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Guide To

Fossil Collecting

in

Minnesota



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Sarah Tufford and Rudolph Hogberg



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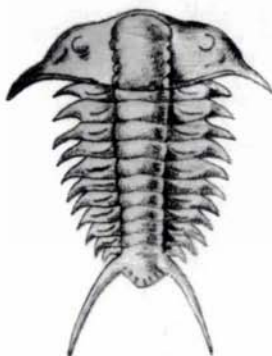


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*Guide To
Fossil Collecting in Minnesota*

Sarah Tufford and Rudolph Hogberg



Illustrations by Ann Cross

Geologic Time Chart—Minnesota

Time	Era	Period	Events in Minnesota	Characteristic Life
Millions of years ago	CENOZOIC	Quaternary	Continental glaciation followed by warm period	<i>Age of Mammals</i> 
		Tertiary	No record in Minnesota	
	MESOZOIC	Cretaceous	Sea enters Minnesota from West. Deposition of sediments.	<i>Age of Reptiles</i> 
		Jurassic	No record in Minnesota	
		Triassic		
	PALEOZOIC	Permian	No record in Minnesota	<i>Age of Amphibians</i> 
		Pennsylvanian		
		Mississippian		
		Devonian	Sea enters Minnesota from South. Deposition of sediments.	<i>Age of Fishes</i> 
		Silurian	No record in Minnesota	<i>Age of Corals</i> 
Ordovician	Seas cover Minnesota at intervals.	<i>Age of Straight Cephalopods</i> 		
Cambrian	Deposition of sediments.	<i>Age of Trilobites</i> 		
PRECAMBRIAN 4 1/2 billion years long			Lava flows and deposition of sediments. Deposition of iron-rich sediments. Formation of mountains and igneous intrusions.	<i>First record of life</i>  

Guide To Fossil Collecting in Minnesota

Sarah Tufford and Rudolph Hogberg

FOSSILS tell us what life was like on earth in ancient geologic time. A fossil clam, for example, lived on a sea bottom much as its modern relatives do. By finding many fossil clams, we can determine the extent of a prehistoric sea. Fossils also indicate the climates of the geologic past.

Fossils show us that life on earth has not always been the same. In fact primitive algae and bacteria have given rise to reptiles, mammals, and finally to man.

Fossils aid geologists in finding oil and other mineral deposits.

What is a fossil?

A fossil is a trace or remains of an ancient animal or plant--for example, a shell, leaf print, or worm burrow--preserved within rocks or unconsolidated material at the earth's surface. Simple, primitive life forms--algae and bacteria--have been collected by paleontologists (students of fossils) in the oldest or Precambrian rocks on Minnesota's iron ranges. We find more complex plant and animal fossils in more recently formed rocks in the southern part of our State.

How is a fossil preserved?

It is preserved because it had hard parts--shell or bone--and was quickly buried. An animal may be buried in desert sand, in swamp mud, in river silt, or in sea-floor sediments. The animal's soft parts are destroyed by bacteria. Even after being covered by layer upon layer of sand and mud, a fossil may be partially or completely destroyed: ground water may dissolve its hard parts; shifting of the sediments may crush it; mountain building forces may distort it; and solutions may replace some or all of the hard parts with new minerals. Therefore fossils are rarely found complete, but a trilobite tail, a shark tooth, or a leaf impression identifies the animal or plant. Because plant fossils are quite delicate, they are destroyed more easily than animal fossils. Hence we are most apt to find fossils where the rocks have not been disturbed since they were deposited.

Where are fossils found?

Fossils are most commonly found by beginning collectors at localities where they have tumbled down from weathered rock ledges. Also, plucking and transportation by glaciers and streams bring fossil-bearing rocks to a gravel pit or stream bank. Fossils are found in sedimentary rocks--former sands and muds. The fossiliferous sedimentary formations of Minnesota are illustrated in the figure Fossiliferous Rock Units--Minnesota, p. 4.

Geologic History of Minnesota's Fossils

About 600 million years ago the extremely long Precambrian Era was drawing to a close and the high mountain ranges and vast lava plateaus were

