A Guide to Fossils

IN THE NORMAN WELLS AREA, NORTHWEST TERRITORIES

Northwest Territories
Resources, Wildlife and Economic Development
Minerals, Oil and Gas Division

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Introduction

Norman Wells, located on the Mackenzie River in the Sahtu Region of the Northwest Territories, is built over a Devonian reef complex and is the centre of a fossil-rich area. The Mackenzie River Valley is the northern extension of the Western Canada Sedimentary Basin. To the east are the Franklin Mountains and then the Canadian Shield, and to the west, the Mackenzie Mountains. In addition to abundant Devonian fossils, fossils from the Precambrian to Cretaceous age have been found along the riverbanks and inland on both sides of the river.

This booklet has been prepared to assist in identifying fossils found in the Norman Wells area.

All of the illustrated fossils are found in the region, and have been photographed in the "as found" state. For each photograph, the magnification is given. If the magnification is x 2, the photo is twice the size of the fossil, if x 0.2, 20% the size of the fossil. Most of the fossils are Middle Devonian in age (Eifelian and Givetian, 391 to 370 million years ago) with a few Upper Devonian (Frasnian, 370 to 364 million years ago) representatives (see diagram on the next page).

Most of us are comfortable with common names for plants and animals and wonder why Latin and Greek names are necessary. A system of scientific names and hierarchical classification published in 1753 by the Swedish scientist Linnaeus is still in use today. Scientific names are universal, and understood around the world. The basic unit of classification is the species, often defined as a group of organisms that can interbreed. Related species belong to a genus that in turn fits into increasingly broad categories of Family, Order, Class and Phylum. The name of a species consists of

two words, the first the name of the genus and the second, an adjective, describing the particular species belonging to the genus. For example, *Canis lupus* is the species name for wolf and *Canis latrans* for coyote, both belonging to the genus *Canis*. By convention, a different typeset is used for the genus and species names. Here italics are used.

In this Guide, the fossils are organized by phylum. Most of the fossils are identified to the genus level. In several instances fossils have been identified to Order or Family level only.

Information

The Norman Wells Historical Society is a fascinating regional museum, with displays on the history, natural history, geology and fossils of the area. The Museum staff can provide information regarding fossils and fossil localities, and give assistance in planning activities.

