Manitoba Geological Survey
B.G.C.M. Series
Kasmere Lake, NTS 64N, 1:250 000

MARGINAL NOTES

The Kasmere Lake map area (NTS 64N) lies on the south and east flanks of the Hearne Province, part of the Archean Rae-Hearne craton. The Snowbird Shear Zone divides the Rae-Hearne craton into the Rae Province to the west and the Hearne Province to the east (Hoffman, 1990). The Archean continental crust of the Hearne Province is overlain by Paleoproterozoic cover rocks and, together with the cover rocks, has undergone varying degrees of thermotectonism during the Paleoproterozoic Trans-Hudson orogeny (Cree Lake Ensialic Mobile Zone; Lewry et al., 1978; Lewry and Sibbald, 1980). Parts of the Hearne Province are considered to be cratonic or semicratonic with respect to the Trans-Hudson Orogen, since they are little affected by Hudsonian thermotectonism. One of these regions, the Ennadai Block (Lewry et al., 1985), trends southwesterly from Rankin Inlet to the extreme northwest corner of Manitoba. The Hearne Province is separated from the accreted Paleoproterozoic juvenile terranes of the Trans-Hudson Orogen to the south by the Wathaman-Chipewyan batholithic domain, which is interpreted as the root of a magmatic arc.

The Ensialic Mobile Zone has been subdivided into six domains in Saskatchewan and Manitoba. They are the Mudjatik, Peter Lake (Saskatchewan only), Wollaston, Seal River, Great Island and Nejanilini domains. The Mudjatik and Wollaston domains and the west end of the Seal River Domain occur in the Kasmere Lake map area (NTS 64N).

Lithostratigraphy

Metasedimentary rocks of the Paleoproterozoic Hurwitz Group and sedimentary-derived gneissic rocks of the Wollaston Group unconformably overlie the Archean basement rocks of the Hearne Province. The rocks of the Hurwitz Group occur almost entirely in Nunavut as discontinuous structural keels along a southeasterly trend from Rankin Inlet to the northwest corner of Manitoba.

Hurwitz Group

Rocks of the Hurwitz Group are present in the northwest corner of the Kasmere Lake map area, based on mapping and interpretation by Weber et al. (1975a). Argillite (unit H**P**) overlain by dolomite (unit H**Do**) occurs in the Ennadai Block in the extreme northwest of the Kasmere area. The argillite has been correlated with the Ameto Formation of the Hurwitz Group in Nunavut (Weber et al., 1975a) and a metagreywacke, with metasiltstone (unit H**W**) and minor calc-silicate zones, occurring in the Wollaston Domain from Tice Lake northeasterly through the area of Putahow Lake into Nunavut. This unit (H**W**) has been tentatively correlated with a similar greywacke of the Hurwitz Group in the Ennadai Lake area (Nunavut). Eade (1971) considered the greywacke to be part of the Ameto Formation and possibly time equivalent to the argillite.

Wollaston Group

The basal unit of the Wollaston Group in Manitoba and Saskatchewan is a psammitic to semipelitic garnet-biotite ± cordierite gneiss (unit W**N**). It contains sporadic interlayers of calc-silicate rocks and impure to pure quartzite. The gneiss shows a well developed metamorphic layering defined by alternating grey to dark grey, biotite-rich layers (1-100 cm thick), and white to cream, medium- to coarse-grained granitic *lits*. Both of these components are intruded by white, pegmatitic, boudinaged sills of granite. Areas underlain by these rocks coincide with areas of low magnetic intensity (2000-2200 gammas).

Garnet and cordierite are common accessory minerals in the garnet-biotite gneiss; sillimanite is a minor component and occurrences of hypersthene and andalusite are more localized (Schledewitz, 1986). Hypersthene occurs in the semi-pelitic gneiss that is underlain by either hypersthene-bearing granitic rocks or Archean rocks. Andalusite, very commonly with sillimanite, occurs in the garnet-biotite gneiss along the north flank of the Hudsonian Wathaman-Chipewyan batholithic domain.

The application of a regionally significant geologic age to the semi-pelitic gneiss (unit W**N**) remains uncertain. The Rb/Sr ages for semipelitic and pelitic rocks of the Wollaston Domain, which range from 1815 to 1835 Ma (Weber et al., 1975b; Cummings and Scott, 1976), are evidence for Paleoproterozoic metamorphism. The high initial $^{87}Sr/^{86}Sr$ ratios for these rocks suggest that a component of their sedimentary provenance was Archean; however, the ratio does not support an Archean age of sedimentation. Nevertheless, the possibility exists that this rock type may in part be of Archean age (Eade, 1973; Weber et al., 1975a; Lewry and Sibbald, 1980). This possibility is greatest in the Mudjatik Domain (NTS 64K, Manitoba; NTS 64L and 64E, Saskatchewan) and the Nejanilini Domain (NTS 64O and 64P) where the semipelitic to pelitic gneiss forms enclaves within Archean granitic domains.