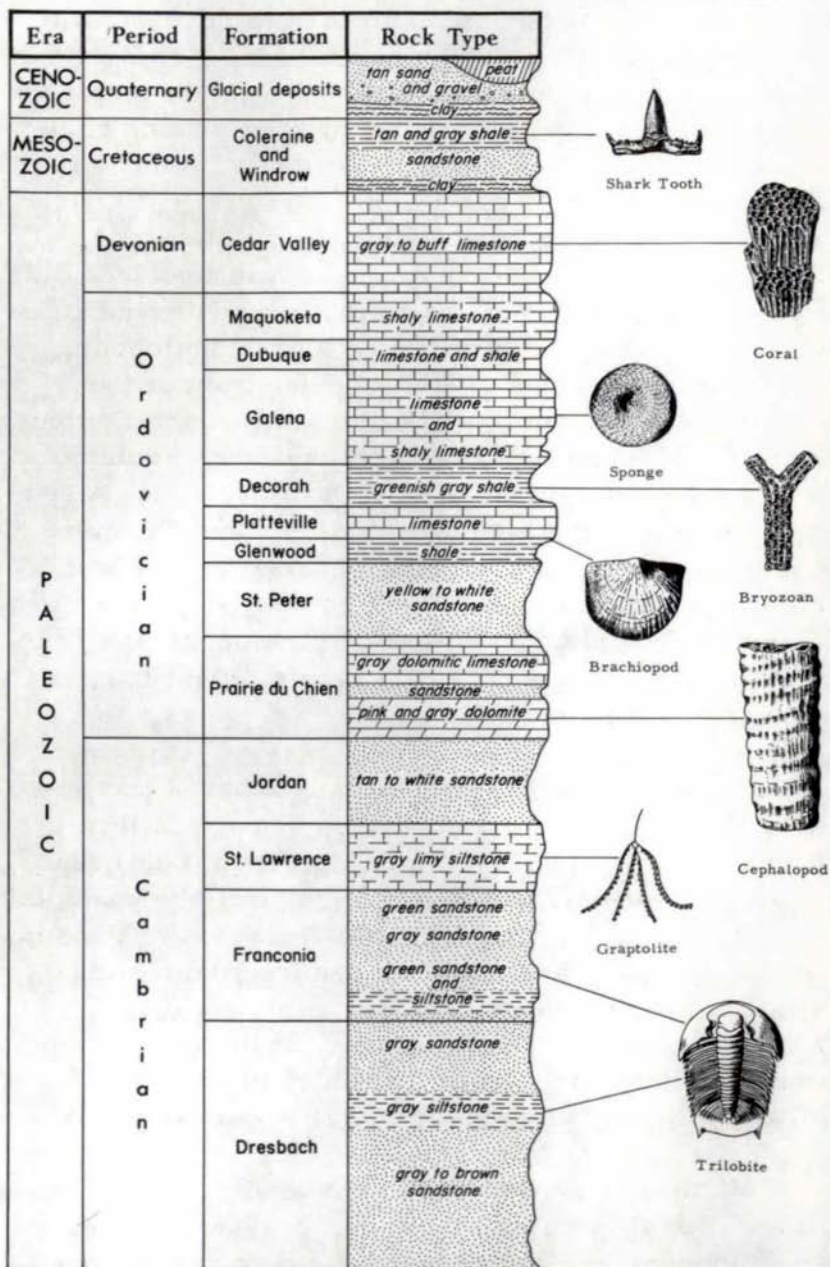
worn to low-lying foothills by running water. Late in the first division of Paleozoic time, the Cambrian Period, a sea advanced northward to cover southeastern Minnesota. Many animals lived in its warm, shallow waters; most common were the brachiopods and trilobites, now fossilized in rocks which once were the muddy sediments of this sea floor.

The sea moved briefly out of the State and returned to southeastern Minnesota in the Ordovician Period. Brachiopods and trilobites still lived on the bottom of the shallow sea, with cephalopods, crinoids, and sponges. After deposition of the Ordovician sediments--and until late in the Devonian Period--Minnesota was a high land area standing well above sea level. In late Devonian time, a sea covered parts of Freeborn, Mower, and Fillmore counties, Minnesota; scattered fossil remains indicate that fish lived in its waters; however, the most common Devonian fossils are brachiopods and corals. In other parts of the world, plant fossils appear for the first time in Silurian rocks.

During the late Paleozoic and most of the Mesozoic Era, Minnesota again stood above sea level. Rivers carried their sediment to the distant ocean, wearing away Minnesota's hills particle by particle, and preparing the way for a new invasion of the sea. During this long interval, dinosaurs roamed the western states; their fossil remains are found where they were caught in river sands and swamp muds. These large reptiles may have lived in Minnesota, but we have no fossil record of them.

Minnesota lay below the sea again in Cretaceous time. Fossil snails, clams and oysters, coiled cephalopods, and shark teeth occur in the marine Cretaceous sediments of the western Mesabi range

Fossiliferous Rock Units—Minnesota



area. Plants from shales near New Ulm and Springfield grew in the tidal swamps bordering the Cretaceous sea.

Minnesota has been above sea level from the close of the Cretaceous to the present day. Sands, gravels, clays, and silts picked up, carried, and deposited by the Pleistocene continental ice sheets now mantle the rocks formed earlier in the geologic history of the State. In fact, a large part of our present landscape is a result of different types and thicknesses, and subsequent erosion of glacial materials. Mammoth, mastodon, and bison were abundant animals in the Pleistocene Period. Pollen and spores collected from buried peat deposits identify the plants and trees that lived in Minnesota between ice sheet advances. The oldest man-made tools found in the State are about 11,000 years old. As you can see, man has lived in Minnesota for a very short time, geologically speaking.

