A GUIDE

FOR IDENTIFYING COMMON ROCK AND FOSSIL SPECIMENS FOUND IN SASKATCHEWAN MUSEUMS

3rd Edition 2021

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Crinoid stem in Ordovician limestone

FOREWARD

The following guide was originally developed by the author in order to compliment the Saskatchewan Archaeology Societies (SAS) summer archaeological caravan tours that began in 2012 and visited many local Saskatchewan museums. The document has been regularly updated with additional illustrations and photos with this being the third edition.

This guide is designed to aid local museums to identify some of the rock and fossil specimens that they contain. It is not meant to be an exhaustive resource that will allow the user to identify all the material in museums and personal collections as they often contain many unusual and unique specimens. It does however attempt to cover many of the specimens of rocks and fossils that are commonly found in local provincial collections.

The guide is laid out in two main sections. The first section deals with identifying common rock specimens while the second section deals with common fossil specimens.

In preparing this document the author has drawn on an extensive career in mining exploration and palaeontology as well as experience with local provincial museum collections.

Note: This guide was produced by the author as a free public document and is not meant for sale.

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1.0 INTRODUCTION

Most of the specimens of rocks and fossils found in Saskatchewan museums are sourced from the province itself with a few exotic ones that have been brought in from outside by people who have travelled abroad. This guide is aimed at the ones that have been found within the province itself. Many of the provincially sourced specimens are quite common and examples of them are found in most museum collections.

This guide will talk first about the sources of the material and then will give specific information on the most common rock and fossil specimens found.

2.0. SOURCES OF ROCK AND FOSSIL MATERIAL IN SASKATCHEWAN

Although some localities of bedrock occur in the southern half of Saskatchewan especially in the southwest and along the US border, these are limited and most of the rock and fossil specimens that are found come from what are commonly referred to as "fieldstones". These are the rocks that we often see laying out in pastures and farm fields throughout the province. They vary in size from a few centimetres up to some that are many meters in diameter and weigh hundreds of tonnes (Figure 1). Many of these fieldstones can contain fossils.

Figure 1: The Young Erratic, one of the largest fieldstones in southern Saskatchewan. It is composed of fossiliferous limestone and weighs roughly 700 tons. . Photo credit: Belinda Riehl-Fitzsimmons.

These fieldstones are more correctly known as Glacial Erratics. Glacial Erratics are pieces of bedrock that have been picked up by the glaciers during the ice age (Pleistocene) and transported to new locations where they were dropped in deposits up to 400 metres thick. In this way fieldstones with bedrock sources as far away as the east side of Hudson Bay have been deposited over virtually the entire province.

Naturally the moving ice does not discriminate as to which type of bedrock it picks up. Therefore fieldstones found in any given area are often composed of a wide variety of rock types that can represent all of the bedrock that the ice travelled over from the time of its formation to the time that it melted.

The northern half of Saskatchewan is mainly underlain by bedrock of Precambrian age (Figure 2) and although glacial deposits are common here too the bedrock is much better exposed than in the south as the ice was picking up much of the till material here rather than depositing it. These ancient rocks are virtually devoid of any fossils and as a result the fieldstones in this part of the province contain fewer fossils than in the south. Some fossil bearing material has been transported into northern Saskatchewan from the Hudson Bay area that is underlain by post Precambrian rocks and there is also potential for fossils of animals from the Pleistocene to be present in the glacial deposits. It is from this northern area of Precambrian bedrock that the fieldstones in the southern half of the province that are composed of crystalline rocks such as pink granite originate.

The southern half of the province is underlain by bedrock of Ordovician or younger age. Much of this bedrock is fossiliferous and as a result the fieldstones in this part of the province contain many more fossils. The age of these fossils vary from the Ordovician right up to the end of the Pleistocene. Not all of this period of time is represented in Saskatchewan's fieldstone fossils however, as bedrock exposures from some of the major time periods such as the Permian and Jurassic do not occur at the surface in Saskatchewan.

The periods of time that these main bedrock exposures within the province represent are shown in Figure 2.

3.0 COMMON ROCK AND MINERAL SPECIMENS FOUND IN MUSEUMS

Although many different specimens of rock can be found in museums representing a great variety of source types, many of them can be attributed to two types: Concretions, and rocks of variable composition that develop differential weathering.

3.1 Concretions

Concretions represent a lot of museum specimens because of the many unique shapes and forms that they create. The word "concretion" is Latin meaning "Grown together". They are produced by the precipitation of minerals from percolating ground waters in sedimentary rocks such as sands and clays. All sub-surface water contains various amounts and types of minerals in solution. When these minerals are attracted to certain particles of rock or fossils that are chemically different from the enclosing sediments they can be precipitated in the spaces between the surrounding sediment particles. The result is the cementing of the sand or clay grains together to form dense rock in sediment that may be quite unconsolidated and soft.

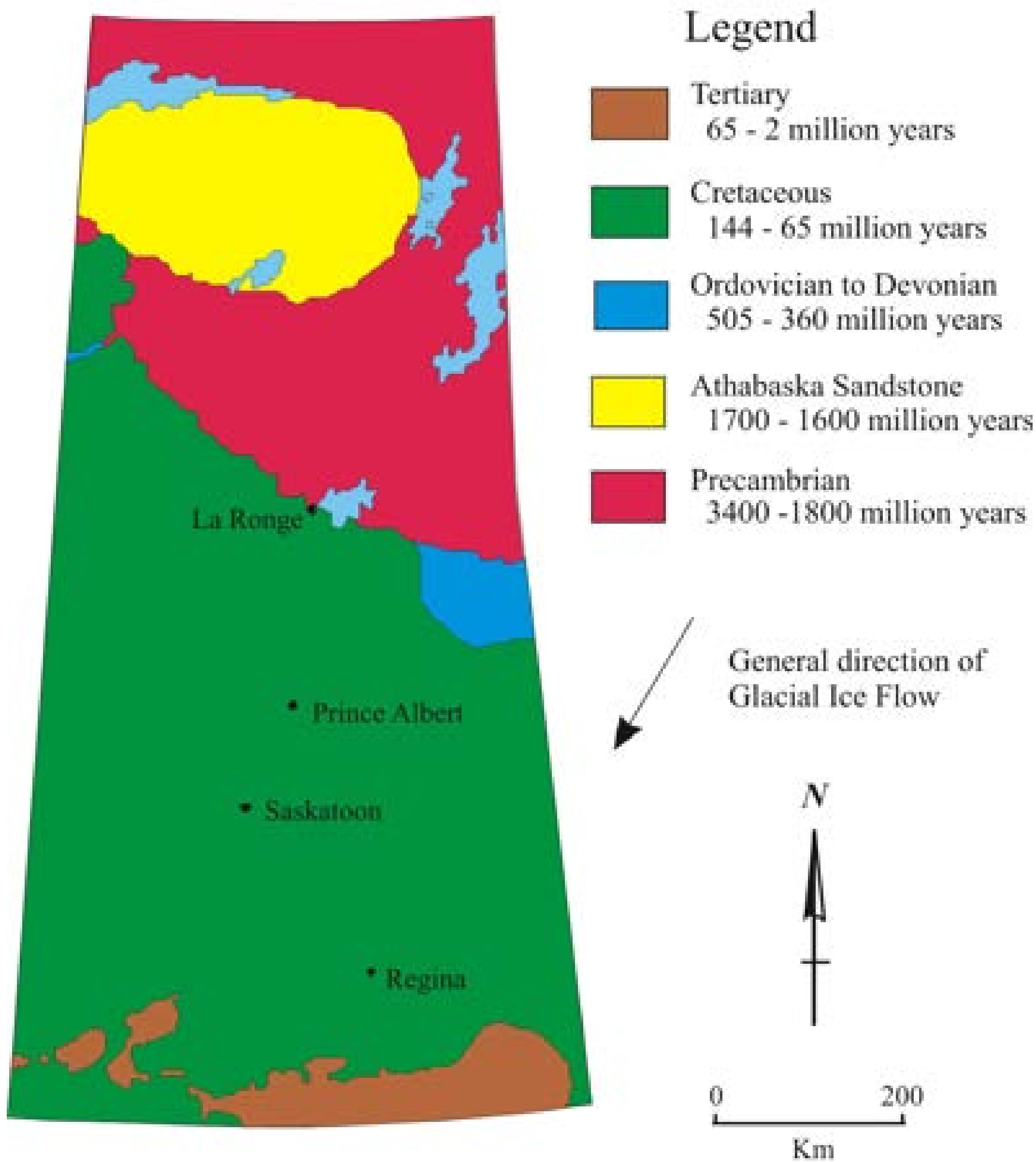

Figure 2: Distribution of bedrock deposits underlying the glacial till in Saskatchewan. The periods of time that the various deposits represent are indicated.

The growth of concretions is a slow process and since it is usually outward from a central core may of them are spherical or elliptical in shape. When broken open they often exhibit concentric layering due to changes in mineral content in the groundwater while they were growing. The bedding planes of the sediment in which they grow can often be observed passing through them as they were formed after the sediments were deposited.

The main minerals which are carried in ground water and are responsible for the formation of most of the concretions are “silica” (quartz), “limonite” (iron oxide), “siderite” (iron carbonate), “pyrite” (iron sulphide), and “calcite” (calcium carbonate). Silica and calcite form concretions that are usually the same color as the surrounding sediments, iron oxide forms concretions that are red or brown in color and contrast with the surrounding sediments.

