SURFICIAL GEOLOGY
COMPILATION MAP SERIES
SG-MB

Surficial geology of Manitoba


Esker along shore of Nejanilini Lake

Esker (unit G) along shore of Pulahook Lake

Manitoba

Explanation of the graphic description of map units

To make this geological map easier to use, images depicting significant features of each map unit are laid out and described below. To the left of each row of images is the corresponding unit name and colour used on the 1:1 000 000 map (overleaf). The 'Image index map' to the right provides the location of the area depicted by each numbered image. The map units are arranged from oldest at the bottom to youngest at the top; however, sediment from adjacent units can be deposited at the same time. For example, beach sand along the shore of glacial Lake Agassiz (unit Ls) was deposited at the same time as silt and clay (unit Lc) in the depths of the lake.

Glacial retreat and Lake Agassiz

Glacial retreat and the evolution of glacial Lake Agassiz, 11 700 to 7700 years ago, are depicted in a group of twelve diagrams to the right. Drainage in Manitoba is to the north and consequently glacial Lake Agassiz persisted until the continental ice sheet had retreated far enough northward to allow drainage into Hudson Bay. Glacial ice-flow patterns are presented on the front of the map (*see* inset map 'Major landforms and ice-flow directions').

Isostatic rebound

The Earth's relatively cool and solid crust (lithosphere) floats on the much hotter and softer interior (mantle), much like icebergs float on the ocean. This concept is called 'isostasy'. Weight on the surface pushes the crust down. The continental ice sheets of the last glaciation put an enormous weight on the Earth's crust and pushed it down significantly. When the glaciers retreated, the crust began to rise, a process known as 'isostatic rebound'. Because the glacial ice was thicker in the north than in the south, isostatic rebound is greater in the north than the south. The crust is still rebounding in Churchill at a rate of one metre per century. Beaches that have formed since the glaciers retreated are tilted, and therefore allow geologists to document the rate of the isostatic rebound. Applying this documented rate of rebound, geologists can estimate where the shore of the Tyrrell Sea and Manitoba's great lakes (lakes Winnipeg, Manitoba and Winnipegosis) would have been in the past (*see* 'Isostatic rebound' diagrams to the right).

The third dimension

In the lower right corner is a block diagram depicting southern Manitoba as viewed from the south. The block has been cut east to west just south of Winnipeg and Brandon. The surface of this perspective view shows the Precambrian shield east of Lake Manitoba; the first prairie level, including the basins of lakes Winnipeg and Manitoba; and the second prairie level, above the prominent Manitoba Escarpment. In cross-section view, the rocks of the Precambrian shield are represented in pink and extend westward beneath younger layered sedimentary rocks. The first prairie level is underlain primarily by Paleozoic carbonate rocks (e.g., limestone and dolomite) and the second prairie level is underlain primarily by younger Mesozoic shale.

The Quaternary sediment layers (above the thick black line) are relatively thin and thicken westward. The Quaternary sediments make up the majority of the units on the surficial geology map (overleaf) but are discontinuous, so that rock units occasionally show through to surface. The sediment layers are colour coded to match the corresponding map units on the surficial geology map (overleaf).

Graphic description of map units

O - organic peat, muck

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2


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4

Wetlands can be subdivided into four categories: fens, bogs, swamps and marshes. Fens and bogs are areas of peat accumulation that can be many metres thick, whereas the peat in swamps and marshes is constantly breaking down and therefore does not accumulate to a significant thickness. A bog tends to have a radial drainage pattern as it is higher than the surrounding fen, whereas a fen has a more uniform flow pattern, with rainwater and groundwater flowing through it (Image 1, source Google Earth, June 2007). Bogs contain a high percentage of sphagnum moss, which is valued for its absorbent properties (Image 2). In areas of permafrost, polygonal frost patterns are commonly found in wetlands (Images 3 and 4). Swamps and marshes are generally found west of Lake Manitoba and the Red River. Due to the insufficient thickness of peat in swamps and marshes, they are generally not represented on this map. Netley and Delta marshes (Image 8) are important exceptions.

