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MINERAL EXPLORATION AND LEASING IN NORTHERN WISCONSIN

by

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<u>Mineral exploration & leasing in Northern Wisconsin</u>

The crystalline rocks of Precambrian age which outcrop in northern Wisconsin are a southern extension of the so-called "Canadian Shield". They are very old, on the order of 1-2 billion years, and very complex both in rock types and geologic structure. They record periods of mountain building and erosion; of the deposition of ancient sediments including iron formation, and of the deep-seated injection of magma, of quiet, massive, lava flows, and of explosive volcanic eruptions.

The Canadian Shield has long been known as one of the great metalogenic provinces in the world, and much geologic research has been done to attempt to relate the occurrence of mineral deposits to the regional sequence of geologic events which resulted in their formation. Most recent studies indicate that mineralization is integrally associated with a complex series of volcanic events. The resultant rock units were formerly called "greenstone belts" but the terms "volcanic-sedimentary belts" or "volcanic piles" are now more commonly used.

Recent geologic work in Northern Wisconsin has shown that such volcanic piles occur in the Precambrian rocks, and test-drilling has shown that mineralization is also present. Due to these factors, as well as to the fact that northern Wisconsin is the largest, unexplored, segment of the Canadian Shield in the United States, the area presents a most favorable target for exploration and is attracting great interest by many major mining companies.

Exploration in northern Wisconsin is, however, neither easy nor inexpensive. Not only have the rock units been altered and contorted over geologic time, but glaciation, within the recent geologic past, left a blanket of glacial debris (drift) over the bedrock surface. In some areas bedrock outcrops are plentiful enough so that the rock types and geologic structures can be determined by observation in the field, but in many areas outcrops are so scarce that this is not possible and indirect methods must be used. Among these the most basic is air-borne magnetics. This is a rapid, and relatively inexpensive technique which differentiates rock groups on the basis of their magnetic properties. Along with magnetics some other data may be gathered at the same time such as measurements of radio-activity and electromagnetic measurements.

Targets for more detailed study are selected on the basis of contrasting properties (anomalies) revealed by the air-borne surveys. When these have been identified detailed, ground-based, geophysical studies are made and the target area is further refined. Up to this point virtually all geologic knowledge is based on interpretation, and it is now that the geologist has to decide whether the results indicate going any further and, if so, to sell his company in taking the next exploratory step, namely drilling. This is a very expensive process, but it is the only way that the cause of the geophysical anomalies can be determined. It is at this point that the companies must negotiate for exploration permits giving them proprietary rights to drill on specified tracts of land, and, at the same time, secure a mining lease that will give them the right to mine the deposit should the drilling program locate an ore-body.

This is a tense period for both the landowners and the companies. The landowners are convinced that they are sitting on a gold mine, but the companies realize that the odds on success are long indeed. The negotiations must be made with a relative degree of secrecy to prevent attracting the entry of competitors, and it is a period of uncertainty for all concerned. What, then, should the owners of mineral rights do to both encourage exploration and protect their interests at the same time.

1. The Company.

Be sure that you are dealing with a reliable company. Many major companies have exploration subsidiaries which do not bear the name of the parent company, some companies may negotiate through consultants. Exploration, or rumors of exploration, tend to attract speculators who may offer what look like attractive contracts but who have no mining capability themselves, and stand to profit only by peddling the contract at a higher rate to a bona fide mining company. If a company, or its representative, is unable to identify itself satisfactorily don't deal with them.

It is in the interest of both the company and the landowners that exploration rights are acquired as promptly as possible. Long delays and unreasonable hold-outs may kill a project entirely, however minerals are not like crops that must be harvested periodically, they remain indefinately until mined. Be reasonable, but take adequate time to examine the contract and the background of the company offering it. You may wish to hire a qualified consultant to advise you. This may be expensive but worth it in the long run.

2. The prospecting permit.

During the prospecting period the company is, or should be, making a substantial investment with no guarantee of any return. Among the suggested provisions of a prospecting permit are the following.

