that one does not get a Ph.D. unless he has proven himself worthy and capable and has a complete mastery of the subject, in all its phases. If we were young again, and were to follow a walk in life other than our chosen field, (which we wouldn't) we might choose Geology. We have observed, also, during the last ten years, the increasing number of those with this degree advancing in the oil industry. Many are now in high executive positions. However, it is in the field of pedagogy that they must find a great field for service and a lot of personal satisfaction.

BULLETINS. We note the steady improvement in foremats, arrangement and printing of the individual bulletins published by the societies of the Midwest Federation. There has been also a steady growth and improvement in the selection and quality of the material published. We congratulate the editors and the societies. Time was when our bulletin was something of a leader in this field, but we will have to step ahead somewhat if we are to keep the lead. Your editors hope to do just that. Our plans may become obvious in our next issue.

"GEM STONES OF THE BIBLE". On February 21st at 8:15 o'clock P.M. in the East Room in the Curtis Hotel, Reverend Carl Erickson of Rockford, Illinois, will give a lecture on this subject. He also will exhibit an exceptional fluorescent display of minerals. Our Society has joined with the Minnesota Mineral Club in sponsoring this lecture. Admission is free.

MUSEUM SOCIETY. Our directors have, by a majority vote, determined to join the Minneapolis Science Museum Society, for the current year. Your editors strongly opposed this action, notwithstanding the expediency of the situation. We personally believe that, although there may be some material advantages, it is contrary to fundamental reactions of human nature and is not to our long term advantage. When one society permits another to underwrite its "work", it might as well close the book. Any society to be progressive and virile, must do its own housekeeping and manage its own affairs. We do not believe that any society can grow and progress while someone else collects its dues, maps its programs, publishes its notices and bulletin, and acts as a general nursemaid to it, however altruistic their motives may be. This seems so obvious to us as to be irrefutable. Joining the Museum Society may not have this effect on our Society, but why place ourselves in jeopardy. It does mean, emphatically, that our Society and particularly its management, must be ever on guard and vigilant to see that it does not happen. If they are not, it will happen. We think also that before the experiment ripens into a permanent arrangement, the membership should be informed and given an opportunity to express themselves on the subject. It is, of course, to our advantage to promote the Museum, but it is not to our advantage for the Museum to exploit the societies.

GEOLOGY OF ALEXANDER RAMSEY STATE PARK

GEORGE A. THIEL, Ph.D.

Chairman, Department of Geology and Mineralogy
University of Minnesota

Alexander Ramsey State Park was named for the first territorial governor of Minnesota. This park, containing approximately 200 acres, is located near the city of Redwood Falls. It is readily accessible from U. S. Highway No. 71 and State Highway No. 19. The park has good roads, camping and picnicking facilities, a pavilion, tennis courts and an enclosure with elk, deer, buffalo and other wild animals. Virgin hardwoods and red cedar cover the rugged topography.

The most outstanding topographic feature in the park is the picturesque gorge which has been cut in the granite rock by the Redwood River at and below Redwood Falls. "The beauty of this deep, rock-walled gorge, about 1½ miles long with its cascades and rapids and meandering river, can scarcely be over-stated" (Upham). The Redwood river has its headwaters in the west-central part of Redwood County from where it flows northeastward in a shallow valley across the upland prairie, but where it approaches the Minnesota River Valley it has cut downward through the glacial drift and into the underlying granite ledges.

The depth of the gorge at Redwood Falls is due to the great amount of stream erosion accomplished by the Glacial River Warren that occupied the Minnesota Valley during the time that Lake Agassiz drained southward to the Mississippi River at Fort Snelling. This great lake was formed as the Des Moines Lobe of the last continental ice sheet melted from the Red River Valley region. Wherever the natural drainage of a region was in the direction occupied by the glacier, extensive lakes were formed in front of the ice.

Thus the drainage from northwestern Minnesota, which would otherwise have flowed northward as it does now, was blocked by the thick ice sheet and a large lake known as Lake Agassiz was formed. This lake extended over northwestern Minnesota, eastern North Dakota and northward over a very large area in Canada. During its maximum extent it covered more than 110,000 square miles. Lake Winnipeg, Lake of the Woods and Lower and Upper Red Lake still occupy a part of the old lake basin. The glacial lake at first drained southward at the lowest point in the rim of its basin. This point was at Browns Valley between Lake Traverse and Big Stone Lake. The large amounts of water derived from the melting ice rapidly eroded a great valley which is from one to five miles wide and from 150 to 200 feet in depth below the general level of the area it traverses.