FINDING AND COLLECTING FOSSILS

Not all sedimentary rocks contain fossils. The St. Peter Sandstone, for example, is formed of sand rolled about by waves to such a degree that all fossils were destroyed. Even in highly fossiliferous rocks, the fossils are easier to see and collect from weathered outcrops in stream valleys, in highway and railroad cuts, and in old quarries. The Geologic Map (p. 16-17) should help you locate outcrops of fossiliferous rocks.

Always be sure to ask permission before collecting on private property.

Very little equipment is necessary to the fossil collector. Here is a check list for your expeditions:

1. Brick-layer's hammer or geologic hammer.
2. Chisels, at least one large and one small.
3. Magnifying glass or hand lens.
4. Collecting bags of sturdy paper or cloth.
5. Tissue paper for wrapping small and delicate specimens.
6. Labels to note locality, formation, date, and collector (see record and labels, p. 29-33).
7. Pencil or pen.
8. Maps--a state highway map will help you locate collecting sites. For more detail, topographic maps may be obtained from the U. S. Geological Survey in Washington, D.C. Geologic maps, where completed, are available from the Minnesota Geological Survey.

The Geologic Map shows where a formation may be encountered below the surface soils, sands, and gravels, or cropping out along streams. Symbols on the map are abbreviations for formation names given in full in the explanation. To get the full value of this map, each formation should be colored to set it off from formations above and below.

After you collect your fossils, you may wish to clean them. Scrub the tough ones with vegetable brush, soap, and water. Bits of rock hiding parts of a specimen can be removed with a small chisel; use a mounted pin for detailed work. Broken specimens are easily repaired with household cement. A coating of clear fingernail polish holds crumbly specimens together.

Reference books listed on page 27 of this booklet are suggested for those who wish to learn more about geology and paleontology. Also, descriptions of specific fossil-collecting localities are given in the literature.

FOSSILS OF MINNESOTA

Marine Plant Fossils

Algae

Algae are small plant-like organisms: modern algae form green scum on ponds in summer. Some ancient forms built large biscuits or domes of limestone. These fossil algal structures may be seen in outcrops of the Ordovician Prairie du Chien Formation along the Mississippi River in southeastern Minnesota.

Structures much like these Ordovician algal domes also occur in the Precambrian iron-rich rocks of the Mesabi range. They are among the world's oldest known fossils--about 2 billion years old.

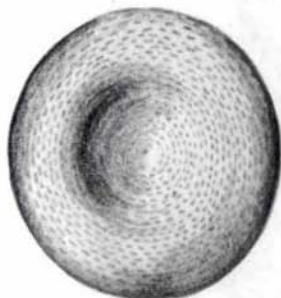
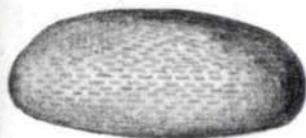


Cryptozoan (Ord.) 1/10x

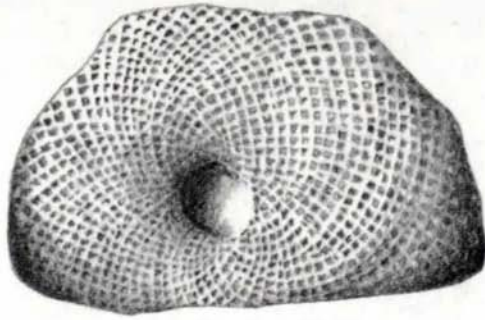
Animal Fossils

Sponge-like animals

Fossil sponges, like many of those living today, had hard skeletons of calcium carbonate or silica. These skeletons account for their preservation. Sponges are very old, ranging from the Precambrian to the present day. They are found in many geologic formations: all lived attached to the bottom of shallow seas.



Ischadites (Ord.) 1/2x



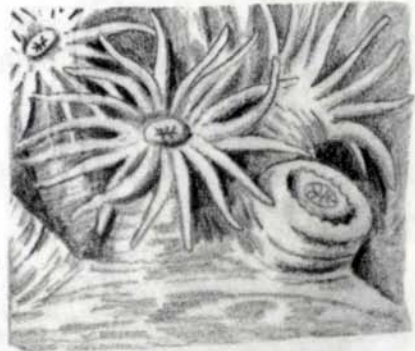
Receptaculites (Ord.) 2/3x

The two "sponges" found in Minnesota are both Receptaculids, the so-called "sunflower corals." Actually their classification as sponges is problematical. Receptaculites and Ischadites are common in the Ordovician Galena Formation of the southeastern part of the State.

Corals (Phylum Coelenterata, class Anthozoa)

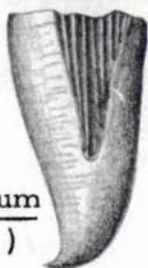
Corals first appear as fossils in Ordovician rocks. They grew in the warm shallow sea which covered portions of southeastern Minnesota in both the Ordovician and Devonian Periods. Many looked much like the modern coral colonies of warm ocean areas; others occurred as horn-shaped individuals, the solitary horn or cup corals.