In Saskatchewan most of the concretions are sourced from the late Cretaceous Bearpaw, Eastend, and Frenchman Formations, and from the early Tertiary age Ravenscrag Formation. These different formations often produce different types of concretions.

3.1.1 Iron Oxide Concretions

Iron Oxide or Ironstone concretions are most commonly found in the late Cretaceous age Eastend and Frenchman Formations (Figure 3). They most often form when balls of clay within sand river channels absorb iron from the groundwater. They are usually very dense due to their high iron content and are often misidentified as meteorites. They can contain plant material when broken open if there was plant material present in the clay they were formed from. Color can vary from brown to purple.

Figure 3: Iron concretion formed from iron cementing of a clay ball in channel sands within the Late Cretaceous Frenchman Formation of southern Saskatchewan. Note the spalling off of the outer layers of the concretion.

The process of formation of these clay ball iron concretions within channel sands is shown by the graphics in Figure 4. Overbank clays that have fallen into the river are moved down the stream and become rounded in the process. They come to rest on the stream bottom and are buried by more sand. Post depositional movement of iron rich waters through the sand then deposits iron into the outside of the clay ball similar to how smoke is deposited into the outside of meat in a smoker. The iron bindes with the clay minerals while it does not with the quartz in the sand. This process leaves the highest iron concentration on the outside of the clay ball.

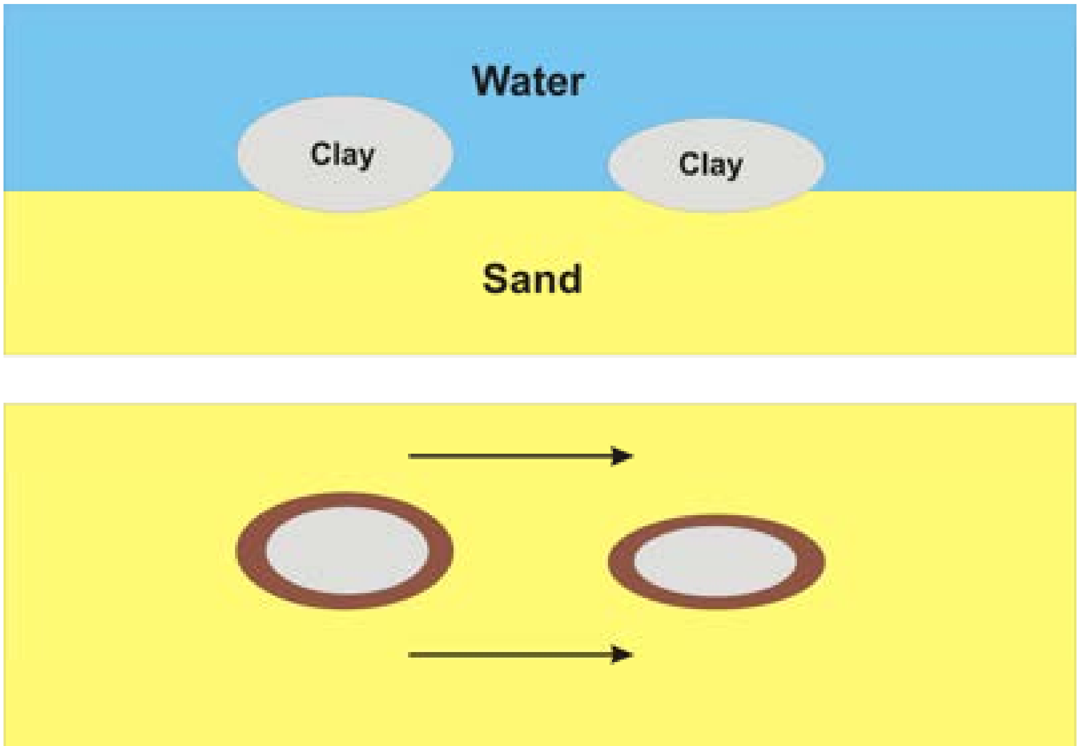

Figure 4: The process of formation of clay ball iron concretions in stream channel deposits. The top illustration shows balls of over bank clay being deposited on sand deposits on the bottom of a stream bed. The bottom illustration shows the clay balls after burial by more sand. Iron rich groundwater traveling through the sand (arrows) deposits iron onto the outside of the clay balls.

Figure 5 shows an iron concretion that has been broken open and shows the iron rich outer layer and the grey clay interior which has no iron present.

Iron concretions are often layered as a result of the highest iron content being concentrated on the outside of the original clay ball. Spalling off of these outer layers can sometimes produce spectacular surface patterns such as the one shown in Figure 6.

Figure 5: A broken iron concretion showing a cross section of the interior. The layered nature of the iron deposited on the outside of the clay ball and the unaffected interior clay is visible. Note that the clay contains dark pieces of organic material such as plant fragments.

Figure 6: Complex patterns formed on the outside of an iron concretion due to spalling of outer layers. The specimen is 15 cm long.

3.1.2 Calcite Concretions

Calcite concretions are the most common concretions and are found in many deposits with the most common sources being the Late Cretaceous age sedimentary deposits. They form in both sand and clay sediments and some of them can be of enormous size and weigh many tons. The largest examples occur in river sand deposits in the Cretaceous and are the cause of the famous Hoodoo's of the badlands of Alberta. The Hoodoo's form when large resistant concretions exposed by erosion form a cap protecting the soft sediments underneath from erosion. Figure 7 graphically shows how these concretions form in sand deposits.

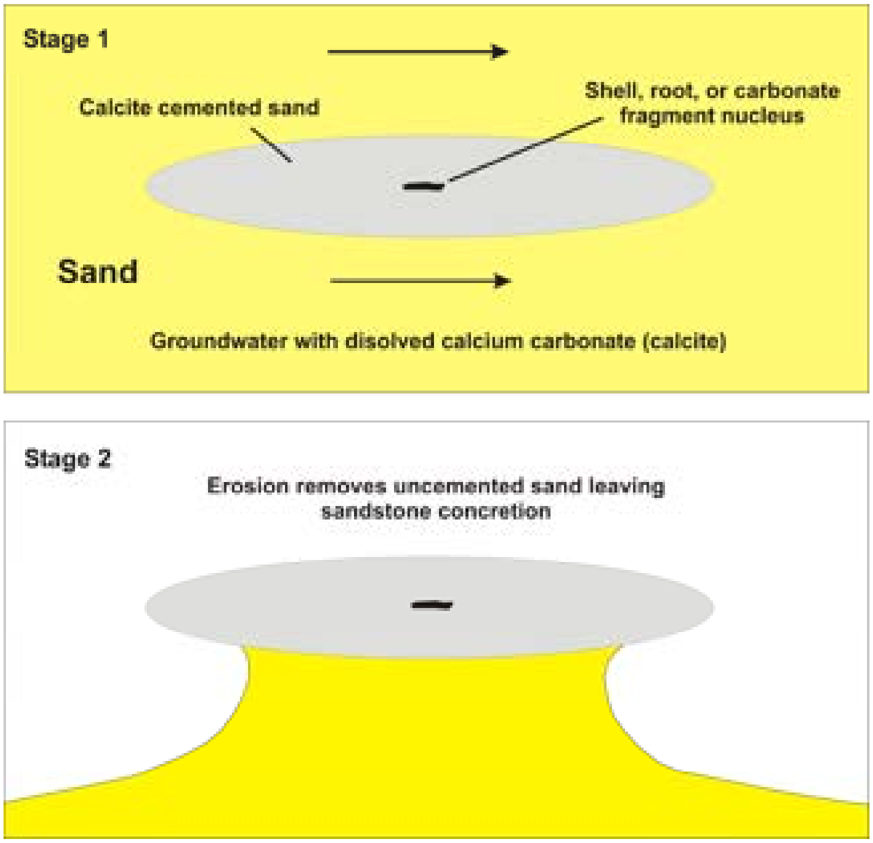

Figure 7: Formation of sandstone concretions in river sand deposits. Stage 1 shows the growth of a concretion within the sand body as calcium carbonate dissolved in groundwater is deposited as calcite on the sand grains to cement them. This often starts around a calcite rich object such as a buried shell. Stage 2 shows how erosion removes the surrounding uncemented sand to leave the concretion on the surface.

Figure 8 shows an example of a Hoodoo from the badlands of southern Alberta with the concretionary layer forming a resistant cap protecting the softer more easily eroded sands beneath it. Some of these concretions form unusual shapes when completely weathered out of the surrounding sand as illustrated in figure 9.

Calcite concretions also form in the clay deposits of the Late Cretaceous age Bearpaw Formation that underlies much of Southern Saskatchewan. These concretions are up to a half-meter or more in diameter and are often very spherical in shape. They are dark to medium grey in colour and are prone to fracturing and fall apart with relative ease. Their interior usually contains open fractures that have been partially filled in with calcite crystals (Figure 10). They usually contain a fossil shell in the centre that acted as the nucleating point for the growth of the concretion Figure 11).

Because they are so spherical these concretions are often used as ornamental tops on cairns (Figure 12).

Other types of concretions that appear in museums are ones that form bizarre looking shapes and if found are usually collected. They are often mistaken for fossils and are referred to as pseudofossils.

Figure 8: Hoodoo like feature from the badlands in southern Alberta. The calcite cemented concretionary layer that forms the resistive cap prevents the erosion of the soft un-cemented sediments beneath it.

