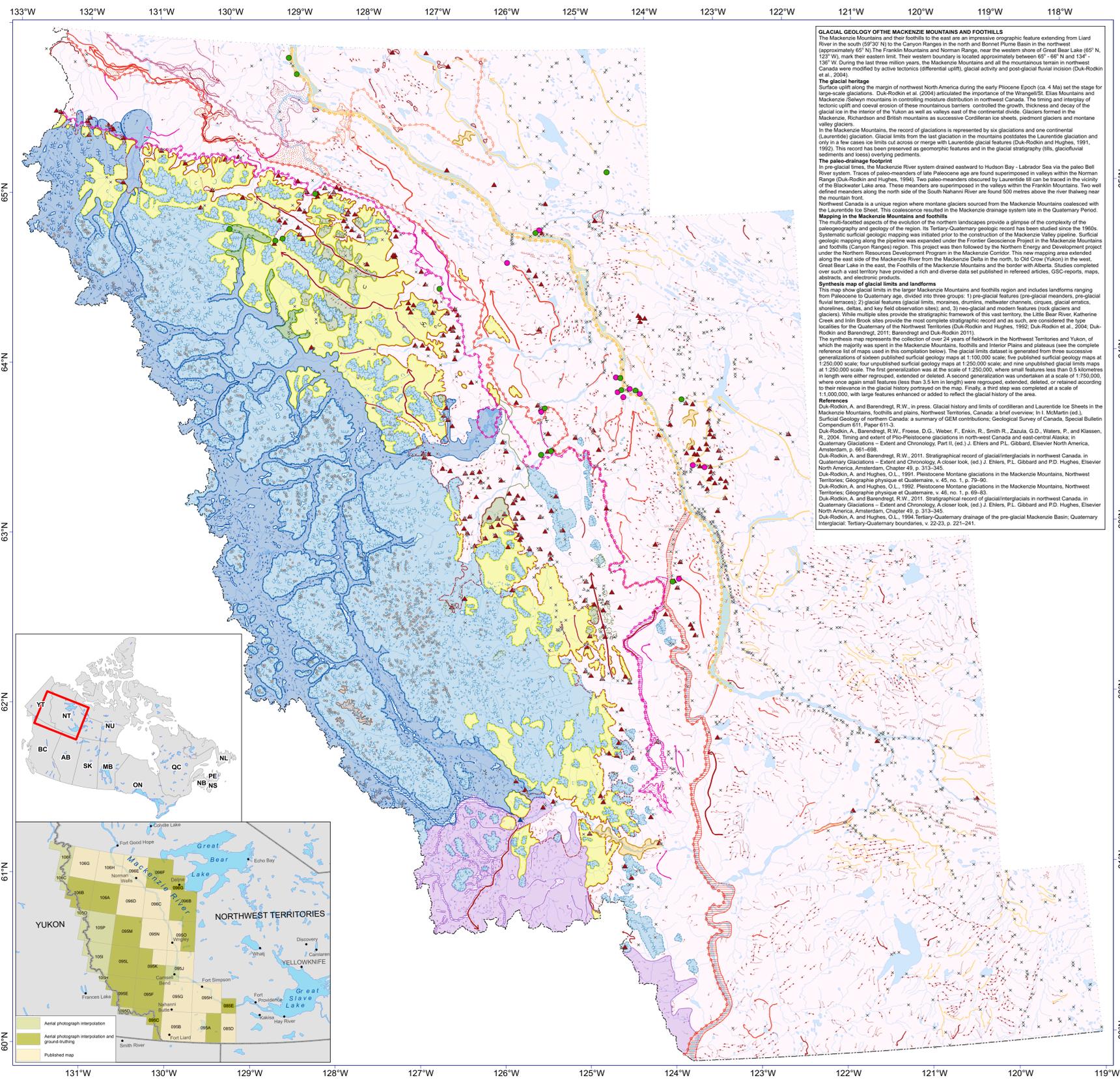


GLACIAL LIMITS, MACKENZIE MOUNTAINS AND FOOTHILLS, NORTHWEST TERRITORIES, CANADA

A. Duk-Rodkin¹



GLACIAL GEOLOGY OF THE MACKENZIE MOUNTAINS AND FOOTHILLS
The Mackenzie Mountains and their foothills to the east are an impressive orographic feature extending from Liard River in the south (59°26' N) to the Canyon Ranges in the north (Borner Flume Basin in the northwest (approximately 65° N). The Franklin Mountains and Norman Range, near the western shore of Great Bear Lake (65° N, 123° W), mark their eastern limit. Their western boundary lies located approximately between 65° - 65° N and 124° - 136° W. During the last three million years, the Mackenzie Mountains and all the mountainous terrain in northwest Canada were modified by active tectonics (differential uplift), glacial activity and post-glacial fluvial incision (Duk-Rodkin et al., 2004).