1. An initial payment and a nominal rental fee should be required. This would depend on theacreage involved, the state of development of the property, the current use of the land, the disturbance that would be caused by the prospecting activity. This is a time to get information not to get rich.

2. An annual minimum amount of work by the company should be specified, and an annual report of work performed should be required. The detailed results, however, should remain confidential.

3. The work should be done with minimum amount of damage, or disturbance to the surface of the property. The company should be responsible for repairing any damage, re-imbursing owner for any timber cut etc.

4. The period of exploration should be limited, and at the termination of the exploration permit complete records of all exploration

work, geophysical, core drilling, assays etc. should be furnished to the owner and to the Wisconsin Geological Survey. It is extremely important that records of exploration be filed whether they be negative or positive. Five years should be adequate for the term of a prospecting permit but provision could be made for an extension by mutual agreement.

There are, of course, other legal considerations that are included in prospecting permits and the provisions above are for substantive consideration rather than legal format.

3. The Mining Lease.

At the same time that a prospecting permit is signed, a permit to mine should also be signed, as no company can invest in a major exploration program if it has not secured the right to mine the ore that it might discover.

a) Royalty Payments

The prime purpose of a mining lease, other than permitting the company to mine, is to provide for royalty payments to the owner for ore removed from his property.

It should be noted that rather than entering into a mining lease, an option to purchase might be preferred. In this case the company has the option to purchase the property outright thus giving the landowner an immediate financial return, and also releasing the company from royalty payments.

When the mining lease is in force there are two phases of activity, one while the property is being held prior to mining, and the other when mining is actually begun. During the period prior to mining the companies conventionally pay an "advance royalty". As soon as mining commences the companies pay a "production royalty", and the advance royalties paid previously are deducted from the production royalites.

Mining leases are also conventionally written for a long period of time as a company could not obtain financing if it were not guaranteed a long-term operation to permit complete mining of the ore body.

Although it has been generally assumed that when a bona fide company obtains a mining lease it intends to mine, recent experience has shown that this may not be always true. Once a company has a long term lease on an undeveloped property it can use this for leverage to obtain both tax concessions on properties operating in other areas, or price concessions from other companies with whom its operations would compete. Thus a company could hold lands by a mining lease for decades without any mining activity, during which period the surface owner is severely limited in the use to which he may put the surface not knowing when mining might commence. Moreover if other companies evidence interest in mining the deposit it is the company holding the long-term lease, not the property owner, who controls the decision.

With the above concerns in mind, it is recommended that mining leases be structured to provide incentives for early mining and discourage long-term holding.

Specifically:

1. Mining leases be limited to a maximum of twenty years without mining.

2. When mining begins the lease shall be automatically extended for that period of time necessary to complete the mining of the ore.

3. "Mining" shall mean continuous operations except when prevented by strikes or other forces outside of the control of the company.

4. Payments made to the owner prior to mining shall not be considered "advance royalties" but shall be termed rental.

5. The amount of rental should escalate annually. (Ex. $1.00 per acre the first year, $2.00 the second....$20.00 the twentieth year.)

6. Rental payments paid for only those five years prior to payment of production royalties should be deducted from royalties.

The above provisions would, of course, have to apply to the total mining property, not to individual holdings as it may be impossible to mine the entire property at the same time.

The amount of production royalties to be paid is a matter of negotiation, and there are several bases on which these are figured. Most commonly the royalty is based on a percentage of the value of minerals produced f.o.b. mine. In the case of sulfide ores, which are those of immediate concern in northern Wisconsin, the values is based on the net proceeds from the sale of the ores, concentrates and/or mill products, less the cost of transportation and smelting. Some leases may provide for royalties to change with the grade of ore, others may change with depth of mining, however a percentage of value f.o.b. mine is simple and fair.

Often a unit of government such as a county, can profitably stimulate mining by accepting a lower royalty rate than an individual due to the multiplier effect of the mining activity on the local and regional economy through jobs created, taxes etc.