In the Kasmere Lake area, the garnet-biotite gneiss (unit W**N**) is overlain by a compositionally variable sequence of calc-silicate rocks (unit W**K**) interpreted to have been deposited in a platform setting (Weber et al., 1975a). Regionally, the calc-silicate rocks occur in the Wollaston, Seal River and Nejanilini domains, as bodies of variable size and varied lithologic relationships (Schledewitz, 1986). The calc-silicate rock comprises amphibole-plagioclase-quartz layers with discontinuous diopside ± scapolite layers and carbonate ± wollastonite lenses. The two other rock types in this suite are quartz± tremolite-bearing marble and an albite-pyroxene rock. The marble is best exposed on Fort Hall Lake and Thanout Lake in the Kasmere Lake map area, where it is greater than 45 m thick (Thanout Lake). The albite-pyroxene rock forms small, sparse outcrops that can rarely be traced for more than a few kilometres along strike. The rock weathers pale pink to white, with discontinuous crudely aligned green to dark green layers. The principal minerals are albite and augite to aegerine-augite, with minor amounts of quartz, ilmenite and sphene. The suite of calc-silicate rocks is of economic interest because of the observed high concentrations of uranium, the rare occurrence of cobalt- and nickel-bearing minerals, and trace amounts of gold.

The calc-silicate rocks are overlain by regionally discontinuous biotite psammite gneiss (unit W**Sb**) and a locally restricted conglomerate comprising calc-silicate and quartz clasts in a quartzite matrix. These rock types are interpreted to mark a change from the platform stage to a stage of tectonic disturbance which resulted in some areas experiencing uplift while other areas underwent subsidence. The uppermost unit in the Wollaston Group is an areally extensive, pink-weathering, magnetiferous, arkosic ± hornblende ± diopside gneiss (unit W**Sn**).

Hurwitz Group and Wollaston Group Relationship

The Wollaston Group biotite psammite gneiss (unit W**Sb**) and the Hurwitz Group metagreywacke (unit H**W**) in the Kasmere Lake area are considered to be stratigraphic equivalents, based on their lithological similarity and apparent lateral gradation (Weber et al., 1975a). These formations can, in turn, be correlated with the Hurwitz Group Ameto Formation in Nunavut. The Hurwitz Group Ameto and post-Ameto formations define a change from cratonic basin sedimentation (in the underlying Padeli and Kinga formations) to a period of crustal subsidence and tectonic destabilization. Zircon and baddeleyite from gabbro sills in the lower to middle Ameto Formation, in the area of North Henik Lake, Nunavut were dated by the U-Pb method at 2094 +26/-17 Ma (Patterson and Heamen, 1991). This establishes a minimum depositional age of ca. 2100 Ma for the Hurwitz lower to middle Ameto Formation. By inference, the change from platform sedimentation (unit W**K**) to a stage of tectonic disturbance (unit W**Sb**) in the Wollaston Group in Manitoba correlates with the change from cratonic basin sedimentation in Nunavut.

A similar minimum age of 2100 Ma has been established for the Wollaston Group in Saskatchewan. A date of 2076 ± 3 Ma, interpreted to be an igneous crystallization age, was obtained from samples of mylonitic quartzofeldspathic gneiss in the rocks of the Courtenay Lake Formation of the Wollaston Group (Annesley et al., 1992). Courtenay Lake Formation conglomerate, arkose and quartzite are interlayered with mafic volcanic rocks characterized by within-plate lithogeochemistry, thus favouring emplacement in a continental rift setting (Fossenier et al., 1995; MacNeil et al., 1997). The timing of continental rifting recorded in the Courtenay Lake Formation in Saskatchewan, at ca. 2100 Ma, is consistent with the observations in Nunavut and Manitoba.

The Mudjatik Domain was defined in Saskatchewan (Lewry and Sibbald, 1977) and is characterized by flat-lying, migmatitic Archean infrastructural lobes infolded with screens of supracrustal-derived garnet-biotite migmatite. Reconnaissance samples of granitoid rocks in the Cree Lake Ensialic Mobile Zone in Saskatchewan yielded Archean Sm-Nd model ages of 2.9 to 2.7 Ga (Bickford et al., 1990). The Archean rocks record two main pulses of Neoarchean magmatism, one at 2740 to 2700 Ma and another at 2630 to 2590 Ma, plus an interpreted metamorphic age of 2566 Ma from a migmatitic tonalite gneiss (Annesley et al., 1997). The age of the supracrustal migmatites is unknown and has been inferred to be Paleoproterozoic but the possibility of an Archean age cannot be entirely ruled out (Lewry and Sibbald, 1980).

The Archean rocks of the Mudjatik Domain in Saskatchewan trend northeasterly into Manitoba. However, the Mudjatik Domain changes from a basement-cover mobile belt in Saskatchewan to granitoid Archean infrastructure overlain by metasedimentary rocks of the Hurwitz Group in Manitoba. These rock types were intruded by Hudsonian, synkinematic, moderately uraniferous granite (unit **G**), dated at (1850 to 1823 Ma ; Tella et al., 1985; Le Cheminant et al.,1987) and anorogenic, high-uranium, fluorite-bearing granite (unit **G**f), dated at 1753 Ma (Loveridge et al., 1987).

The change in the character of the Mudjatik Domain, which begins in Saskatchewan near the Manitoba border, coincides with a change in the regional Bouguer gravity and aeromagnetic patterns. In Manitoba, the Mudjatik Domain is characterized by greater negative values and marked by a well defined northwesterly trending - 60 mGal contour interval. The aeromagnetic pattern suggests that the gneiss belt, characterized by flat-lying, infrastructural lobes in Saskatchewan, forms an elongated dome that rises west of the Manitoba-Saskatchewan border and plunges in a northeasterly direction west of Putahow Lake, Manitoba.