Corals are relatively common fossils as their hard skeletons are easily preserved. Some occur in the Ordovician Prairie du Chien Formation of Minnesota but are difficult to collect from very hard



Modern Corals 100x

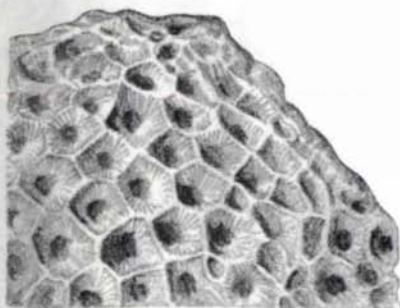
dolomitic rock. The Devonian Cedar Valley Limestone, which crops out chiefly in Mower and Fillmore counties, provides better collecting sites. Of the solitary corals, Lambeophyllum occurs in the Platteville and Decorah Formations; its relative Streptelasma, in the Galena and Maquoketa Formations. Heliophyllum and Hexagonaria are found in the Devonian. Two common colonial corals in the Galena Formation and Cedar Valley Limestone are Halysites, occurring as chains of small tubes growing side by side and Favosites, as a honeycomb mass.



Lambeophyllum
(Ord. -Dev.)
2/3x



Heliophyllum (Dev.) 1x



Hexagonaria (Dev.) 1/2x



Favosites (Dev.) 2/3x



Halysites (Dev.) 2/3x

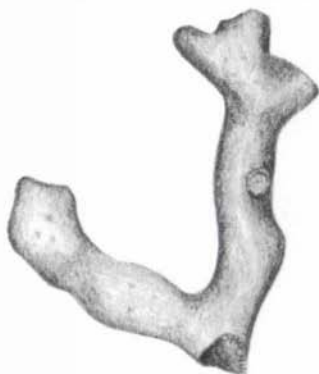
Bryozoans (Phylum Bryozoa)

Bryozoans are referred to as "moss animals" because they resemble plants. Their colonies form biscuit-like masses or crusts on shells; they may also resemble twigs or leaves. Most fossil forms occur in marine sediments, but some modern forms live in fresh water. Bryozoans are abundant as fossils from Ordovician and later rocks. They are especially common in the limestone beds of the Decorah Formation of southeastern Minnesota.

Two of the most common types of Bryozoans found in Minnesota are Phylloporina and Batostoma.



Phylloporina (Ord.) 1/2x



Batostoma (Ord.) 1/2x

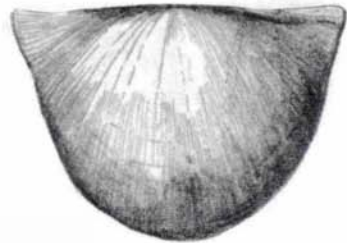
Brachiopods (Phylum Brachiopoda)

Brachiopods have been common on shallow sea floors since the beginning of the Cambrian period. The brachiopod animal is enclosed in two shells or valves, one larger than the other. The valves are hinged together at one end and near the hinge is a hole in one shell for a fleshy tube or stalk. The animal attaches itself by this stalk to solid objects on the sea floor.

Most of the brachiopods found in Minnesota are of Ordovician age. They include Sowerbyella, Strophomena, Rafinesquina, Lepidocyclus, and Lingula. Atrypa is a common Devonian brachiopod. The Platteville, Decorah, and Galena Formations provide good collecting in the Twin Cities, near Rochester, and throughout southeastern Minnesota.



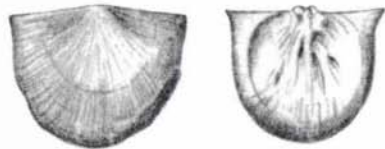
Sowerbyella (Ord.) 1x



Strophomena (Ord.) 1x



Lepidocyclus (Ord.) 2/3x



Rafinesquina (Ord.) 2/3x



Lingula (Camb. -Rec.) 1x



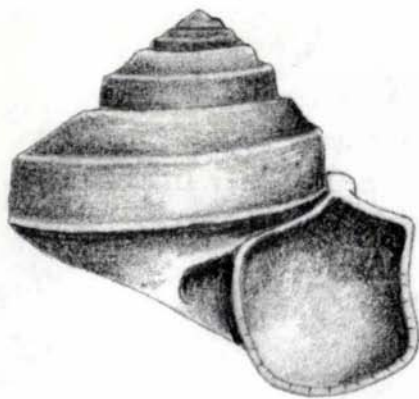
Atrypa (Ord.) 2/3x



Maclurites (Ord.) 1/2x



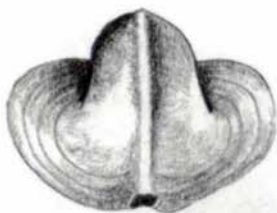
Hormotoma (Ord.) 1/2x



Trochonema (Ord.) 1/2x



Loxonema (Ord.) 1/2x



Bellerophon (Ord.) 1/2x

Snails (Phylum Mollusca, class Gastropoda)