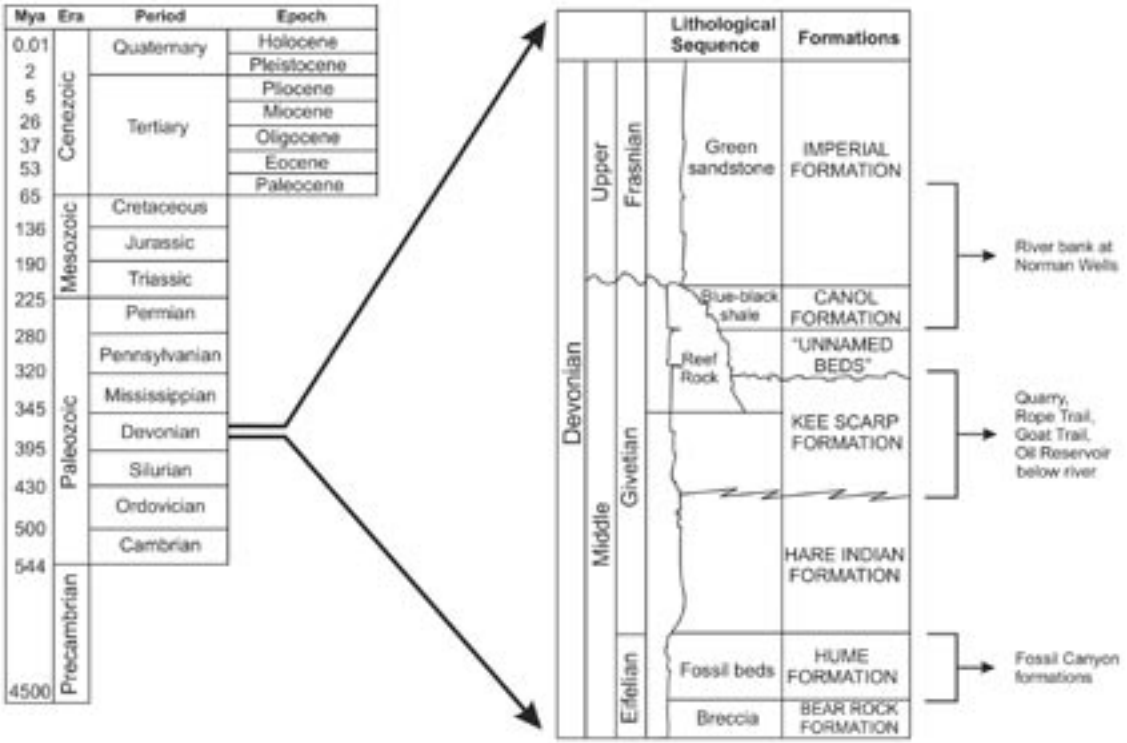
Fossil Collecting

Collect fossils that interest you, but do not take more than you need. Fossils are a non-renewable resource. Keep a field notebook and record the location where each fossil is found.

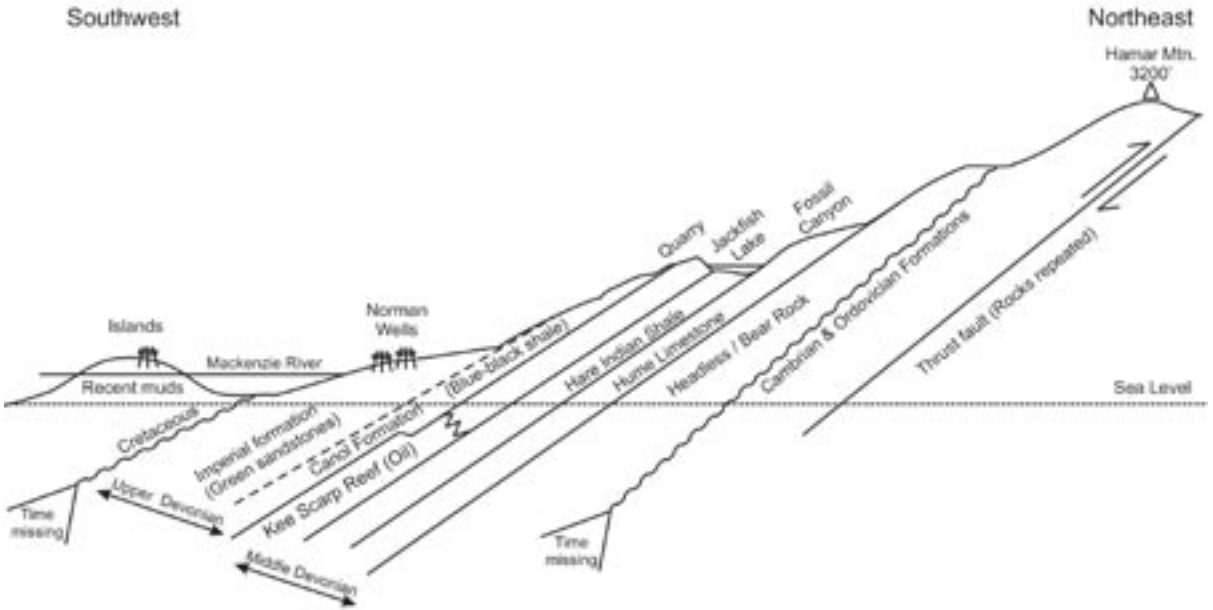
Every year new fossils are exposed and discovered. If you find an unusual fossil, we recommend you have it identified and recorded. Those wishing to take fossils out of Canada must pay attention to the "Regulations Respecting the Export of Cultural Property from Canada".

Paleontology depends on the cooperation of professionals and amateurs, and amateurs have been responsible for many important finds. Good luck!

Geological Time Scale and Formations in the Norman Wells Area



Geological Cross Section – Norman Wells Area



Corals (Phylum Cnidaria)

Corals may be solitary or colonial. They are radially symmetrical. The polyp (the living organism) secretes a calcareous cup in which it lives. Two orders of coral, both now extinct, are found in this area. In addition to corals, this phylum includes jellyfish and sea anemones.

Order Rugosa

Rugose corals may be solitary or colonial. The solitary corals are often called horn corals (Figs. 1, 3 to 5) because of their shape.

Fig. 1. Horn coral (unidentified), x 1.
Fig. 2. *Palaeocyclus*, x 2.1. A discoid solitary coral.
Fig. 3. *Macgeea*, three-quarter view, x 1.3.
Fig. 4. *Grypophyllum*, x 0.82.
Fig. 5. *Heliophyllum*, a) top view, x 0.53;
b) three-quarter view, x 0.51.