Grey quartz dioritic and granodioritic gneiss and pink mylonitic rocks of the Archean infrastructure of the Mudjatik Domain in Manitoba continue along strike to the northeast into Nunavut, where they are referred to as the Kasba gneisses. Kasba gneiss has yielded bimodal ages of 3274 ± 18 Ma and 2777 +95/-66 Ma (Loveridge et al., 1988).

The Archean rocks are structurally overlain by Hurwitz Group argillite (unit H**P**) and dolomite (unit H**Do**) in the extreme northwest corner of the Kasmere Lake map area in Manitoba and along the eastern boundary of the Mudjatik Domain. The Hurwitz Group rocks have been folded into a syncline that extends southwesterly into Saskatchewan. The syncline is the southerly part of a larger, complex, bifurcating synclinal structure that extends into Nunavut where it is cored by post-Hurwitz Group rocks of the Kiyuk Group (Aspler et al., 1989). A pluton of fluorite-bearing granite occupies a domal structure at the point of bifurcation. Aeromagnetic trends indicate that the Hurwitz Group in northeastern Saskatchewan forms a closure, and that the two synclines converge. The complex synclinal structure is considered to be at the southeasterly termination of a segment of the Archean infrastructure, the Ennadai Block (Lewry et al., 1985), that is characterized by a lesser degree of reactivation than elsewhere in the Mudjatik Domain. The nature of the transition from the structural style in the Ennadai Block to that of the rest of the Mudjatik Domain remains problematic, due largely to the lack of bedrock exposure.

The Hurwitz Group argillite (unit H**P**) in Manitoba is underlain in part by mylonitic to protomylonitic granodioritic to granitic gneiss (unit **T**k) in a shear zone that is 2 to 9 km wide and trends southwesterly into Saskatchewan. The textures of the deformed rocks in this shear zone indicate partial recrystallization under conditions of amphibolite-facies metamorphism, indicating that deformation must have taken place prior to the Hudsonian metamorphism (Weber et al., 1975a).

Low magnetic intensity Hurwitz Group metagreywacke (unit H**W**) overlies magnetic quartz diorite to granodiorite gneiss (unit **Tn**) along and immediately northwest of the eastern boundary of the Mudjatik Domain. Magnetic maps suggest that the Hurwitz Group metagreywacke forms a thin cover overling the Archean basement of the Mudjatik Domain, from Tice Lake through Putahow Lake to the Nunavut border. The Hurwitz Group rocks are openly folded and can be traced north to Kiyuk Lake, Nunavut, into a large area of openly folded Hurwitz Group and younger Kiyuk Group metasedimentary rocks. The structural style is similar in the Ennadai Block to the northwest, which is considered to be the part of the Hearne Province least affected by the Trans-Hudson thermotectonism.

The eastern boundary of the Mudjatik Domain dips steeply to the southeast and is defined by a narrow, linear, magnetic gradient that trends northeasterly. This pronounced geophysical lineament is traceable without deviation from the Manitoba-Saskatchewan border northeasterly to the Nunavut border. A trough of low magnetic intensity, correlating with rocks of the Wollaston Domain, lies to the south of the more magnetic rock types in the Mudjatik Domain. This boundary is considered to be structural in origin and similar in age to the Needle Falls Shear Zone (1855-1800 Ma; Stauffer and Lewry, 1993) that forms the eastern boundary of the Wollaston Domain in Saskatchewan. This interpretation is consistent with the observation that the metamorphic foliation in the quartz dioritic to granodioritic gneiss and the migmatitic layering in supracrustal inliers is openly folded about large, easterly trending axial planes, such as at Wolk Lake and Sector Lake (Weber et al., 1975a). The folding is related to an array of east-northeasterly trending shear zones rooted in the larger northeasterly trending structures on the west side of the Mudjatik-Wollaston domain boundary.

The Wollaston Domain and Seal River Domain share a common lithostratigraphy and metamorphic history. Wollaston Group paragneiss unconformably overlies Archean granitoid rocks and possibly Archean volcanic and sedimentary-derived gneiss. The Wollaston Domain is a northeast-trending fold belt with minor Hudsonian plutonism, whereas the Seal River Domain exhibits an early, easterly trending, open fold set locally overprinted by northeasterly structures. The Seal River Domain contains a greater volume of Hudsonian plutons.

The Wollaston Domain is defined by 1) the predominance of supracrustal-derived gneisses of the Wollaston Group, and 2) the fold-belt structural style. These criteria were first established in Saskatchewan and termed the Wollaston Fold Belt System (Money, 1965) with a width of approximately 100 km. The Wollaston Domain in Manitoba is well defined from the Manitoba-Saskatchewan border, where it is approximately 90 km wide (Whiskey Jack Lake map area, NTS 64K) and trends northeasterly to the south end of Kasmere Lake, where it is approximately 35 km wide (Kasmere Lake map area, NTS 64N). Northeast of Kasmere Lake, the Wollaston Domain is less well defined and narrows to 20 km at the Nunavut border. The Manitoba segment of the Wollaston Domain is characterized by tightly spaced elongate domes, antiforms and synforms that are generally tight to isoclinal. The antiforms contain cores of pelitic and semipelitic gneiss (unit W**N**) and the elongate domes are cored by Archean hypersthene-bearing enderbite to monzocharnockite (unit **Zx**). The synforms contain in their cores Wollaston Group meta-arkose (unit W**Sn**) or biotite psammite gneiss (unit W**Sb**).

