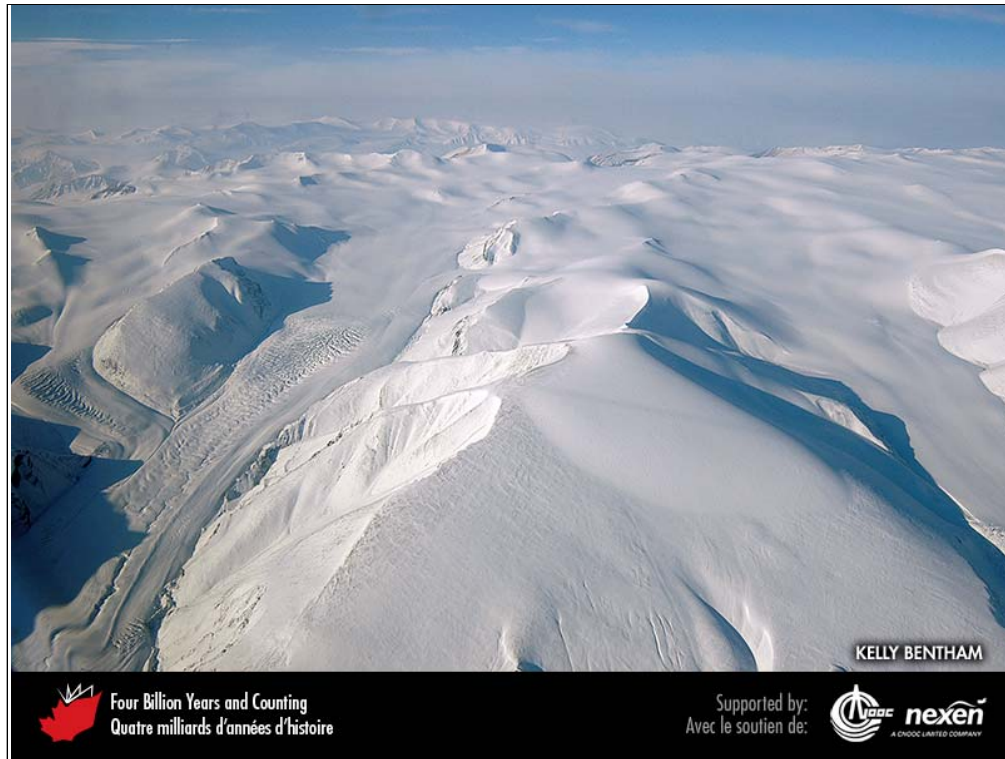


CHAPTER 11

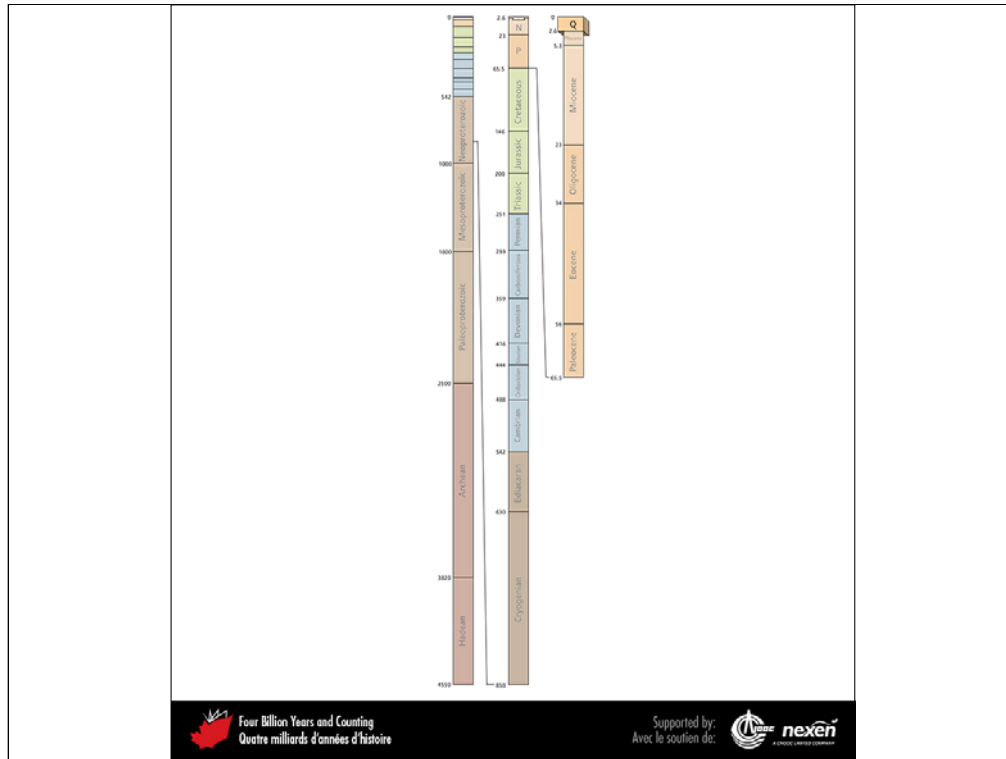
Part 1 of 3

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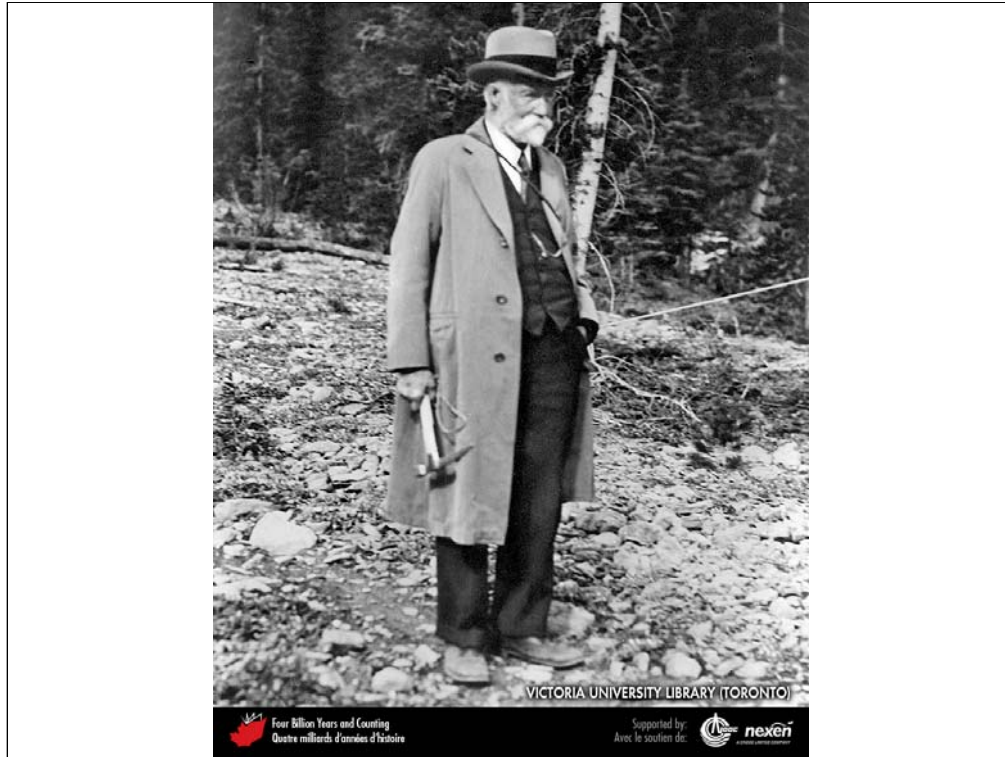
Aerial view of Axel Heiberg Island, Nunavut, an icy scene reminiscent of what much larger areas of Canada would have looked like during the last glaciation. KELLY BENTHAM, FROM THE LORITA (LOMONOSOV RIDGE TEST OF APPURTENANCE) FIELD PROJECT, GEOLOGICAL SURVEY OF CANADA UNCLOS PROGRAM.