Note: The radiating lines seen in the calyx (e.g. Fig. 5a) are structural elements called septa. Horn corals lived in a soft-substrate environment and were not anchored to the substrate. Evidence suggests that in life, the horn would lie on its side, half sunk in the soft sediment, with the opening where the polyp lived, above the sediment surface.

Rugose Corals (Horn Corals)

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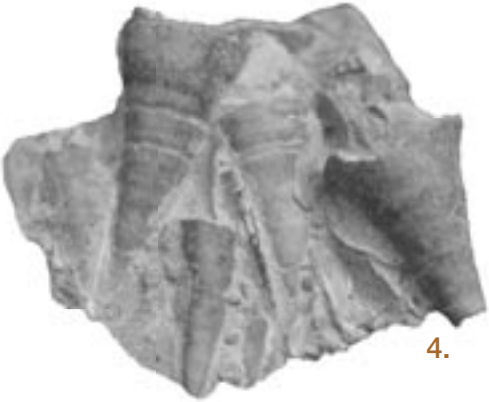
2.

3.



4.

5a.

5b.

Rugose Corals

Fig. 6. *Thamnophyllum*, x 0.5.
Fig. 7. *Disphyllum*, x 0.3. This is a large clump of individual corallites.

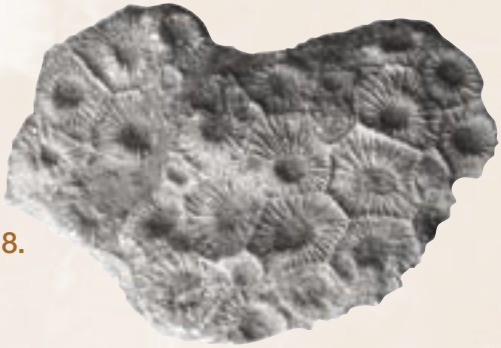
Colonial Rugose Corals

Fig. 8. *Hexagonaria*, x 0.8.
Fig. 9. *Billingsastrea*, a) x 0.8; b) detail x 1.2.
Fig. 10. *Radiastrea*, a) x 1; b) detail, x 3.

6.

7.

Colonial Rugose Corals



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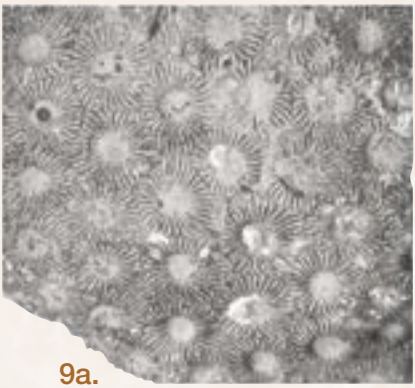


9a.

9b.

10a.

10b.

Tabulate Corals

Order Tabulata

The name tabulate refers to the tabulae, horizontal elements visible in longitudinal section. All tabulate corals are colonial.

Favosites (Figs. 11, 12), in its many forms, is the most common tabulate coral found in this area. It is often called honeycomb coral because of the honeycomb appearance of the corallites. The overall structure is highly variable in appearance.

Fig. 11. *Favosites*, a) whole specimen, x 0.6;
b) detail, x 1.5.

Fig. 12. *Favosites*, a) large mound, x 0.25;
b) base of mound, x 0.25.

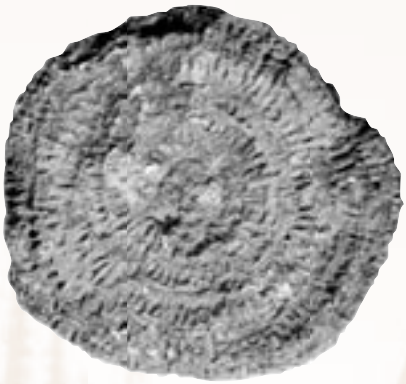
Fig. 13. *Coenites*, x 2.8.

11a.

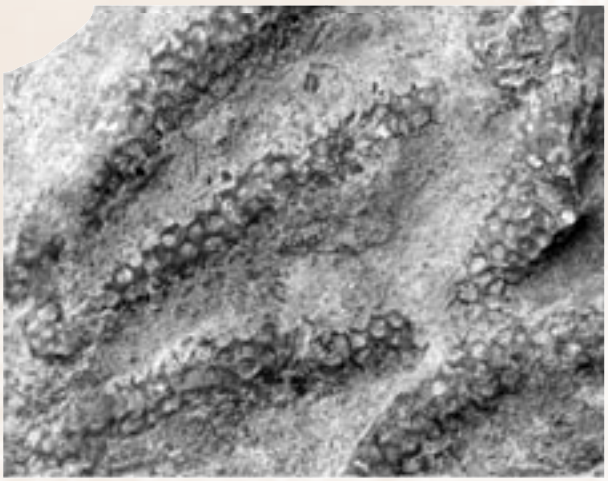
11b.