The glacial heritage
Surfaces uplift along the margin of northwest North America during the early Pliocene Epoch (ca. 4 Ma) set the stage for large-scale glaciations. Duk-Rodkin et al. (2004) articulated the importance of the Wrangel/Si. Elias Mountains and Mackenzie (Selym) mountains in controlling moisture distribution in northwest Canada. The timing and interplay of tectonic uplift and orogenic erosion of these mountainous barriers controlled the growth, thickness and decay of the glacial ice in the interior of the Yukon as well as valleys east of the continental divide. Glaciers formed in the Mackenzie, Richardson and British Columbia mountains as successive glacial periods and mountain valley glaciers.

In the Mackenzie Mountains, the record of glaciation is represented by six glaciations and one continental (Laurentide) glaciation. Glacial limits from the last glaciation in the mountains postdates the Laurentide glaciation and only in a few cases ice limits cut across or merge with Laurentide glacial features (Duk-Rodkin and Hughes, 1991, 1992). This record has been preserved as geomorphic features and in the glacial stratigraphy (tills, glaciofluvial sediments and loess) overlying pediments.

The paleo-drainage footprint
In pre-glacial times, the Mackenzie River system drained eastward to Hudson Bay - Labrador Sea via the paleo Bell River system. Traces of paleo-meanders of late Pliocene age are found superimposed in valleys within the Norman Range (Duk-Rodkin and Hughes, 1994). Two paleo-meanders observed by Laurentide till can be traced in the vicinity of the Blackwater Lake area. These meanders are superimposed in the valleys within the Franklin Mountains. Two well defined meanders along the north side of the South Nahanni River are found 500 metres above the river thalweg near the mountain front.

Northwest Canada is a unique region where montane glaciers sourced from the Mackenzie Mountains coalesced with the Laurentide ice Sheet. This coalescence resulted in the Mackenzie drainage system late in the Quaternary Period.

Mapping in the Mackenzie Mountains and foothills
The multi-faceted aspects of the evolution of the northern landscapes provide a glimpse of the complexity of the paleogeography and geology of the region. Its Tertiary-Quaternary geologic record has been studied since the 1960s. Systematic surficial geologic mapping was initiated prior to the construction of the Mackenzie Valley pipeline. Surficial geologic mapping along the pipeline was expanded under the Frontier Geoscience Project in the Mackenzie Mountains and foothills (Canyon Ranges) region. This project was then followed by the Northern Energy and Development project under the Northern Resources Development Program in the Mackenzie Corridor. This new mapping area extended along the east side of the Mackenzie River from the Mackenzie Delta in the north, to Old Crow (Yukon) in the west, Great Bear Lake in the east, the foothills of the Mackenzie Mountains and the border with Alberta. Studies completed over such a vast territory have provided a rich and diverse data set published in refereed articles, GSC-reports, maps, abstracts, and electronic products.

Synthesis map of glacial limits and landforms
This map shows glacial limits in the larger Mackenzie Mountains and foothills region and includes landforms ranging from Pliocene to Quaternary age, divided into three groups: 1) pre-glacial features (pre-glacial meanders, pre-glacial fluvial terraces); 2) glacial features (glacial limits, moraines, drumlins, meltwater channels, cirques, glacial erratics, shorelines, deltas, and key field observation sites); and, 3) neo-glacial and modern features (rock glaciers and glaciers). While multiple sites provide the stratigraphic framework of this territory, the Little Bear River, Katherine Creek and Inlin Brook sites provide the most complete stratigraphic record and as such, are considered the type localities for the Quaternary of the Northwest Territories (Duk-Rodkin and Hughes, 1992; Duk-Rodkin et al., 2004; Duk-Rodkin and Barendregt, 2011; Barendregt and Duk-Rodkin, 2011).

The synthesis map represents the collection of over 24 years of fieldwork in the Northwest Territories and Yukon, of which the majority was spent in this compilation (below). The glacial limits dataset is generated from three successive generalizations of sixteen published surficial geology maps at 1:100,000 scale, five published surficial geology maps at 1:250,000 scale, four unpublished surficial geology maps at 1:250,000 scale, and nine unpublished glacial limits maps at 1:250,000 scale. The first generalization was at the scale of 1:250,000, where small features less than 0.5 kilometres in length were either regrouped, extended or deleted. A second generalization was undertaken at a scale of 1:750,000, where once again small features (less than 3.5 km in length) were regrouped, extended, deleted, or retained according to their relevance in the glacial history portrayed on the map. Finally, a third step was completed at a scale of 1:1,000,000, with large features enhanced or added to reflect the glacial history of the area.