Figure 9: Large calcite cemented sandstone concretions in the Late Cretaceous age Frenchman Formation in the Frenchman River valley of southern Saskatchewan. They have been weathered out of the unconsolidated sands that surrounded them. Note the preserved bedding features.

Figure 10: Broken concretion from the clays of the Cretaceous age Bearpaw Formation. Note the layering and the development of calcite crystals (brown) along fractures in the broken faces.

Figure 11: Partial shell of a Baculite, a large Cretaceous nautiloide, which formed the core of a Bearpaw Formation concretion.

Figure 12: Spherical concretion from the Bearpaw Formation of southern Saskatchewan used as the top of a stone cairn.

3.1.3, Omars

By far the most common concretion specimens found in Saskatchewan museums are Omars. Indeed these are perhaps the most common rock specimens of all that are present in their collections. Figure 13 shows a couple of examples of Omars from the author's collection.

Figure 13: A couple of examples of Omars from the glacial till of Saskatchewan.

Also referred to as “Belchers”, “drill stones”, and “drip stones” they are often misinterpreted as being archaeological artifacts (Pseudoartifacts). They are however formed naturally and are the result of calcite concretion cementing. These rocks are all a light to medium green in colour and have round holes in them. Their abundance in museums is a reflection of the relative abundance of them in the glacial till covering much of Saskatchewan

These "drill stones" were described in the literature as early as 1872. In 1886 Robert Bell noted greywacke with "eyes up to the size of cricket balls" in the drift overlying Palaeozoic and Precambrian rocks south and west of Hudson Bay and James Bay. J.B. Tyrrell also noted them in northern Ontario in 1913. In recent years several researchers have revived interest in them. The source of these unique concretion bearing rocks has now been recognized and has been described by several authors including; McEwan (1978), Ricketts (1981), and Prest (1990).

The original source of these unique concretion-bearing rocks seems to be limited to a particular sedimentary sequence in the Belcher Islands in the southeast end of Hudson Bay near the entrance to James Bay. Figure 14 shows the source area and the approximate present distribution in glacial tills of these rocks. The unique character of the rock appears to confirm this as being the only possible source.

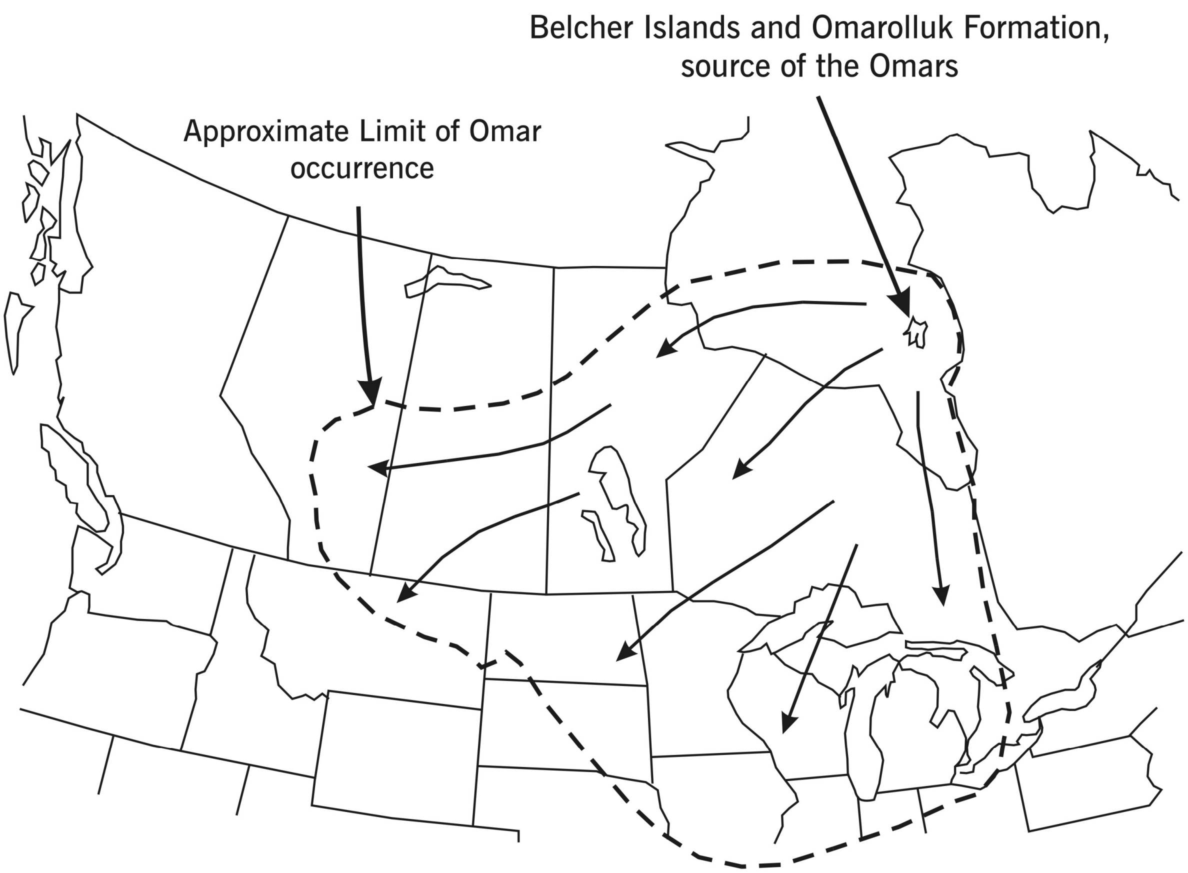

Figure 14: Map showing the source and distribution of Omars in glacial till in North America. Arrows indicate the movement of the glacial ice that dispersed them.

The distribution of the rocks from their source area indicates that the flow of ice that distributed them was to the west, southwest, and south. The western limit of the distribution is near the foot of the Rocky Mountains where the ice met the mountain glaciers, and the southern limit appears to be the southern limit of the glacial advance into the northern United States.

They are referred to as "Omars" for the Omarolluk Formation from which they come. The other name "Belchers" is due to the source for them being from the area around the Belcher Islands. There are two types of Omars; those with, and those without the calcite concretions which form the round holes. There are about 10 times as many without concretions as those with them. The specimens with the concretions are fairly easy to recognize in the field but the ones without are not and can be more easily confused with greenstone erratics from multiple other sources.

The Omarolluk Formation from which these concretion bearing rocks are derived is part of a larger series of sedimentary rocks known as the Belcher Group. These sediments have undergone very little metamorphism considering their age and the concretions and other structures are thus well preserved. The sediments which form the Group are a series of Proterozoic (young Precambrian) age Turbidites. Turbidites are formed underwater by currents or flows of turbid or sediment rich water out of which the sediments settle to form deposits with very distinct characteristics. They often form off the edges of large deltas where underwater sediment "avalanches" occur on the slope of the delta. The avalanches form turbid clouds of water which cascade down slope into deeper water where the sediments settle out to form turbidite deposits. These deposits also form off the coast of volcanically active island chains such as Japan, and are therefore sometimes difficult to distinguish in hand specimen from volcanic lava flows due to their similar composition. The Omarolluk Formation and the overlying Loaf Formation are believed to underlie a major part of the area between the Belcher Islands and the Quebec shore to the east.

The holes in the Omars are a type of "negative concretion" as they weather out of harder rock to form a spherical shaped hole instead of being strongly cemented spherical structures in soft sediments like sand which then weather out of the surrounding material to form spherical ball shaped masses as is the case with most concretions.

Calcite cemented concretions originally formed early on in the volcanic sands which make up the Omarolluk Formation. These concretions were usually nucleated around a small clast of calcite rich shale. Figure 15 shows a photomicrograph of a thin section of one of these concretions preserved inside an Omar that has not yet been dissolved to form a hole. The black fragment of shale at the centre is the nuclei of the concretion. The light circular halo around it shows the extent of the original calcite cementing. The angular nature of the volcanic sand clasts can also be seen. Figure 16 shows a partly dissolved concretion with the nucleating core still intact in the center.

Figure 15: Photomicrograph of an un-weathered concretion inside an Omar. The calcite shale fragment at the concretions centre and the angular nature of the volcanic sand are clearly visible. The circular halo shows the extent of the original calcite concretion.

Figure 16: Partly dissolved concretion on the surface of an omar showing the nucleating core still preserved in the center. If the rest of the concretion is dissolved this core will fall out.

After the calcite concretions were formed the rest of the Omarolluk formations sediments were cemented up during metamorphism that resulted in a hard rock that is very resistant to weathering. After transportation and deposition by the Pleistocene glaciers, any of the original calcite concretions that were exposed at the surface of cobbles of the rock were subjected to ground water which is often slightly acidic. This resulted in the dissolving of the calcite cement that left the holes in the rocks surface.

Sometimes not all the calcite concretion material has been dissolved out of a hole. In this case if the rock is put in hot vinegar for a few days the acetic acid in the vinegar will dissolve out the last of the calcite cement and the original sand can be washed out leaving a completely circular hole.

If you run your fingers around the inside of the holes you can feel the rough surface caused by the angular nature of the original sand from which the rock is composed.

The process of the formation of the concretions and the weathering out of them described above is sumarized in the graphic shown in Figure 17.