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Geological time scale, showing the interval covered in this chapter. Numbers indicate millions of years ago. P = Paleogene (Paleocene to Oligocene), N = Neogene (Miocene and Pliocene), and Q = Quaternary.

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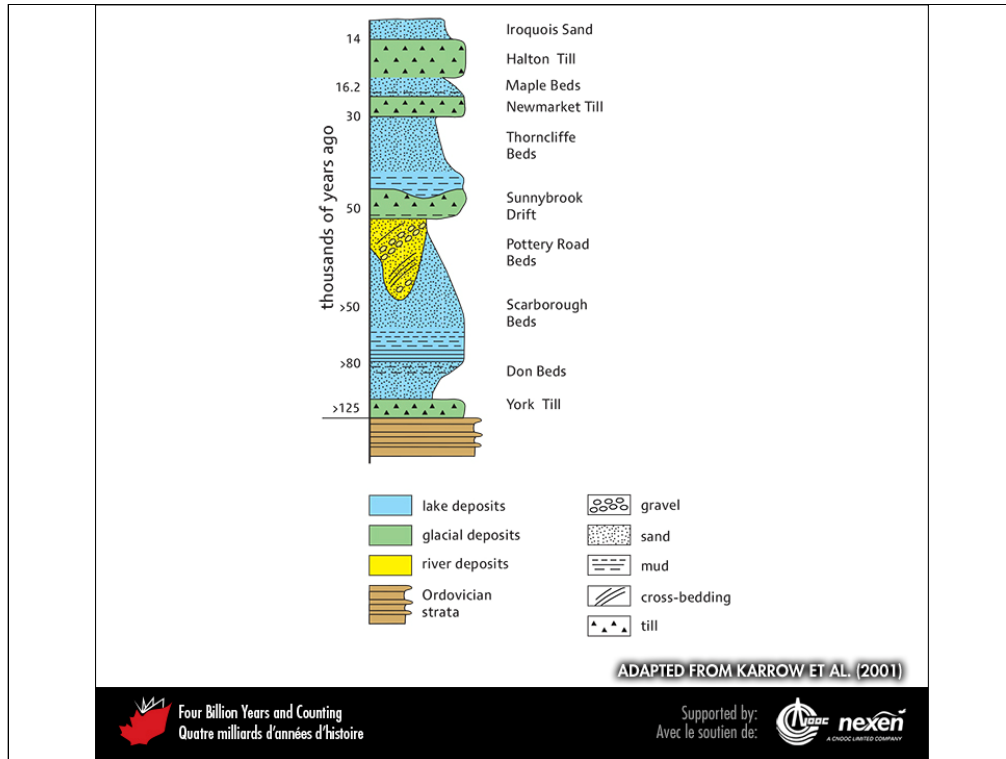
Arthur Coleman—mountaineer, artist, and geologist—in his later years. COURTESY OF VICTORIA UNIVERSITY LIBRARY (TORONTO).

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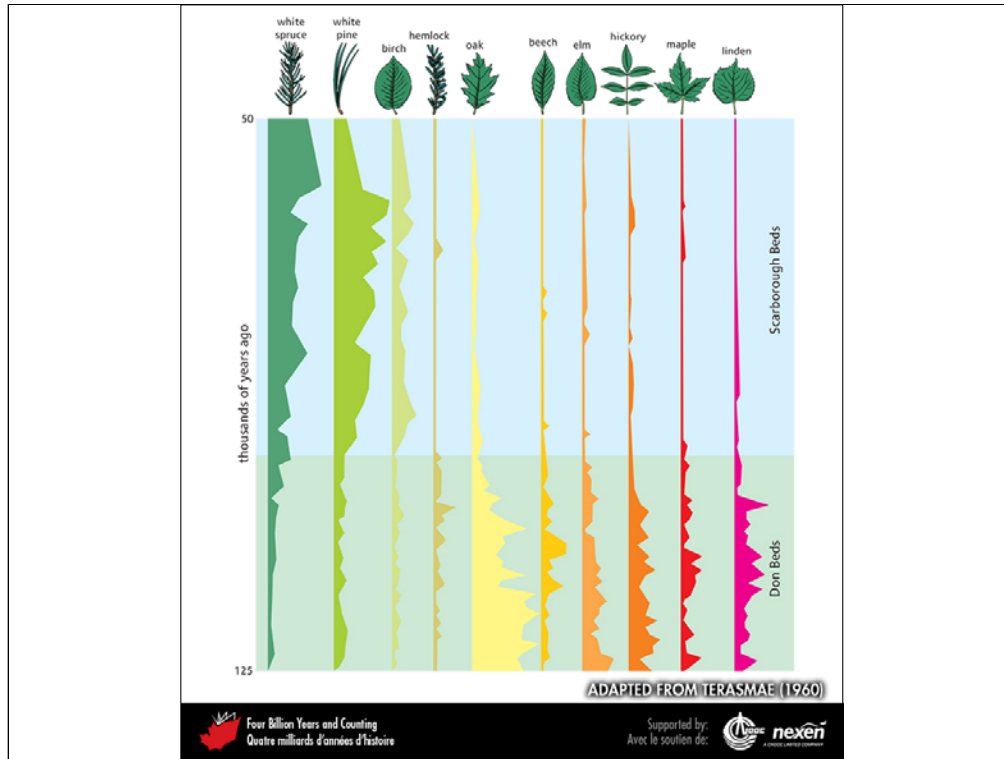
Remains of giant beaver have been found in Quaternary sediments at various locations across Canada, including the Toronto area. For scale, the inset shows an imagined confrontation between a giant beaver, which could be up to 2.5 metres long, and a black bear. *GIANT BEAVER*, COPYRIGHT GOVERNMENT OF YUKON / ARTIST GEORGE "RINALDINO" TEICHMANN, 1997.

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Composite column of the succession of sediments at the Don Valley Brick Works and Scarborough Bluffs, near Toronto, Ontario, and their ages. ADAPTED FROM KARROW ET AL. (2001).

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Pollen assemblages recorded from the Don and Scarborough beds, largely reflecting changing climatic conditions. The coloured graphs represent the proportions of particular trees in the pollen assemblage, the broader the coloured band the greater the proportion. The dominant pollen in the interglacial Don Beds are from deciduous trees (oak to linden on the right side of the figure) that flourished during the last interglaciation, whereas the relative abundance of conifer pollen (spruce and pine) in the Scarborough Beds reflects a cooler climate as the last glaciation began to gain momentum. ADAPTED FROM TERASMAE (1960).

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Crevasses can have concentric and radial patterns, as on this tumbling glacier on Baffin Island, Nunavut. CRYSTAL HUSCROFT.

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Glacial grooves and striations on a rock surface near Clam Harbour Beach, Nova Scotia. The rock surface was scratched and grooved by stones and grit frozen into the bed of the glacier. The grooves show various orientations, evidence for changes in the direction of glacier flow. ROB FENSOME.