Tabulate Corals

12a.



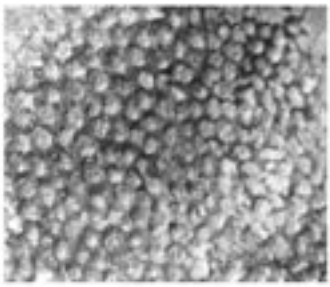
12b.



13.

Tabulate Corals

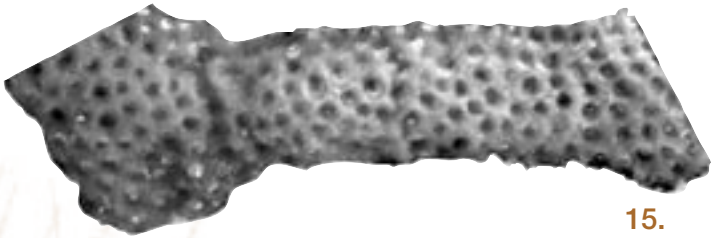
Fig. 14. *Alveolites*, a) plan view, x 1.8; b) detail, x 5.2.
Fig. 15. *Thamnopora*, x 4. This specimen is from the Alexandra Formation, Hay River Area. Similar specimens are found in Norman Wells.
Fig. 16. *Aulopora*, a) network of trumpet shaped corallites, x 1; b) drawing showing detail of corallites, x 5.



14b.

14a.

Tabulate Corals



15.

16a.

16b.

Brachiopods (Phylum Brachiopoda)

A brachiopod has two valves or shells that interlock at the hinge and are joined by muscles. The two valves are usually different in shape, but each valve is bilaterally symmetrical. Brachiopods were abundant and diverse in the Paleozoic Era. Following the Permian extinction, brachiopods were no longer an important component of the marine fauna.

Fig. 17. *Productella* (spiny brachiopods) on slab, x 1.
Fig. 18. *Howellella*, a spiriferid brachiopod, x 1.6.
Fig. 19. An orthid brachiopod, x 4.
Fig. 20. Brachidia or spiralia of an atrypid brachiopod, x 1.2.

17.

Brachiopods

18.

19.

20.

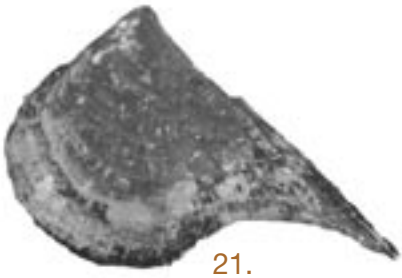
Note: The spiralia (Fig. 20) are internal structures supporting the feeding apparatus or lophophore. Brachiopods are filter feeders, filtering small particles out of the water flowing over the lophophore.

Bivalves (Phylum Mollusca)

Bivalves are so named because they have two valves (shells). The two valves are usually the same shape, but each valve is asymmetrical and the plane of symmetry is along the hinge line. Clams, mussels and scallops are examples of bivalves.

Fig. 21. Pteriid bivalve, x 1. Finding a complete specimen is unusual.

Fig. 22. Pteriid bivalve, x 1. An incomplete specimen such as this is more commonly found.



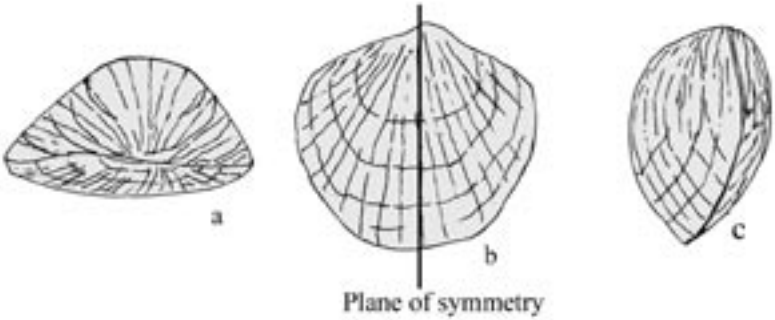
21.

22.

