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GEOLOGY AND MINERAL POTENTIAL OF THE SOUTHERN RAE CRATON, NORTHWEST TERRITORIES, NTS 75-G AND H

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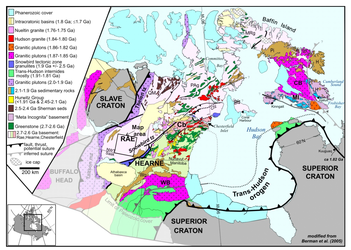
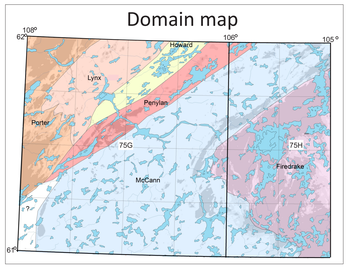


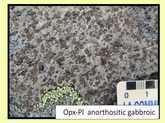
The southern Rae craton in the Northwest Territories (NT) has seen little research since it was first mapped by canoe and float plane at reconnaissance scale in the 1950-60s. Under the Geological Survey of Canada's (GSC) Geomapping for Energy and Minerals (GEM2) program, the GSC-Northwest Territories Geological Survey (NTGS) South Rae 1:250,000-scale bedrock mapping project is improving understanding of the evolution, economic potential, and role of this region in assembly of the Canadian Shield. Field work in 2016, focused in NTS 75G and the west half of 75H, covered over 17,500 km² of previously unmapped ground. This study provides insights on six new, informally-named, geophysically, and isotopically defined domains (see Domain map below), each with a distinct record of magmatic and tectono-metamorphic events. The domains have roughly northeast-southwest striking boundaries and are defined by crustal-scale structures that are marked by both high-strain ductile zones and discrete brittle faults, which appear to be the locus of multiple movements.

Domain map



Howard domain

The Howard domain is defined by an intense magnetic low, and includes distinct rocks such as orthopyroxene anorthosite to gabbro, andalusite and/or cordierite-sillimanite-garnet-biotite-bearing wacke, plagioclase-phyric meta-andesite, muscovite-biotite schist and calc-silicate, banded iron formation as well as foliated to gneissic granodiorite, and granite.


Opx-Pl anorthositic gabbroic

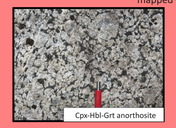

And/Crd-Sil-Grt-Bt-melt


Grt-Am-Qtz banded iron fm


plagioclase phyric andesite

Penylan domain

The Penylan domain includes hornblende-clinopyroxene-garnet anorthositic gabbro, massive to variably foliated monzogranite, syenite and quartz-diorite, which all yield crystallization ages between 2.03-2.05 Ga. The anorthosite-gabbro complex is larger than previously mapped extending over 100 km northeast-southwest.

