Geoscience Advances in Manitoba's Far North

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The 2008-2011 Manitoba Far North Geomapping Initiative of the Manitoba Geological Survey, in partnership with the Geological Survey of Canada under the Geomapping for Energy and Minerals (GEM) program, was designed to further our understanding of the nature, evolution and mineral potential of the southeast margin of the Archean Hearne craton. Supported by geophysical, geochemical and geochronological data, areas with known or inferred potential for base and precious metals, diamonds, uranium and rare metals were targeted for re-mapping to provide a more solid framework for mineral exploration.

This poster aims to highlight the main advances in our understanding of the regional bedrock geology that result from the Manitoba Far North Geomapping Initiative. Of particular importance for regional tectonic correlations as well as mineral exploration are:

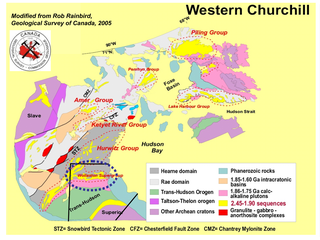
1) a new stratigraphy and chronology of at least four metasedimentary cover sequences, some of which are being explored for uranium, gold and/or rare metals;

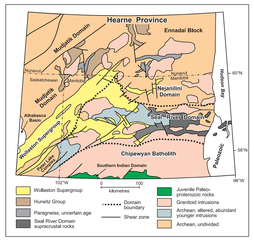
2) the identification of a Neoarchean greenstone belt with known gold occurrences;

3) the discovery of remnants of ancient cratonic lithosphere in the Seal River area, rendering the region favourable for diamond exploration;

4) Rössing-type U-mineralization in the Wollaston Supergroup rocks which are a good source, when subjected to low-T remobilization and re-enrichment, to form high-grade unconformity-type and basement-hosted deposits in the Athabasca basin.

Western Churchill

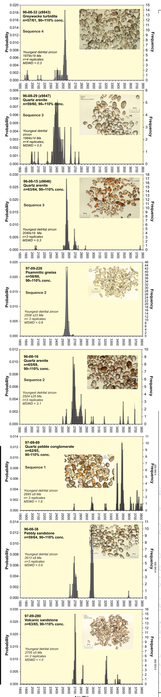


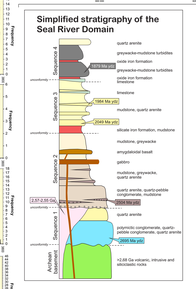


The southeast margin of the Hearne craton has been regionally subdivided into six geological domains: the Mudjatik, Peter Lake (present only in Saskatchewan), Wollaston, Seal River, Great Island and Nejanilini domains. The domains are distinguished by their cover rocks, the proportion or absence of basement rocks, and their dominant structural trends.

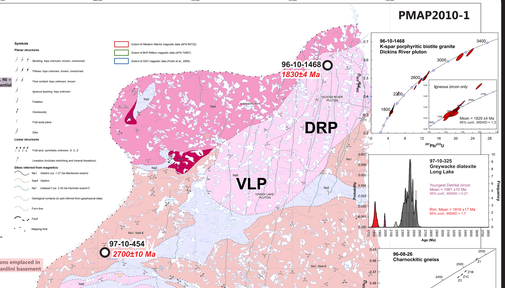
The MGS Far North Geomapping Initiative

2004: Sm-Nd isotopic study of archival granitoid samples collected by Schledewitz et al. from NTS 64P
2005: bedrock and surficial mapping and sampling at Nejanilini Lake in
2006: bedrock and surficial mapping in the Kasmere and Putahow lakes area
2008: scoping study in the Great Island and Munroe Lake areas
2009: bedrock and surficial mapping in the Great Island area
2010: extended bedrock mapping in the Seal River - Great Island area, bedrock mapping in the Misty Lake area
2011: bedrock and surficial mapping in the Snyder Lake area
2012-2013: data and map compilations