The Seal River Domain occurs east of the Wollaston Domain. It is characterized by large, east to east-southeast trending folds and faults that have been further deformed by discrete northerly and northeasterly trending structures. Based on magnetic trends and attitudes of metamorphic layering, the western boundary of the Seal River Domain is irregular and step-like, reflecting a pattern of structural interference.

The west end of the Seal River Domain, for a distance of approximately 40 km to the east, is divided into two segments by the Hudsonian Topp Lake pluton, a large, Paleoproterozoic, synkinematic, porphyritic monzogranite intrusion (unit **Gp**) that occupies the southeast quarter of the Kasmere Lake map area.

Southwest of the Topp Lake pluton, the structure is characterized by basin-and-dome polyphase deformation. This fold pattern is the result of interference of the northeasterly Wollaston fold trend and the easterly Seal River fold trend. Major structures are outlined by large-scale layering of supracrustal-derived paragneiss and migmatite. Domes are cored by Archean and/or Hudsonian granitic rocks. The basins are cored by arkosic gneiss and/or calc-silicate rocks. Synforms in general are highly tightened and the trends of axial traces are highly variable. This basin-and-dome pattern continues to the southwest into the Whiskey Jack Lake map area (NTS 64K).

An easterly trending, approximately 40 km wide synform cored by semi-pelitic to pelitic gneiss and intruded by variably magnetic pink monzogranite, lies on the north flank of the Topp Lake pluton. The south limb of the synform comprises magnetiferous arkosic gneiss, calc-silicate and biotite psammite gneiss (unit W**Sb**). The north limb of the synform comprises magnetiferous arkosic gneiss, and calc-silicate metasedimentary rocks intruded by pyrrhotite-bearing amphibolite after gabbro (Peck et al., 1994). The highly varied magnetic signature of the semi-pelitic to pelitic gneiss in the core of the synform is anomalous; regionally, the paragneiss has a characteristically low magnetic intensity. The magnetic data suggest that the paragneiss may form a thin cover overlying magnetiferous arkosic gneiss. The presence of the basal semi-pelitic to pelitic gneiss in the core of the synform overlying younger arkosic gneiss, the uppermost unit of the Wollaston Group, is evidence of a structural inversion.

The easterly trending synform is truncated to the west at Bagg Lake, in the Kasmere Lake map area (NTS 64N) and trends westerly into the Munroe Lake map area (NTS 64O). The north limb of the synform coincides with a 50 km long, easterly trending series of strong magnetic linears that passes through the south end of Nueltin Lake. Rocks north of the easterly trending magnetic lineament include the semipelitic to pelitic garnet-biotite gneiss, intruded by white tonalite (unit **T**). These rocks exhibit a uniform low magnetic signature characteristic of the semipelitic to pelitic gneiss. The origin of the 50 km long easterly trending magnetic lineament along the north limb of the synform remains unresolved.

Economic Geology

The Uranium Reconnaissance Program (URP) was a nation-wide survey carried out by the Geological Survey of Canada, with Manitoba participating in 1975 and 1976. The survey was flown on a line spacing of 5 km, using a high-sensitivity gamma-ray spectrometer. Lake-centre sediment sampling, with an approximate density of one sample per 13 km^2, was carried out as part of a concurrent geochemical survey. Samples were analyzed for U, Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, Mo, As, Hg and loss-on-ignition.

The URP was intended to define broad regions containing higher than average uranium contents. Broad zones of uranium enrichment were delineated in northern Manitoba, mainly in the Kasmere Lake map area. The potential for uranium deposits in this area was originally indicated from limited prospecting followed by more extensive exploration, by Denison Mines Ltd., Dynamic Petroleum Ltd. and Yukon Antimony Corp. Ltd. (Weber et al., 1975a). Between Snyder Lake and Kasmere Lake the survey revealed a chain of lake sediment anomalies, trains of radiometric anomalies and relatively higher ratios of uranium to thorium. The URP survey also indicated a complex U-Ni-Co lake sediment geochemical anomaly restricted to the region extending from Snyder Lake to Fort Hall and Thanout lakes. The anomalies can be related to calc-silicate rocks that contain a larger than average component of amphibolite and uniquely contain cobalt-and nickel-bearing minerals and trace amounts of gold.

Uranium occurs in both the calc-silicate rocks (unit W**K**) and the basal garnet- biotite gneiss (unit W**N**) of the Wollaston Group. However, concentration levels are higher and more localized in the calc-silicate rocks, compared to the more widely dispersed lower levels of uranium in the garnet-biotite gneiss and the white leucotonalite (unit **T**) that most commonly intrudes the garnet-biotite gneiss.

The known base-metal occurrences are mainly in the calc-silicate rocks. A sedimentary origin is the preferred interpretation for the base metal occurrences (Weber et al., 1975a). The rocks of the Courtenay Lake-Cairns Lake fold belt, which lie along the eastern edge of the Wollaston Group in Saskatchewan, also contain a number of base-metal occurrences interpreted to fit a sedimentary exhalative origin (Delaney et al., 1997). Mineral showings and deposits in Saskatchewan occur sporadically over a distance of 280 km.