References
Duk-Rodkin, A. and Barendregt, R.W., in press. Glacial history and limits of cordilleran and Laurentide ice Sheets in the Mackenzie Mountains, foothills and plains, Northwest Territories, Canada: a brief overview. In: J. McClintock (ed.), *Geological Geology of Northern Canada: a summary of GEM contributions*, Geological Survey of Canada, Special Bulletin Compendium 611, Paper 611-3.

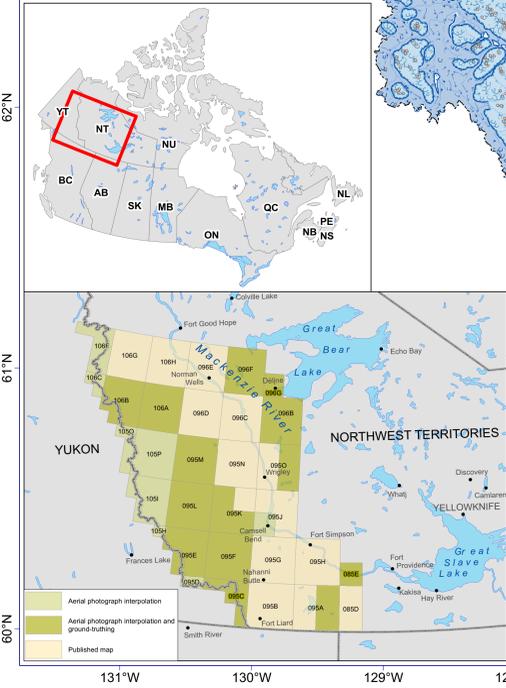
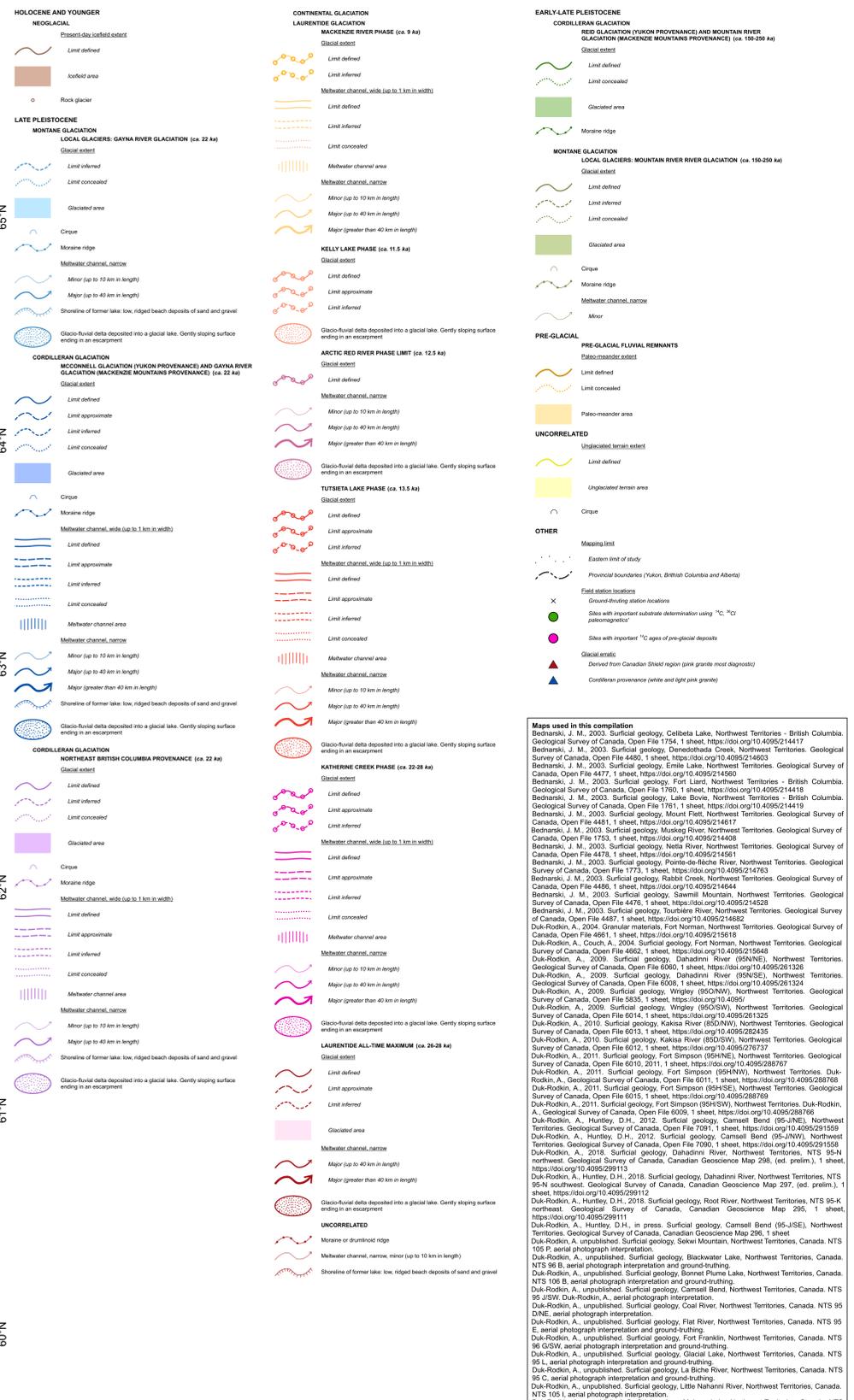
Duk-Rodkin, A., Barendregt, R.W., Frowe, D.G., Weber, F., Erkin, R., Smith, R., Zazula, G.D., Walters, P., and Klassen, R., 2004. Timing and extent of Plio-Pleistocene glaciations in north-west Canada and east-central Alaska. In: *Quaternary Glaciations - Extent and Chronology, Part II*, (ed. J.J. Ehlers and P.L. Gibbard), Elsevier North America, Amsterdam, p. 661-698.

