

Geological Highway Map of Saskatchewan

FOSSIL AND MINERAL COLLECTING

Fossils are irreplaceable and provide unique knowledge about the past. Fragile and easily damaged, many fossils should be collected only by someone with specialized training. All fossils, including vertebrates, invertebrate macro-fossils and plants, are now protected under the province's **Heritage Property Act**. The Act states that all fossils are the property of the Crown, collection requires a permit issued by the Department of Municipal Affairs and Housing. The intent of the legislation is to discourage uncontrolled collecting and preserve the fossils and the knowledge they provide for everyone. If you discover a fossil, note its location, photograph it if possible, and report the discovery to either the **Royal Saskatchewan Museum** in Regina, the **T. rex Discovery Centre** in Estevan or the geology departments at one of the universities.

No such restrictions apply to collecting mineral specimens. However, for specimens of outstanding natural beauty or rarity, the same common sense rules should be applied. It is far better to seek professional assistance and advice, than to damage such specimens by trying to remove them without the necessary specialized knowledge, tools and equipment.

Geological Legend (ages in million years ago, mya)

PRECAMBRIAN PALEOPROTEROZOIC (2500-1600 mya) (variably metamorphosed)

Pgt Granitic gneisses and granite intrusions (1920-1770 mya)

Ano Anorthositic, intermediate to ultramafic gneisses and intrusions (1900-1800 mya)

Psd Metasedimentary rocks (2080-1830 mya)

Pvc Metavolcanic rocks (1920-1870 mya)

ARCHAEO (~4500-2500 mya) & Paleoproterozoic (variably metamorphosed)

Agd Granitic gneisses and granite intrusions (3200-2500 mya)

Asd Metasedimentary rocks (largely >2500 mya)

UNDATED

2 Mylonite

Symbols

Ridged moraine (ridges perpendicular to ice flow)

Striae (ice-flow direction indicators)

Drumlin/inflection

Esker

Beach ridge (strandline)

Qm Moraine deposits

Qmh Stagnant ice moraine; undulating to hummocky

Qmr Ridged moraine

GLACIAL RIVER (and RIVER) DEPOSITS: Gravel, sand and silt transported and deposited by glacial meltwater

Qld Outwash/proglacial

Qh Ice-contact

GLACIAL LAKE DEPOSITS: Sand, silt and clay

Qlp Plain

Qld Delta

GLACIAL DEPOSITS: Till consisting of unsorted mixtures of boulders, gravel, sand, silt and clay; deposited from glacial ice during periods of advance, retreat and stagnation

Qm Moraine deposits

Qmh Stagnant ice moraine; undulating to hummocky

Qmr Ridged moraine

Tertiary

Ter Conglomerate, sandstone, minor siltstone

MESOZOIC (251-65 mya)

Mss Shale and sandstone, minor limestone

PALEOZOIC (544-251 mya)

Pal Dolostone, minor mudstone, shale

NOT ALL WATERS REACH THE SEA

4 Bars on the South Saskatchewan River

While many of Saskatchewan's larger rivers (e.g. the South Saskatchewan River) eventually leave the province and drain into the oceans, there are some areas of the province where streams flow into lakes from which the water exits only through evaporation. This drainage system is called internal drainage. The Old Wives Lake internal drainage basin is one of the larger in North America.

Internal drainage allows salts to build up in some of our lake waters creating saline lakes, which can be identified by the unique smell and white salt deposits that often ring the shoreline.

Antimonite

Modern streams can deposit gravel, sand and mud collectively called **alluvium**. They also cut into underlying glacial deposits and Cretaceous strata, which underlie much of southern Saskatchewan. Ammonites, fossil relatives of the octopus, are commonly found in the marine Cretaceous sedimentary rocks.

Sodium Sulphate Lake

Sodium sulphate is mined from saline lakes for use in powdered detergents and in the manufacture of glass, paper and textiles. The large pile of white "salt" at Chaplin is stockpiled sodium sulphate (mirabilite). These unusual mineral deposits have accumulated since the last glaciation and are still being formed today.