Lm - shoreline sand and gravel


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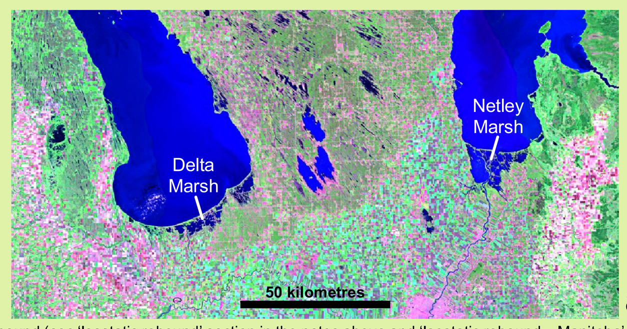

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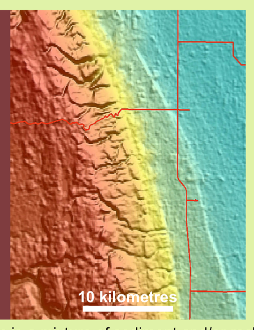
Larger lakes with significant bodies of open water can generate enough wave energy to erode sediment and rock from headlands developing sand beaches along more protected shorelines (Images 5–7). Larger lakes also display the effects of isostatic rebound (see 'Isostatic rebound' section in the notes above and 'Isostatic rebound – Manitoba's great lakes region' to the right). Lakes with northern outlets (rate of rebound increases northward), such as lakes Winnipeg and Manitoba, are expanding southward, thereby drowning the southern shore to form a marsh (Image 8: satellite image of Netley and Delta marshes), whereas lakes with a southern outlet, such as Lake Winnipegosis, have raised beaches, particularly along the north shore. Image 7 shows that the south shore of Lake Winnipeg is retreating southward exposing plant remains that were once in the Netley Marsh.

C - colluvium landslide debris



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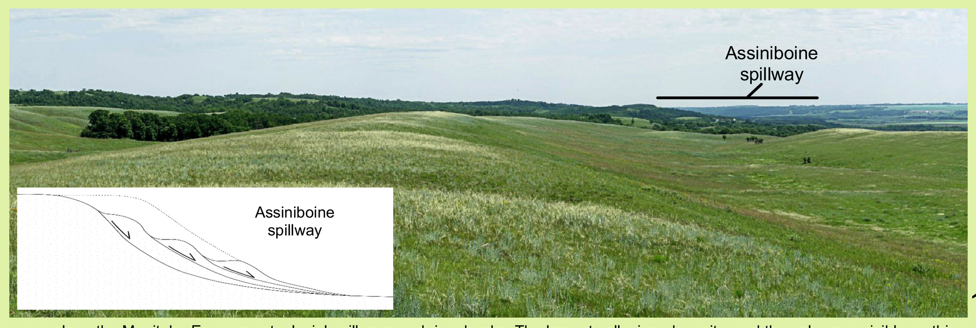

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Colluvium is a mixture of sediment and/or rock that moved by gravity, usually en mass, down a steep slope accumulating at or near the base of the slope. In Manitoba, the primary colluvium occurrences are along the Manitoba Escarpment, glacial spillways and river banks. The largest colluvium deposits, and the only ones visible on this map, are along the Manitoba Escarpment and glacial spillways where sediment and rock slid off wet, slippery shale. Image 9 is a computer-generated image of surface topography along the Manitoba Escarpment. Image 10 depicts the Assiniboine spillway. Spillways are large channels that were cut by glacial drainage. In Image 10, the size of the spillway is compared to the 'tiny' modern Assiniboine River. Image 11 shows large slump blocks that slid down the north wall of the Assiniboine spillway. The inset on Image 11 explains the process.