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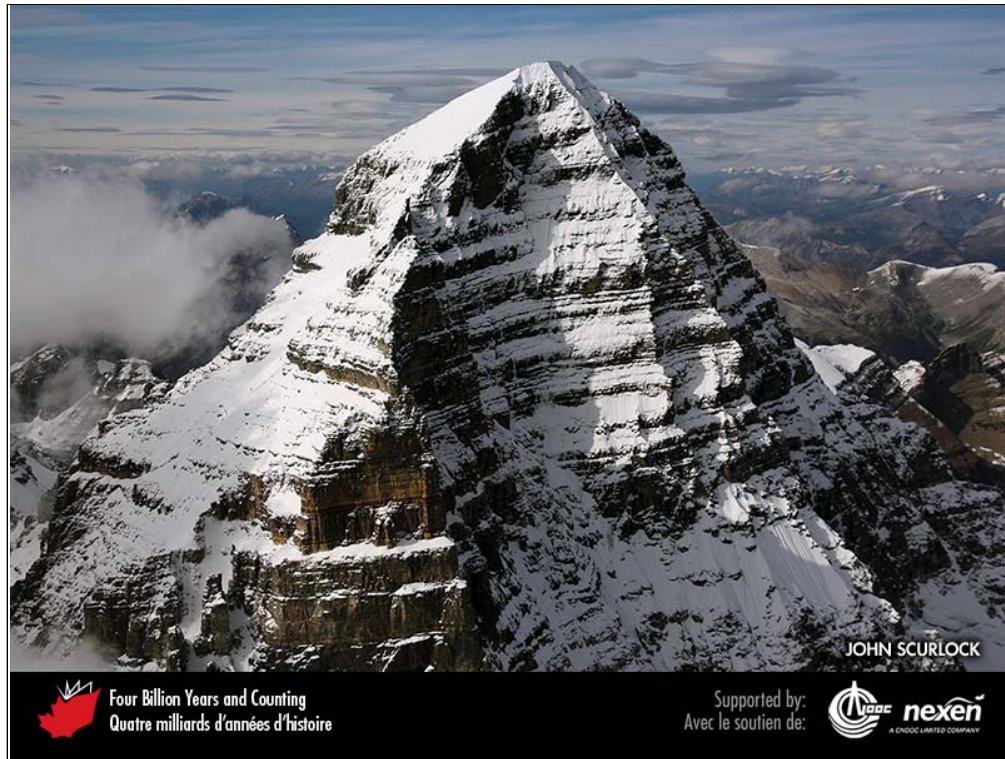
A characteristic feature of a formerly glaciated rocky landscape is a roche moutonnée, a glacially smoothed rocky prominence with a gentler slope on the up-ice side and a steeper slope on the down-ice side. This example, at Prospect, Nova Scotia, occurs in Devonian granite of the South Mountain Batholith. ROB FENSOME.

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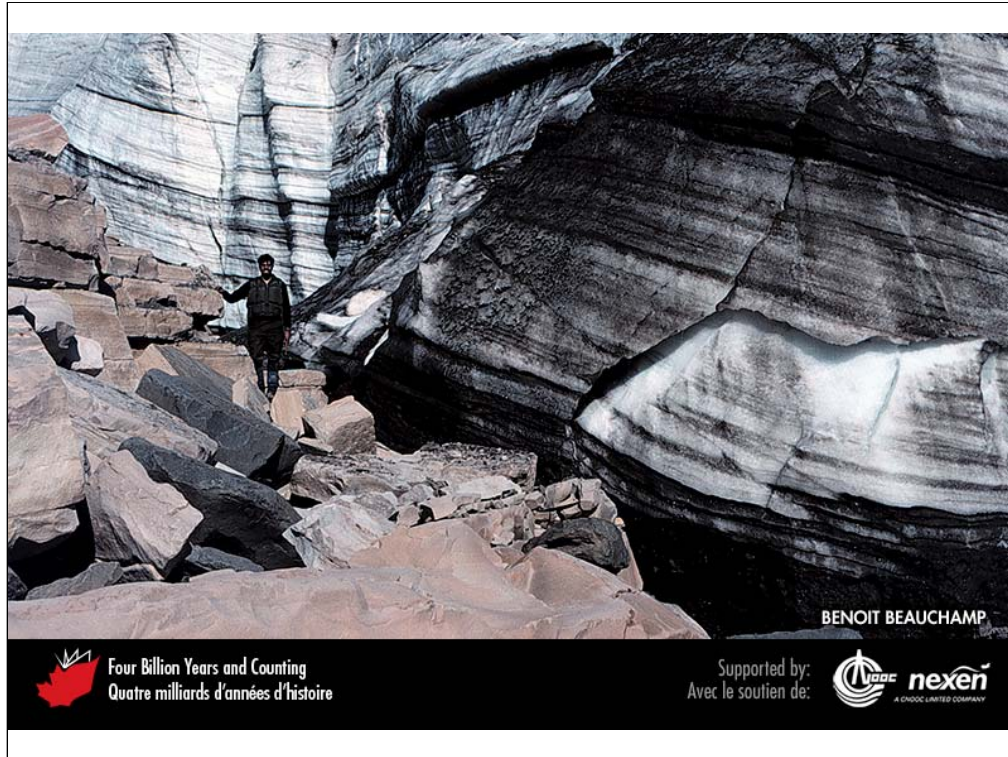
The glacial origin of the valley containing Ten Mile Pond in Gros Morne National Park of Canada, Newfoundland, is evident from its U-shaped cross-section. MICHAEL BURZYNSKI.

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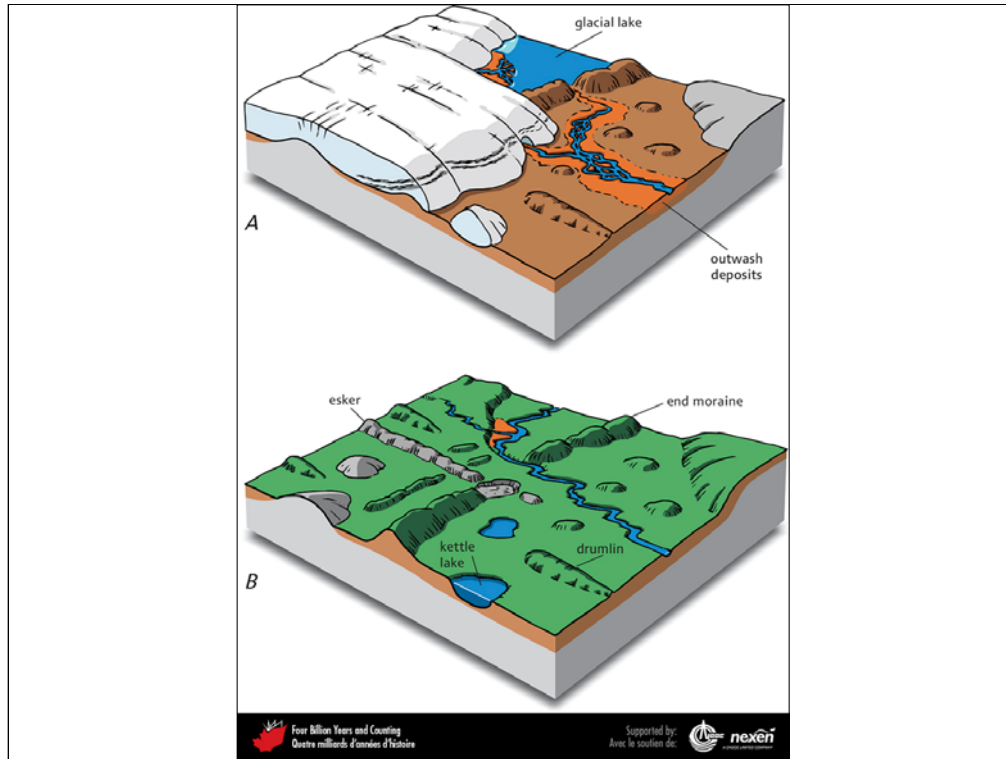
Mount Assiniboine, on the Alberta-British Columbia border, is a Matterhorn-like peak eroded on all sides by glaciers. JOHN SCURLOCK.