Sodium Sulphate Plant (Chaplin)

Types of parabolic dunes with blowouts characterize most of the dunes in Saskatchewan. This dune is still alive but most are now stabilized by vegetation and are more difficult to recognize.

Qed Parabolic Sand Dune

ON TOP OF OUR WORLD

The Cypress Hills, featuring the highest point (1466 m) in Canada between Labrador and the Rocky Mountains, preserve a record of the seas, rivers and swamps, which covered southwestern Saskatchewan from about 70 to 16 million years ago. The uppermost layer of rock provided protection from erosion, resulting in preservation of the Cypress Hills as a dissected plateau. The highest part of the plateau near the Alberta/Saskatchewan boundary is one of the few places in Saskatchewan untouched by the glaciers that covered the area more than 17,000 years ago.

Landslide

Landslides can occur anywhere there is a slope and are apparent on the steep side walls of many meltwater channel valleys in Saskatchewan. This older slide, recognized by the large blocks that slid to the base of the slope, is one of hundreds that have occurred along slopes in the Cypress Hills since the glaciers retreated.

Conglomerate Cliffs

Conglomerate Cliffs in the West Block of the Park are composed of pebbles and cobbles which were eroded from uplifted highlands in Montana, deposited by northward-flowing rivers approximately 44 to 25 million years ago and then cemented together by calcium carbonate precipitated from groundwater.

OIL AND GAS

Drilling Rig

Pump Jack

Vertical Well

Horizontal Well

When a well is drilled, the space created by the drill bit (well bore) acts as a conduit for the hydrocarbons to get to the surface. Gas is a very light hydrocarbon and will easily flow to the surface once the well is drilled. Oil is a heavier, more viscous hydrocarbon. The oil trapped underground in Saskatchewan is typically not under enough pressure to flow to the surface on its own so pump jacks are required to bring it to the surface.

Drilling rigs are a common sight throughout southern and western Saskatchewan. These rigs have drilled oil and gas wells in the province from depths as little as 200 m to over three kilometres. Drilling a horizontal well through oil-bearing rocks opens up more reservoir, a process which is more efficient at bringing hydrocarbons from the subsurface up to the surface.

The end of the age of the dinosaurs 65 million years ago coincides approximately with the base of a prominent coal seam that is visible along Hwy 37 on the north side of the Frenchman River Valley. The presence of high levels of indium at or near the base of the coal seam (dashed lines) may be evidence of an impact event that is interpreted by some as a causal factor in the extinction of the dinosaurs and various other life forms at the end of the Cretaceous Period.

End of an Era

In 1994, the discovery of the partial skeleton of the meat-eating dinosaur *Tyrannosaurus rex*, nicknamed "Scotty", shown here being excavated, attracted considerable media attention. Although other evidence of Saskatchewan's long and detailed fossil history (e.g. rodent teeth and ancient pollen grains) does not draw much interest from the press, all fossils help in piecing together the province's geological and biological history.

THE COUNTRYSIDE CODE

The best rule is - leave things as you find them! Enjoy the countryside and leave it for others to enjoy after you.

Don't trespass on land or property that is posted with "NO TRESPASSING" or similar warning signs. Respect other peoples' property as you would your own.

Heed all notices that warn of natural or man-made hazards.

Keep away from overhanging cliffs or river banks. If you are crossing land that is fenced, use the gates and close them after you.

Don't leave garbage scattered around. If you're in a park, campground or wayside pull-in, use the bins provided - if not, take your garbage home!

Refrain from defacing natural rock outcrops. Don't damage trees or bushes. Don't trample crops.

DIAMOND ELEVATORS

1 Drill Rig

Port is a Come Diamond (0.43 carats)

Kimberlite

50 km Crust

150 km Mantle

Graphite Diamond

Lithosphere

Asthenosphere

About 100 million years ago, Saskatchewan's diamonds were brought to surface from a depth of >150 km (Earth's upper mantle) as exotic inclusions in a volcanic rock called kimberlite. Today, the diamond-bearing kimberlite deposits are covered by 100 m of glacial till. About 50 diamond-bearing kimberlites have been found since the first discovery at Sturgeon Lake in 1988.