3. <u>Conduct of operations, rehabilitation.</u>

Virtually all mining leases contain a clause stating that mining shall be conducted in a careful and workmanlike manner, however the growing concern for the preservation of environmental quality requires that planned reclamation be an integral part of the total operation. There are over-riding state laws that prohibit the discharge of any deleterious substance, including tailings, into streams. Air pollution is likewise controlled. There are, however, no state laws or regulations that spell out how the land shall be left at the conclusion of mining. Mining companies should be required to furnish plans for both mining and reclamation. Mining should not be permitted without the plans being approved and the company posting bond to insure performance. The problem however is who should approve the plans.

It is obvious that the landowners cannot negotiate a reclamation plan on an individual basis. There is no state agency that has the authority to require and approve reclamation plans, therefore it would appear that, at present, this could well be a function of county government through zoning ordinances. Regional planning commissions could be of great aid in advising the individual counties. Major mining companies have now become extremely sensitive to their images and no company should object to reclamation provisions providing that they are reasonable. If properly reclaimed open pit mines operations can often create greater recreational values than previously existed. This is another area in which counties could adjust their royalty rates in return for reclamation plans over and above those which might be normally expected, but which might enhance the long term financial base of the county.

Needless to say that the property owner should receive compensation for loss of surface values (harvestable timber, crops, etc.) over and above any royalty payments.

4. Mineral rights and surface rights.

Throughout most of Wisconsin the owner of the surface rights is also owner of the mineral rights. In some areas, however, the mineral rights have been reserved, and separated from the surface rights. If the mineral rights have been separated this fact should show on the property records. This creates two separate estates. A surface estate which is taxable and which may revert back to the county for non-payment of taxes, and a mineral estate which is not taxable hence does not revert due to tax delinquency of the owner of the surface estate.

As there is no law in Wisconsin which requires the registration of mineral rights it is often extremely difficult to determine who the owner is. Indeed the mineral rights may have been separated generations ago, and the present legal owner may not even be aware of his ownership. This has created an extremely confusing situation which is by no means unique to Wisconsin.

Minnesota recently passed a law that if, after a reasonable search, the owner of the mineral rights could not be located the state would act as trustee and enter into mining contracts on his behalf. If the owner appeared later the state would pay him the royalties due less the costs of administration.

Wisconsin legislators are considering legislation which would require the registration of mineral rights, when separated from the surface rights, and the payment of a small annual registration fee. Failure to register, or pay the annual fee, would result in the mineral rights reverting back to the owner of the surface rights.

Some study appears necessary to clarify the rights of the owner of the surface when the owner of the minerals enters a mining contract. When mineral rights are separated the separation implies the right to mine, and to utilize as much of the surface as is necessary to conduct the mining operation. In the case of sinking a shaft this might be a small fraction of the surface, but in the case of an open pit mine this could constitute the entire surface.

It would appear that the surface owner could not prohibit mining, but it also would seem obvious that the surface owner would have to be compensated for any damage done to surface property.

If the document separating the mineral rights specifies the respective rights of both owners, and the method of resolving conflicting interests, there might be little, if any, problem. However where a definite agreement is lacking it might be extremely difficult to reconcile the rights of the respective owners and the compensation due.