E - eolian sand


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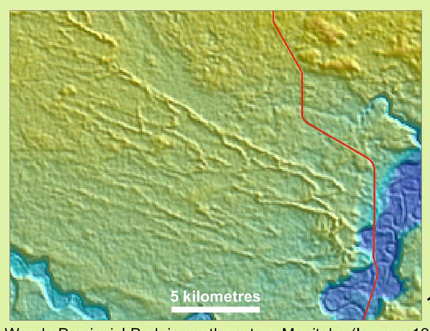

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Sand dunes (Unit E) in Manitoba are largely a result of the reworking by wind of glaciofluvial sand deposits (Unit Gs). Some sand dunes are also associated with modern beaches (Unit Lm). The largest area of dunes is in Spruce Woods Provincial Park in southwestern Manitoba (Images 12–15), where active and stabilized dunes provide a unique environment for specialized flora and fauna (Image 16).

A - alluvial sediments


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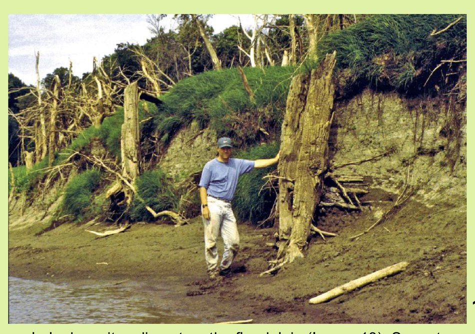
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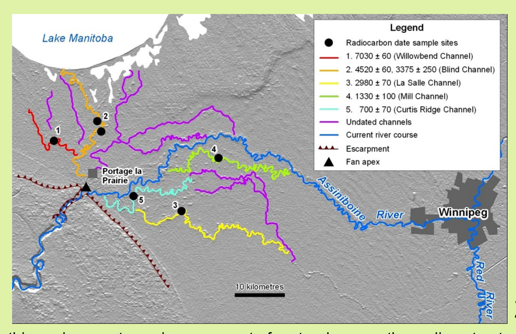

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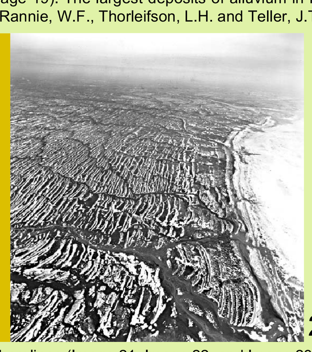
Alluvium is sediment eroded, carried and deposited by river water. Over time, through erosion and deposition, rivers become less straight and more meandering (Image 17). Rivers regularly deposit sediment on the floodplain (Image 18). Some trees have adapted to this environment growing a new set of roots whenever the sediment gets too deep (Image 19). The largest deposits of alluvium in Manitoba are alluvial fans which are deposited below abrupt changes in river slope. Image 20 depicts the Portage la Prairie alluvial fan and indicates that the Assiniboine River initially drained into Lake Manitoba before it established its current course into the Red River (source: Rannie, W.F., Thorleifson, L.H. and Teller, J.T. 1989: Holocene evolution of the Assiniboine River paleochannels and Portage la Prairie alluvial fan; in Late Quaternary Paleohydrology of Canada, ed(s). Church, M., Clague, J.J. and Ritchie, J.C.; Canadian Journal of Earth Sciences, v. 26, no. 9, p. 1834-1841.).

M/Ms - glaciomarine sand, silt, and clay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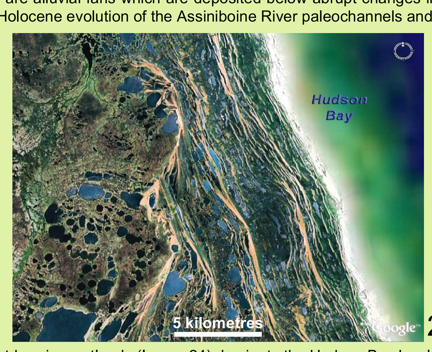