BLOWING IN THE WIND

There are numerous areas in southern Saskatchewan where sand dunes have developed from prevailing winds blowing on sandy materials deposited during the last glaciation. The Great Sand Hills is the largest of these areas.

Types of parabolic dunes with blowouts characterize most of the dunes in Saskatchewan. This dune is still alive but most are now stabilized by vegetation and are more difficult to recognize.

Qed Parabolic Sand Dune

Sodium Sulphate Plant (Chaplin)

Cypress Hills

Fossils from the Cypress Hills include this rhino-like herbivore known as a *Bronthothere*, together with three-toed horses, early members of the dog family, and many others. Saskatchewan fossils document mammal evolution at the time of the extinction of the dinosaurs (65 million years ago) and, from approximately 44 to 14 million years ago, the most complete rock record of this time period in Canada.

Bronthothere

VALLEY OF THE DINOSAURS

Sediments exposed in the Frenchman River Valley were deposited between 60 and 70 million years ago. These deposits record the retreat of the shallow inland sea that once covered much of the province, the end of the dinosaur era, and the coal swamps that followed. The prominent white layer, part of the Whittemud Formation, is a floodplain deposit and is a source of **refractory clays**.

Frenchman River Valley

Whitemud Formation

Triceratops

Triceratops roamed southwestern Saskatchewan 66 to 65 million years ago together with other dinosaurs, such as *Tyrannosaurus rex* and the duck-billed *Edmontosaurus*, and various small reptiles, amphibians and mammals.

Scotty's Teeth

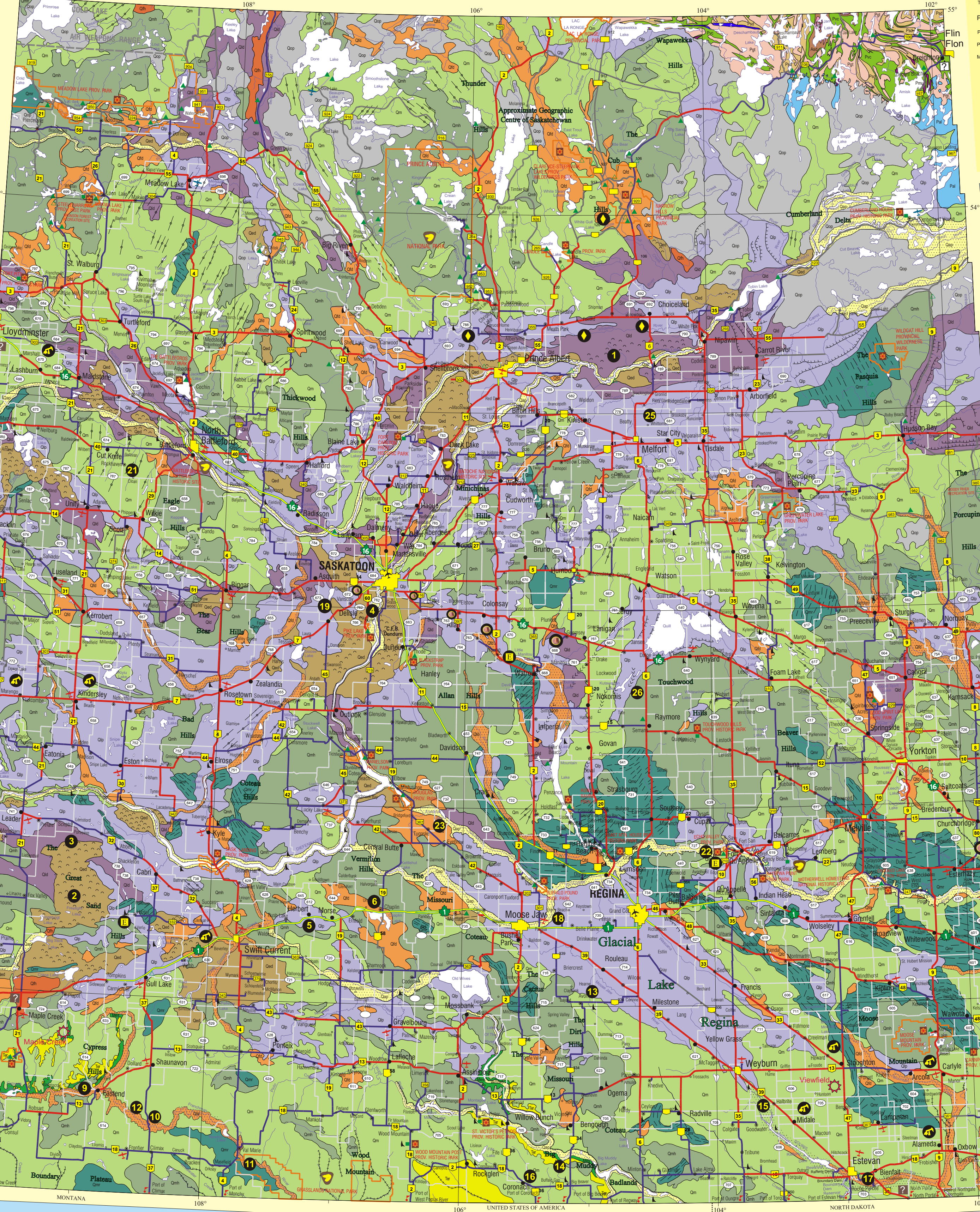
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Our Most Famous Fossil at the Discovery Site