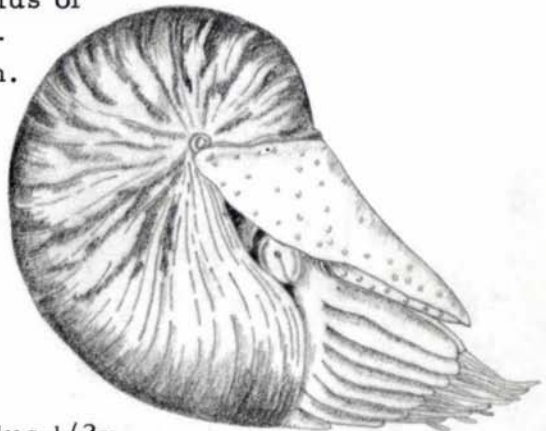
The gastropods or snails are an old and highly varied group of molluscs. They have a single shell that is generally coiled and often ornamented with bumps or spikes. Paleozoic snails were sea-dwellers, although some Mesozoic and later types moved into fresh water and even onto land.

Fossil snails can be found in the Prairie du Chien Formation, but the specimens are poor and hard to recover. Collecting is better in the Platteville, Decorah, and Galena Formations.

Gastropods found in Minnesota include: Maclurites, Hormotoma, Trochonema, Loxonema, and Bellerophon.

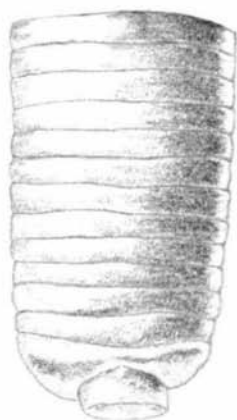
Cephalopods (Phylum Mollusca, class Cephalopoda)

The cephalopods found as fossils in Minnesota are relatives of the "pearly" or "chambered" nautilus of the present day southwestern Pacific Ocean. The animal lives in a coiled shell--as it grows, it seals off parts of the shell leaving a series of empty chambers.

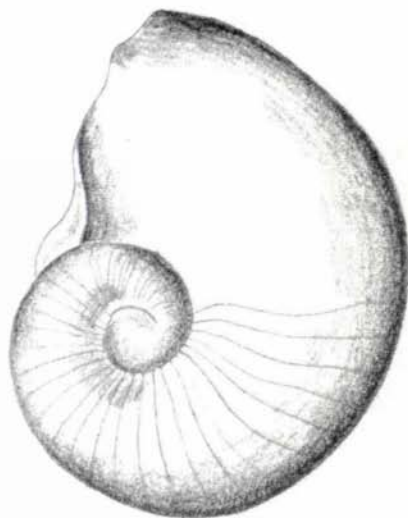


Modern Nautilus 1/2x

Cephalopods occur in the Ordovician limestones of Minnesota, particularly the Platteville Formation. Many Ordovician cephalopods have straight shells which may be as large as 1 foot in diameter and 14 feet long. Coiled cephalopods (ammonites) are found in the Cretaceous rocks of the western Mesabi range. Common Ordovician cephalopods found in Minnesota are: Westonoceras, Charactoceras, and Endoceras.



Endoceras (Ord.) 1/3x



Charactoceras (Ord.) 2/3x

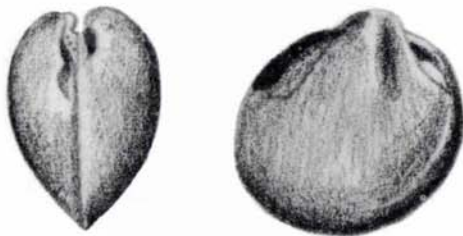


Westonoceras (Ord.) 1/2x

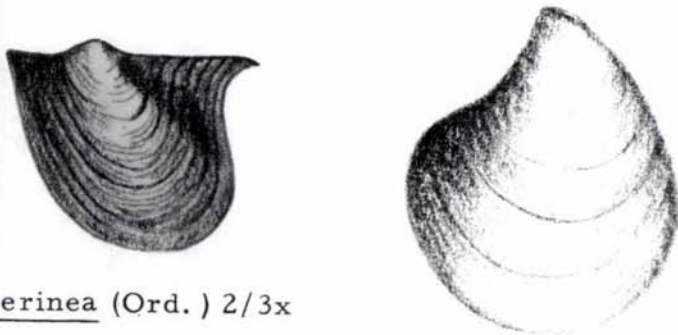
Clams and oysters (Phylum Mollusca, class
Pelecypoda)

Clams are an old and conservative group of animals. Most live on shallow sea floors, although some live in fresh water. All clams have two shells, one the mirror image of the other (compare with brachiopods). Oysters, mussels, and scallops are special types of clams.