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A sediment-laden glacier resting on early Permian sandstone, northwestern Ellesmere Island, Nunavut. BENOIT BEAUCHAMP.

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Features produced by glacial deposition or glacier-related water-lain deposits. A shows a landscape still partly glaciated; B shows the same landscape after deglaciation.

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Till deposited during the last glaciation in the Chibougamau area of Quebec. The orientation of elongated boulders and pebbles provides evidence of the flow direction of the last ice to cover the area; in this case it was to the southwest. GILBERT PRICHONNET.

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These snow-covered drumlins near Nicola Lake, south of Kamloops, British Columbia, were formed beneath the Cordilleran Ice Sheet. From the shape of the drumlins, we can infer that the ice flowed toward the lower right. DARREL LONG.

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Aerial view of a glacier on Baffin Island, Nunavut, surrounded by moraines. TED LITTLE.

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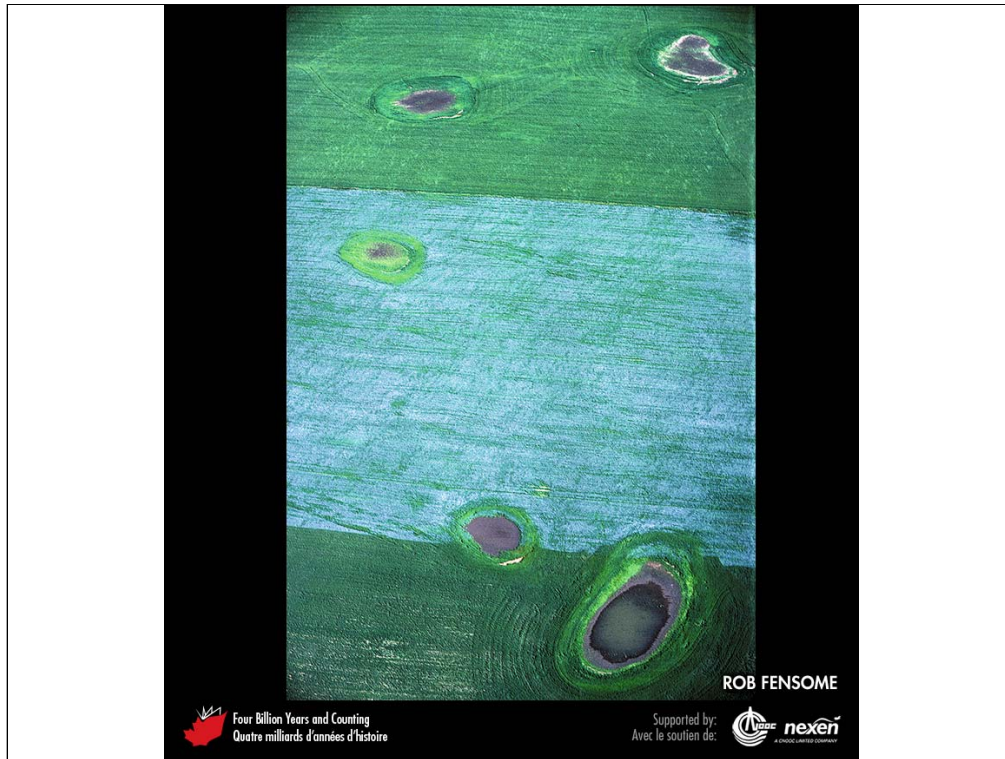
An esker snakes across the landscape in the Northwest Territories. IAN WARD / AIRSCAPES.CA.

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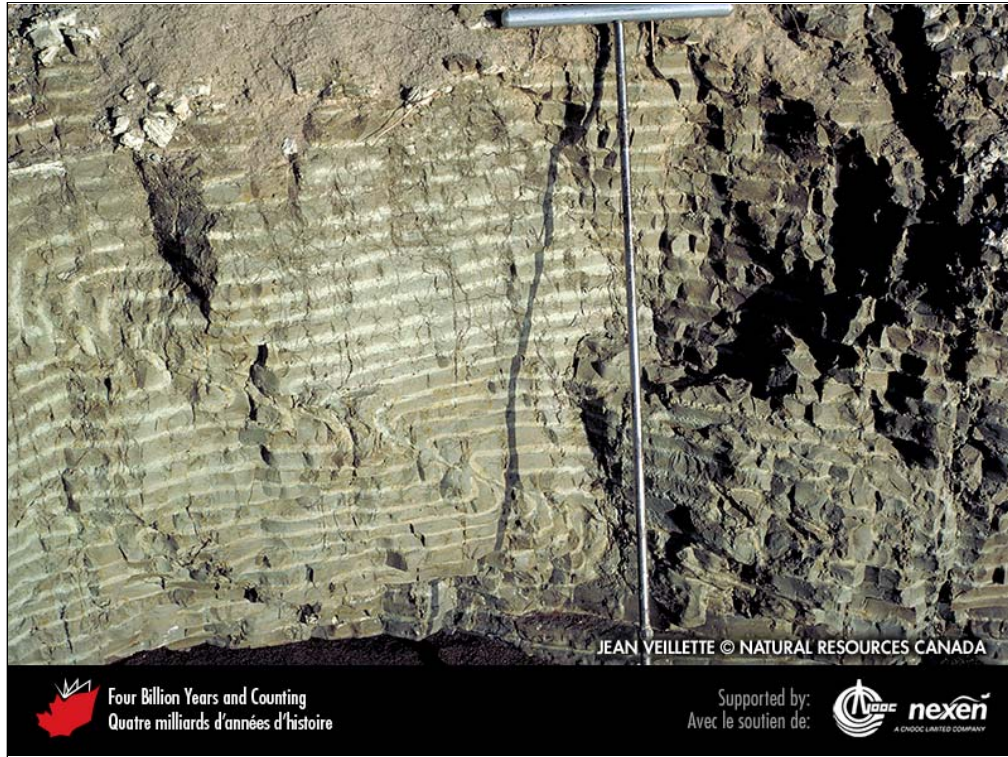
Moraine-dammed lake at the foot of Bishop Glacier in the southern Coast Mountains of British Columbia. JOHN CLAGUE.