Scotty's teeth are up to 30 cm in length and have serrated edges similar to those on steak knives.

FOSSIL AND MINERAL DISPLAYS

Many fossils, minerals and rocks can be viewed at the Royal Saskatchewan Museum in Regina, the T. rex Discovery Centre in Estevan and the Department of Geological Sciences at the University of Saskatchewan in Saskatoon.



Highway Legend

Route Markers

Provincial Routes

Trans-Canada

Provincial Highways and Other Roads

Provincial Highway

Provincial Road

Municipal Road

Symbols

Provincial Parks

National Parks

National Historic Sites

Regional Parks

Provincial or Federal Parks

Provincial or Federal Proclamations

Major Airport

Public Airport

Northern Provincial Airport

Population Symbols

0 to 249

250 to 499

500 to 999

1,000 to 4,999

Over 5,000

Ferry

Point of Entry

Transit Saskatchewan

Border Community

Visitor Information Centre

AFTER THE ICE...

24 That Strange Hill - Kamsack Drumlin

This hill near Kamsack is a drumlin, an asymmetric hill with the steep end pointing up ice and the long axis oriented parallel to the direction of ice flow. The drumlin is composed of materials deposited from the glacier (see schematic cross section and B).

Schematic Cross Section

Stoss (steep) slope

Ice direction

Lee (gentle) slope

This block diagram illustrates the retreating glacial ice margin and the resulting glacial features, many of which are listed in the legend. They can be identified throughout the map of Saskatchewan by the different colours and symbols.

Ridged Moraine

Erratic

Ice Block

Flute

Drumlin

Moraine

Delta

Sand Dune

Meltwater Channel with undercut

Rockhagen Erratic

A Farmer's Nightmare: Boulders dropped by the retreating glaciers are called erratics. This granitic gneiss erratic at the Big Rock Heritage Site was carried for at least 400 km from the Precambrian Shield (B41), before being deposited by the glacier. It weighs approximately 2500 tonnes and was originally 10 m x 10 m x 10 m in size, but has since broken apart.

Qu'Appelle Valley

The Qu'Appelle Valley is considered to be one of the most spectacular meltwater channels in Canada and like most has a complicated history. These valleys, carved by glacial meltwater, are relatively wide with a flat floor and steep sidewalls (the Qu'Appelle Valley's maximum depth is 120 m, with a floor 1.6 km wide). Later, many of these valleys acted as glacial spillways, draining water from glacial lakes. Today, small lakes and meandering streams occupy many of the valley bottoms.

SALTY SEAS

Potash was precipitated from a very salty sea, which covered southern Saskatchewan nearly 400 million years ago. Potash is commercially recovered in two ways:

- 1) underground mining of the ore by mining machines (e.g. Cory, Rocanville)
- 2) solution mining in which less salty water is pumped down to dissolve the potash and then pumped back to the surface where the potassium chloride is extracted (e.g. IMC, Kalium Belle Plaine)

Cory Potash Mine

Rocanville Potash Mining Machine

Underground mining of potash takes place at depth of about one kilometre below the surface. Most of the mined potash is used as fertilizer.