Later, when the ice sheet had disappeared, the amount of water in the Glacial River Warren and in many other streams decreased greatly and today the small streams often seem out of proportion to their relatively large valleys. The small Redwood River could not erode downward as fast as the great glacial river and consequently it cut the steep gorge with its cascades and falls, where it tumbles down to the level of the floor of the Minnesota Valley.

ROCK FORMATIONS. Granite rocks of pre-Cambrian age crop at numerous places along the channel of the Redwood River. The rock, where fresh and unaltered, is similar in character and composition to that quarried in the Minnesota Valley at Worton. Technically it is a biotite granite gneiss. It is composed of red feldspars and dark minerals which appear mostly in the form of streaks and bands. The feldspars constitute the larger share of the rock, both orthoclase and plagioclase being abundant. Considerable quartz is also present. The chief dark mineral is biotite, with a small amount of hornblende and a few grains of magnetite. When seen on the fresh surfaces of quarry walls, the rock is distinctive and outstanding. Because of its attractive color tones and its peculiar wavy veins and

swirling figures, the rock has been given a variety of trade names such as "Oriental", "Rainbow", "Empestry", "Antique", "Imperial", "Variegated", etc.

In most of the area of Ramsey Park the upper surface of the granite is altered to light gray and white clay. This decomposed mantle is well exposed in the wall of the gorge in the Park and in the road cuts along the highway from Morton to Redwood Falls. Another good section may be seen in the cut along the road up the hill near the village of North Redwood. The same material is encountered in many wells in Redwood and adjoining counties both to the north and to the south of the Minnesota Valley. It passes gradually into fresh rock at depths ranging from 15 to 150 feet.

The white clays in Ramsey State Park have had a different origin than the clayey sub-soils in the fields of south-central Minnesota. Much of the clay in our fields is a product of glacial abrasion. Boulders and stones which were carried or pushed along the bottom of the ice upon a stony or a hard rock floor, received severe treatment. Not only were their rough corners ground off, but many were ground to powder. Such "rock flour" makes up a high percentage of the average clayey soil in Minnesota. It is a product of the great ice-mill of the past.

The white clays over the granite in the park, however, were not formed by the glacier. They were formed in place by the weathering or decomposition of the granite. Such decomposition is accomplished mainly by the chemical action of water. When the gravedigger in Hamlet said, "For your water is a sore decayer of your dead body," he uttered a great geological truth, if we may take "dead body" to mean anything that is not alive. Directly or indirectly, water is the universal solvent and destroying agent. One of its first and simplest effects, is the hydration of minerals, especially the feldspars, which are exposed to it. During hydration, which is the taking of water into chemical union, potassium and some silica are removed in solution from the feldspar, and the insoluble residue is clay.

The rate at which clay is formed from feldspar is exceedingly slow. Wherever the glacial drift rests directly on the smooth, glaciated outcrops of granite, the rock shows very little alteration. Thus during the 20,000 years of post-glacial time, scarcely enough clay has been formed to be detected with the unaided eye. If the rate of hydration is so very slow, how long did it take to form the great thickness of white clay seen along the gorge in the Park? Undoubtedly many millions of years were required.

At several points along the gorge of the Redwood River, black lignitic clays interbedded with white sands and shales occur directly beneath the glacial drift. A similar association is exposed in the cut along the highway between Redwood Falls and Morton. These sedimentary strata indicate the former existence of a basin of sedimentation into which some of the residual clays were transported, sorted and later deposited. Various plant fossils have been found in the shales but no remains of marine forms of life have been discovered. However, from fossil evidence in similar strata farther toward the north and also toward the south, it is generally believed that the sediments are of Cretaceous age.

The youngest geological sediments in the area are the various types of glacial drift and the alluvium derived from it. The high land in the Park is covered by clayey ground moraine deposited by the receding glacier and the valley flats are covered by a veneer of alluvial silts and sands.

After the ice had retreated to the north and most of the temporary glacial lakes had drained, conditions became much as they are today. Vegetation began to flourish on the barren drift sheets, forests sprang up, lakes occupied the undrained depressions formed by the irregular deposition of debris by the ice, and streams developed new drainage channels. Thus gradually the present aspect of the country was developed except for the changes made by man during the past century.

BULLETIN BOARD

DR. BELL'S LECTURE COURSE is progressing nicely, and, at the conclusion those who have attended should have a broad general knowledge of General Geology. This course is a good background for further reading and study. Regularity in attendance is the secret of acquiring such a background. There are six more lectures in this course.

PLEASE NOTE: Because Washington's birthday, this year, falls on Sunday, it will be celebrated as a holiday on Monday, February 23rd. The Library will, therefore, be closed on Monday, February 23rd, and no lecture will be given on that date.