Clams have been abundant since the Ordovician period. Vanuxemia, Pterinea, and Ctenodonta may be found in the Ordovician limestones of southeastern Minnesota.

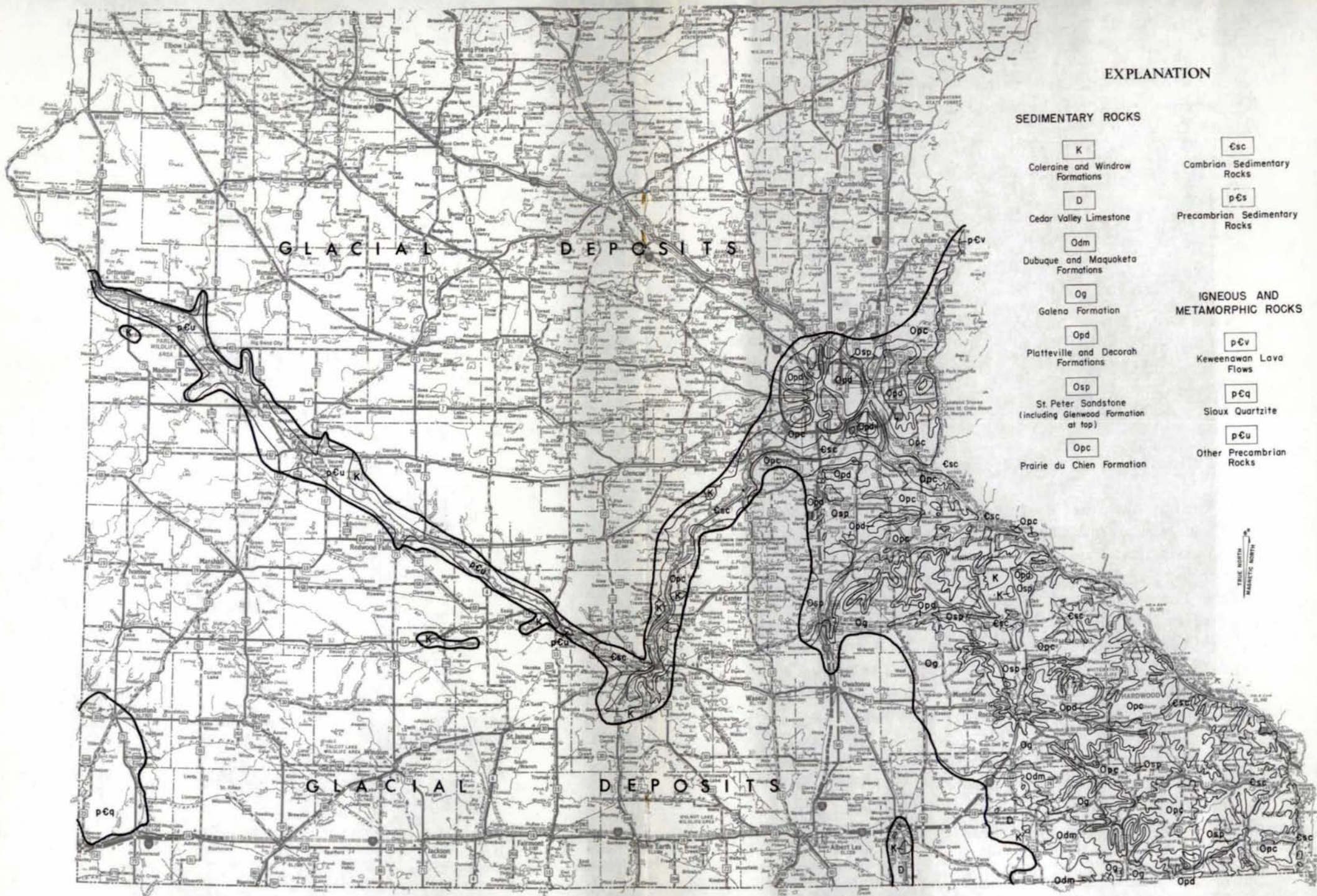


Vanuxemia (Ord.) 2/3x



Pterinea (Ord.) 2/3x

Ctenodonta (Ord.) 2/3x



Bedrock Geologic Map, southern Minnesota

Oysters originated in the Mesozoic Era, and the Cretaceous rocks of the western Mesabi region contain Ostrea and Exogyra.