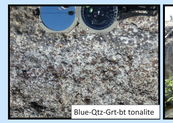

Cpx-Hbl-Grt anorthosite

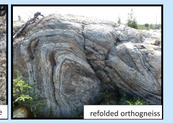

extreme strain partitioning


Cpx-Hbl-Grt syenite

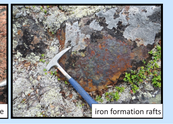
McCann domain

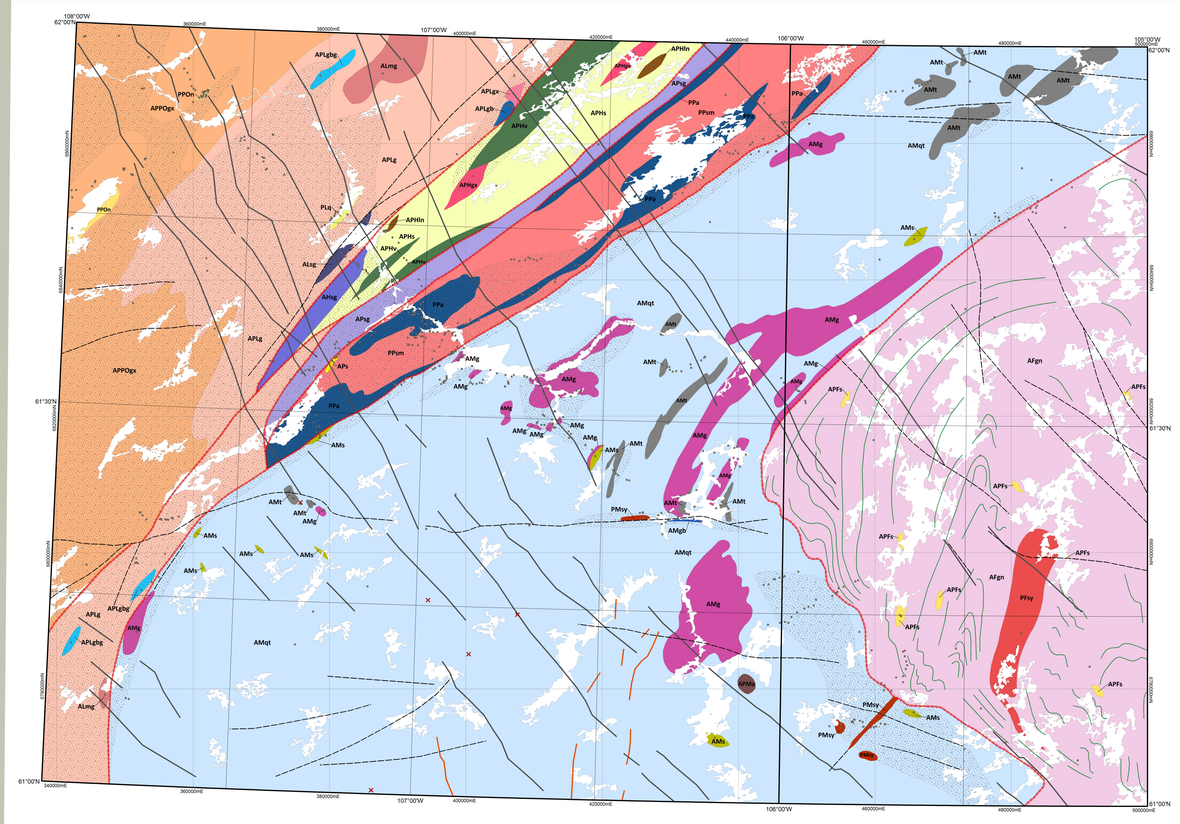
The McCann domain consists mainly of biotite-garnet-orthopyroxene tonalite, granodiorite and granite, with sparse mafic-ultramafic rocks, paragneiss and iron formation enclaves, cut by ca. 2.17 Ga Orpheous gabbro dykes. It records the medium-pressure and high-temperature Arrowsmith orogeny at ca. 2.45-2.32 Ga as well as Trans-Hudson metamorphism ca. 1.88 Ga at minimum 8 kbar. Due to the late 1.88 Ga overprint on originally high temperature Arrowsmith metamorphism the quartz in older McCann domain units is distinctly blue. Late syenite bodies cut the foliation in the gneissic granulites.


Blue-Qtz-Grt-bt tonalite


refolded orthogneiss


Cpx-Mag syenite


iron formation rafts



Legend

- Station location
- Regional fabric form line
- Cataclastic overprint

Faults
- Brittle fault
- Shear zone

Dykes
- Mackenzie dyke (ca. 1.27 Ga)
- Orpheous dyke (ca. 2.17 Ga)

Geology Units

Porter domain
- PPOn — Proterozoic sedimentary rocks; sandstone, conglomerate
- APPOgx — Orthopyroxene-clinopyroxene-hornblende-magnetite granite with abundant mafic xenoliths and dykes

Lynx domain
- PLq — Proterozoic sedimentary rocks; quartzite
- APLgbg — Gabbroic rock intruded by granitic melt
- APLgb — Gabbro, amphibolite
- APLg — Granite, shows ductile strain overprinted by pervasive chlorite-epidote-quartz-hematite alteration, cataclastic deformation
- APLgx — Hornblende-biotite-magnetite granite, equigranular to megacrystic, rare mafic xenoliths
- ALsg — Banded / straight gneiss; granite and amphibolite layers
- ALmg — Megacrystic granite

Howard domain
- APHs — Cordierite and/or andalusite-sillimanite-garnet-biotite rafts of metasedimentary rocks in garnet-bearing tonalite melt, includes blocks of iron formation
- APHgx — Hornblende-biotite-magnetite granite, equigranular to megacrystic, rare mafic xenoliths
- APHin — Orthopyroxene metagabbroic anorthosite / leuconorite
- APHv — Metavolcanic rocks; metabasaltic schist, plagioclase phyric andesite
- AHsg — Banded / straight gneiss; granite and amphibolite layers

Penylan domain
- PPg — Clinopyroxene-hornblende±garnet, gabbroic anorthosite, diorite, gabbro
- PPsm — Hornblende±clinopyroxene±garnet syenite to monzonite
- APs — Sillimanite-garnet-biotite rafts of metasedimentary origin
- APsg — Banded / straight gneiss; granite and amphibolite layers

McCann domain
- Amphibole-garnet-quartz banded iron formation
- PMsy — Clinopyroxene-magnetite syenite
- APMs — Agmatite; mafic rock intruded by tonalite melt
- AMt — Clinopyroxene-magnetite±garnet±orthopyroxene metatonalite
- AMg — Granite, medium to coarse grained to megacrystic, garnet-blue quartz
- AMs — Sillimanite-garnet-biotite rafts of metasedimentary origin
- AMgb — Gabbro, amphibolite
- AMqt — Garnet-blue quartz metatonalite and diatexite

Firedrake domain
- PFsy — Clinopyroxene-magnetite syenite
- APFs — Sillimanite-garnet-biotite rafts of metasedimentary origin
- AFgn — Hornblende-biotite-relict garnet orthogneiss. Granite with hornblende-biotite±magnetite schlieren

0 10 20 Kilometres
Universal Transverse Mercator projection, Zone 13
North American Datum 1983

Firedrake domain

The Firedrake domain comprises ca. 2.66 Ga felsic to intermediate orthogneiss, mafic to ultramafic rocks and rare paragneiss, all injected by widespread migmatitic granitoids. Late syenite bodies, similar to the ones intruding the McCann domain, are present .This domain shows evidence for early 1.89 Ga granulite facies metamorphism at 8-11 kbar and subsequent decompression to 4-6 kbar amphibolite facies conditions ca.1.84 to 1.80 Ga.