Subsequent to the release of the URP survey, extensive ground follow-up was carried out by mining companies, the Manitoba Mineral Resources Division and the Geological Survey of Canada. This activity is summarized in Schledewitz (1986) and Soonawala (1980).

Tectonic Synthesis

The rocks of the Kasmere Lake map area are part of the Trans-Hudson Orogen. This collision belt extends for approximately 5000 km from the north-central United States, through the Churchill Province in Canada, and ultimately to Greenland (Lewry and Collerson, 1990). In Manitoba and Saskatchewan two major elements of the Trans-Hudson Orogen, the Cree Lake Ensialic Mobile Zone of the Archean Hearne Province, and 2) the Paleoproterozoic arc-related terranes, are separated by the Andean-type Wathaman-Chipewyan magmatic arc which has a minimum strike length of 900 km and a width of 15 to 150 km.

Radiometric dating has allowed the recognition of Paleoproterozoic, pre -Trans-Hudson Orogen sedimentary and igneous rocks, and discrete events of the multistage subduction and collision process.

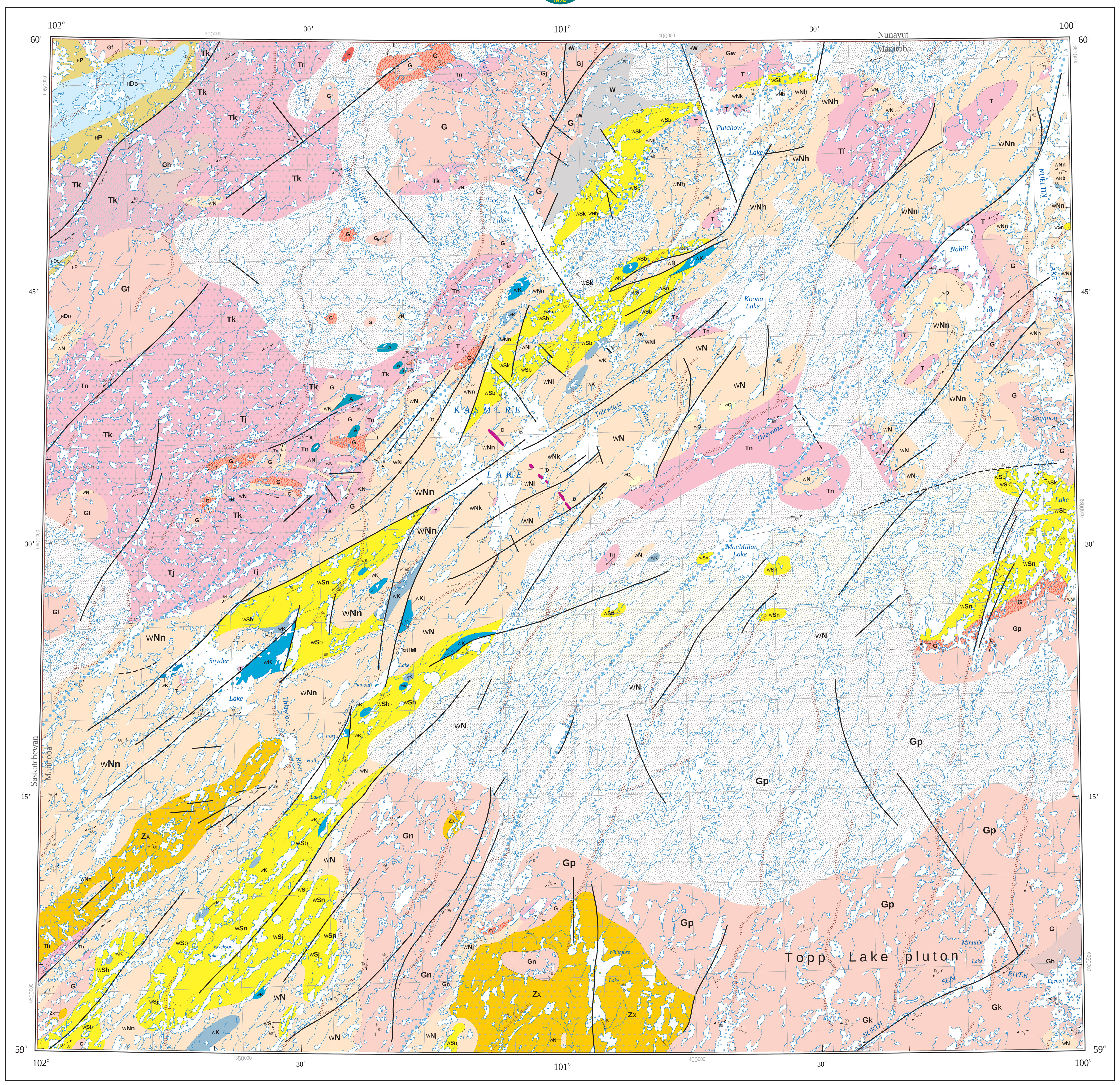
- Pre-Trans-Hudson Orogen sedimentation:
  - Montgomery Group and Hurwitz Group Kinga and Padlei formations, and the overlying Ameto Formation (Nunavut), range in age from 2400 to 2100 Ma (Patterson and Heaman, 1991), and possibly represent cratonic-basin sedimentation (Aspler and Bursey, 1990).
  - Wollaston Group Courtenay Lake Formation (Saskatchewan), with a minimum age of 2100 Ma (Annesley et al., 1992), unconformably overlies garnet-biotite gneiss (age uncertain).
  - Wollaston Group calc-silicate rocks (Manitoba) overlie garnet-biotite gneiss (age uncertain).
- Pre-Trans-Hudson Orogen mafic igneous and volcanic rocks (geochemistry favours continental-rift setting):
  - Mafic sills and flows, dated at 2094 +26/-17 Ma (Patterson and Heaman, 1991) intrude Hurwitz Group lower Ameto Formation and underlying Kinga Formation (Nunavut).
  - Mafic pillowed and massive flows in the Courtenay Lake Formation (Saskatchewan) have a minimum age of 2100 Ma (Fossenier et al., 1995; Annesley et al., 1992).
- The earliest dated magmatism related to Trans-Hudson orogenesis is recorded in felsic volcanism in the Lynn Lake belt at 1.91 Ga (Baldwin et al., 1987). The mafic igneous activity at ca. 2100 Ma may have related to opening of the Manikwan Sea (Patterson and Heaman, 1991; Aspler and Bursey, 1990). Units deposited within the Trans-Hudson Orogen may have been limited to post-Courtenay Lake Formation (Wollaston Group), post-Ameto Formation (Hurwitz Group) and the overlying Kiyuk Group. The entire Paleoproterozoic cover sequence and Archean infrastructure was deformed during the Trans-Hudson orogenesis.
- Possible early arc-continent collision (1888-1860 Ma; Bickford et al., 1990):
  - deformation of cratonic basin and (?) passive margin successions into fold and thrust belts, overthrusting of (?) fore-deep deposits;
  - deformation and metamorphism in the Rottenstone Domain (Saskatchewan) minimum age 1867 ±8 Ma on synkinematic tonalitic gneiss which postdate some phases of deformation (Lewry et al., 1987).