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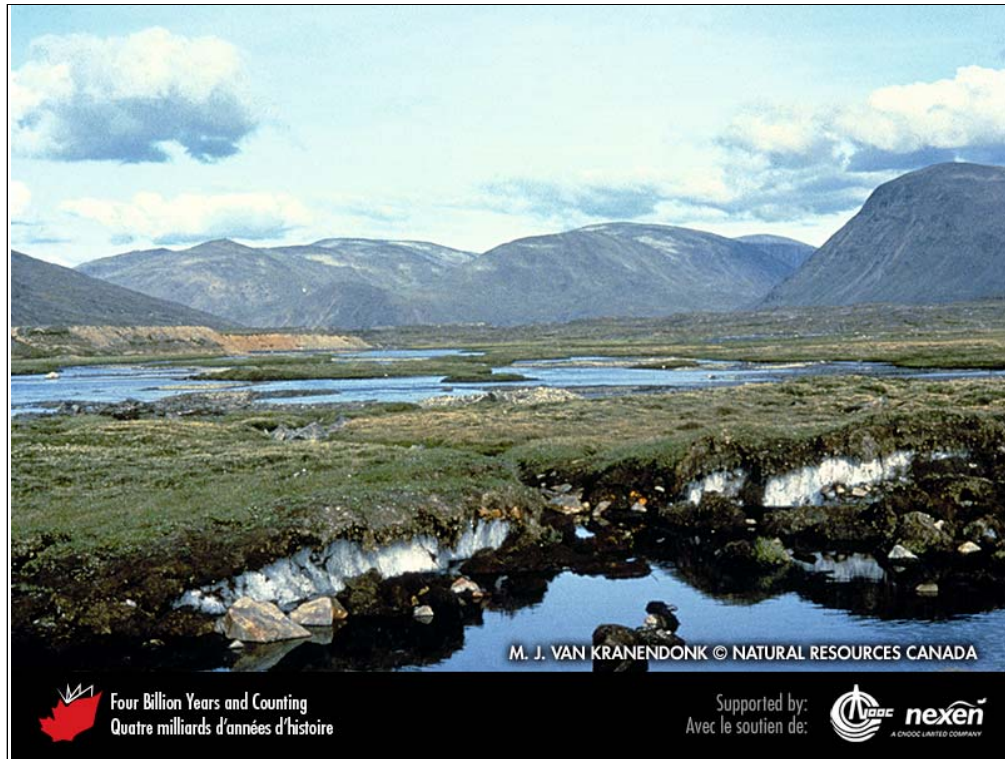
Kettle holes punctuate the farmland in this aerial view taken east of Saskatoon, Saskatchewan. The blue-flowering crop is flax. ROB FENSOME

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These cyclic layers of mud deposited in a former glacial lake and now exposed along the shore of Lac Temiscamingue, Quebec, represent annual accumulations and are known as varves. JEAN VEILLETTE, REPRODUCED WITH THE PERMISSION OF NATURAL RESOURCES CANADA 2013, COURTESY OF THE GEOLOGICAL SURVEY OF CANADA.

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Ice lens in permafrost in the Katherine River valley, Torngat Mountains, Labrador. M. J. VAN KRANENDONK, REPRODUCED WITH THE PERMISSION OF NATURAL RESOURCES CANADA 2013, COURTESY OF THE GEOLOGICAL SURVEY OF CANADA.

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Aerial view of polygonal patterned ground, produced by ice wedges, on Ellef Ringnes Island, Nunavut. CAROL EVENCHICK.

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An ice wedge, near Arundel, Quebec, formed about 11,500 years ago. After ice had opened the wedge and melted, probably several times, gravel partially filled the hole, followed later by windblown dust. More recent gravel has been deposited over the top of the structure. GILBERT PRICHONNET.

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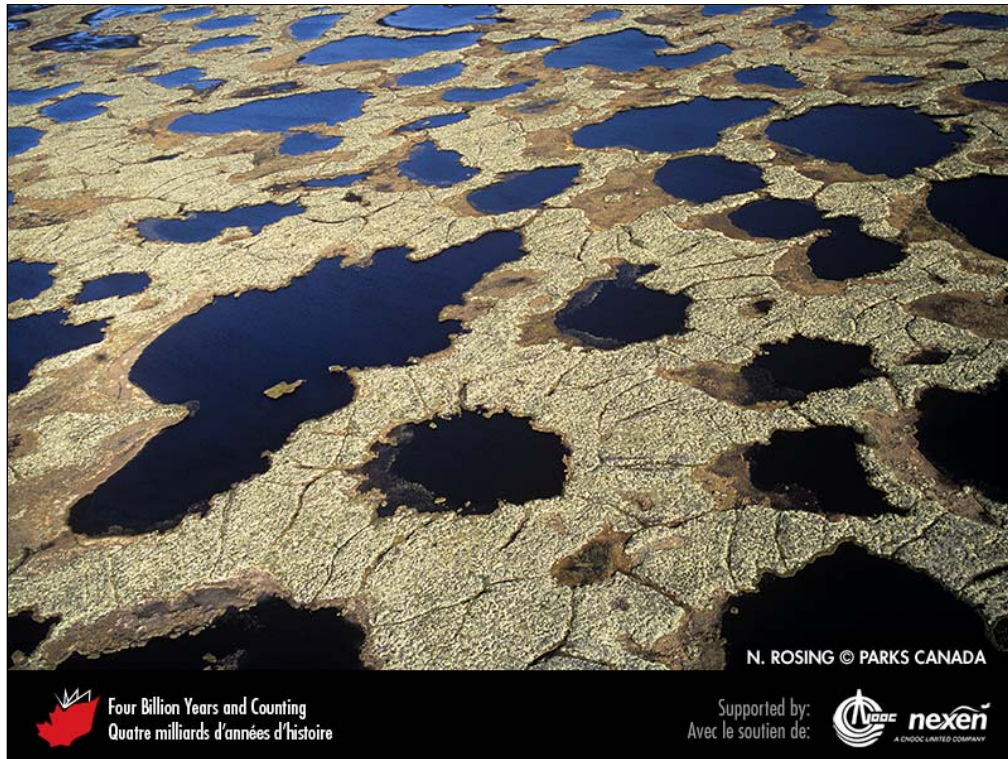
Pingo near Erly Lake, Tuktut Nogait National Park of Canada, Northwest Territories. I. K. MACNEIL, COPYRIGHT PARKS CANADA.

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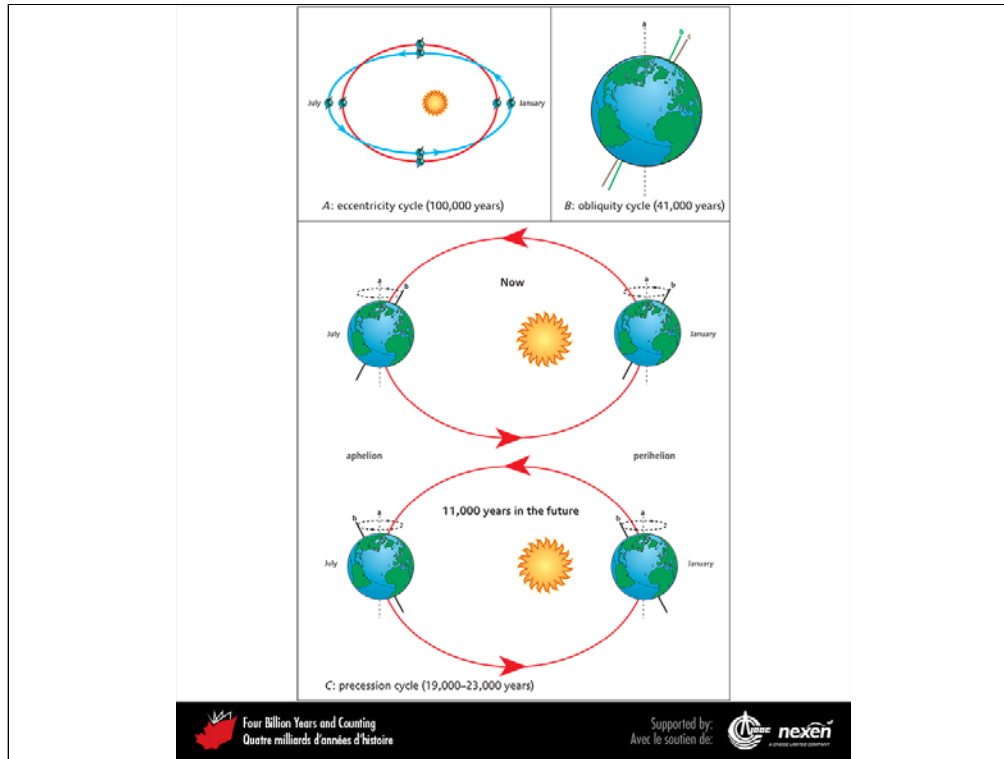
Felsenmeer on a small plateau high in the Torngat Mountains, close to the Quebec-Labrador border. The frost-shattered bedrock is composed of Archean gneisses from the eastern margin of the Superior Craton. JAMES GRAY.