1948

MONDAY, JANUARY 19:	XI	VOLCANOES
MONDAY, JANUARY 26:	XII	DEFORMATION OF EARTH'S CRUST
MONDAY, FEBRUARY 2:	XIII	EARTHQUAKES
MONDAY, FEBRUARY 9:	XIV	METAMORPHISM
MONDAY, FEBRUARY 16:	XV	ORIGIN AND HISTORY OF MOUNTAINS
MONDAY, MARCH 1:	XVI	LAND FORMS

... PICTURE ...

On the next page is a group picture of those who went on the Black Hills field trip, June 21st-29th, 1947. The picture was taken at the entrance of the Sylvan Lake Hotel. The picture was taken by J. Orval Engen.

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GEOLOGICAL SOCIETY OF MINNESOTA
Black Hills Field Trip
1947

DIRECTORY OF BLACK HILLS FIELD TRIP GROUP

From Left to Right

FIRST ROW - Seated

1. Master Ray Little
2. Theodora Melone
3. George A. Rickert
4. Charles H. Preston, Leader
5. Mrs. Anna Kolderie
6. Mrs. Isabelle O'Shaughnessy
7. Jean Gee

THIRD ROW - Standing

1. Lucille Hunter
2. Ethel Sullivan
3. Dr. Edward H. Mandell (President)
4. Elmer H. Brown
5. Mrs. Margaret H. Addy
6. Mrs. E. J. Prochaska
7. Mrs. A. T. Hopworth
8. Mrs. Myra Little
9. Mable F. Kendrick

SECOND ROW - Standing

1. Henry Aarnes (Kansas City)
2. Alger R. Syme

FOURTH ROW

1. Ray J. Little, Sr.
2. Samuel T. Young
3. Reuben Nordberg
4. Willard Smoot (Bus Driver)
5. Dr. L. O. Dart
6. Herbert C. Rowberg (top of head)
7. E. J. Prochaska
8. E. B. Eliason
9. Charles H. Havill
10. W. C. Wilson
11. Mrs. Nanele K. Wells
12. Mrs. Helen J. Syme
13. Mrs. Loretta E. Koppen
14. Pearl Lucius
15. Myra Murray
16. Elsie Hinchley
17. Caroline Vanstrum
18. Mrs. Hertha G. Chapin
19. Dena Kolderie
20. J. Orval Engen

SECOND ROW - Seated

3. Elmer L. Koppen
4. Ralph Hollingsworth
5. Mrs. Ralph Hollingsworth
6. Mrs. Florence E. Havill
7. Mrs. Elsa Mandell
8. Leone Patricia Knox
9. Winnie Doerenberg
10. Mrs. Alice C. Straight
11. Helene H. Becker
12. Mrs. Mary A. Mayyotte

The Duluth metropolitan area, that is the city and surrounding area in Minnesota as far as Two Harbors, Cloquet and Carlton, is an area of great geological interest. Its location at the head of Lake Superior is not only a strategic one with respect to commerce, but also places it at a sort of focal point for much of the geology of the north and south shores.

Lake Superior not only occupies a topographic basin of great extent and depth, but it also occupies a structural basin in the rocks. That is to say the rocks are downfolded into a great elongated basin or geosyncline. Rocks on the north shore generally dip from ten to fifteen degrees toward the lake; on the south shore the dip is much steeper, for example, from 35° to 70° to the north on Keweenaw Point.

Geologists find it convenient to treat the rocks of the earth's crust systematically according to age. If we arrange the formation of the Duluth area in a systematic way, we have a table about as follows, the oldest formations being placed at the bottom.

TABLE 1. GEOLOGIC FORMATIONS OF THE AREA

Upper Keweenaw--
Lake Superior series.
Hinckley sandstone.
Fond du Lac beds.
Middle Keweenaw--
Duluth gabbro and other intrusives.
Keweenaw Point volcanics.
Lower Keweenaw--
Puckwange formation.
Sandstone.
Conglomerate.
Unconformity.
Algonian--
Granite.
Lower Huronian--
Thomson formation.
Unknown.

THOMSON FORMATION. The Thomson formation was named by N. H. Winchell from the outcrops in and near the village of Thomson. Exposures of these rocks are numerous along the St. Louis river from Cloquet down part way through Jay Cooke park. Also scattered exposures extend eastward on the upland as far as the Grandview golf course and southwestward through Carlton county to Denham in Pine county. An isolated series of exposures of probably the same formation occur near Little Falls on the Mississippi river.

The Thomson formation consists of alternating beds of slate, graywacke and graywacke-slate. Slaty cleavage is well developed in the slate beds and has a varying relation to the usually well marked bedding. Muscovite mica, chlorite, and quartz are the principal minerals. The graywacke beds vary from an inch or two to several feet in thickness. They are normally rather dense and fine grained, but in some beds small pebbles occur. Small amounts of carbonate, especially as small crystals, are found in many horizons. Locally definite carbonate lenses occur and carbonate concretions are a characteristic feature of the rock throughout its known extent. These vary from an inch or so in diameter up to as much as three feet in length. The characteristic shape is a flattened oval or elongated ellipsoidal form.