Duk-Rodkin, A. and Hughes, O.L., 1991. Stratigraphical record of glacial/interglacial in northwest Canada. In: *Quaternary Glaciations - Extent and Chronology, a closer look*, (ed. J.J. Ehlers, P.L. Gibbard and P.D. Hughes, Elsevier North America, Amsterdam, Chapter 49, p. 313-345.

Duk-Rodkin, A. and Hughes, O.L., 1992. Pleistocene Montane glaciations in the Mackenzie Mountains, Northwest Territories. *Geographie physique et Quaternaire*, v. 46, no. 1, p. 69-83.

Duk-Rodkin, A. and Barendregt, R.W., 2011. Stratigraphical record of glacial/interglacial in northwest Canada. In: *Quaternary Glaciations - Extent and Chronology, a closer look*, (ed. J.J. Ehlers, P.L. Gibbard and P.D. Hughes, Elsevier North America, Amsterdam, Chapter 49, p. 313-345.

Duk-Rodkin, A. and Hughes, O.L., 1994. Tectonic and Quaternary drainage of the pre-glacial Mackenzie Basin. *Quaternary International*, Tertiary-Quaternary boundaries, v. 22-23, p. 221-241.



OPEN FILE 8891
GLACIAL LIMITS, MACKENZIE MOUNTAINS AND FOOTHILLS
NORTHWEST TERRITORIES, CANADA
1:1,000,000

0 25 50 100 150 200 km

Geomatics and cartography by F. Hardjowigno
GIS data management by C. DeBlonde

Topographic Data from Natural Resources Canada
Map projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 0
False Northing: 0
Central Meridian: 126
First Standard Parallel: 63.5
Second Standard Parallel: 66.5
Scale Factor: 1
Latitude of Origin: 60
Units: Metre

Maps used in this compilation

Bednarski, J. M., 2003. Surficial geology, Calibeta Lake, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1754, 1 sheet, <https://doi.org/10.4095/214117>

Bednarski, J. M., 2003. Surficial geology, Denesdohda Creek, Northwest Territories. Geological Survey of Canada, Open File 1480, 1 sheet, <https://doi.org/10.4095/214603>

Bednarski, J. M., 2003. Surficial geology, Emile Lake, Northwest Territories. Geological Survey of Canada, Open File 4477, 1 sheet, <https://doi.org/10.4095/214560>

Bednarski, J. M., 2003. Surficial geology, Fort Liard, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1760, 1 sheet, <https://doi.org/10.4095/214418>

Bednarski, J. M., 2003. Surficial geology, Lake Bovie, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1761, 1 sheet, <https://doi.org/10.4095/214419>

Bednarski, J. M., 2003. Surficial geology, Mount Flat, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Muskeg River, Northwest Territories. Geological Survey of Canada, Open File 4482, 1 sheet, <https://doi.org/10.4095/214618>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Rabot Creek, Northwest Territories. Geological Survey of Canada, Open File 4478, 1 sheet, <https://doi.org/10.4095/214561>

Bednarski, J. M., 2003. Surficial geology, Fronte-de-Rocher River, Northwest Territories. Geological Survey of Canada, Open File 1773, 1 sheet, <https://doi.org/10.4095/214783>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

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Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

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Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

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Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, <https://doi.org/10.4095/214619>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4481, 1 sheet, <https://doi.org/10.4095/214617>

Bednarski, J. M., 2003. Surficial geology, Samelli Mountain, Northwest Territories. Geological Survey of Canada, Open File 4476, 1 sheet, <https://doi.org/10.4095/214528>

Bednarski, J. M., 2003. Surficial geology, Tourbriere River, Northwest Territories. Geological Survey of Canada, Open File 4487, 1 sheet, [https://doi.org/10.4095/21461](https://doi.org/10.4095/214619)