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Aerial view of thermokarst, Wapusk National Park of Canada, Manitoba. N. ROSING, COPYRIGHT PARKS CANADA.

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A. The orbit of the Earth around the Sun changes from strongly ellipsoidal to almost circular and back to strongly ellipsoidal every 100,000 years; this is the eccentricity cycle. B. The ecliptic axis (a) is an imaginary line perpendicular to the Earth's orbit around the Sun. The angle between the Earth's rotational axis (b and c) and the ecliptic axis varies between 22.1° (b) and 24.5° (c) and back every 41,000 years. This is the obliquity cycle. C. Earth's rotational axis (b) completes a precession cycle by circling the ecliptic axis (a) every 19,000 to 23,000 years. The upper diagram represents today, with the Northern Hemisphere tilted towards the Sun in July and away from it in January. The bottom diagram shows the halfway stage in the cycle, about 11,000 years in the future, when the Northern Hemisphere will be tilted away from the Sun in July and toward it in January. To avoid confusion, the shape of the Earth's orbit and the position of the Sun are shown unchanged in this diagram.

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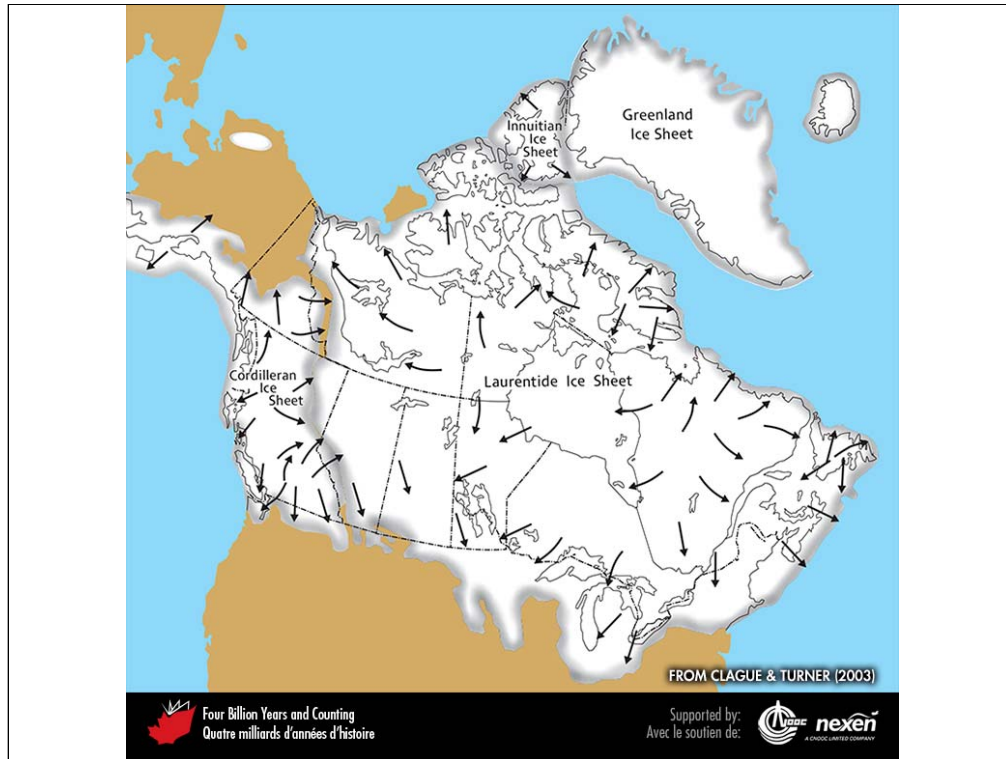
The bench at the top of the jutting cliff of Silurian strata at Arisaig, Nova Scotia, marks a raised beach cut by the sea during the Sangamon interglaciation about 125,000 years ago. Above this beach is till deposited during the last glaciation. RALPH STEA.

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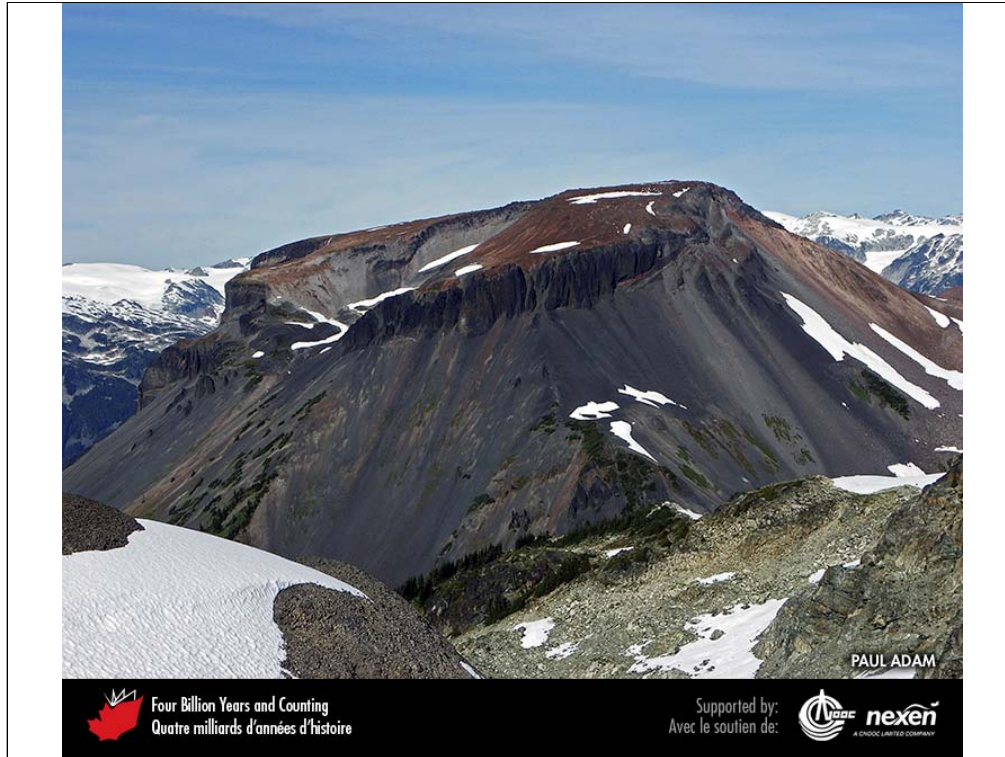
The ground sloth *Megalonyx*, which lived in Beringia during the Ice Age, could have been up to 3 metres long and weighed about 850 kilograms. *GROUND SLOTH* BY GEORGE "RINALDINO" TEICHMANN, COPYRIGHT 1999.