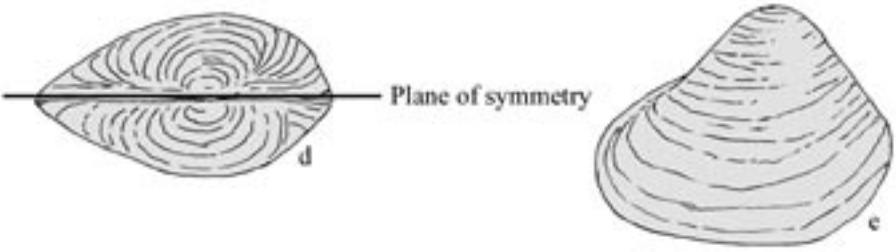
Note: Bivalves have two shells and brachiopods have two shells, but, apart from this similarity, they are entirely different animals and are not related to each other.

Is it a Brachiopod or a Bivalve?

There is an easy way to determine if your fossil is a brachiopod or a bivalve, using the plane of symmetry. This is a general and helpful rule, but there are, as always, exceptions to the rule.



Brachiopod: Each valve is bilaterally symmetrical, as seen in (b). The two valves may be very different in shape (a, c).



Bivalves: The plane of symmetry is between valves as seen in (d). Each valve is asymmetrical (e).

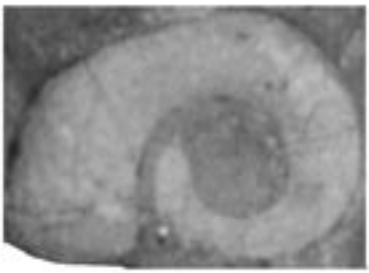
Gastropods (Phylum Mollusca)

The shell is usually, but not always, helically coiled, as in snails. Snails, slugs and abalone are all gastropods.

Fig. 23. *Loxonema*, x 0.8.
Fig. 24. *Buchellia*, x 0.5.
Fig. 25. *Euomphalus*, x 1.1.
Fig. 26. *Euomphalus*, x 0.41.

23.

24.



25.

26.

Cephalopods (Phylum Mollusca)

Cephalopods are large, fast-swimming, carnivorous predators. Modern examples are octopus and squid. Fossil cephalopods found in this region belong to one of two main groups, nautiloids and ammonoids. Cephalopods may be coiled or straight. Suture lines (junctions between chambers) are important clues to identification; those of nautiloids are usually simple, and those of ammonoids more folded and complex. Ammonitic suture types become increasingly complex with time, but in the Devonian, the relatively simple goniatic suture is most common.

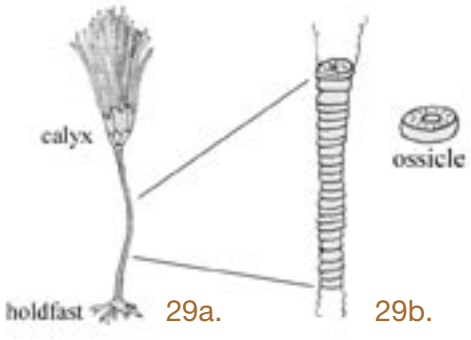
Fig. 27. *Manticoceras*, x 0.6. Note the goniatitic sutures.
Fig. 28. Nautiloid, x 1.

27. 28.

Crinoids (Phylum Echinodermata)

Crinoids, sometimes called "sea lilies", look like plants, but are echinoderms, relatives of starfish and sea urchins. The stem consists of ossicles (small discs), each with a central hole. The base of the stem is attached to the substrate by a holdfast and the top of the stem is connected to a cup or calyx made up of a number of plates. Feathery arms are attached to the calyx. The stem ossicles, usually disarticulated (separated), are the most frequently found crinoidal material. The shape of the hole in the centre of the ossicle varies and possible shapes are a circle, a double circle ("dumb-bell"), a key-hole or a star. Ossicles and the occasional holdfast and calyx have been found in this region.

Fig. 29. Crinoid, a) drawing of whole crinoid; b) crinoid stem (stacked ossicles) and single ossicle (x 1).