A complex collage of Paleoproterozoic volcanic island arc, back-arc-ocean-floor rocks and intrusive rocks (the Rottenstone Domain and La Ronge belt in Saskatchewan; and the Southern Indian, Lynn Lake and Leaf Rapids domains in Manitoba were accreted to the Rae-Hearne craton, possibly via southeast-directed subduction (Bickford et al., 1990).

- Emplacement of Wathaman-Chipewyan magmatic arc at 1865 to 1855 Ma (Van Schmus and Schledewitz, 1986; Meyer et al., 1992) is interpreted as a continental-margin magmatic arc related to a northerly subduction flip.

The Wathaman-Chipewyan magmatic arc lies between the Archean Rae-Hearne craton and an accreted terrane consisting of the Rottenstone Domain, the Southern Indian Domain, and the La Ronge and Lynn Lake-Leaf Rapids greenstone belts. The magmatic arc effectively stitches the craton and the Paleoproterozoic accreted-arc terranes. Plutons with this tectonic relationship occur in the Seal River Domain and at the northern end of the Wollaston Domain in Manitoba and Nunavut. The Topp Lake pluton in the Kasmere Lake area has a Rb-Sr whole rock isochron age of 1815 ± 32 Ma (initial ratio 0.7113; Weber et al., 1975b). This age must be considered a minimum age for crystallization, because Rb-Sr ages in northern Manitoba are consistently lower by 2 to 3% when compared to U-Pb zircon ages (Clark and Schledewitz, 1988). A recalculated maximum age for these rocks would be consistent with the emplacement age of 1865 to 1855 Ma for the Wathaman-Chipewyan magmatic arc. High initial ratios of $^{87}Sr/^{86}Sr$ are characteristic of plutons in the Cree Lake Zone, whereas the south flank of the magmatic arc has lower initial ratios (Halden et al., 1990). This relationship indicates that Trans-Hudson plutonism in the Cree Lake zone contained a much larger component of reworked Archean crust than did the magmas which gave rise to the magmatic arc.

- Continent-continent collision, deformation and emplacement of nappe sheets (1830-1800 Ma; Bickford et al., 1990):
  - The northwest margin of the Wathaman-Chipewyan magmatic arc is deformed along the Needle Falls Shear Zone (an oblique collision structure), 1855 to 1800 Ma (Stauffer and Lewry, 1993) at the boundary with the Wollaston Domain and along shear zones at the boundary with the Peter Lake Complex (Reindeer Lake, Saskatchewan).
  - The age of peak thermal metamorphism of the Wollaston Group, the underlying Archean basement, and early-formed Hudsonian intrusions (ca. 1820-1812 Ma; Annesley et al., 1997) is similar to the age of peak metamorphism in the Trans-Hudson Orogen south of the magmatic arc.
- Late to postcollisional deformation:
  - Ductile/brittle deformation continued along the Needle Falls Shear Zone and the mostly sheared boundary of the Peter Lake Complex (Ray and Wanless, 1980; Van Schmus et al., 1987).
  - tFolds tightened and ductile/brittle shearing occurred in the Wollaston and Mudjatik domains.
  - Northeast-, north- and east-trending ductile/brittle shear zones were superimposed on the east-trending structures of the Wathaman-Chipewyan magmatic arc, Seal River Domain and the Nejanilini Domain.
- Postcollisional granites (1753 +3/-2Ma; Loveridge et al., 1987), characteristically fluorite-bearing and with rapakivi texture and high uranium background, occur most commonly in parts of the Hearne Province where negative gravity anomalies exceed -60 mGals (Schledewitz, 1986).