GRANITE. Granite intrusives of Algonian age are not known in the Duluth area, but are important on the Mesabi range and southwest of the Carlton area in Pine county, extending west to St. Cloud and beyond. The intrusion of this granite no

doubt had some indirect effect on the older rocks of the Duluth area, that is, the Thomson formation.

PUCKWUNGE FORMATION. The Puckwunge was also named by W. H. Minchell for rocks along Puckwunge creek in northern Cook county. The name was applied to rocks of the same age in the Duluth area. Recently the conglomerate at the base of the Puckwunge was found lying directly on the Thomson slate in the lowest exposures in the gorge of the St. Louis river in Jay Cooke park. The same conglomerate is exposed a short distance above the slate along a small creek which joins the St. Louis river about one-half mile above the Fond du Lac dam on the north side of the river. The sandstone and conglomerate are well exposed below the lowest basalt lava flow just above the Grandview golf links. Slate is exposed in the fields below so the thickness of the Puckwunge at this place probably does not exceed 50 feet. It is noteworthy that the sandstone and conglomerate have suffered very little metamorphism in contrast to the slate below, which has a highly developed cleavage and is much folded and faulted. The slate beds stand nearly at 90° near the Grandview golf course, whereas the sandstone and flows dip southeast at not to exceed 15°. A great unconformity thus separates the two formations.

MINNEAPOLIS POINT VOLCANICS. Perhaps the greatest geologic event or series of events in the western Lake Superior area was the pouring out of the great thickness of basalt (black) and rhyolite (red) lava flows. These flows came, not from volcanoes but from great fissures which were located according to the evidence of the direction of flow, out in the center of the basin. These flows came in a great series and continued to pile up for a long time probably during progressive sinking of the area. According to A. L. Sandberg, who made a very careful study of the flows of the Duluth area, there are 20,539 feet of flows exposed between the Grandview golf course and Two Harbors, and the total number of flows is fully 250. The oldest is exposed at the Grandview bluff and the youngest at Two Harbors. Still younger flows occur up the shore as far as Two Islands in Cook county beyond which successively older flows are again encountered as one travels northeastward.

DULUTH GABBRO AND OTHER INTRUSIVES. After the lava flows had been poured out, the molten material (magma) continued to work its way upward, but at places it could not reach the surface and it forced its way between the flows and other rocks and formed huge masses of intrusive rocks now recognized as gabbro, diabase, and syenite. The Duluth gabbro is the largest mass of this material. It extends from Duluth north and east in a broad belt reaching Lake Superior at the Reservation river, 25 miles east of Grand Marais. At many places along its border it has affected by its great heat the rocks with which it came in contact. This is true, for example, at Short Line park near Duluth. This mass was so large that the molten material segregated more or less after intrusion and near the top the black gabbro grades to "red rock" (syenite or granite). Diabase and gabbro rocks also are found as sills and dikes in the lava flows at places from Duluth to Grand Portage Bay and in the slates north of that point. At places for example on shore near Encampment Island, the diabase has clearly tipped up the flows by the force of its intrusion.

The gabbros, diabase and syenites (red rock) are coarse grained rocks, that is the minerals which compose them may be easily recognized with the naked eye. The coarse texture is a result of the slow cooling of the mass of molten material under cover. It is known from the poor conductivity of rocks that it must have taken centuries for a mass the size of the Duluth gabbro to cool. There was probably little difference in the composition of the molten material which formed the basalt floor and the gabbro, but the difference in the time of cooling has resulted in a distinctly different texture in the two types. The intrusive rocks are hard and massive and resist weathering better than the surrounding flows. The almost mountainous character of the north shore country is directly attributable to the presence of the numerous diabasic intrusions.

According to Sandberg the Duluth gabbro is 14,500 feet thick at Duluth and it is much thicker farther northeast in Lake and Cook counties. The sills which occur above the gabbro are of considerable interest and have also been studied in detail. These are well exposed along the shore at intervals from 16th Avenue East nearly to

the Lakewood pumping station.

At the shore of Lake Superior the Endion sill is separated from the gabbro by 2,760 feet of flows and diabase. The gabbro transgresses the flows at such a large angle that about two miles to the north it is probably in contact with the Endion sill, but unfortunately glacial deposits cover the contact. Farther north outcrops are scarce, but at places the nearest exposures above the gabbro are diabase. It is therefore possible that this sill continues for several miles northward. The Endion sill is not considered an offshoot of the gabbro because its texture even close to the gabbro is notably fine-grained as compared with that of the very coarse gabbro. An example is the Endion diabase near Forest Hill cemetery.