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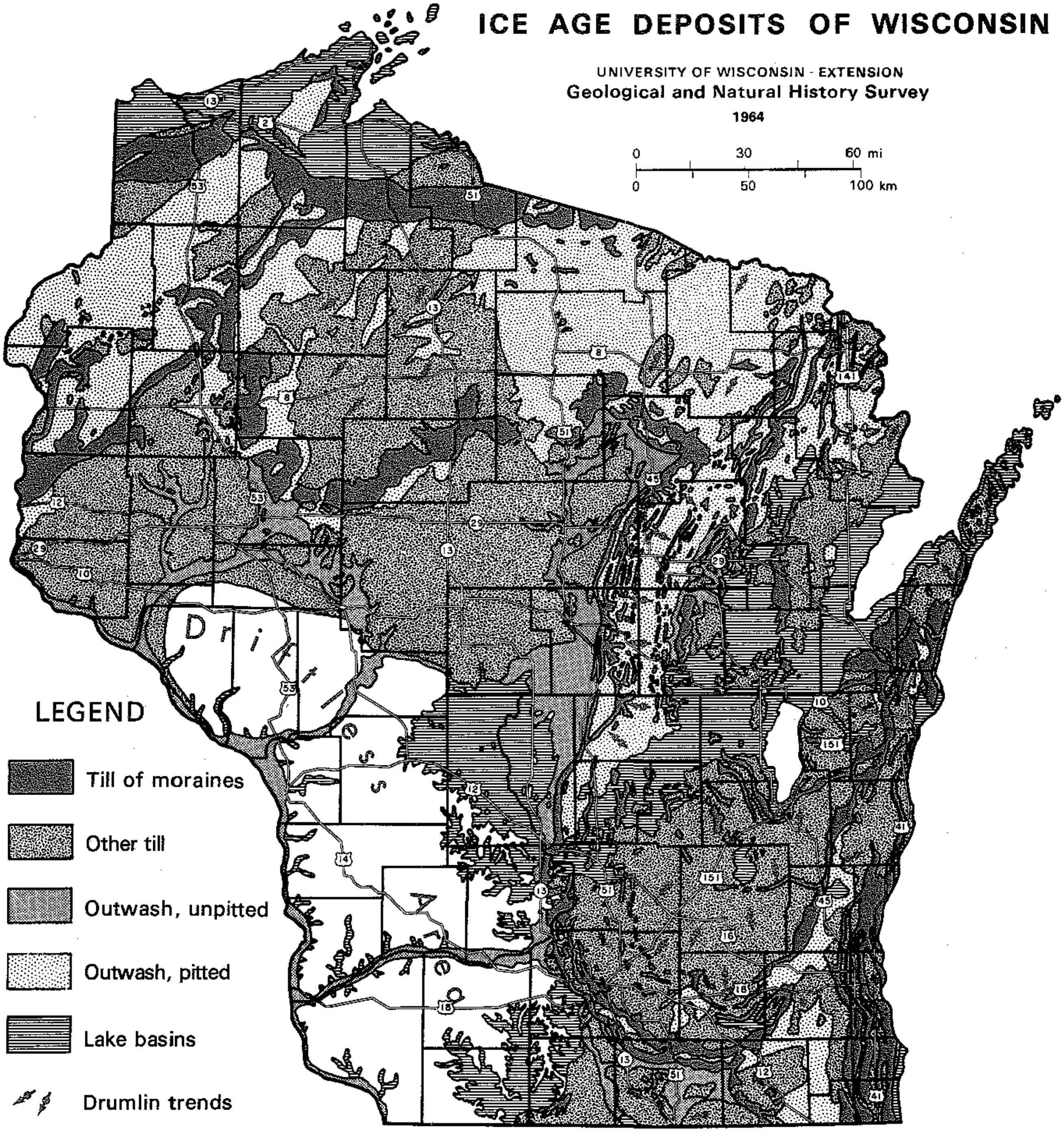
Geological and Natural History Survey
The University of Wisconsin-Extension
April 6, 1971

Note

On the attached bedrock geology map the "Canadian Shield" is primarily the area shown in pink. More detailed information on the Precambrian Geology of the state may be found in "Lithologic, Geophysical, and Mineral Commodity Maps of Precambrian Rocks in Wisconsin" by Carl E. Dutton and Reta B. Bradley, 1970. USGS MGI Map I-631. They may be obtained from the Wisconsin Geological Survey, 1815 University Avenue, Madison, 53706 for $2.50.

ICE AGE DEPOSITS OF WISCONSIN

UNIVERSITY OF WISCONSIN - EXTENSION
Geological and Natural History Survey
1964



from Thwaites 1956 modified 1985

SHORT HISTORY OF THE ICE AGE IN WISCONSIN

The Pleistocene Epoch or Ice Age began about 1,700,000 years ago which, in terms of geologic time, is not long ago. There were many separate glaciations during the Ice Age, each followed by a period when the ice sheets (except those on Greenland and Antarctica) melted away. The last major glacial episode is called the Wisconsin Glaciation, because it was first studied in detail in this state. It ended about 10,000 years ago.