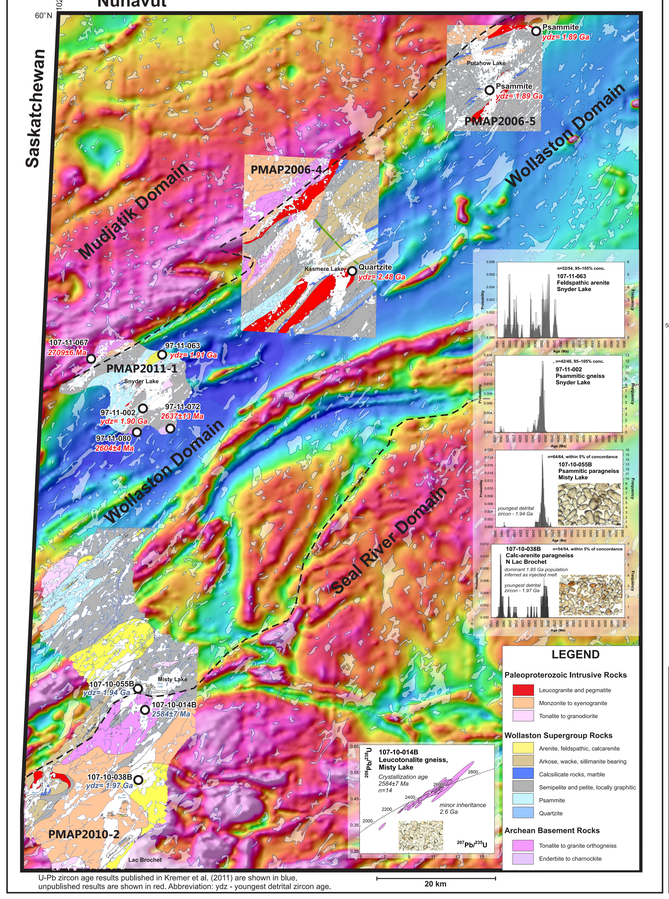








Geology of the Seal River region (modified after Anderson et al., 2010). U-Pb zircon age results published in Rayner (2020) are shown in blue, unpublished results are shown in red.
Abbreviations: CRP - Caribou River pluton; DRP - Dickins River pluton; GIB - Great Islan basin; GLGB - Garfinkel Lake greenstone belt; GRP - Gross River pluton; HLGB - Howard Lake greenstone belt; NLB - Nowell Lake basin; NLP - Nichol Lake pluton; SBB - Seal Bend basin; VLP - Vinsky Lake pluton; ydz - youngest detrital zircon age.



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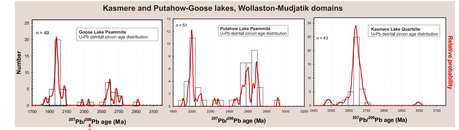
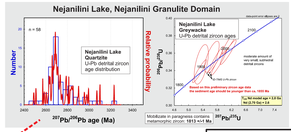
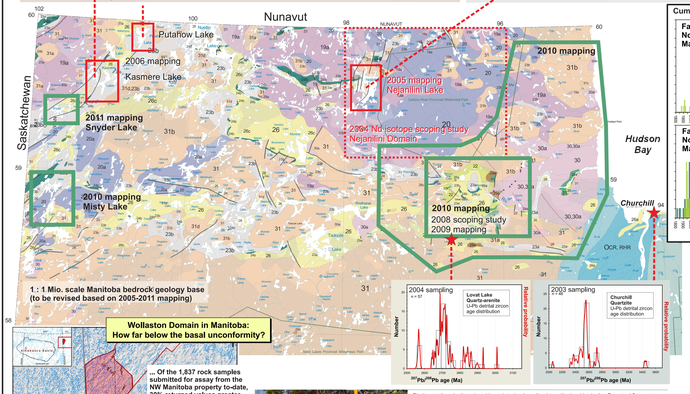
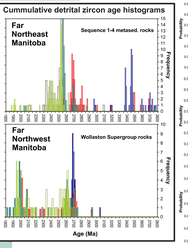
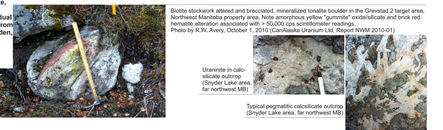










Wollaston and/or Hurwitz Group rocks in northern Manitoba?

The lower Hurwitz Group comprises four conformable formations >2.11 Ga that contain detrital zircons dominantly >2.5 Ga. Equivalent formations of the Wollaston Supergroup may be preserved in rift and passive margin sequences below the Daly Lake Group along the eastern margin of the Wollaston Domain (e.g. quartzite-arkose in Kasmere Lake area, far NW Manitoba). The upper Hurwitz Group comprises 3 formations that contain abundant 2.4-1.9 Ga detrital zircons as well as Archean ones. The 2.11-1.9 Ga hiatus between the lower and upper Hurwitz groups may be correlative with a hiatus between rift-passive margin development and onset of Daly Lake Group sedimentation in the Wollaston Supergroup. The upper Hurwitz and Daly Lake groups are both characterized by broad stratigraphic regression-transgression cycles and may thus represent coeval sequences that formed over nearly 1000 km strike length.
The Paleoproterozoic cover rocks in northern Manitoba allow deriving the connection between coeval formations of
1) the lower Hurwitz and relics of pre-Daly Lake groups and
2) the upper Hurwitz and the Daly Lake groups.
In addition, the new lithostratigraphy of four siliciclastic sequences established in the Seal River region in Manitoba allows the following tentative correlations:

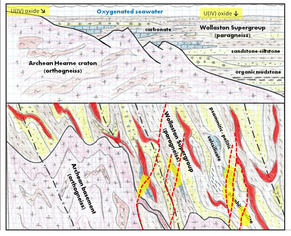
Sequence 3+4 - (Upper) Hurwitz Group/Daly Lake Group
Alternatively: Amer Group
(Rainbird et al. 2010, Prec. Res. 181)

Sequence 2 - Spi Group (~2.45 Ga; Sandeman and Ryan 2008, CJES)

Sequence 1 - Montgomery Group (>2.45 Ga; e.g. Rainbird et al. 2002, GSC Current Res.)