The third sill above the gabbro is separated from the Endion sill by about 445 feet of flows at the shore of Lake Superior. This has been called the Northland sill because it forms large rock hills on and near the Northland Country Club grounds. The sill is only 31 feet thick on the shore but thickens rapidly northward and possibly merges with the Endion sill.

A small diabase sill 132 feet thick is exposed on the shore at the foot of 48th Avenue East between the Northland and Lester river sills. This sill may be traced for only a short distance northeast by intermittent outcrops but probably is thin all the way and eventually pinches out or disappears under the drift.

The Lester river sill is 3,350 feet stratigraphically above the Northland sill and is exposed along shore for slightly over a mile beginning just east of the mouth of Lester river. The sill may be traced for many miles inland.

FOND DU LAC SERIES. In the vicinity of Fond du Lac and along the south shore of Lake Superior east of Superior is a thick series of sandstones. The exact relation of this sandstone to the other rocks of the Duluth area is not well shown at Duluth, but from data elsewhere around Lake Superior it is known that these sandstone beds are younger than the lava flows.

GLACIATION. The last series of events of geologic time in North America was the formation of a series of great continental glaciers which moved southward from centers in Canada to cover portions of Minnesota several times. The basin of Lake Superior was occupied by lobes of ice which came from centers south and east of Hudson's Bay. Thus much of the topography of the area is a result of the work of glacial ice and of the water which resulted from its melting.

The last episode of glaciation is naturally the most important because its results were not destroyed or covered by subsequent events. The ice moved along the Superior basin from the northeast and then spread out over the lands above the present Lake level. In Duluth proper the ice moved essentially parallel to the shore line but as it continued southeastward it fanned out so that at Carlton the scratches and grooves on the rocks show that it moved from east-southeast to west-northwest. Near the borders of the ice sheet huge piles of rock debris were left by the melting ice and the very hilly moraines of the area north of Duluth were formed. These moraines form rude curving belts southeast of Duluth and Superior in both Wisconsin and Minnesota.

When the ice retreated to the Superior basin drainage to the east was still cut off and water ponded in front of the ice until it overflowed first by one route and then another into the St. Croix-Mississippi drainage. Thus Glacial Lake Duluth once extended southwest to Moose Lake where it overflowed into the Kettle river. Later the main outlet was by way of the Brule valley in Wisconsin. During its existence high shore lines were developed by Glacial Lake Duluth as much as 400 feet above the present Lake level. The general course of the upper beach is marked by the Skyline Boulevard in Duluth. Clay was deposited in large amounts in this basin and the red lake clay plains such as at Wrenshall were developed. The clay, however, is red only where it is weathered; below it is a greenish gray and the annual layers of deposition may often be seen in fresh cuts.

With the retreat of the ice drainage to the east gradually developed and the lake subsided to nearly its present level of 602 feet above sea level.

READING LIST

We have secured the following READING LIST from the University of Michigan. Some of our members do a considerable amount of reading on geological subjects. To those of you who have not acquired that habit, we earnestly recommend that you make a start now. One of the main purposes of our lecture courses is to give our members sufficient background so that they may be able to read geologic literature understandingly and enjoy what they read. The following READING LIST is recommended for this purpose. Most of these books can be obtained in the libraries available to you. The publisher and the price are given so that you may purchase these books if you care to.

A.R.S.

GEOLOGY

- Lee, Willis T. *STORIES IN STONE*. N. Y.: Van Nostrand, 1926. 226pp. Illus. \$3.00.
A delightful account of some of the wonderlands of western America and some of the curious incidents in the history of geology.
- Hobbs, William H. *EARTH FEATURES AND THEIR MEANING*. N. Y.: Macmillan, 1931. 517pp. Illus. \$4.90.
A revised and enlarged edition of a standard introduction to geology for the general reader.
- Bradley, John H. *THE EARTH AND ITS HISTORY*. Boston: Ginn, 1928. 414pp. Illus. \$3.00.
An elementary text which gives a systematic idea of the subject.
- Merriam, John C. *THE LIVING PAST*. N. Y.: Scribner, 1930. 144 pp. Illus. \$2.00.
The romance of past life and evolution is presented with lively interest in the episodes of geological and anthropological discovery.
- Schuchert, Charles, and LeVene, Clara M. *THE EARTH AND ITS RHYTHMS*. N. Y.: Appleton-Century, 1933. 409pp. Illus. \$4.00.
A simplified authoritative account of the earth's history.
- Snider, Luther C. *EARTH HISTORY*. N. Y.: Appleton-Century, 1932. 683pp. Illus. \$4.50.
An account of the earth's beginnings and history through the ages expressed in the simplest language. Technical terms are excluded as far as possible.
- Mather, Kirtley F. *OLD MOTHER EARTH*. Cambridge, Mass.: Harvard Univ. Press. 1928. 177pp. \$2.50.
A series of radio "armchair talks," on topics such as the origin of life, how mountains are made, and the Appalachian Mountains. Several of the chapters are devoted to the northeast, and, as this region is well known to many, the book has a wide appeal. It should follow, rather than precede, a general treatment.