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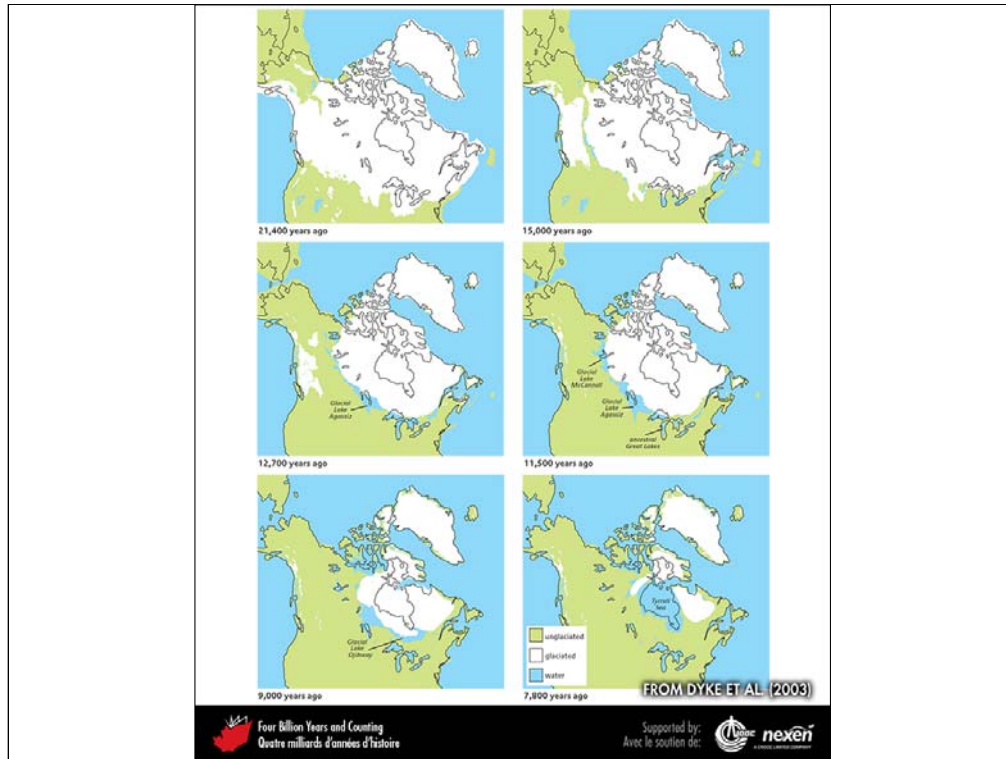
Ice cover over North America and adjacent areas during the last glacial maximum, about 19,000 years ago. The arrows show directions of ice flow from the major ice centres. ADAPTED FROM A GRAPHIC BY RICHARD FRANKLIN FOR CLAGUE AND TURNER (2003), USED WITH PERMISSION FROM TRICOUNI PRESS.

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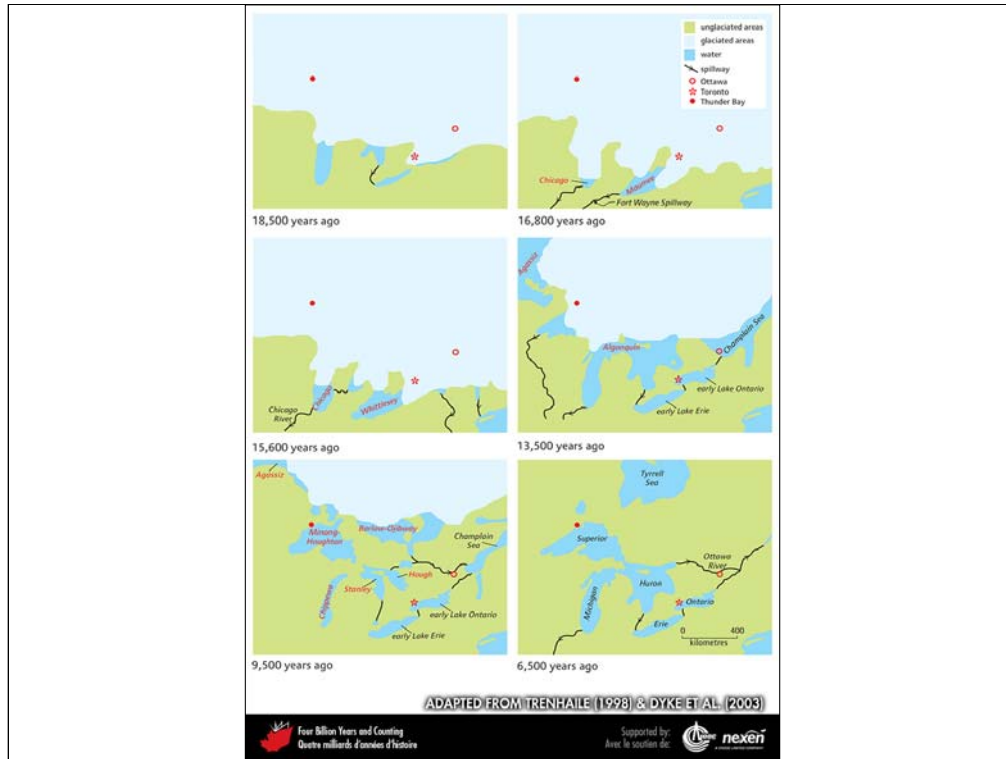
Ring Mountain, a tuya northwest of Whistler, British Columbia, was active during the last glaciation. PAUL ADAM.

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Stages in the deglaciation of North America and adjacent regions from 21,400 to 7,800 years ago. ADAPTED FROM DY KE ET AL. (2003).

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Stages in the evolution of the Great Lakes from 18,500 to 6,500 years ago. Glacial lakes are labelled in red. ADAPTED FROM TRENHAILE (1998) AND DYKE ET AL. (2003).

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This excavated section in sediments near Lismore, Nova Scotia, records rapid climate change at the end of the last glaciation. Reddish sediments at the base were deposited about 14,000 years ago in a glacial lake centred over the present-day Northumberland Strait. The glacial-lake sediments are capped by black peat and pale reddish to cream-coloured clay, which formed during a warmer phase from about 14,000 to 12,500 years ago in a forested landscape. The overlying sequence of reddish sediments was deposited when ice re-advance blocked local drainage and re-established the glacial lake. This occurred during the cooler Younger Dryas. Above the upper lake deposit is the modern soil. RALPH STEA.