The ice sheets were formed by the accumulation of snow that turned to ice and reached a thickness of two miles in some areas. The North American ice sheet formed in east-central Canada, spreading outward in every direction. The south edge of the advancing ice sheet had many tongues or lobes whose direction and rate of movement were controlled by the topography of the land surface over which they flowed and by the rates of ice accumulation in the different areas from which they were fed.

The ice sheet transported a great amount of rock and soil debris. Some of this debris, which is called till, was piled up at the margins of the ice lobes to form moraines. The pattern of moraines, in brown, shows the location of the major ice lobes in Wisconsin. One lobe advanced down the basin of Lake Michigan, another down Green Bay, and others down Lake Superior and over the northern peninsula of Michigan. The well-known Kettle Moraine was formed between the Lake Michigan and Green Bay Lobes. Drumlins are elongated mounds of debris that were molded by the ice passing over them; their orientations indicate the direction of ice movement. As the ice melted, the debris was reworked by melt-water rivers, and large amounts of sand and gravel were deposited to form outwash plains. Pits were formed in the outwash where buried blocks of ice melted, and many of these are now occupied by lakes.

The action of the ice profoundly modified the landscape, smoothing off the crests of hills and filling the valleys with till and outwash. In some places it changed the course of rivers forcing them to cut new channels such as that of the Wisconsin River at the Wisconsin Dells. Elsewhere it dammed valleys to create lakes such as those of the Madison area.

The Pleistocene glaciations were largely due to variations in the solar energy reaching the earth as a result of changes in its orbit and axial inclination. We are still in the Ice Age, and it is likely that glaciers will grow and again cover much of Wisconsin in future millennia.

More detailed information on Ice Age material in Wisconsin is given in the following publications.

Hadley, D.W., and Pelham, J.H., 1976, Glacial deposits of Wisconsin: Wisconsin Geological and Natural History Survey Map Series No. 10.

Mickelson, D.M., and others, 1984, Pleistocene stratigraphic units of Wisconsin: Wisconsin Geological and Natural History Survey Miscellaneous Paper 84-1, 15 p.

Goebel, J.E., and others, 1983, Quaternary geologic map of the Minneapolis 4° x 6° Quadrangle, United States: U.S. Geological Survey Map I-1420(NL-15).

Farrand, W.R., and others, 1984, Quaternary geologic map of the Lake Superior 4° x 6° Quadrangle, United States and Canada: U.S. Geological Survey Map I-1420(NL-16).

Lineback, J.A., and others, 1983, Quaternary geologic map of the Chicago 4° x 6° Quadrangle, United States: U.S. Geological Survey Map I-1420(NK-16).

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BEDROCK GEOLOGY OF WISCONSIN

UNIVERSITY OF WISCONSIN - EXTENSION
Geological and Natural History Survey
M.E. Ostrom Director and State Geologist

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LEGEND

Extent of glaciation

PHANEROZOIC

DEVONIAN FORMATIONS
- dolomite and shale

SILURIAN FORMATIONS
- Sd — dolomite

ORDOVICIAN FORMATIONS
- Om — Maquoketa Formation—shale and dolomite
- Os — Sinnipee Group—dolomite with some limestone and shale
- Osp — St. Peter Formation—sandstone with some limestone shale and conglomerate
- Opc — Prairie du Chien Group—dolomite with some sandstone and shale