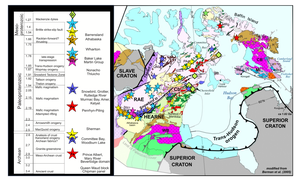

Sil-Grt-Bt paragneiss


Hbl-Grt orthogneiss


Cpx-Mag syenite


Hbl-Bt-Grt mafic gneiss

Economic potential

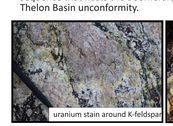


REE

The discovery of several new syenite bodies suggests a widely distributed alkali magmatic event spatially associated with some of the crustal-scale domain boundaries. Some of the syenite plutons exhibit a similar mineralization style to that responsible for Hoidas deposit (REE) in northern Saskatchewan.

U-Au-Cu

Various young clastic sedimentary sequences with poorly constrained ages (2.20 to 1.74 Ga?) have been mapped and are potentially correlative with the Nonacho, Amer and Wharton groups. The presence of outliers of Proterozoic basinal Nonacho Group rocks unconformably overlying basement rocks highlights the potential for unconformity-related and basement hosted U and Au deposits in this poorly explored area of the NWT. Also, preliminary synthesis suggests the newly mapped supracrustal rocks of the Howard Lake domain are a continuation of the sequence that hosts the Boomerang U deposit just below the Thelon Basin unconformity.


uranium stain around K-feldspar


rusty zone along structure

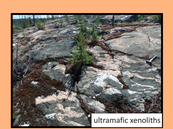
Diamond

Recent diamond exploration in northern Saskatchewan suggest kimberlite potential where late ductile extension has been documented along mantle piercing structures that bound juxtaposed lower and upper crustal domains. These structures in Saskatchewan are potentially continuous into the Northwest Territories.

Porter domain

The Porter domain includes hornblende-biotite and orthopyroxene-clinopyroxene-hornblende-magnetite granodiorite with mafic and ultramafic enclaves and dykes, and lesser garnet-bearing charnockite. Broad zones of cataclastic and brittle-ductile greenschist-facies deformation and associated chlorite-hematite-epidote alteration are widespread.


Opx-Cpx-Hbl-Mag granite


ultramafic xenoliths


amphibolite and granite layers


Grt-bearing charnockite melt

Lynx domain

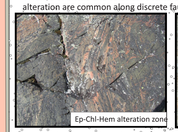
The Lynx domain is largely composed of granodiorite to tonalite with enclaves of mafic composition. Epidote, chlorite and hematite alteration and cataclastic deformation is common. One sedimentary outlier unconformably overlies the Lynx domain and consists of metamorphosed pink, purple, grey and white quartzite and minor siltstone.


granite with mafic xenoliths


cataclastic granite


leucogranite injections in host granite

A range of brittle and cataclastic textures and chlorite, epidote and hematite alteration are common along discrete faults in Lynx and Porter domains.


Ep-Chl-Hem alteration zone


pseudotachylite


Chl-Qtz schist/high strain zone

Unconformably overlying the Porter domain, unmetamorphosed clastic sedimentary sequences including conglomerate and arkose occur in linear, fault-bounded outliers.


conglomerate and sandstone


rhyolite clast

Ongoing research & publications

Theses in progress:
Age and provenance of newly mapped sedimentary outliers: Benjamin Neil, SFU, Dan Gibson
Tectonometamorphic evolution of the south Rae: Eric Thiessen, SFU, Dan Gibson
Structural evolution of the Black Bay fault zone: implication for REE deposits: Dylan Jamieson, U of W, Shoufa Lin

Available publications:
Percival, J. Pehrsson, S.J., Campbell, J.E., Martel, E., Agosta-Gongora, P., Thiessen, E., Jamieson, 2016: Report of 2016 activities for the geologic and metallogenic framework of the South Rae Craton, southeast Northwest Territories: GEM 2 South Rae quaternary and bedrock project, Geological Survey of Canada, Open File 7958, 24 p.
Pehrsson, S.J., Campbell, J.E., Martel, E., McCurdy, M.W., Agosta-Gongora, P., Thiessen, E., Jamieson, D., Lauzon, G., Bullet, G., Falck, H. and Dyke, A.S. 2015. Report of 2015 activities for the geologic and metallogenic framework of the South Rae Craton, southeast Northwest Territories: GEM 2 South Rae quaternary and bedrock project, Geological Survey of Canada, Open File 7958, 24 p.
P., Acosta-Góngora; S.J., Pehrsson; E., Martel; D., Jamieson; G., Lauzon. 2016. South Rae Project: Preliminary field observations (2015) and lake sediment analysis. Geological Survey of Canada Open File 8094. ppt.

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