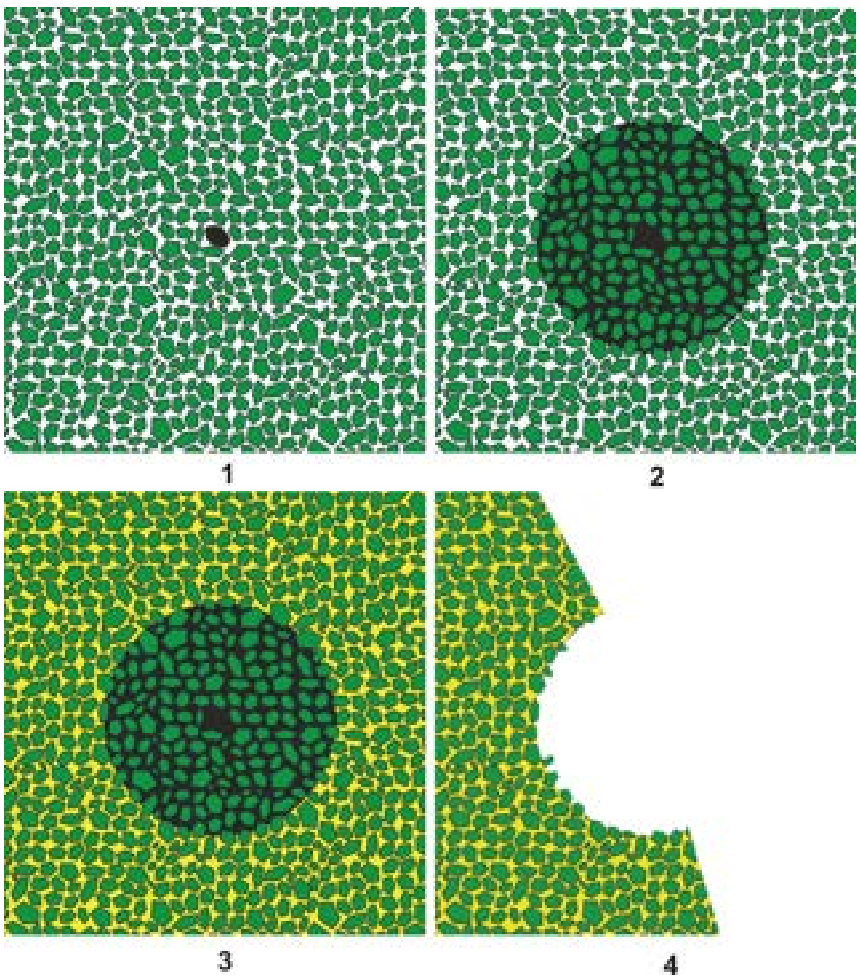

Figure 17: Graphic showing the sequence of events producing the Omars. 1, deposition of angular volcanic sand with carbonate rich clast (black). 2, growth of calcite cemented concretion. 3, cementing of remaining sand during metamorphism. 4, exposure of concretion at surface and calcite dissolves leaving a hole.

3.1.4, Pseudo Fossils

Because concretions can form all sorts of bizarre shapes they are often mistaken for fossils on the bases of shape alone. These are referred to as pseudo fossils. Figure 18 is an example of a piece of sedimentary concretion that has been worn by natural erosion into a shape resembling a claw.

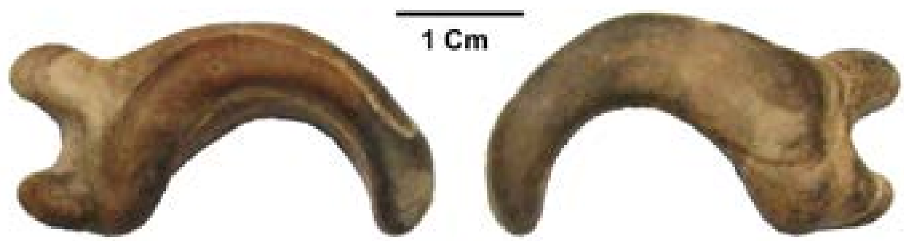

Figure 18: Example of pseudo fossil. Two sides of a piece of sedimentary concretion that has been worn into a shape resembling a claw.

3.2: Rocks with Differential Weathering.

The other main type of rock specimens found in museums are rocks that have been subjected to differential weathering. Rocks often have several layers or bodies of material of different composition that have different rates at which they erode or abrade when they are exposed to the elements. As a result they produce naturally sculpted forms of unusual shapes. Igneous and metamorphic rocks with veins or layers of hard material (Figure 19) or rocks which have been fractured, often in several directions, and in which fluids moving along the fractures have emplaced minerals which harden the rock can give rise to strange surface patterns when they are differentially weathered (Figure 20). The same can happen with sedimentary rocks. Figure 21 shows a couple of examples of differential weathering of rocks with layers of different composition that result in shapes that can be mistaken for human made stone artifacts.

Figure 22 shows a rock that has been differentially weathered along fractures along which silica had been introduced into the original rock type. These silicified bands are more reistant to weathering than the original rock and now stand out as the light colored ridges.

Note: If the pattern of weathered out areas on a rock specimen conforms to the distribution of a certain type of rock composition the shape is likely natural and due to differential weathering.

Figure 19: Fresh exposure of metamorphic basalt (dark) with granitic vein intruding through it (light).

Figure 20: Unique looking field stone formed by the differential weathering of rock similar to the one shown in Figure 19. The darker more mafic rock has weathered much faster than the pink granitic intrusive vein has.

Figure 21: Differential weathering of rocks composed of layers of variable composition that result in shapes that appear to be man made stone artifacts.

Figure 22: Example of a rock that was fractured and subsequent silicification has occurred along the fractures causing them to stand out when the rock underwent surface weathering.

3.3: Common Mineral Specimens

There is a wide variety of mineral crystal specimens that can be found in museum collections. The one that is most common is the gypsum mineral variant known as selenite. This is because it is fairly abundant in the clays of the Cretaceous age Bearpaw Formation which underlies much of southern Saskatchewan. It also tends to form large clear crystals that are attractive and easily seen. Being gypsum it is fairly easily weathered but still retains its clear transparent nature. Abundant exposures along valleys and lakes in parts of southern Saskatchewan provide lots of opportunities for it to be found.

Figure 23 shows several good specimens of selenite crystals from the Bearpaw formation.

Figure 23: Examples of selenite crystals from the Late Cretaceous age Bearpaw Formation of southern Saskatchewan.

4.0. COMMON FOSSILS FOUND IN MUSEUMS

4.1. Fossils Found in Limestone Rocks

Most of the fossils described in this pamphlet are found in fieldstones composed of limestone of Ordovician, Silurian and Devonian age. Major bedrock exposures of limestones from these periods occur in the east central part of the province along the Hanson lake road from Deschambault Lake to the Manitoba border (Figure 2).

Fossiliferous Ordovician limestone referred to as Tyndall Stone is often used as facing stone on many buildings throughout the province and as a result many of the fossils described in this pamphlet can be seen on their walls. An example of Tyndall Stone is shown in Figure 24 and shows examples of the two most common Ordovician fossils found in museum collections; Nautiloid shells and Receptaculites that are described below.

Limestone is formed in shallow warm seas and in some cases can be made up entirely of the remains of ocean dwelling animals. Most fieldstones composed of limestone are a light whitish pink to buff colour and often have orange lichens growing on them. The surface is usually pitted as limestone reacts to acidic water and is easily weathered. This weathering often enhances any fossils that are present due to different rates at which fossil and matrix material dissolve.

A simple test for limestone is to put it in warm vinegar. If the rock is limestone, the acetic acid in the vinegar will start to dissolve the calcite in the limestone and release bubbles of carbon dioxide.

Figure 24: Tyndall stone with two of the most common Ordovician limestone fossils found in Saskatchewan. Receptaculites occur in the lower right and upper left and a Nautilod showing the chamber walls runs diagonally across the center of the photo. This slab is in the Geological Sciences Building, University of Saskatchewan.

4.1.1. Receptaculites

Perhaps the most common limestone fieldstone fossil in Saskatchewan museums is this large ocean dwelling organism that looks like the face of a sunflower head, and can reach a diameter of half a meter. A complete specimen is shown in Figure 25. They have a perfectly round edge and surface pattern similar to a sunflower head. They are most often found in Ordovician limestone from the Red River Formation. A bedrock exposure of this formation on the Hanson Lake Road just west of the Northern Lights Lodge on the south arm of Deschambault Lake contains abundant examples of them.

The relationship of these sea bottom dwelling organisms is uncertain but they are thought to have been relatives of the sponges.