Ostrea

(Trias. -Rec.) 2/3x



Exogyra

(Jur. -Cret.) 2/3x

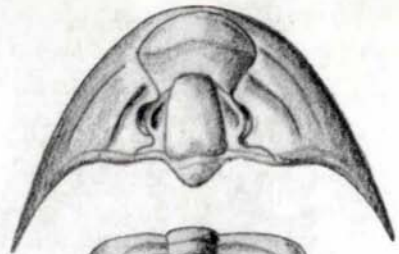
Trilobites (Phylum Arthropoda, class Trilobita)

Among the most common fossils of the Paleozoic rocks of Minnesota are the trilobites, a group of arthropods that are now extinct. Trilobites lived as scavengers and hunters on the floor of Paleozoic seas. They had hard, segmented shields covering and protecting their soft bodies like armor; furrows divided them lengthwise into 3 lobes. As the animal grew, it molted or changed its armor for a new and larger shield. Separated parts of the head and tail armor are the most common trilobite fossils.

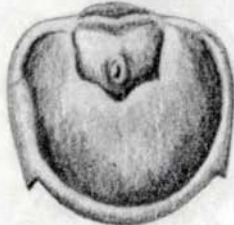
The Cambrian of Minnesota, especially some beds of the Dresbach and Franconia Formations cropping out along the St. Croix and Mississippi rivers, contain numerous fragments of Ptychaspis, Idahoia, Pseudagnostus, and Dikelocephalus. Flexicalymene, Ceraurus, and Isotelus characterize Ordovician rocks in southeastern Minnesota and Dalmanites can be found in the Devonian Cedar Valley Limestone.



Idahoia (Camb.) 1/2x

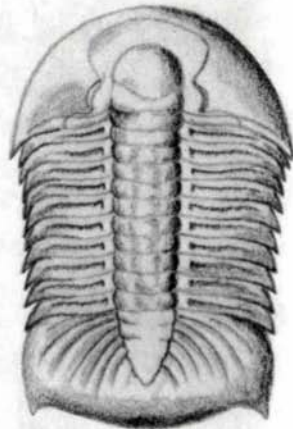


Ptychaspis (Camb.) 1/2x



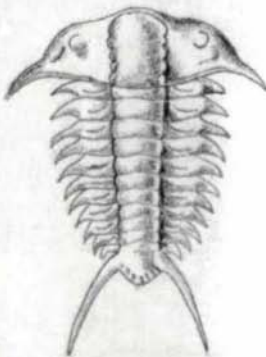
Pseudagnostus (Camb.)

1/2x



Dikelocephalus (Camb.)

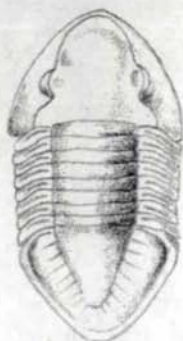
1/2x



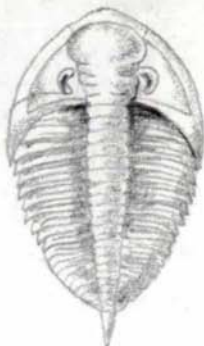
Ceraurus (Ord.) 1/2x



Flexicalymene (Ord.) 1/2x



Isotelus (Ord.) 1/3x



Dalmanites (Sil. -Dev.) 1/2x

Ostracodes (Phylum Arthropoda, class Crustacea)

Ostracodes are very tiny and ancient relatives of crabs, shrimp, and crayfish. The animal is enclosed in a pair of shells that may be ornamented in a variety of ways. Ostracodes are very abundant in both fresh and salt water.

Ostracodes are important fossils to the petroleum geologist because they are helpful in tracing oil- and gas-bearing beds from well to well. Most are too small to be seen with the naked eye. Primitia, Leperditia, and Bollia can be found in the Ordovician limestone and shale of southeastern Minnesota.



Primitia (Ord.) 12x



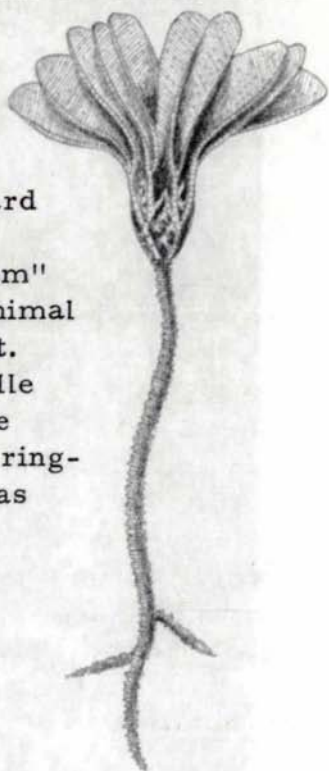
Bollia (Ord.) 18x



Leperditia (Ord.) 3x

Sea lilies (Phylum Echinodermata, class Crinoidea)

Crinoids are commonly called sea lilies, but they are really animals related to the starfish and sea urchins. Crinoids were very numerous on the bottom of shallow seas throughout the Paleozoic and Mesozoic Eras, beginning in Middle Cambrian time. The animal is enclosed in a cup-shaped skeleton made of many plates closely fitted together. Usually five arms extend outward from the top of this cup. The animal attaches itself by a "stem" to the sea bottom. When the animal dies the stem and cup fall apart. Common fossils in the Platteville and Galena Formations near the Twin Cities and Rochester are ring-like pieces of the jointed stem as well as calcareous plates.