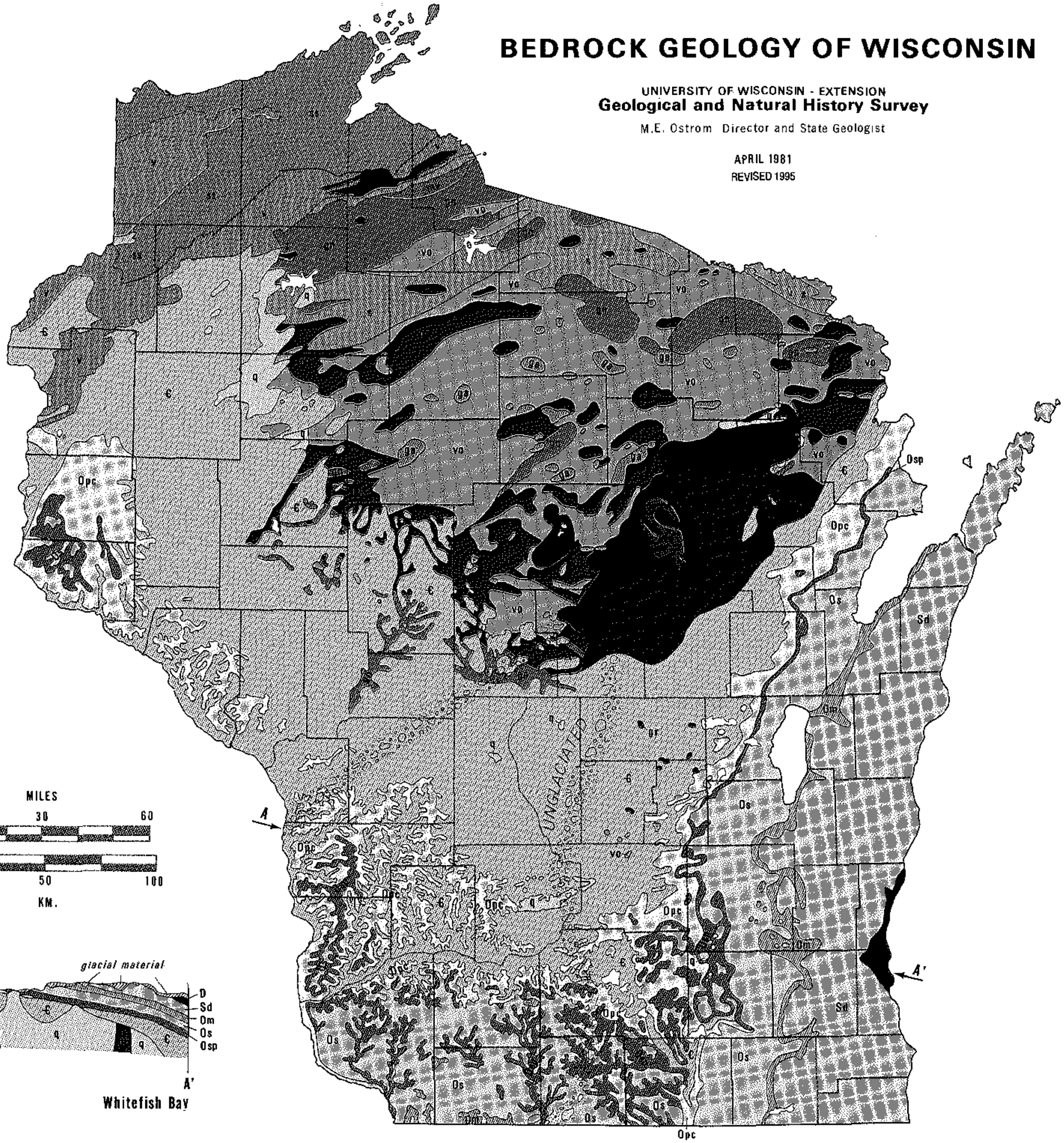
CAMBRIAN FORMATIONS
- Є — sandstone with some dolomite and shale

PRECAMBRIAN

MIDDLE PROTEROZOIC ROCKS
- Keweenawan Rocks—
  - ss, sandstone
  - v, basaltic to rhyolitic lava flows
  - t, gabbroic, anorthositic and granitic rocks
- Wolf River Rocks—
  - g, rapakivi granite, granite and syenite
  - a, anorthosite and gabbro