Universal Transverse Mercator Projection
Zone 14 North American Datum 1983

Printed 2005

Scale 1:250 250000
Kilometres 5 0 5 10 15 20 25 Kilometres

LEGEND

MUDJATIK DOMAIN
Proterozoic
Hudsonian
- G: Granite; Gf - pink granite, fluorite bearing; Gj - granite and granodiorite diatexite to biotite-metatexite, ± garnet; Gw - granite and Hurwitz Group metagreywacke, metasiltstone
- Gh: Granite with grey tonalitic to granodioritic gneiss
- R: Quartz feldspar porphyry
- T: Tonalite, cordierite bearing ± tourmaline

Hurwitz Group
- HDo: Dolomite
- HP: Argillite
- HW: Metagreywacke, metasiltstone

Wollaston Group
- wSb: Biotite psammite gneiss, ± calc-silicate lenses
- wK: Calc-silicate rocks
- wK: Albite-pyroxene rocks
- wN: Semipelitic paragneiss to metatexite, + garnet

Proterozoic and/or Archean
- G: Granodiorite diatexite to biotite metatexite, ± garnet
- A: Amphibolite

Archean
- Tn: Grey tonalitic to granodioritic gneiss
- Tk: Cataclastic grey tonalite to granodioritic gneiss and granite

WOLLASTON DOMAIN
Proterozoic
Post-Hudsonian
- D: Diabase

Hudsonian
- G: Granite, massive to foliated, ± aplite ± pegmatite zones
- T: Tonalite, cordierite bearing, ± tourmaline

Wollaston Group
- wSn: Meta-arkose; derived arkosic gneiss with metatexite
- wK: Calc-silicate rock
- wK: Marble quartz tremolite
- wK: Albite-pyroxene rock
- wN: Semipelitic paragneiss to metatexite, + garnet
- wQ: Impure quartzite to quartzite

Proterozoic and/or Archean
- Gn: Foliated granite

Archean
- Tj: Grey tonalitic to granodioritic gneiss with granodiorite diatexite to biotite metatexite
- Zx: Hypersthene granite (monzocharnockite)

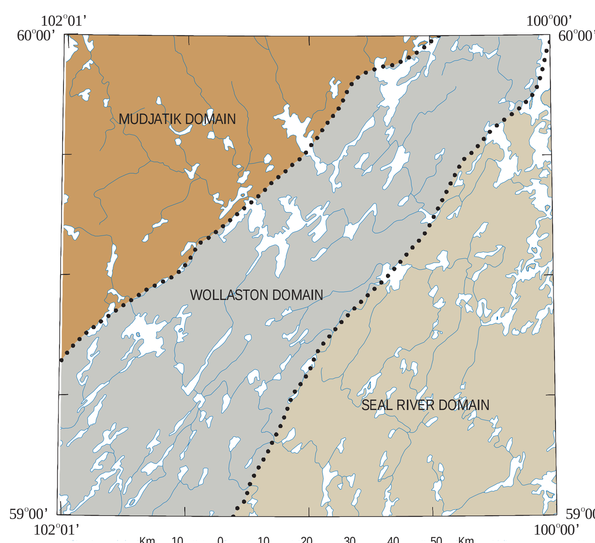
SEAL RIVER DOMAIN
Proterozoic
Hudsonian
- G: Granite, massive to foliated, ± aplite ± pegmatite; Gp - pink porphyritic granite
- Gh: Hybrid granite
- T: Tonalite, cordierite bearing, ± tourmaline

Wollaston Group
- wSn: Meta-arkose; derived arkosic gneiss with metatexite
- wKb: Calc-silicate rocks with biotite psammite gneiss
- wN: Semipelitic paragneiss to metatexite
- wQ: Impure quartzite to quartzite

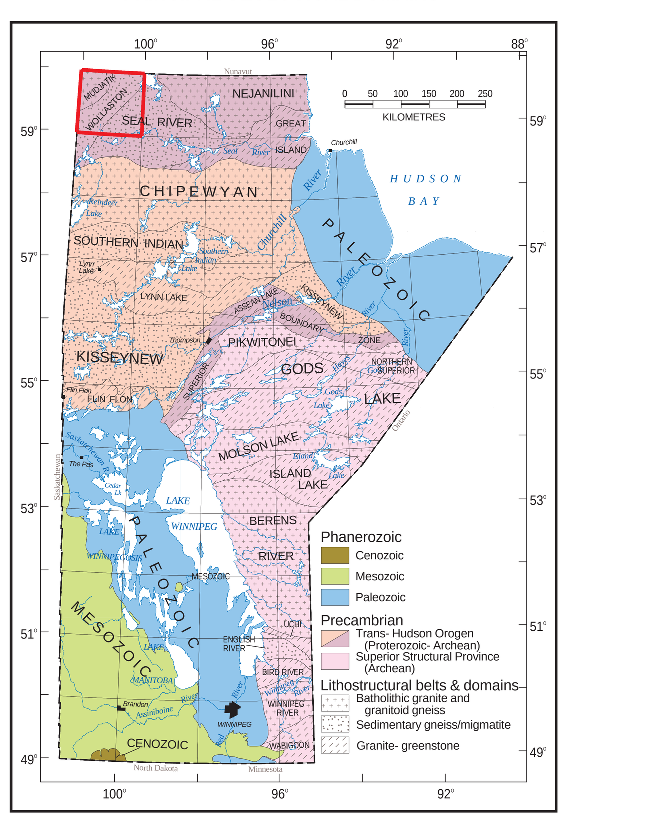
Proterozoic and/or Archean
- Gk: Foliated alaskite with hybrid granite and pink aplite, ± hornblende; Gn - foliated granite
- G: Granodiorite diatexite to biotite metatexite, ± garnet