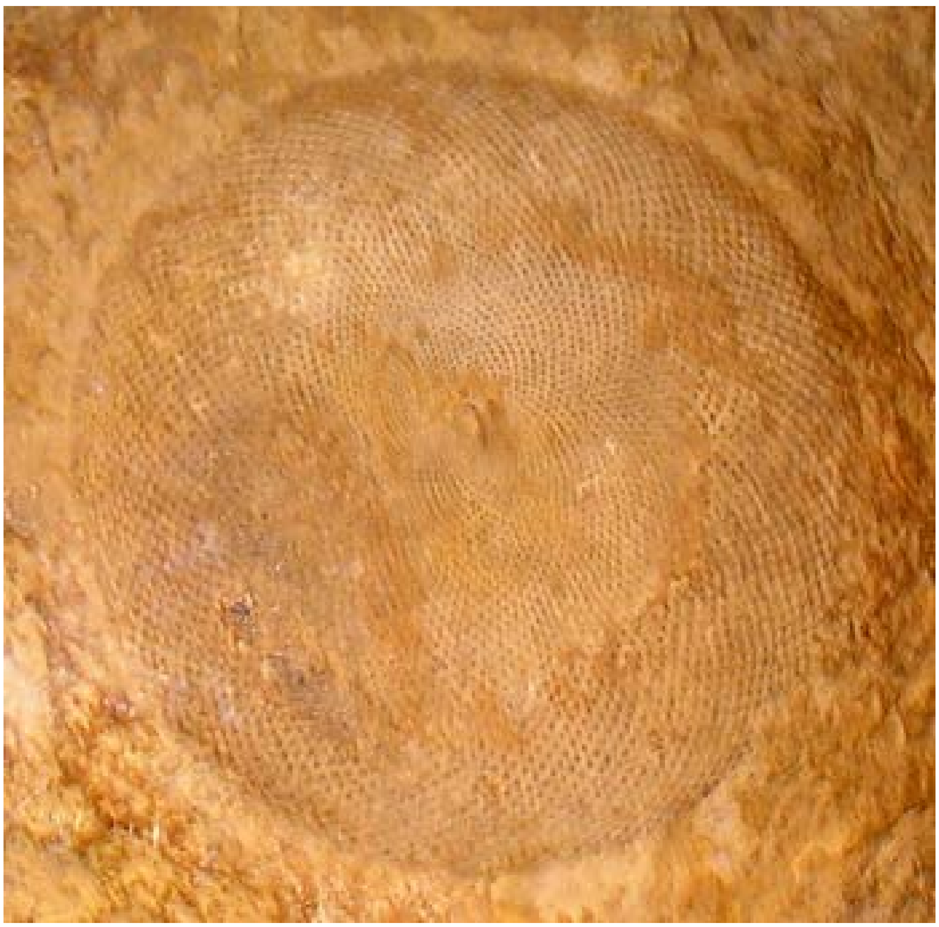

Figure 25: Complete specimen of Receptaculites from Ordovician age Limestone in Saskatchewan. Specimen is about 30 cm in diameter.

4.1.2. Nautiloids

Often mistaken for vertebrate columns, Nautiloids are shellfish belonging to the Cephalopoda a group that includes the squid and octopus. Like their modern relatives the Nautiloids were free swimming and used their shells as protection and as flotation systems. An example of the modern Chambered Nautilus is shown in Figure 26. Unlike the modern Nautilus these older Nautiloids usually had straight rather than coiled shells.

Figure 26: Shell of a modern Chambered Nautilus that has been cut in half to show the internal cell walls.

Like the modern Nautilus, the shells of these old Nautiloids contained internal chambers that acted like the ballast tanks of a submarine allowing them to float and swim freely in the ocean. Like the Nautilus, squid, and octopus they probably propelled themselves through the water using water jets.

Figure 27 shows three Nautiloid shells from Ordovician age limestone. Like many of the shellfish fossils found in limestone of this age, the "mother of pearl" external shell is not preserved and only the internal cast showing the chamber walls still exists. The chamber walls of these early Nautiloids are simple in shape and form a line where they meet the outer shell wall. The stacked individual chambers have the superficial appearance of a vertebrate column. The right end of the complete shells would have tapered to a point. The animal would have grown the shell from right to left, adding chamber walls as it went. Figure 24 shows an excellent Nautiloid specimen with the internal cell walls well preserved.

During the Ordovician some Nautiloids had shells up to 4.5 metres long and were the largest living animals on earth at that time.

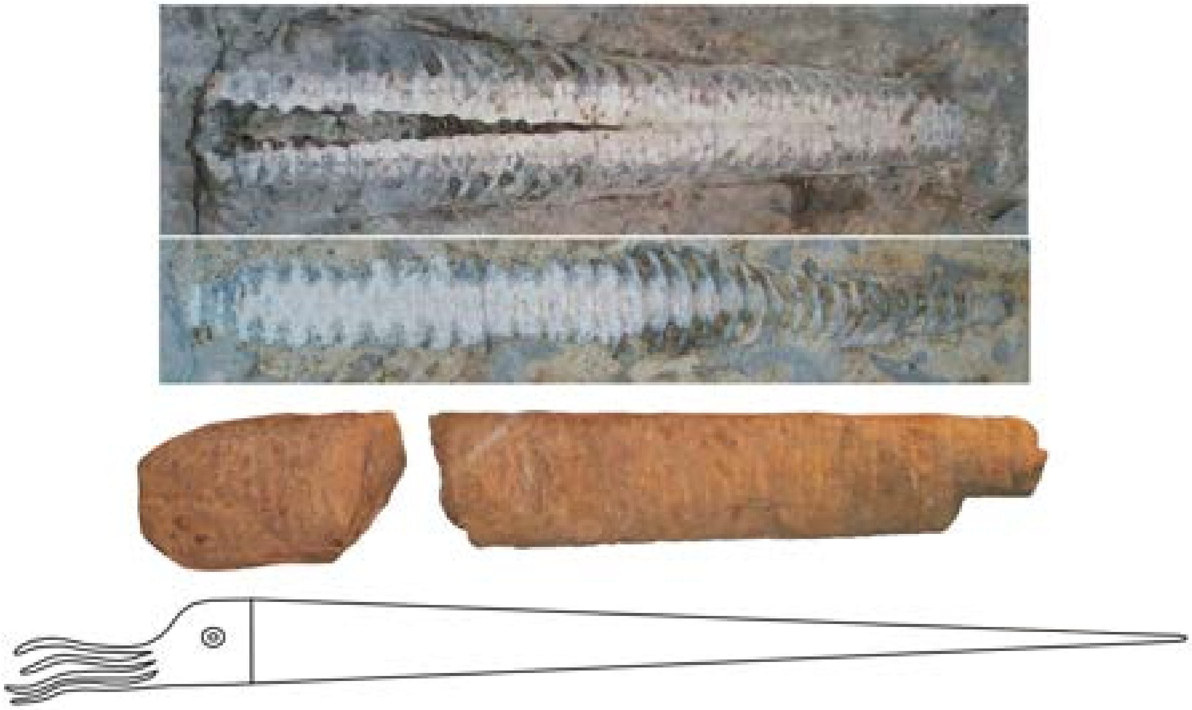

Figure 27: Examples of Ordovician limestone Nautiloid shell showing what the original shell and animal would have looked like. Refer also to figure 24.

4.1.3. Crinoids

Crinoids (Figure 28) belong to the Echinoderma that includes modern starfish and sand dollars. The figure shows a reconstruction of a complete specimen showing the different parts. They were held onto the sea floor by a root-like system. Unlike land plants these roots did not provide food, rather the frond-like arms appear to have collected food from the water currents.

Crinoids had an external shell-like skeleton that was composed of individual plates that were hollow rings in the stem portion. They are seldom found preserved in a complete state as these skeletal plates tended to come apart on death and were scattered about. Broken sections of their stems are often found however and resemble a role of lifesaver candies. The photo in Figure 28 and the specimen on the front cover of this publication are examples of preserved stem portions.

Like the Nautiloids these stem fragments can sometimes be mistaken for fossil backbones, or they can be confused with Nautiloids themselves. However they can be distinguished from both by the presence of the hole in the centre which vertebrate do not have, their small size that is usually a centimetre or less in diameter, and the fact that they do not taper in one direction the way a Nautiloid shell does. The stem plates are usually round but can also be star shaped with five points like starfish and sand dollars. They also contain fine radiating patterns on the faces of each segment.

Crinoids occur throughout the Ordovician, Silurian, and Devonian.