MINERALOGY

- Kraus, Edward H., Hunt, Walter F., and Ramsdell, Lewis S. *MINERALOGY*. N. Y.: McGraw-Hill, 1936. 638pp. Illus. \$5.00.
An introduction to the study of minerals and crystals.

- Kraus, Edward H., and Hunt, Walter F. TABLES FOR THE DETERMINATION OF MINERALS BY MEANS OF THEIR PHYSICAL PROPERTIES, OCCURRENCES AND ASSOCIATES. N. Y.: McGraw-Hill, 1930. 254pp. \$3.00.
- Loomis, Frederick B. A FIELD BOOK OF COMMON ROCKS AND MINERALS FOR IDENTIFYING THE ROCKS OF THE UNITED STATES AND INTERPRETING THEIR ORIGINS AND MEANINGS. N. Y.: Putnam, 1923. 278pp. \$3.50.
- An excellent manual for the identification of rocks and minerals without elaborate equipment or previous training. Fully illustrated in color.
- Tutton, Alfred B. H. THE NATURAL HISTORY OF CRYSTALS. N. Y.: Cutton, 1924. 287pp. \$4.65.
- A complete survey of the science of crystallography.
- Pirsson, Louis V., and Knopf, Adolph. ROCKS AND ROCK MINERALS. Revised by Adolph Knopf. N. Y.: Wiley, 1926. 426pp. Illus. \$3.50.
- A manual of the elements of petrology. For use without a microscope.
- Brookings Institution, Washington, D. C. MINERAL ECONOMICS. Edited by Frederick G. Tryon and Edwin C. Eckel. N. Y.: McGraw-Hill, 1932. 311pp. \$2.50.
- An authoritative work.
- Read, Thomas F. OUR MINERAL CIVILIZATION. Baltimore, Md.: Williams and Wilkins, 1932. 165pp. \$1.00.
- A study of the important part played by minerals in our civilization.
- Rickard, Thomas A. MAN AND METALS. N. Y.: McGraw-Hill, 1932. 2V. Illus. \$10.
- A history of mining in relation to the development of civilization.
- Rickard, Thomas A. A HISTORY OF AMERICAN MINING. N.Y.: McGraw-Hill, 1932. 419pp. Illus. \$3.00.
- Explorations, discoveries, and experiments connected with mining in different sections of the West are described in nontechnical, interesting narrative that relates the history of the country to the history of the mining industry.
- Leith, Charles K. WORLD MINERALS AND WORLD POLITICS. N.Y.: McGraw-Hill, 1932. 213pp. \$2.00.
- A factual study of minerals in their political and international relations.
- English, George L. GETTING ACQUAINTED WITH MINERALS. N.Y.: McGraw-Hill, 1934. 324pp. Illus. \$2.50.
- An introductory manual and simple guide, with good descriptions of many minerals, an identification list, and a pronouncing vocabulary.
- Emeny, Brooks. THE STRATEGY OF RAW MATERIALS. N.Y.: Macmillan, 1934. 202pp. Maps. \$3.00.
- A study of America in peace and war.
- Dake, Henry C., Fleener, Frank L., and Wilson, Ben H. QUARTZ FAMILY MINERALS. N.Y.: McGraw-Hill, 1938. 304pp. Illus. \$2.50.
- A handbook for the mineral collector.

PALEONTOLOGY

- Andrews, Roy Chapman. ON THE TRAIL OF ANCIENT MAN. N.Y.: Garden City Publishing Co., 1935. 375pp. \$1.00.
- A vivid adventure story of explorations in the Gobi Desert.
- Loomis, Frederick B. HUNTING EXTINCT ANIMALS IN THE PATAGONIAN PALPAS. N.Y.: Dodd, Mead, 1913. 141pp. Out of print.
- An account of an expedition in the wilds of South America, of the fossil remains discovered, and of the native tribes encountered.
- Merriam, John C. THE LIVING PAST. N.Y.: Scribner, 1930. 144pp. Illus. \$2.00.
- Popular essays on the earth's history. One deals with a remarkable asphaltum lake in California and the prehistoric animals trapped there.