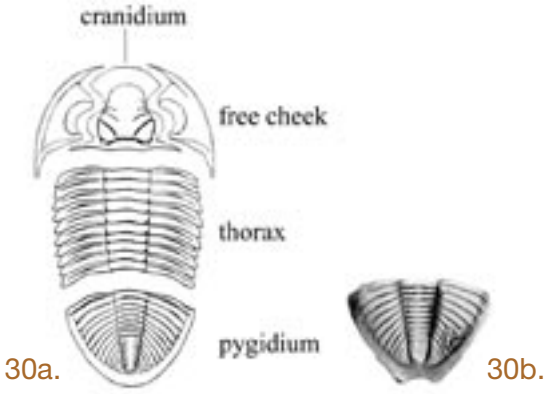


Trilobites (Phylum Arthropoda)

The body is divided into three longitudinal lobes (tri-lobe). There are also three main body parts, the head or cephalon (cranidium plus free cheeks), thorax

and tail or pygidium. As the trilobite grew, it was forced to moult, shedding its exoskeleton and growing a new, larger exoskeleton. Cranidia, free cheeks, thoracic segments and pygidia representing several genera have been found, including the two illustrated here.

Fig. 30. a) *Dechenella,* x 1 (approx.);
b) *Humeia*, pygidium, x 2 (approx.).



30a. 30b.

Sponges (Phylum Porifera)

Sponges are a predominantly marine group, with a few modern freshwater members. Sponges have internal hard parts called spicules and these are the most common sponge fossils known, but occasionally solid forms and impressions of soft parts are found.

Fig. 31. Sphaerospongia, x. 0.66. This is a mould of the sponge.

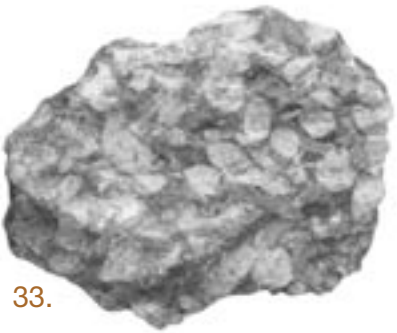
31.

Stromatoporoids (Phylum Porifera)

Stromatoporoids are a problematic group, meaning it is a group difficult to categorize. They were long thought to be related to the corals, but now are considered to be more closely related to sponges. Stromatoporoids have a calcareous skeleton with an internal structure consisting of pillars and laminae. They are reef-building organisms, widely distributed from the Ordovician to Devonian (490 to 354 million years ago) and becoming less common after that.

Fig. 32. Stromatoporoid framestone containing *Stachyodes* and other stromatoporoids, x 0.7.
Fig. 33. *Amphipora*, a small branching stromatoporoid, x 1.
Fig. 34. Cross section of domal stromatoporoid, x 0.7.
Fig. 35. Plan view of bulbous stromatoporoid, x 0.22.
Fig. 36. Basal surface of a stromatoporoid, x 0.33 (approx.).
Fig. 37. Upper surface of stromatoporoid, a) mamelons (small mounds), x 0.9; b) detail, showing astrorhizae (radiating grooves) on mamelons, x 1.3.

32.



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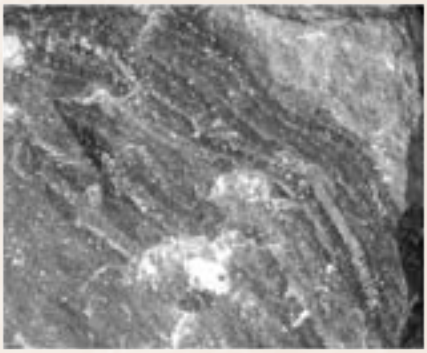
Stromatoporoids



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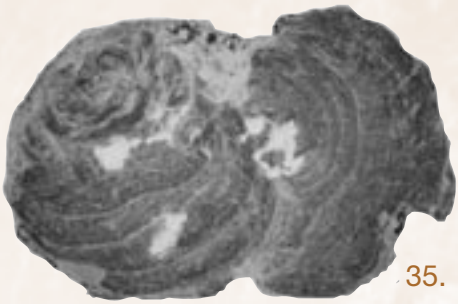

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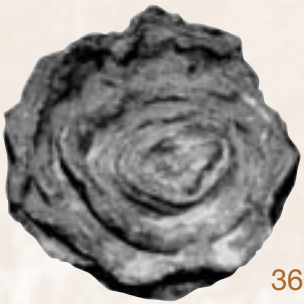

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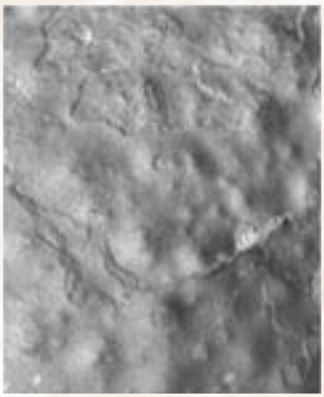
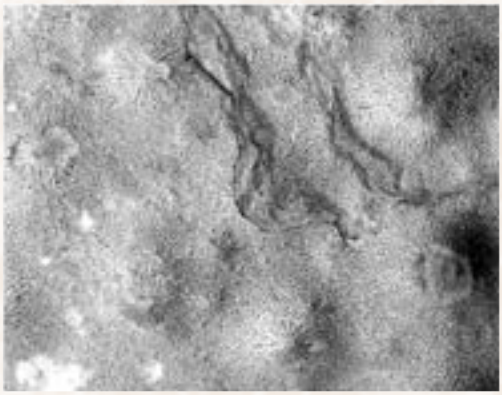


37a.