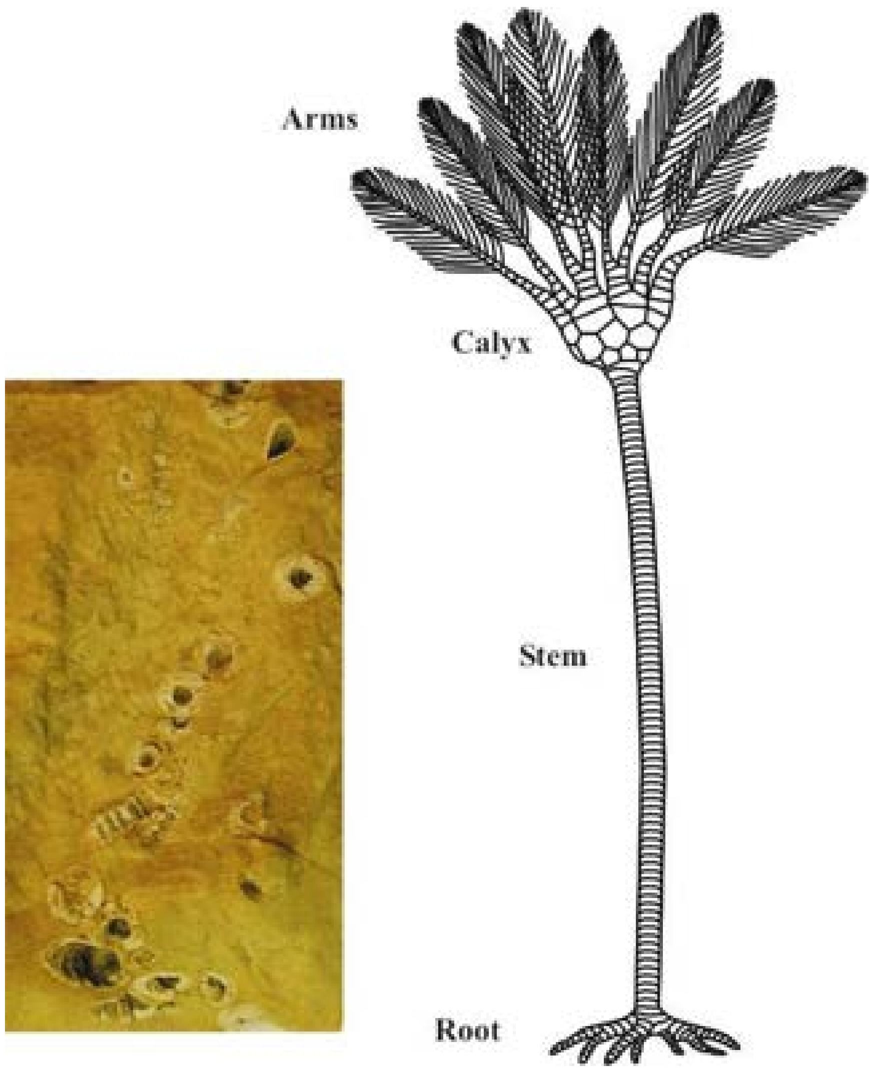

Figure 28: *Left:* Fragments of Crinoid stems in limestone. Note the hole in the centre. The stems are usually 1 cm or less in diameter. *Right:* A typical Crinoid showing the major parts. The fossil on the front cover of this publication is a portion of a Crinoid stem.

4.1.4. Gastropods

Common in the Ordovician age and younger limestone rocks in Saskatchewan, and still common today as snails, Gastropods are shellfish that have a coiled shell. Unlike the Nautiloids, Gastropods do not have internal chamber walls in their shells, as they are not free swimmers and do not have to regulate their buoyancy. The shells are usually coiled in a spiral unlike the Ammonites, another group of chambered Cephalopods which have shells coiled in a flat plane. However there are a few gastropods that do have their shells coiled in a flat plane and the lack of internal chamber walls has to be used to tell these from the Ammonites. Fossil Gastropods found in Saskatchewan generally range in size from less than a centimetre to about 10 centimetres.

Two examples of Ordovician gastropod fossils are shown in Figure 29 along with a modern ocean gastropod shell that has been cut open to show the internal structure and the lack of internal chamber walls.

Figure 29: Two examples of Ordovician limestone gastropod fossils are shown on the left and centre. A section through a modern ocean gastropod shell is shown on the right and illustrates the lack of internal chambers.

4.1.5: Brachiopods

Also known as "Lamp shells" due to their similarity in appearance to ancient oil lamps, Brachiopods are one of two great groups of bivalve shellfish. The other group is the Pelecypods that are described under the section on Mudstone Fieldstones.

Bivalves have two separate shells or valves that are hinged together like that of a clam. For the most part they are immobile and live on the sea floor.

Brachiopods, which were common in Ordovician to Devonian times, can be distinguished from Pelecypods by the symmetry of their shells or valves. Figure 30 shows that Pelecypods individual valves do not have symmetry from one side to the other, however the two valves are symmetrical (mirror images) of each other. Brachiopods are the opposite with the individual valves being symmetrical from one side to the other, while the two valves are not symmetrical to each other. **Note:** This distinction is a general rule and is not always true as some Pelecypods have upper and lower shells that exhibit symmetry that is similar to that of Brachiopods and vice versa.

Many different types of Brachiopods with variable shell shapes and sizes can be found in Saskatchewan’s limestone fieldstones. Although the original shell material is sometimes preserved in the limestone, more often than not only an internal or external cast of the shell is all that is present. While complete shells are common, often only the individual valves are preserved. In many instances layers composed of nothing but Brachiopod shells occur within the limestones. Some examples of Brachiopod fossils are shown in Figure 31.

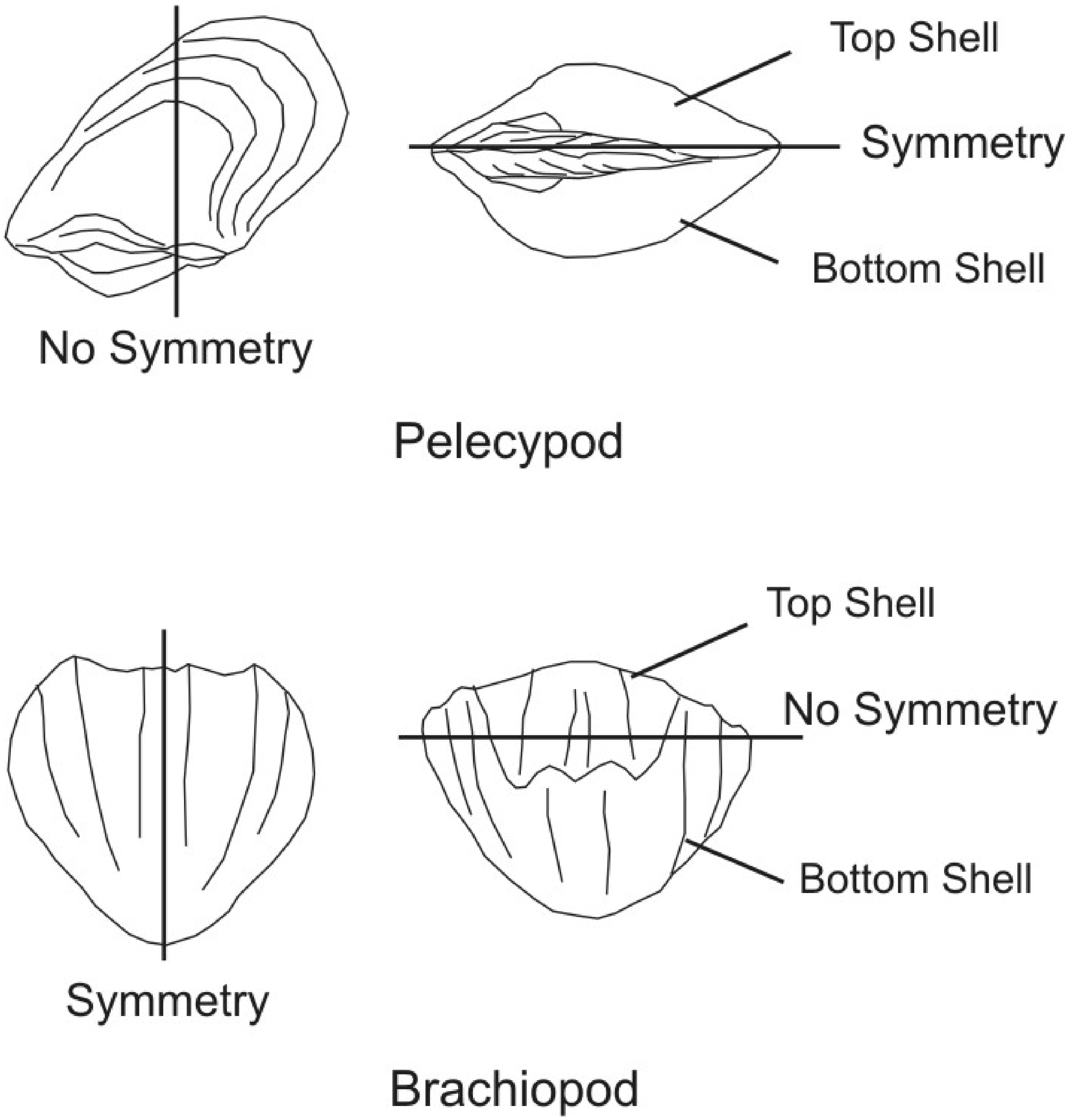

Figure 30: This figure shows the basic difference between Pelecypods and Brachiopods shells by the difference in the symmetry of their two shells. (Note: In some cases this does not hold true).

Figure 31: Some examples of brachiopod shells from Ordovician limestones. Images are of the front of the shell with them orientated the way they would have laid on the ocean floor. The lack of symmetry between the upper and lower valves is clearly visible.

4.1.6. Rugose Corals

Also known as Horn Corals due to their similarity in appearance to the horns of cattle, rugose corals can be recognized as a coral by the radiating pattern of internal septum common to all corals. These internal septum look like the internal pattern of an orange or grapefruit that has been cut in half.

They were probably attached to the sea bottom by the tip of the horn with the large end facing upward. They range in size up to several centimetres in diameter. Figure 32 shows an illustration of a complete Rugose coral and a fossil example showing the internal structure.

Figure 33 shows another example of a rugose coral that has been cut through in a block of polished limestone and also shows the internal structures in detail.