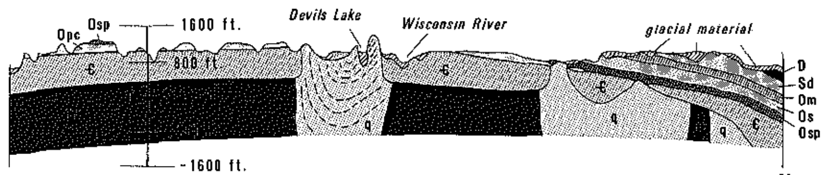
LOWER PROTEROZOIC ROCKS
- q — quartzite
- granite, diorite and gneiss
- s, argillite, siltstone, quartzite, graywacke, and iron formation
- vo, basaltic to rhyolitic metavolcanic rocks with some metasedimentary rocks
- ga, meta-gabbro and hornblende diorite

LOWER PROTEROZOIC OR UPPER ARCHEAN ROCKS
- mv, metavolcanic rocks
- gn, granite, gneiss and amphibolite



MILES 0 30 60

0 50 100 KM.



A
Stoddard

Vertical scale exaggerated 50X
Horizontal scale is same as map.

A'
Whitefish Bay

GEOLOGIC HISTORY OF WISCONSIN'S BEDROCK

Introduction

The bedrock geologic record in Wisconsin is divided into two major divisions of time: the Precambrian, older than 600 million years, and the Paleozoic, younger than 600 million years. The Precambrian rocks are at the bottom and consist predominantly of crystalline rocks. They are overlain by Paleozoic rocks which consist of relatively flat-lying, in some cases fossil-bearing, sedimentary rocks.

Precambrian rocks form the bedrock beneath the glacial deposits in northern Wisconsin and occur beneath the Paleozoic rocks in the south (see the last paragraph and the cross-section on the reverse side). Paleozoic rocks may once have covered northern Wisconsin, but if they did, they have been removed by erosion. Glacial deposits, including clay and sand and gravel, cover bedrock in the northern and eastern three-fifths of the state.

In areas covered by glacial deposits, surface outcrops are so sparse that details of the bedrock geology are obscured. In such areas the only clues to the underlying rocks are obtained from rock cuttings and cores obtained from drill holes and from geophysical surveys which disclose magnetic and gravity variations.

Precambrian Eon

The Precambrian is divided into two eras, the older Archean and the younger Proterozoic. Each is subdivided into three periods--Early, Middle, and Late.

Archean

Rocks older than 2,500 million years are termed Archean. The oldest Archean rocks are gneisses (gn), or banded rocks. These are more than 2,800 million years old and are in Wood County. Similar old ages have been determined for rocks south of Hurley, where recognizable volcanic rocks (mv) have been intruded by 2,700 million year old granite (gn). All of these rocks have been extensively deformed, and in many areas they are so highly altered that their original nature and origin are extremely difficult to interpret. Because of this difficulty, both the older gneisses and some younger (Proterozoic) gneissic and crystalline rocks are combined on this geologic map.

Proterozoic

There are four principal groups of rocks in the Proterozoic. The oldest are around 1,800 to 1,900 million years old. These Early Proterozoic rocks consist of sedimentary (s) rocks including slates, graywacke and iron formation, and volcanic (vo) rocks. The sedimentary rocks dominate in the north, with volcanic rocks becoming more abundant in central Wisconsin. These layered rocks were intruded by gabbros (ga), diorities, and granites (gr) about the same time that they were being folded and deformed.

Quartz-rich Early Proterozoic sedimentary rocks (q) occur as erosional remnants, or outliers, on the older Proterozoic rocks; they were deformed about 1,700 million years ago. The Barron Quartzite in the Blue Hills of Rusk and Barron counties, the Baraboo Quartzite in Sauk and Columbia counties, and Rib Mountain Quartzite in Marathon County are some of the major remaining areas of once widespread blankets of sandstone.

The oldest Middle Proterozoic rocks include the granites, syenites, and anorthosites (g, a) of the Wolf River complex. This extensive body of related granitic rocks was intruded into Lower Proterozoic volcanic and sedimentary rocks around 1,500 million years ago.

The youngest Proterozoic rocks in Wisconsin are about 1,100 million years old and are called Keweenawan rocks. At the time of their formation a major rift or fracture zone split the continent from Lake Superior south through Minnesota and into southern Kansas. Keweenawan rocks can be divided into two groups: an older sequence of igneous rocks including lavas (v) and gabbros (t); and a younger sequence of sandstone (ss). These rocks occur in northwestern Wisconsin. In central Wisconsin diabase dikes were also emplaced at this time.