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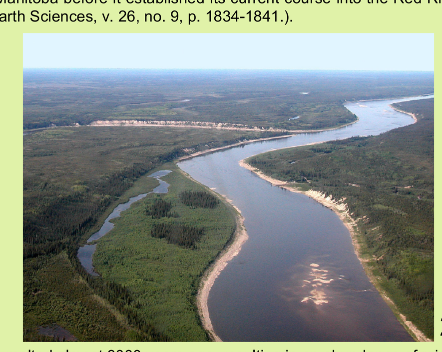
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Raised shorelines (Image 21, Image 22, and Image 23) and peat-bearing wetlands (Image 24) dominate the Hudson Bay Lowland (Unit M/Ms). The Hudson Bay shore area is currently rising at a rate of approximately one metre per century, and has been rising since the glaciers melted almost 8000 years ago, resulting in an abundance of raised shorelines (Unit Ms; see 'Isostatic rebound' section in the notes above and 'Isostatic rebound - Tyrrell Sea' to the right). Primarily because of isostatic rebound, numerous large rivers in the Hudson Bay Lowland have cut deeply into the underlying sediments, exposing glacial till and associated sediments that represent multiple glaciations (Image 25).
Source: Image 21, http://geoinfo.amu.edu.pl/wpk/geos/geo_6/geo_plate_c-24.html [May 2007]; Image 22, Google Earth, June 2007.

Lc/Ls - glaciolacustrine sand, silt, and clay


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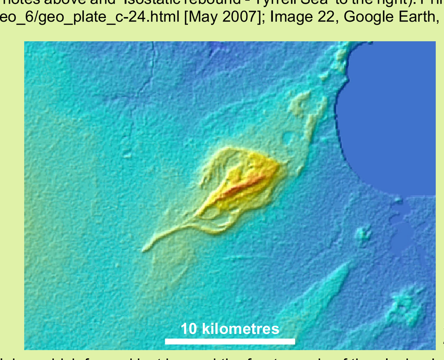

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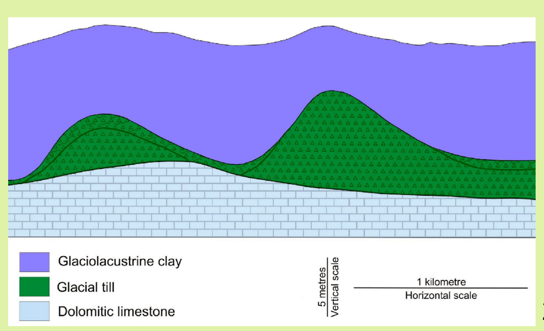

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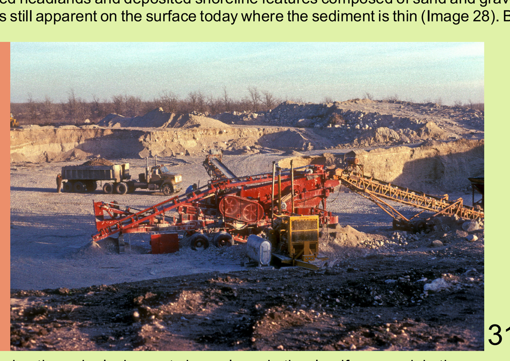
Glaciolacustrine sediments were deposited in proglacial lakes which formed just beyond the front margin of the glacier. Lake Agassiz was the largest proglacial lake in Manitoba. Image 26 depicts rhythmically bedded clay and silt (Unit Lc) overlying glacial till. Lake Agassiz was an extremely large lake, which generated considerable wave energy that eroded headlands and deposited shoreline features composed of sand and gravel in more sheltered areas (Unit Ls). Image 27 is a computer-generated image of a small island rimmed by a beach ridge. Unit Lc represents sediments deposited in the deep water of Lake Agassiz. In places, these sediments (glaciolacustrine clay) draped pre-existing landforms still apparent on the surface today where the sediment is thin (Image 28). Because the north shore of the lake was commonly glacial ice, many icebergs floated in the lake. Where the water was shallow enough, icebergs scoured the floor of the lake (Image 29). Selenite rosettes (crystallized gypsum) are commonly found in Unit Lc (Image 30).