37b.

Trace Fossils (Ichnotaxa)

Trace fossils are just that, traces left behind by organisms going about their daily business. A modern example would be footprints of birds or burrows of clams in sand. Traces represent behaviour such as feeding, resting, moving about or burrowing. Often the organism making the trace is unknown, but some possibilities are worms, brachiopods or arthropods. The different types of traces have been given names that are treated as genus and species names. These names are totally unrelated to the animal that made the trace. Trace fossils are useful in identifying paleoenvironments since certain traces are often associated with each other, and with a given environment such as beach, shallow water or deeper water. The study of trace fossils is called ichnology.

Fig. 38. Feeding traces, x 0.05.

Fig. 39. *Nereites*, or a related ichnotaxon, a grazing trace x 0.31.

Fig. 40. a) burrows, x 0.25. Note the burrows are crossing over or under, but not through, each other; b) detail from lower left of specimen, *Chondrites*, feeding structures, x 0.7.

Trace Fossils

38.

39.

40b.

40a.

Quarry Tour

The quarry is the source of material used to build the artificial islands in the middle of the Mackenzie River. These islands provide a platform for drilling into the oil reservoir beneath the river.

The Norman Wells oil reservoir is a Devonian reef, part of the Kee Scarp Formation.

The growth of a reef is controlled by sea level rise, water circulation and sedimentation rates. Most reef-building organisms require sunlight so live in relatively shallow water (up to about 100 m deep). Good water circulation ensures a constant supply of nutrients. If there is too much sediment, or if the sea level rises, the organism dies. A major sea level rise drowned the Kee Scarp reefs. The carbonaceous Canol Formation shales are deep-water deposits on top of the reef and these shales are the source of the oil found in the Kee Scarp reservoir.

Mountain building events in the Cretaceous (about 65 million years ago), which formed the Mackenzie and Franklin Mountains, tilted the reef (see geological cross section) and caused fracturing of the layers. The oil migrated through these fractures and other spaces in the rocks to be trapped in the reef structure.

There are two levels to the quarry. The lower quarry is in the Kee Scarp Formation and gives us a window into a reef similar to the reservoir reef. The upper quarry is in the Canol Formation shales.

This is an active quarry. Obey posted signs. Bears are common in the area of the quarry.

Typical Fossils of Lower Quarry

The most common fossils in the quarry are stromatoporoids, the major builders of this reef. Stromatoporoids, like corals, take on different shapes depending on whether they lived in a high-energy or low-energy environment. They can form fingers, branching structures, domes and bulbous heads that stand up above the sea floor, and undulating encrustations covering an area on the sea floor. Delicate and branching forms are found in low-energy areas, and massive and platy forms in high-energy environments such as the reef front where the waves hit.

Some of the stromatoporoids found in the quarry are illustrated in Figs. 32 to 37.

Other fossils include large bivalves, crinoids, corals, including horn corals, and tabulate corals such as *Thamnopora*, *Alveolites* and *Coenites.*

Stylolites

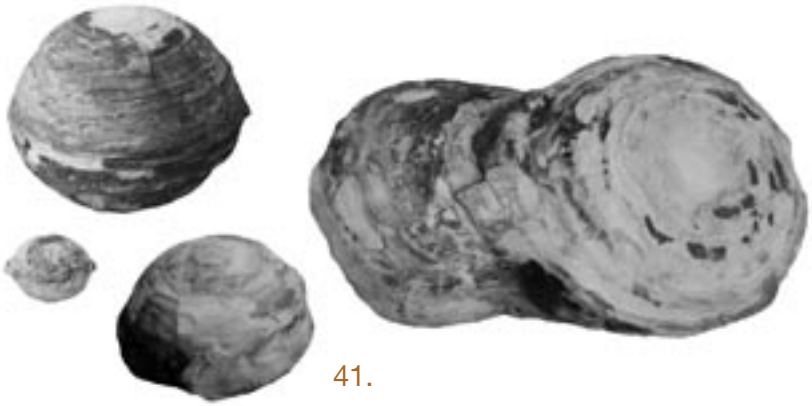
If you see black jagged lines, often quite complex in design, these may be stylolites. Stylolites are not fossils. The presence of stylolites indicates a pressure solution surface. At this surface, calcium carbonate and bitumen (solid and semi-solid hydrocarbons) dissolved under pressure, and then re-precipitated, leaving a dark insoluble residue. There are both horizontal and vertical stylolites in the quarry.