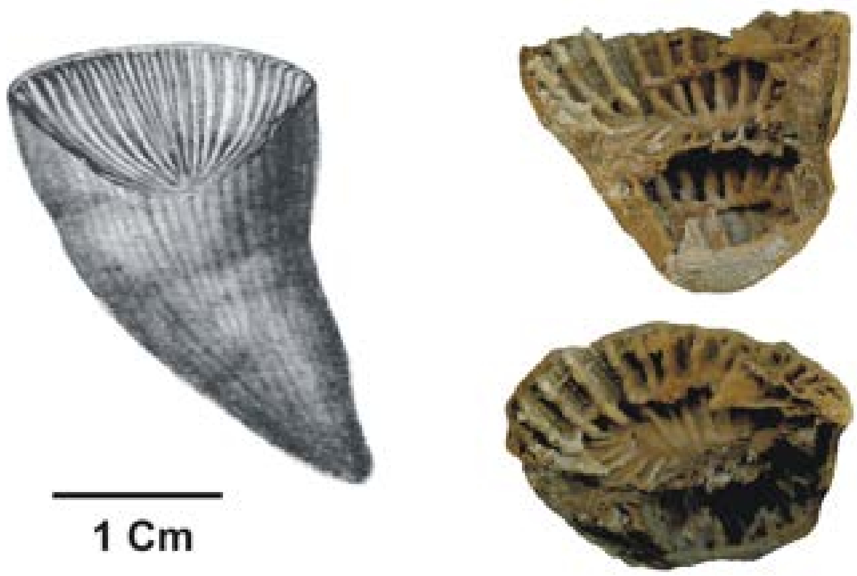

Figure 32: Illustration of a rugose coral on the left and the internal structure of a specimen on the right.

Figure 33: Cut section of Tyndall limestone with a section through a rugose coral showing the internal septa.

4.2. Fossils Found in Mudstone Rocks

Many fieldstone fossils are found in pieces of consolidated clay or mudstone. These rocks are generally a light green to reddish buff colour and were deposited in shallow inland waters during the Late Cretaceous period or later.

Although these mudstones are much less resistant than the limestones and do not stand up to glacial transport as well, many fieldstones are still composed of them as most of the south half of the province is underlain by Late Cretaceous bedrock (Figure 2) and the source area for them is therefore much greater than for the limestones.

Because they are much younger rocks and their depositional environment was much different than for the limestones, the preservation of fossils in these mudstones is often much better. The original shells of many are in pristine shape with the "mother of pearl" still well preserved. They are often still hollow inside.

4.2.1 Baculites (Cretaceous Nautiloids).

Baculites are the later Cretaceous age equivalent of the Ordovician age Nautiloids found in limestones and described in section 4.1.2. Baculites are similar in most respects to the Ordovician ones except for the shape of the chamber walls. Their chamber walls have complex folding and frilling near the contact with the outside shell that results in complex patterns where the outside shell has been broken away to expose them (Figures 34,35,36). Baculite shells are often very long and taper very slowly towards a point.

Figure 34: Two examples of partial Baculite shells from Late Cretaceous deposits of southern Saskatchewan.

Figure 35: Broken section of Baculite shell showing the internal chamber walls and the frilling along the edge of the walls where they contact the outer shell

Figure 36: A fragment of Baculite with the outside shell broke off which shows the frilly pattern where the internal cell wall contacts the outer shell.

4.2.2. Ammonites

Like the Nautiloids, the Ammonites were free-swimming members of the Cephalopods that had coiled shells and lived in the Late Cretaceous age shallow inland seas covering the southern half of Saskatchewan at that time. They have been known to have shells up to several meters in diameter with the largest ones found in the province being over half a meter across.

Similar to the Nautiloids, the Ammonites had a chambered shell with individual chamber walls and like the Baculites their chamber walls were not flat and simple in shape, rather they were intricately folded and frilled at their edges and as a result the suture lines where they contacted the outside shell also form complex frilly patterns. Figure 37 shows the general features of an ammonite.

Figure 38 shows an example of a large Cretaceous ammonite specimen from Saskatchewan with the internal cell wall structures visible, the original shell and the frilly pattern where the cell walls meet the external shell.

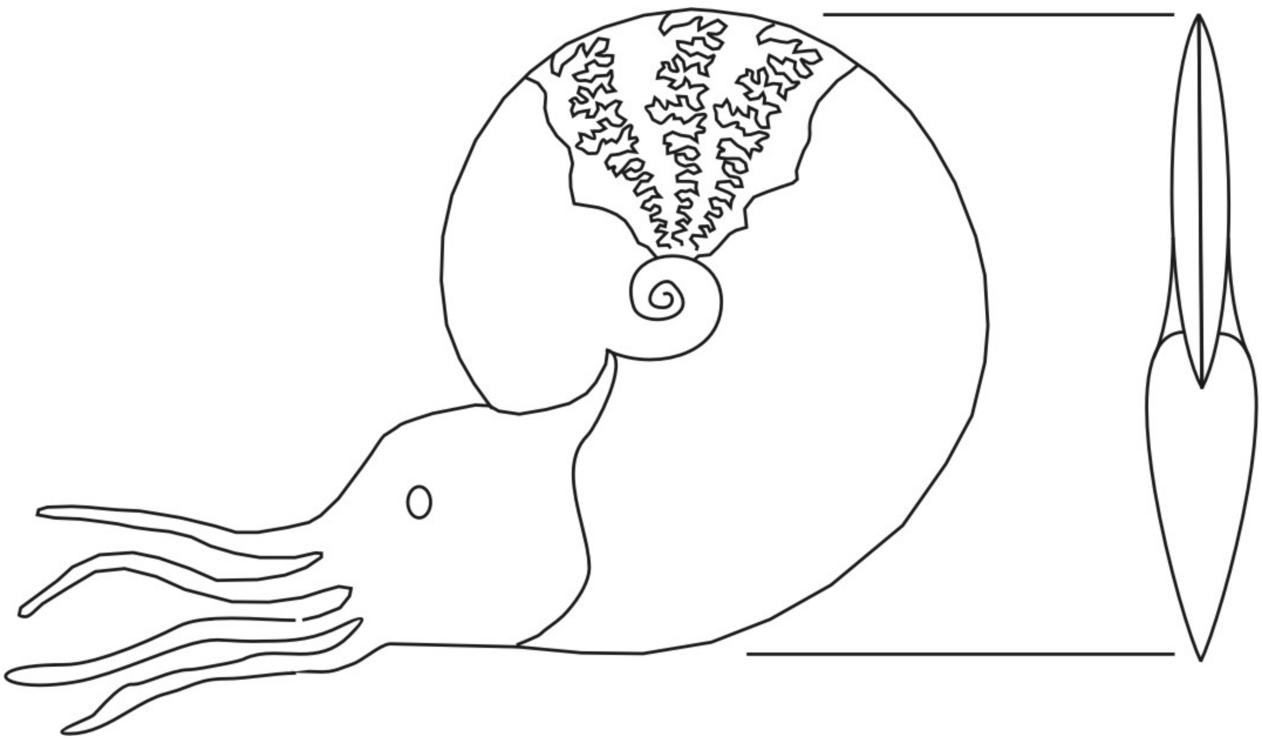

Figure 37: Diagram showing typical ammonite shell with animal in it and detail of cell wall contact where outer shell has been broken away. The ammonite would have swam in this orientation similar to a modern chambered nautilus.

Figure 38: Example of large Ammonite shell showing the mother of pearl shell still preserved as well as details of the cell wall pattern where the outside shell is broken away. The broken section on the right shows details of the internal cell walls. This specimen is displayed in the University of Saskatchewan geological sciences building, Saskatoon.

4.2.3: Pelecypods

While the Brachiopods were the dominant bivalve found in limestone fieldstones, Pelecypods are dominant in the mudstone fieldstones. Figure 30 shows the difference between the two based on their shell symmetry.

The Pelecypods include the modern clams, and like clams often form massive shell beds within the Cretaceous mudstones. Pelecypods found in Saskatchewan's mudstones can range from less than a centimetre to several tens of centimetres in diameter. The mother of pearl shells are often well preserved in these Cretaceous examples. Figure 39 shows examples of two fossil Pelecypods found in Saskatchewan.

Figure 39: Two exampes of pelecypod shells from the Late Cretaceous age Bearpaw Formation of southern Saskatchewan. The top views are side views that show the symmetry between the top and bottom valves, while the lower views show the lack of symmetrical shape of the individual valves. The specimen on the left is much larger than the one on the right.

4.3. Other Common Fossils

A few other fossil types are commonly found in Saskatchewan. Two of the more common ones are discussed here.

4.3.1: Fossil or "Petrified" wood.

Examples of fossilized wood are common in the surface deposits of southern Saskatchewan and therefore it is common in museum collections. While it does occur in lesser amounts in most surface glacial deposits in the south half of the province, the largest concentrations occur in the most southerly part where abundant amounts of it occur in the Late Tertiary age deposits of the Cypress Hills and Wood Mountain Formations that are exposed at the surface.

What is commonly referred to as "Petrified" wood is branches or trunks of trees that have been silicified by groundwater over long periods of time after the burial of the wood. Silica in the groundwater has replaced the original wood molecule by molecule often resulting in a perfect copy of the original wood right down to the cellular level. A good example is shown in Figure

40 that shows the growth rings of the tree. Periods of wet and drought can even be seen in this specimen due to the thickness of the rings. This specimen is likely of Late Cretaceous age.