G/Gs - glaciofluvial sand and gravel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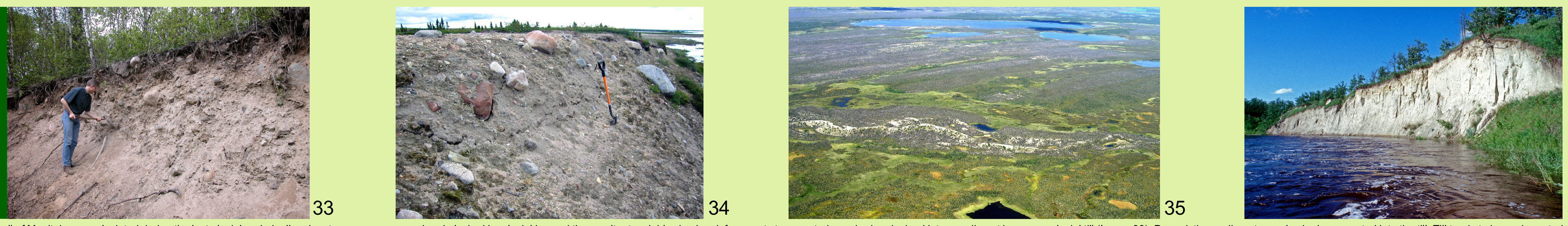
Water flowing through glaciers cut channels and other landforms and, in the process, washed out the fine sediment from glacial till, leaving behind sand and gravel in glaciofluvial deposits, such as eskers (see two images in top left corner). Glaciofluvial sand and gravel is extremely important in the construction industry, providing aggregate for use in the construction of roads and buildings (Image 31). In Image 32, water flowing from left to right underneath a glacier in northern Manitoba cut a small channel and left behind a sand deposit in the bottom of the channel.

Tp/Tc/Tm - glacial till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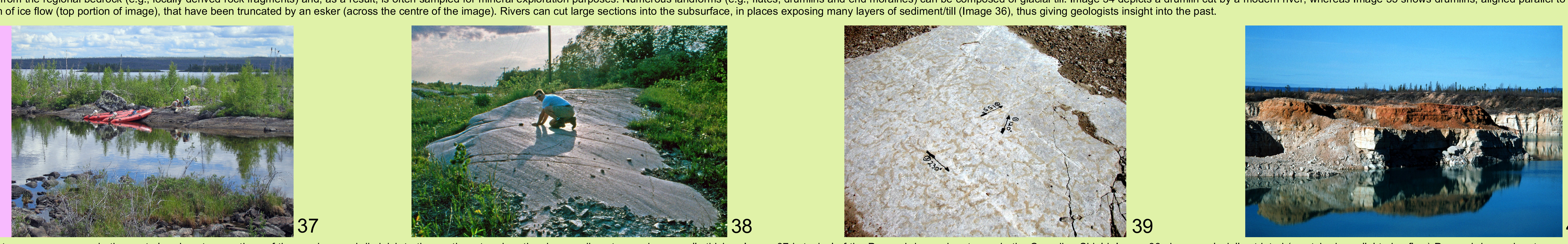
Because all of Manitoba was glaciated during the last glacial period, all rock outcrops were scraped and plucked by glacial ice and the resultant variably sized rock fragments transported, crushed and mixed into a sediment known as glacial till (Image 33). Pre-existing sediment can also be incorporated into the till. Till tends to have characteristics derived from the regional bedrock (e.g., locally derived rock fragments) and, as a result, is often sampled for mineral exploration purposes. Numerous landforms (e.g., flutes, drumlins and end moraines) can be composed of glacial till. Image 34 depicts a drumlin cut by a modern river, whereas Image 35 shows drumlins, aligned parallel to the direction of ice flow (top portion of image), that have been truncated by an esker (across the centre of the image). Rivers can cut large sections into the subsurface, in places exposing many layers of sediment/till (Image 36), thus giving geologists insight into the past.