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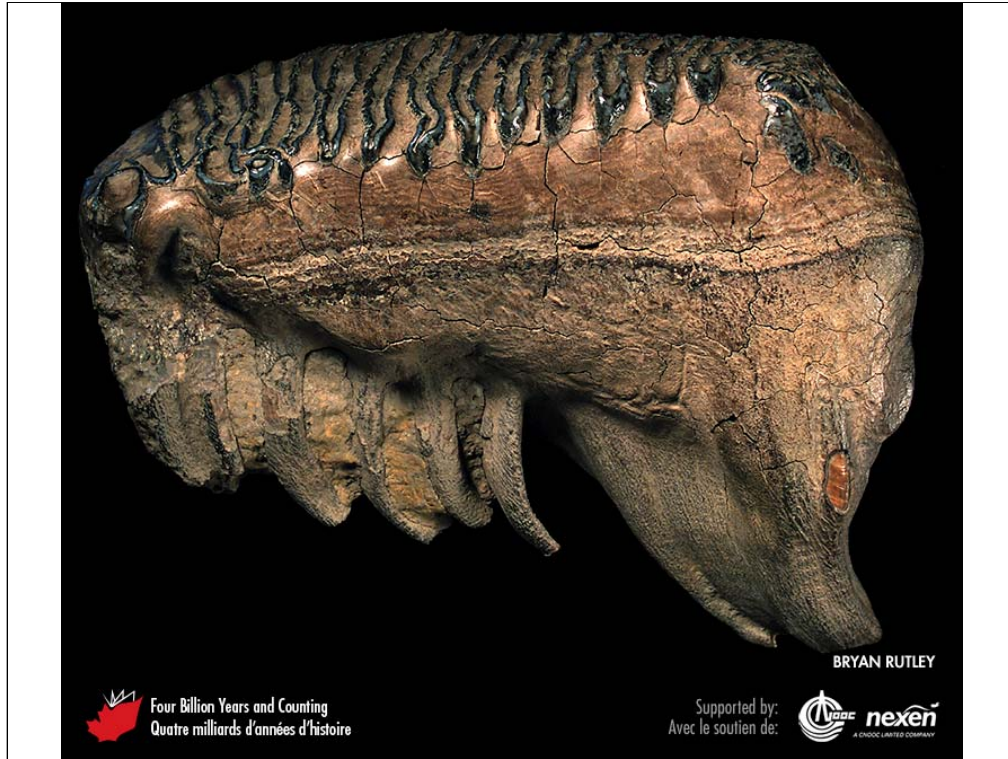
Remains of the giant short-faced bear, a laurasiather that in life may have weighed up to 900 kilograms, have been found in Yukon and on the Prairies. This animal was the largest carnivorous land mammal to have lived in North America. The inset compares the size of a giant short-faced bear (right), a grizzly bear (centre), and a black bear (left). *GIANT SHORT-FACED BEAR* BY GEORGE "RINALDINO" TEICHMANN, COPYRIGHT 1999.

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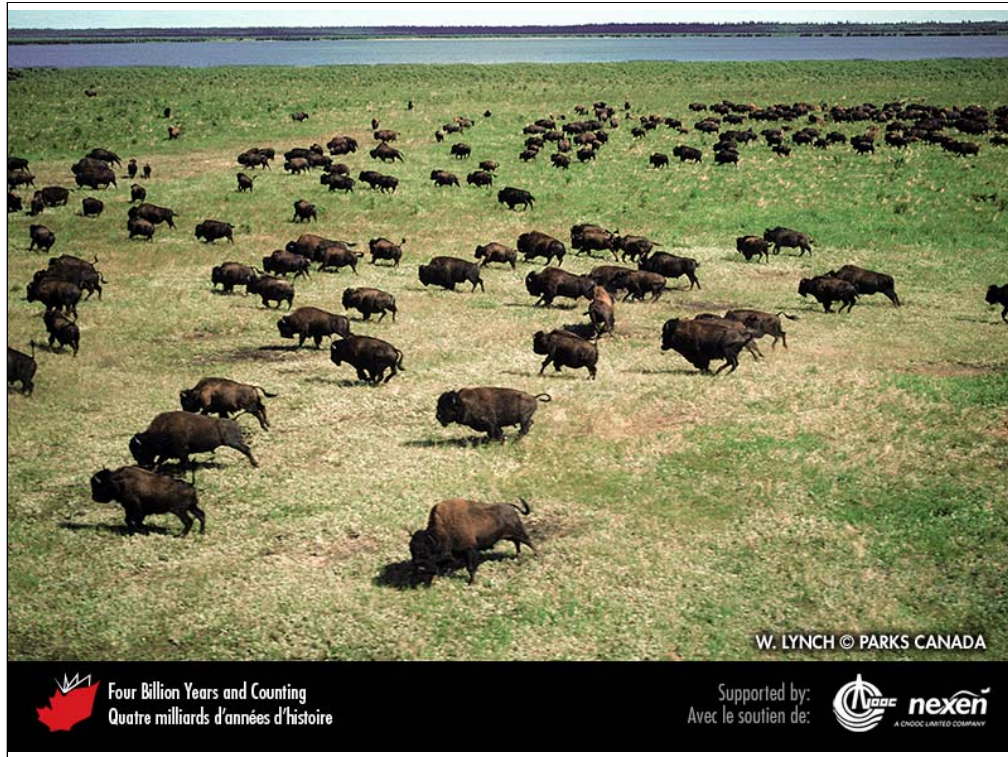
Teeth in the lower jaw of a 75,000-year-old mastodon found near Milford, Nova Scotia.
HEINZ WIELE, COURTESY OF THE ATLANTIC GEOSCIENCE SOCIETY; SPECIMEN COURTESY OF
THE NOVA SCOTIA MUSEUM.

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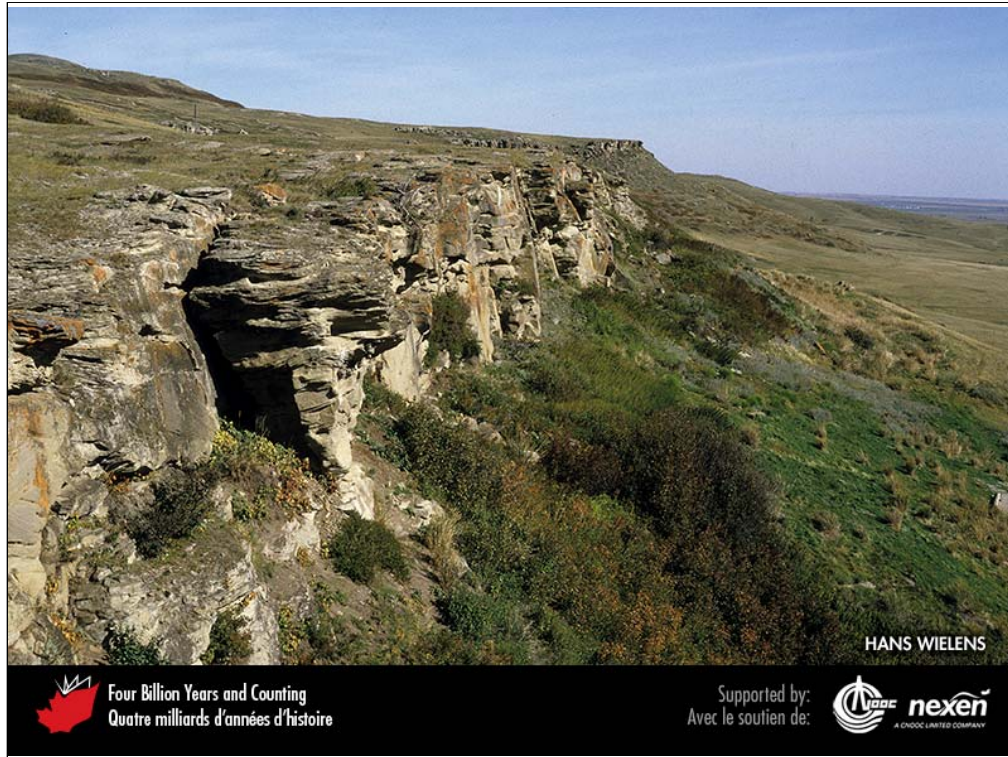
Pleistocene mammoth tooth found on the bank of the Porcupine River about 30 kilometres west of Old Crow, Yukon. BRYAN RUTLEY, SPECIMEN PROVIDED BY ALEJANDRA DUK-RODKIN.

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Bison were the main prey of the first hunters in what is now Canada. This aerial view shows wood bison in Wood Buffalo National Park of Canada in northern Alberta and southern Northwest Territories. W. LYNCH, COPYRIGHT PARKS CANADA.

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Aboriginal hunters used to drive bison over the cliff at Head-Smashed-In Buffalo Jump, Alberta. HANS WIELENS.

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Thule Inuit archaeological site near Resolute, Cornwallis Island, Nunavut. DAVID ASHE.

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