Hotchkiss, William O. THE STORY OF A BILLION YEARS. Baltimore, Md.: Williams and Wilkins, 1932. 137pp. Illus. \$1.00.

A brief, popular account of geological history for the intelligent layman.

GEMS AND GEM MATERIALS

Kraus, Edward H., and Slawson, Chester B. GEMS AND GEM MATERIALS. N.Y.: McGraw-Hill, 1939. 287pp. Illus. \$3.50.

Reliable information on the various properties and forms of gems and on the various minerals and materials used as gems.

Kraus, Edward H., Hunt, Walter F., and Ramsdell, Lewis S. MINERALOGY. N.Y.: McGraw-Hill, 1936. 638pp. Illus. \$5.00.

An introduction to the study of minerals and crystals.

Kunz, George F. THE CURIOUS LORE OF PRECIOUS STONES. Philadelphia: Lippincott, 1913. 406pp. Illus. \$8.50.

An interesting history of precious stones and of the stories and legends that have grown up about them.

Kunz, George F. THE MAGIC OF JEWELS AND CHARMS. Philadelphia: Lippincott, 1915. Illus. \$8.50.

Contains much material of value to the student, but is interesting also to the general reader.

Pavitt, William T., and Pavitt, Kate. BOOK OF TALISMANS, AMULETS, AND ZODIACAL GEMS. Philadelphia: McKay, 1915. 292pp. Illus. \$2.50.

A fascinating book for the student.

Smith, George F. H. GEM STONES AND THEIR DISTINCTIVE CHARACTERS. London: Methuen, 1935. 314pp. Illus. 7s. 6d.

A valuable book for the collector; many illustrations in color.

Wade, Frank B. DIAMONDS. N.Y.: Putnam, 1916. 150pp. \$2.00.

An excellent handbook, intended primarily for the dealer in diamonds.

Williams, Alphaeus F. THE GENESIS OF THE DIAMOND. London: Benn, 1932. 2v. 84s.

A most important work.

Williams, Gardner F. THE DIAMOND MINES OF SOUTH AFRICA. N.Y.: B. F. Buck, 1905. 2v. Illus. Out of print.

An interesting history of diamonds, their seeking, cutting, and polishing, from legendary times to the present century.

Spencer, Leonard J. A KEY TO PRECIOUS STONES. N.Y.: Furman, 1937. 237pp. Illus. \$2.75.

An account of the properties and compositions of gem stones, where they are found, and to what uses they can be put.

Whitlock, Herbert P. THE STORY OF THE GEMS. N.Y.: Furman, 1936. 206pp. Illus. \$3.50.

A popular handbook.

Baxter, William T. JEWELRY, GEM CUTTING AND METALCRAFT. N.Y.: McGraw-Hill, 1938. 224pp. Illus. \$2.50.

Written for home draftsmen.

CUTTING AND POLISHING STONES

Bernewitz, M. W. von, and Hess, Frank. CUTTING AND POLISHING STONES. Washington, D.C., Dep't. of Interior, Bureau of Mines, 1940. 23p. Illus. (Information Circular L. C. 7107)

Contains sections on the examinations of mineral specimens, the cutting and polishing of gem stones and the equipment used, and school instruction

in cutting gem stones.

- Howard, James Harry **HANDBOOK FOR THE AMATEUR LAPIDARY DESIGNED TO PROVIDE PRACTICAL INSTRUCTION IN ALL KINDS OF GEM CUTTING FOR THE BEGINNER AND FOR THE ADVANCED AMATEUR.** Greenville, S.C., J. H. Howard, 1935. 140p. Illus. \$2.00.
- Howard, James Harry **WORKING OF SEMI-PRECIOUS STONES.** A brief elementary monograph. A practical guidebook written in non-technical language for those who desire to cut and polish semi-precious stones. Peekskill, N.Y., Rocks and Minerals, 1931. 37p. Illus. \$1.00. (Bulletin No. 1)
- Inghalls, A. G. **SLICING AND POLISHING METEORITES.** Scientific American 159:120. Sept., 1938. Illus.
- Kraus, Edward H., and Slawson, Chester B. **GEMS AND GEM MATERIALS.** 3d ed. N.Y., McGraw-Hill, 1939. 287p. Illus. \$3.50.
- Addresses to the mineralogist, the collector of gems, and jewelers. Includes chapters on the cutting and polishing of stones.
- Thomson, Horace L. **LEGENDS OF GEMS:** the strange beliefs which the astrological birthstones have collected through the ages; incorporated with a revised edition of gems--how to know and cut them. Los Angeles, Graphic Press, 1937. 124p. Illus. \$1.15.
- Shimmel, Charles L. **TREATISE ON THE ART OF AMATEUR LAPIDARY.** Madera, Calif., Bick Printing Co., 1936. 30p. Illus. \$1.00.
- Whitlock, Herbert P. **THE ART OF THE LAPIDARY.** N.Y., American Museum of Natural History, 1926. 29p. Illus. (Guide Leaflet No. 65.)