Rp/Rc/Rm - rock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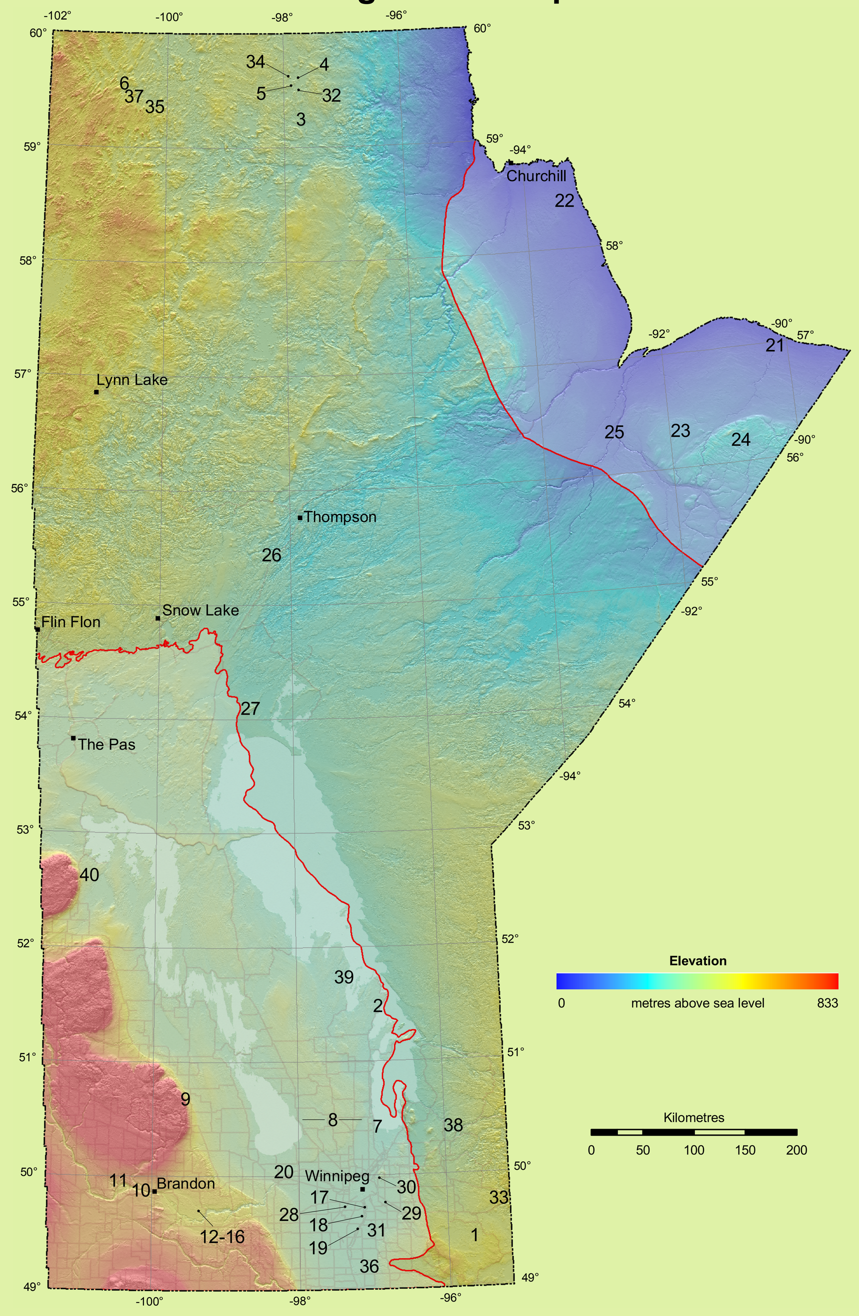
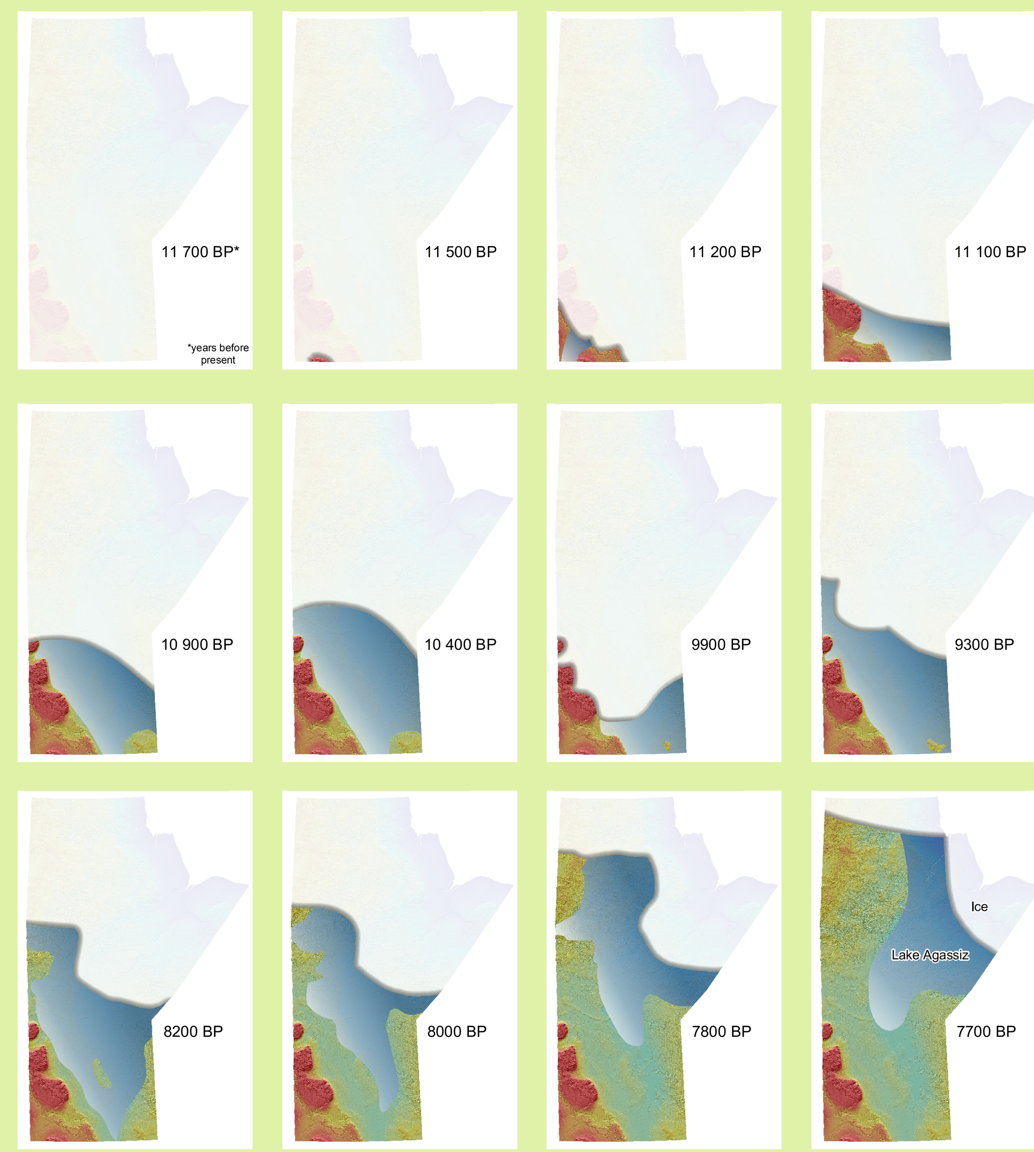
Rock outcrops are common in the central and eastern portions of the province and diminish to the southwest and north, where sediment cover is generally thicker. Image 37 is typical of the Precambrian rock outcrops in the Canadian Shield. Image 38 shows a glacially striated (scratched parallel to ice flow) Precambrian rock outcrop near Lac du Bonnet. The striations are being measured for mineral exploration purposes. Ice flow was from right to left, as is evident from the steeper (plucked) rock face to the left. Image 39 depicts a striated Ordovician rock outcrop near Hecla Island with multiple ice flow directions preserved. Many of Manitoba's mineral resources are found in bedrock and, when close to the surface, can be quarried for minerals or crushed for aggregate (Image 40).