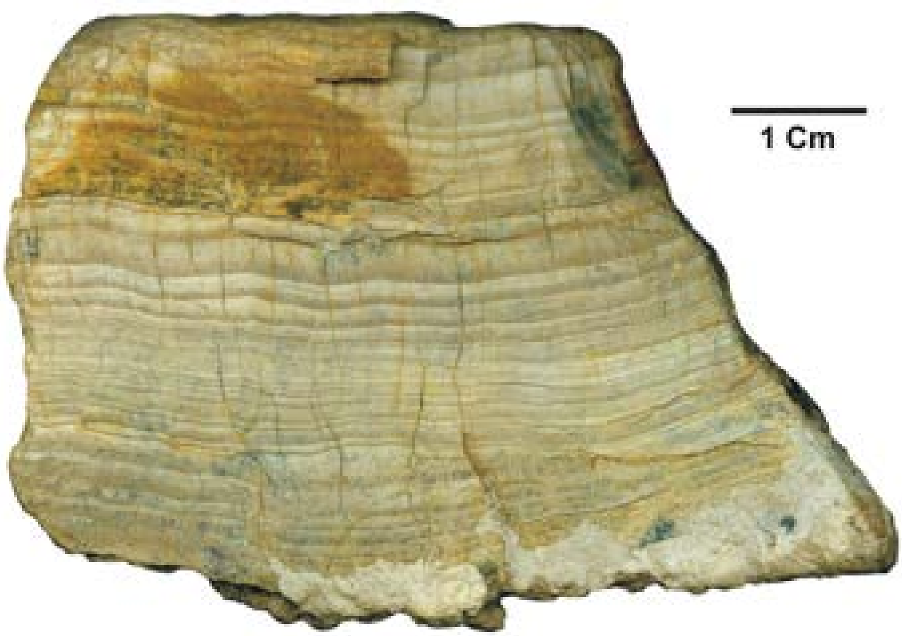

Figure 40: Example of fossilized wood from the Late Cretaceous showing the well-preserved growth rings of the tree.

Silicified wood is very resistant to abrasion and therefore often occurs as separate fragments in river channel sand and gravel deposits such as those found in the Cypress Hills and Wood Mountain Formations.

The quality of silicified wood varies quite a lot and some types of silicified sediments can be misidentified as fossil specimens. Other rocks that are not fossils at all can also appear to resemble fossil wood due to fabrics developed by shearing. An example of this is shown in Figure 41. The only sure way to determine if the specimen is fossilized wood is to be able to see features such as knots where branches were or individual growth rings.

Figure 41: An example of a large piece of fieldstone that resembles fossil wood but is in fact a piece of Precambrian age Missi conglomerate from the Flin Flon Manitoba area which has been metamorphosed, sheared and flattened.

4.3.2: Mammoth teeth

Although this may seem to be an unusual fossil to be found in Saskatchewan, a surprising number of mammoth molar teeth have been found in the province. There are several reasons for this: (a) like all teeth they are composed of very resistant enamel that is harder to destroy than bone is, (b) they are fairly large and robust and are easily seen, and (c) they were fairly common in the last glacial period and deposits of this age cover most of the surface of the province. A good example of a mammoth molar tooth is shown in Figure 42 that shows its major features.

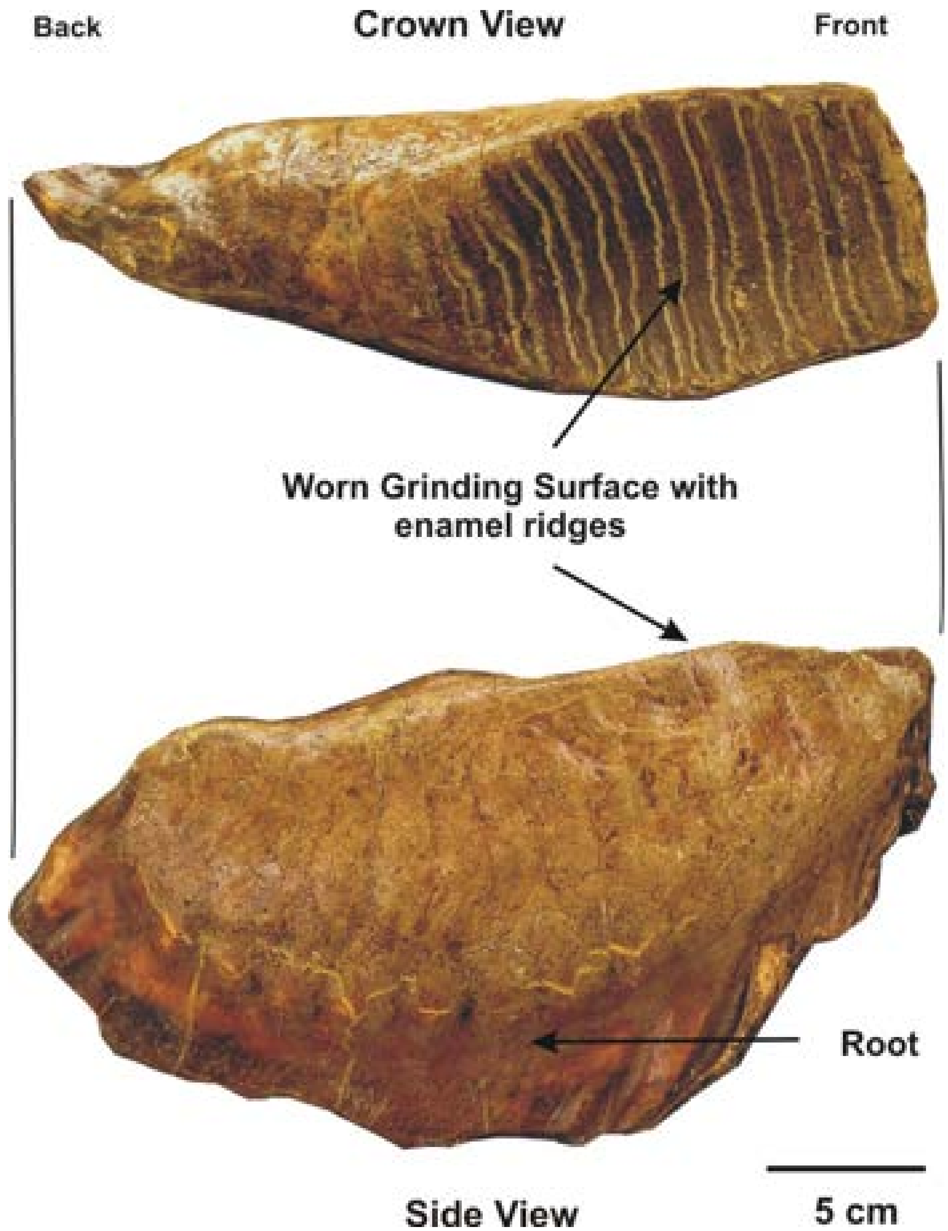

Figure 42: An example of a mammoth molar tooth found in the Pleistocene age glacial sand and gravel deposits of Saskatchewan. Note the scale indicating the size of the specimen.

5.0. SEEKING ADDITIONAL INFORMATION

If this guide does not enable the user to satisfactorily determine the identification of a specimen there are other avenues to get furthur help. The following locations are some of the suggested sources.

Several government and university departments can be contacted as these are public institutions. Within the province of Saskatchewan these include the provincial museum (Royal Saskatchewan Museum), the Saskatchewan Geological Survey, and the geology departments of the University of Saskatchewan in Saskatoon and the University of Regina in Regina. It is advised to go to these institutions web site first to obtain contact information and determine which department to contact. The author would recommend going to the provincal museum first.

Additional sources to contact would include the Saskatchewan Archaeological Society office in Saskatoon, especially if the object in question is thought to be a man made artifact. If the above sources are unable to help they will usually direct you to someone who will.

Identifications can usually be made without having to bring the object to the individual making it if good quality photos are available. If photos of an object are being used it is important to remember to use a scale in the pictures and make them as high a resolution as possible. Several photos from different sides of the object are also useful.

It is advised that non public institutions such as mining companies or private consulting companies are not approached for information.

For further information on Saskatchewan's prehistory and related subjects the following publications are recommended. Some of these may now be out of print.

- Geological History of Saskatchewan (Royal Saskatchewan Museum Publication).

- Concretions and some other Sedimentary Structures (Royal Saskatchewan Museum Publication).

- Geology and Mineral Resources of Saskatchewan (Saskatchewan Energy and Mines Miscellaneous Report 94-6).

- Geological Highway Map of Saskatchewan (Saskatchewan Geological Society Special Publication Number 15).

Additional information on the rock and fossil types discussed in this guide is readily available by Internet search.

6.0. OTHER PUBLICATIONS BY THE AUTHOR

- *Common Fieldstone Fossils of Saskatchewan, 4th Edition*. This guide is a shorter version of this document and does not include the section on common rock specimens found in the province.

The author is working on additional publications on Saskatchewan rocks and fossils. This present document and the above guide are free public information documents in pdf format that can be downloaded from the internet or can also be found on the Saskatchewan Archaeological Society website.

About The Author

Frank McDougall is a retired mining exploration geologist with an interest in palaeontology and archaeology. He is a Professional Geoscientist with a Life Member status in The Association of Professional Engineers and Geoscientists of Saskatchewan (APEGS). His field experience with various mining companies and the geological survey of Saskatchewan was mainly focused on northern Saskatchewan with some additional work in northern Manitoba and the North West Territories. He has also worked on palaeontological projects for national parks, provincial museums, and companies doing heritage impact assessments.

Frank has been a member of the Saskatchewan Archaeology Society (SAS) for over 40 years and does extensive volunteer work for the society. One of his main focuses is on producing free publications on Saskatchewan geology and palaeontology for public use. He is also a regular contributor to the Societies newsletter, the *Saskatchewan Archaeology Quarterly* under his column *The Palaeocorner*.