Belle Plaine Potash Mine (IMC Kalium)

BURIED FORESTS

Trees and other plants, buried in swampy areas 60-65 million years ago, have been transformed by heat and pressure into brown coal (lignite).

Dragline - Estevan Coal Mine

Coal is mined in open pits using draglines in the Estevan and Coronach areas. It is used to generate 75% of Saskatchewan's electrical power.

Split Spherulite Concretion

Halbrite Badlands

Ice-Push Structures

Concretions are hard "balls" composed of mudstone or sandstone that can be found in badlands and along river valleys in southern Saskatchewan. They are formed when chemical-rich fluids precipitated minerals (calcite, siderite or silica) around a nucleus such as a fossil. Many concretions have internal cracks filled with crystals.

Originally laid down as flat-lying river and floodplain deposits, these rocks in the Halbrite Badlands are now contorted into folds and ruptured by faults induced by glacial ice movement.

Popcorn Clays

Hoodoos

Ash, erupting from volcanoes in the Yellowstone area about 70 million years ago, was deposited in southern Saskatchewan. Weathering of this ash has formed **bentonitic** clays, which swell and turn into slippery, slimy mud when wet and, when dry, show a grey crumbly "popcorn" texture. Bentonite can be used in the production of "kitty litter" and drilling mud.

Hummocky Terrain

From the air, small hills and sloughs appear as undulating to hummocky terrain in many areas of the province, although from the road these subtle features can be difficult to see. As the glacier melted, large blocks of ice sometimes became stranded with little or no movement and melted in place; sediments were deposited in some areas forming hills (hummocks) and depressions developed in others forming sloughs (kettles).

Glacial Lake Plain (Ridgedale)

As the glacier retreated, meltwater was often impounded in low-lying areas to form glacial lakes. The meltwater contained large amounts of fine sediments (clay and silt) that were deposited on the bottom of the lake. The lake bottom sediments now form vast, fertile, flat plains throughout the province.

Ice Margin

Unglaciated Terrain

Much of the present topography of Saskatchewan (see B and C) is due to the action of this last glacier. In northern Saskatchewan the ice acted like sandpaper and eroded underlying bedrock surfaces, creating such features as *roche moutonnée* (#53) and *striae* (#54) in the north. The eroded material ranged in size from boulders called *erratics* (#21) to the finest clays and was incorporated in the ice and carried great distances in some cases. Ultimately, this material was deposited by the glacier forming many of the unique surface features illustrated in the block diagrams, such as drumlins (#24 and #57), hummocky moraines (#26), and eskers (#56). Today, many places in southern Saskatchewan are covered by over 300 m of glacial debris (till), which forms the basis for many of the soils that have developed since the retreat of the glaciers. The glacial deposits also contain fossils of animals living in western Canada today (e.g. bison), together with extinct or foreign species such as mammoths, giant ground sloths, camels, and musk oxen. The presence of these animals is evidence of important changes in ecosystems in the recent geological past.

Outwash Plain

This smooth, gently sloping outwash plain was formed by meltwater streams flowing out from the glacial ice margin. The streams deposited multiple layers of gravel, sand, silt and clay.

ACKNOWLEDGEMENTS

The Saskatchewan Geological Society gratefully acknowledges the following organizations and individuals for their support, either financial or material, of the Saskatchewan Geological Highway Map Committee:

For financial support: Saskatchewan Geological Society, Saskatchewan Energy and Mines, Canadian Geological Foundation (award from The Jerome Remick Trust Fund), Saskatchewan Northern Affairs, and Saskatchewan Mining Association Inc.

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Further thanks are due to Saskatchewan Energy and Mines for technical support and to Carol Brown (Copy Editor), Carol Casswell, Jim Christopher, Gordon Dunn, Anita Maxwell, Carmel Noonan, Phil Reeves, Neil Sawley, Mark Simpson, and Michael Waller (Reviewers).

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