ANIMALS

(Fossils)

- Lucas, Frederic A. **ANIMALS OF THE PAST.** N.Y.: Amer. Museum of Natural History, 1929. 221pp. Illus. \$.75.
- A simple and interesting treatment of the more remarkable fossil animals and the reason for their extinction.
- Scott, William B. **HISTORY OF LAND MAMMALS IN THE WESTERN HEMISPHERE.** N.Y.: Macmillan, 1937. 786pp. Illus. \$7.50.
- An elaborate work on the geographical history of the Western Hemisphere and the groups of mammals which successively inhabited it. Particularly good in its description of the animals of South America.
- Locnis, Frederic B. **THE EVOLUTION OF THE HORSE.** Boston: Marshall Jones, 1926. 233pp. Illus. \$3.00.
- An important book on the development of the modern horse from an animal no larger than a dog.
- Hooton, Ernest A. **UP FROM THE APE.** N.Y.: Macmillan, 1931. 626pp. Illus. \$5.00.
- An entertainingly written story of human evolution for the general reader.

PLANTS

(Fossils)

- Knowlton, Frank H. **PLANTS OF THE PAST.** Princeton, N.J.: Princeton Univ. Press, 1927. 275pp. Illus. Out of print.
- A popular account, well illustrated, telling how plants of the past must have appeared when living. Arranged chronologically.
- Seward, Albert C. **PLANT LIFE THROUGH THE AGES.** N.Y.: Macmillan, 1933. 603pp. Illus. \$8.00.
- A detailed geological and botanical summary for general readers.

Periodicals

The following list of periodicals is taken from a recent book written by Professor Richard M. Pearl entitled, "MINERAL COLLECTORS HANDBOOK".

PROFESSIONAL PUBLICATIONS

- THE AMERICAN MINERALOGIST--1916 to date. Monthly or bimonthly. A professional journal. Publisher: Mineralogical Society of America. Editor: Dr. Walter F. Bunt, University of Michigan, Ann Arbor, Michigan.
- ECONOMIC GEOLOGY--1909 to date. 8 issues annually. \$5.00 per year. A professional journal. Publisher: Economic Geology Publishing Company, Urbana, Illinois. Editor: Alan M. Bateman.
- THE GEMMOLOGIST--1931 to date. Monthly. \$2.75 per year. Publisher: N.A.G. Press. Ltd., 226 Latymer Court, Hammersmith, London W. 6, England. Editor: Arthur Fremayne.
- GEAS AND GEMOLOGY--1933 to date. Quarterly. \$3.50 per year. Publisher: Geological Institute of America, 541 South Alexandria Avenue, Los Angeles 5, California. Editor: Robert W. Shipley.
- MINERALOGICAL MAGAZINE--1876 to date. Monthly. Price \$4.00 per year. A professional journal. Publisher: Mineralogical Society, London. Editor: L. J. Spencer.

FOR THE LAYMAN

- EARTH SCIENCE DIGEST--1946 to date. Monthly. Price \$2.00 per year. Publisher: Earth Science Publishing Co., Box 581, Ann Arbor, Michigan. Editor: H. P. Zuidema.
- LAPIDARY JOURNAL--1947 to date. Quarterly. \$1.00 per year. Publisher: Lapidary Journal, Inc., P. O. Box 1228, Hollywood 28, California. Editor: Leland Quick.
- MINERAL NOTES AND NEWS--1937 to date. Monthly. \$1.00 per year. Publisher: California Federation of Mineralogical Societies. Editor: Paul Vander Eike, Route 5, Box 177, Bakersfield, California.
- THE MINERALOGIST--1933 to date. Monthly. \$2.00 per year. Publisher: Mineralogist Publishing Company, 329 S.E. 32nd Ave., Portland 15, Oregon. Editor: Dr. H. C. Dake.
- ROCKS AND MINERALS--1926 to date. Monthly. \$3.00 per year. Publisher and editor: Peter Zodac, Peekskill, New York.

HAND BOOK

"MINERAL COLLECTORS HANDBOOK", by Richard M. Pearl, Professor of Geology and Mineralogy, Colorado College, Colorado Springs, Colorado. 1947. \$3.75. Published by Mineral Book Co., 405A Mining Exchange Bldg., Colorado Springs, Colorado. This book answers all your questions dealing with building a collection, constructing cabinets, cleaning specimens, how and when to lacquer specimens, when to use and not to use water, and so forth; indispensable to the amateur collector.

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