Uranium and rare-earth element mineralization in Manitoba's far northwest

The Wollaston Supergroup and underlying Hearne craton margin form the basement sequence to the Athabasca Basin in Saskatchewan, and are locally host to unconformity-related, basement-hosted U deposits. In northwestern Manitoba, discrete zones of U and/or REE mineralization are characterized by:
1) U, Th and REE enrichments associated with calcareous and/or graphitic horizons within the Wollaston Supergroup, which act as chemostratigraphic traps that allow for the precipitation of U, Th and/or REEs from a fluid phase.
2) Within these horizons, secondary metasomatic veining and alteration associated with late brittle-ductile deformation, which appear to be important controls on the localization of mineralization
3) Two mineralogically distinct vein phases were observed:
a) megacrystic calcsilicate veining and alteration: mainly tremolite, diopside, feldspar and scapolite, enriched in U and Th but not REE
b) late, brittle-ductile calcite-diopside veining and alteration, enriched in REE (>2700 ppm total REE) but low Th and U.

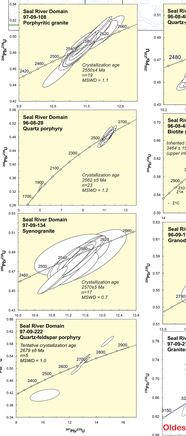


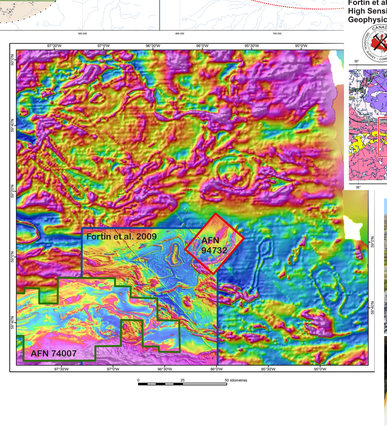
Possible sources of U, Th, REE

Granitic gneisses of the Mudjatik Domain have peraluminous geochemical affinities with high Ba, Sr, Zr +/- REE. Oxidative continental weathering of these rocks could have provided primary enrichments of U, Th, and REE to the Wollaston Supergroup. Highly fractionated, peraluminous S-type leucogranitic dikes and sills that intrude sedimentary rocks of the Wollaston Supergroup are interpreted to be derived from partial melting of the sedimentary pile during high grade metamorphism (upper amphibolite to lower granulite facies). These dikes have elevated values of REE, Th and Rb>>Sr, and are interpreted to have remobilized and concentrated U, Th and REE from the sediments into calcareous and graphitic horizons.
Such occurrences may have been re-enriched during a low temperature hydrothermal event to form the unconfomity-related uranium deposits associated with the Athabasca Basin.









Fortin et al. 2009: High Sensitivity Airborne Geophysical Survey

- Flown fall 2008
- Magnetic: total field
- Gamma-ray spectrometric
- Survey specs:
  - ~17,000 line-kilometres
  - 125 m nominal terrain clearance
  - 400 m line spacing (current 5 km)

Processed variables:
Natural air absorbed dose rate
Potassium (%)
Uranium (ppm)
Thorium (ppm)
Uranium / Thorium
Uranium / Potassium
Thorium / Potassium
Residual total magnetic field data
First vertical derivative of the magnetic field data
Digital elevation model data



References: Anderson, S.D., Böhm, C.O., Syme, E.C. 2010. Far North Geomapping Initiative: bedrock geological investigations in the Seal River region, northwestern Manitoba (parts of NTS 54L, M, 64I, P), in Report of Activities 2010, Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, p. 6–22.
Rayner, N. 2010. Far North Geomapping Initiative: new U-Pb geochronological results from the Seal River region, northwestern Manitoba (parts of NTS 54L, M, 64I, P), in Report of Activities 2010, Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, p. 23–35.
Kremer, P.D., Böhm, C.O., Rayner, N. 2011. Far North Geomapping Initiative: bedrock geology of the Snyder Lake area, northwestern Manitoba (part of NTS 64NS), in Report of Activities 2011, Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, p. 6–17.