Image index map



Glacial retreat and Lake Agassiz evolution

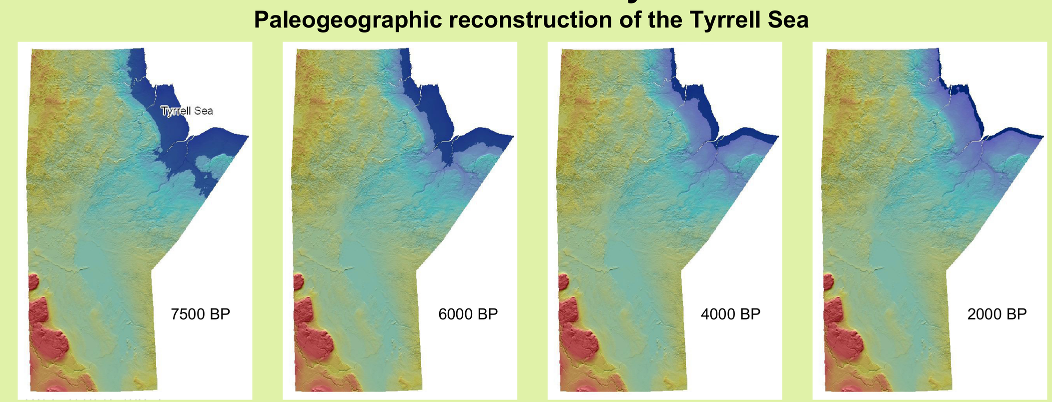
Paleogeographic reconstruction during the last deglaciation



Glacial retreat figures after:
Thorleifson, L.H. 1996: Review of Lake Agassiz history: sedimentology, geomorphology and history of the central Lake Agassiz basin; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Winnipeg, Manitoba, May 27–29, 1996, Field Trip Guidebook B2, p. 56–79.

Isostatic rebound – Tyrrell Sea

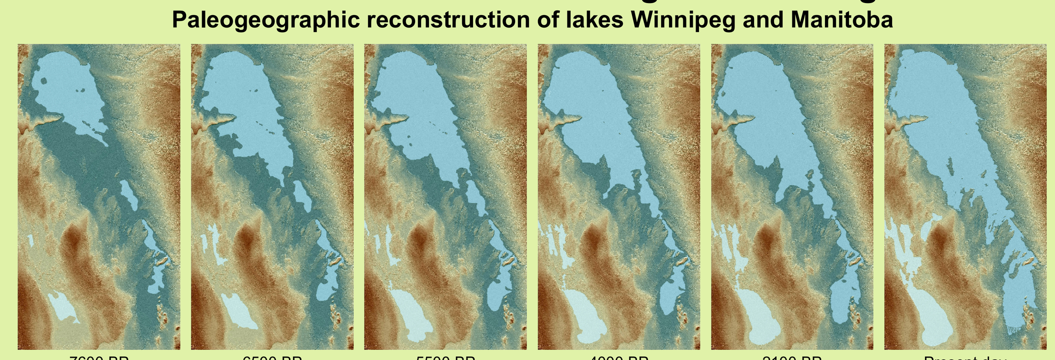
Paleogeographic reconstruction of the Tyrrell Sea



McNeely, R., Nielsen E. and Morlan, R.E. 2000: Manitoba radiocarbon dates: geological radiocarbon dates (section 1), archaeological radiocarbon dates (section II); Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Open File Report OF2000-1, 187 p.

Isostatic rebound – Manitoba's great lakes region

Paleogeographic reconstruction of lakes Winnipeg and Manitoba



Lake Winnipeg figures after:
Matile, G.L.D., Lewis, C.F.M., Nielsen, E., Thorleifson, L.H. and Todd, B.J., 1996: Holocene evolution of the Manitoba great lakes region; Manitoba Energy and Mines, Geological Services, Open File Report OF96-8, 1 sheet.

The third dimension