Glyptocrinus is a common genus of the Crinoidea.

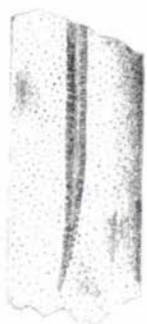
Glyptocrinus (Ord.) 1/2x

Graptolites (Phylum Protochordata, class Graptolithina)

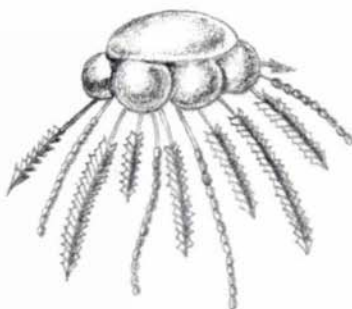
These puzzling creatures formed colonies of thin branches, the earlier forms attached to hard objects on the sea floor, later ones floated with branches hanging down. Small cups along the branches

housed the individual animals. They appeared as fossils in the Cambrian and became extinct in the Mississippian. The fossils consist of flattened films resembling pencil marks on slabs of rock.

They are found in the St. Lawrence Formation (Cambrian) along the St. Croix river and in the Platteville Formation (Ordovician) in the Twin Cities area. Some also occur in the Galena Formation of southeastern Minnesota.



Fossil Graptolite
(Ord.) 2x, 10x



Living Graptolite
(Ord.) 1x

Conodonts

Conodonts are tiny tooth- or horn-shaped fossils. Their relationship to other animals is not known. They occur in great numbers in formations from the Glenwood Formation to the Dubuque Formation. They are easily collected from limestone as the enclosing rock may be dissolved away in acetic acid. A few ounces of rock may yield several hundred fossils. Although visible to the naked eye, some magnification is necessary to observe the detailed characteristics of these fossils.

Minnesota conodonts include: Drepanodus, Cordylodus, Ozarkodina, Polyplacognathus, and Panderodus.



Drepanodus (Ord.) 35x



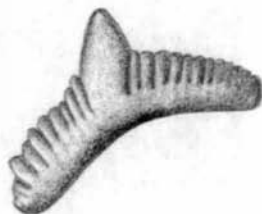
Polyplacognathus (Ord.) 35x



Cordylodus (Ord.) 35x



Panderodus (Ord.) 35x



Ozarkodina (Ord.) 35x

Vertebrate fossils

The vertebrate fossils found in Minnesota are of recent origin compared with the other fossils discussed. Shark teeth are found in the Cretaceous deposits of the western Mesabi range and near Springfield, and in the upper Minnesota River valley in southwestern Minnesota.



Shark Tooth
(Cret.) 1/4x



Mammoth Tooth
(Pleist.) 1/6x



Mastodon Tooth
(Pleist.) 1/6x

The Pleistocene sands, gravels, and clays deposited by glaciers yield teeth and bones of the mastodon and woolly mammoth, bison, musk oxen, and giant beaver. Similar fossils occur in old peat and lake beds in the mantle of glacial drift.

Plant Fossils

A few plant fossils can be found in Cretaceous rocks that formed in swamps marginal to the Cretaceous sea. Fossil leaves and stems occur in shales along the Minnesota River valley from near New Ulm to Morton, and near Springfield, Minnesota.



Laurus (Cret.) 1/2x

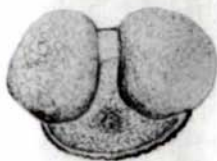


Populus (Cret.) 1/2x

Wood, leaves, and peat found within the glacial drift indicate that plant life thrived during the intervals between advances of the ice sheets. Pollen and spores of these plants also are found in buried lake deposits.



Betula (Pleist.) 1000x



Pinus (Pleist.) 250x

Petrified wood, although uncommon in Minnesota, is found in adjacent states. Colloidal silica deposited by water has taken the place of wood cells preserving portions of the original structure in great detail.

Fossil-like Materials

Fossil-like materials occur in the glacial drift. The clay balls are concretionary, layer upon layer, accumulations of clay minerals in a clay rich till-- a layer of widely varied composition deposited directly by the glacial ice. They may also be associated with concentrations of the mineral pyrite or "fools gold." Calcium carbonate concretions are formed also in the drift layer by precipitation from calcium bicarbonate-bearing waters. The precipitated materials have many shapes and forms.

Moss and lichen covered rocks may also be mistaken for fossils.



Concretions 1/2x

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Many other state geological surveys publish fossil collecting guides which may be of interest. The following displays are very instructive: St. Departments of Geology, University of Minnesota, Minneapolis and Duluth, and Museum of Natural History, University of Minnesota, Minneapolis.

RECORD OF COLLECTED FOSSILS

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RECORD OF COLLECTED FOSSILS

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UNIVERSITY OF MINNESOTA