At the close of the Precambrian, most of Wisconsin had been eroded to a rather flat plain upon which stood hills of more resistant rocks such as the quartzites in the Baraboo bluffs.

Phanerozoic Eon

The Phanerozoic is divided into three eras. They are from the oldest to the youngest: the Paleozoic (old life), Mesozoic (middle life), and Cenozoic (most recent life). The Paleozoic is represented by a thick sequence of sandstones, shales and dolomites (dolomite is similar to limestone); the Mesozoic, possibly by gravels; and the Cenozoic, only by glacier-related deposits.

In the Paleozoic Era the sea advanced over and retreated from the land several times. The Paleozoic Era began with the Cambrian Period (Є) during which Wisconsin was submerged at least twice beneath the sea. Sediments eroded by waves along the shoreline and by rivers draining the land were deposited in the sea to form sandstone and shale. These same processes continued into the Ordovician Period (Opc, Osp, Os, Om) during which Wisconsin was submerged at least three more times. Animals and plants living in the sea deposited layers and reefs of calcium carbonate which are now dolomite. Deposits that built up in the sea when the land was submerged were partially or completely eroded during the times when the land was elevated above sea level. At the close of the Ordovician Period, and in the succeeding Silurian (Sd) and Devonian (D), Wisconsin is believed to have remained submerged. There are no rocks of the Paleozoic Era younger than Devonian in Wisconsin. Whether material was deposited and subsequently removed by erosion, or was never deposited, is open to speculation.

Absence of younger Paleozoic rocks makes interpretation of post-Devonian history in Wisconsin a matter of conjecture. If dinosaurs roamed Wisconsin, as they might well have in the Mesozoic Era some 200 million years ago, no trace of their presence remains. Available evidence from neighboring areas indicates that towards the close of the Paleozoic Era the area was gently uplifted and it has remained so to the present. The uplifted land surface has been carved by millions of years of rain, wind, running water, and glacial action. With the possible exception of some pebbles about 100 million years old, no Mesozoic age bedrock has been identified in Wisconsin.

In the last million years during a time called the Pleistocene, glaciers invaded Wisconsin from the north and modified the land surface by carving and gouging out soft bedrock, and depositing hills and ridges of sand and gravel as well as flat lake beds of sand, silt, and clay. In this manner, the glaciers smoothed the hill tops, filled the valleys, and left a deposit of debris over all except the southwestern part of the state. The numerous lakes and wetlands which dot northern Wisconsin occupy low spots in this Pleistocene land surface. Glacial deposits are not shown on the map of bedrock geology; however, the line of farthest glacial advance is shown. A separate glacial deposits map is available.

Cross Section

To assist in understanding the bedrock geology of Wisconsin, a cross section has been prepared (see reverse side). A cross section represents a vertical slice of the earth's crust showing the subsurface rock layers in much the same way as a vertical slice of cake shows the layers of cake and frosting. The Wisconsin cross section shows the subsurface geology along a line from Stoddard in Vernon County, through Devil's Lake near Baraboo in Sauk County, to Whitefish Bay in Milwaukee County. The horizontal scale is the same as that of the geologic map, but the vertical scale is exaggerated so that vertical thicknesses are expanded 50 times compared to horizontal distances. The Paleozoic rocks are shown as layers, the younger units lying above the older units. They are also shown dipping to the west in the western part of the state and dipping east in the eastern part of the state, thus forming an arch. The center and oldest parts of this arch are found in the Baraboo bluffs, where the Baraboo Quartzite is exposed at the surface. As shown in the cross section by fine lines in the quartzite, the Baraboo area was folded into a U-shaped structure, or syncline, before the Paleozoic rocks were deposited. Quartzite and granite underlie the Paleozoic rocks along this section.

The gray unit shown at the top of the rock sequence in the eastern part of the cross section represents glacial materials which do not occur to the west.