Upper Quarry

The Canol Formation shale overlying the Kee Scarp reef is rich in two categories of interesting material. The first group includes pyrite nodules and concretions of varied shapes, small and large (up to one metre or more in diameter). The second group consists of fossils and/or pseudofossils. Several types of plant-like material have been found. Some is very large and could have grown on nearby shoreline, and, after dying, fallen into the sea where it sank and was preserved. Some of the impressions resemble *Calamites*, an ancient relative of the modern, and very much smaller, horsetail. The material has not yet been identified.

Fig. 41. Concretions ranging in size from 6 to 30 cm (approx).

Figs. 42. (x 0.2), 43. (x 0.2), 44. (x 0.2) and 45. (x 0.6). Upper Quarry fossils or pseudo-fossils.



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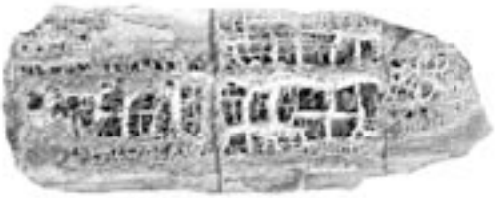

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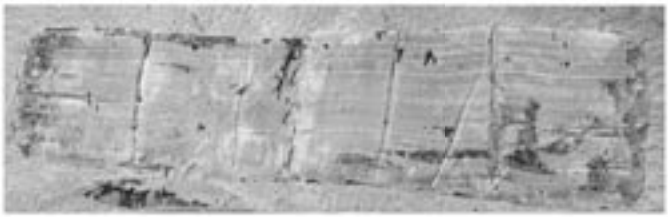

45.

Acknowledgements

The Great Norman Wells Fossil Hunt became an organized event in 1999. Residents and visitors from many parts of Canada and the world can share their common interest in paleontology and the great outdoors. The Town of Norman Wells and Resources, Wildlife and Economic Development (RWED), Government of the Northwest Territories provided support to initiate and operate the community event. Numerous local businesses provided sponsorship and prizes, and many individuals provided a warm northern welcome.

Many thanks to the late Bruce Moffett, Doris Rose Smith, Alice and Jamie Chambers, Liz Danielson, Town Economic Development Officers, Walt Humphries, Diane Baldwin, and visiting paleontologists, including Stacey Gibb, Terry Poulton and Margaret Campbell for their hard work and contributions to this event.

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Photo and Figure Credits

J.W. Campbell: Fig. 1-11, 13-15, 17-22, 27, 28, 31-34, 37; sketches.
W.J. Humphries: Fig. 7, 12b, 23-26, 35, 36, 38, 41.
M.J. Campbell: Fig. 12a, 39, 40, 42-45.
C.R. Stelck: Fig. 30b.
L. M. Campbell: Geological time scale and cross section.
S. Smith: Fig. 16, a portion of plate 28, Fig. 8 in Upper Devonian Corals of the Mackenzie River Region, Canada. Geological Society of America, Special Paper 59.
Fig. 29a: Drawing adapted from Fig. 17 in Harish, Verma M. 1979. Geology and Fossils of the Craigleith Area; Ontario Geological Survey Guidebook No. 7.
Fig. 30a: Drawing adapted from Fig. 297,1 in The Treatise of Invertebrate Paleontology, Vol. O, 1959.

Fossil Notes:

Safety in the Field

1. Wear sturdy footwear.
2. Walk carefully, and only on surfaces and outcrops that appear safe.
3. Do not walk under overhangs.
4. Be aware of people around you, particularly when walking on slopes and in areas of loose rocks, or when using a rock hammer.
5. Do not throw rocks or samples downhill; rocks can bounce in an unpredictable fashion.
6. Protect your eyes when using a rock hammer. Rock chips can do considerable damage.

Be prepared for bear and wildlife encounters.

Fossil Notes:

Resources, Wildlife and Economic Development
Minerals, Oil and Gas Division

2003