Archean
- Zx: Hypersthene granite (monzocharnockite)

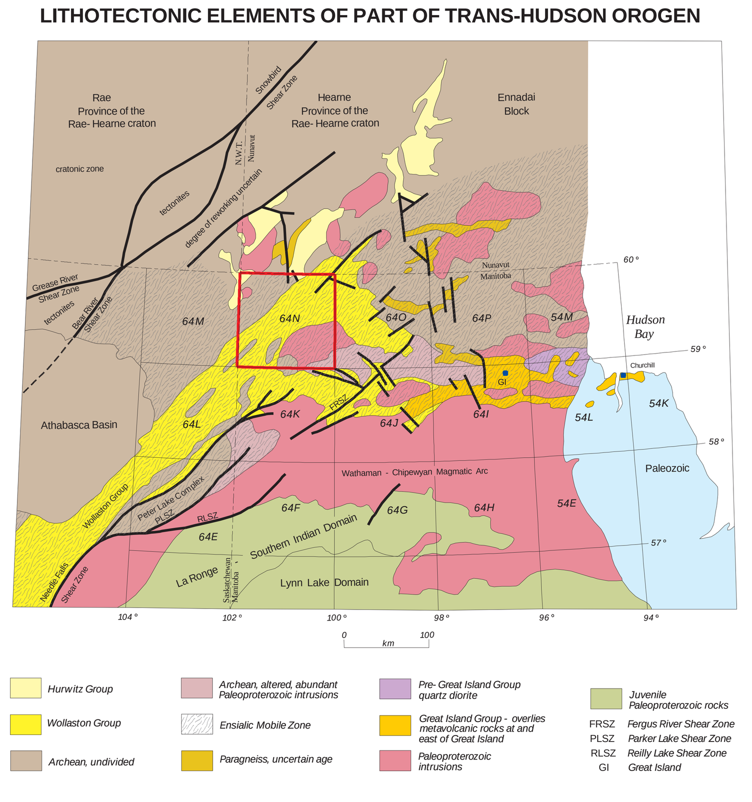
GEOLOGICAL DOMAINS



PRINCIPAL GEOLOGICAL DOMAINS



LITHOTECTONIC ELEMENTS OF PART OF TRANS-HUDSON OROGEN



SELECTED BIBLIOGRAPHY

Annesley, I.R., Madore, C., and Krogh, T.E.
1992: U-Pb geochronology of some granitoids from the Peter Lake domain: a summary; *in* Summary of Investigations 1992, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Misc. Report 92-4, p. 168-171.

Annesley, I.R., Madore, C., Rupan, S., and Krogh, T.E.
1997: U-Pb geochronology of thermotectonic events in the Wollaston Lake area, Wollaston domain: a summary of 1994-1996 results; *in* Summary of Investigations 1997, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Misc. Rep. 97-4, p. 162-173.

Aspler, L.B., Bursey, T.L., and Miller, A.R.
1989: Sedimentology, structure, and economic geology of the Poorfish-Windy thrust-fold belt, Ennadai Lake area, District of Keewatin, and the shelf to foredeep transition in the foreland of Trans-Hudson Orogen; *in* Current Research, Part C, Geological Survey of Canada, Paper 89-1C, p. 143-155.

Aspler, L.B. and Bursey, T.L.
1990: Stratigraphy, sedimentation, dome and basin basement-cover infolding, and implications for gold in the Hurwitz Group, Hawk Hill-Griffin lakes area, District of Keewatin, N.W.T.; *in* Current Research, Part C, Geological Survey of Canada, Paper 90-1C, p. 219-230.

Baldwin, D.A., Syme, E.C., Zwanzig, H.V., Gordon, T.M., Hunt, P.A., and Stevens, R.D.
1987: U-Pb zircon ages from the Lynn Lake and Rusty Lake metavolcanic belts, Manitoba: two ages of Proterozoic magmatism; Canadian Journal of Earth Sciences, v. 24, p. 1053-1063.

Bickford, M.E., Collerson, K.D., Lewry, J.F., Van Schmus, W.R., and Chiarenzelli, J.R.
1990: Proterozoic collisional tectonism in the Trans-Hudson Orogen, Saskatchewan; Geology, v.18, no. 1, p. 14-18.

Clark, G.S. and Schledewitz, D.C.P.
1988: Rubidium-strontium ages of Archean and Proterozoic rocks in the Nejanilini and Great Island domains, Churchill province, northern Manitoba, Canada; Canadian Journal of Earth Sciences, v. 24, p. 246-254.

Cummings, G.L. and Scott, B.P.
1976: Rb/Sr dating of rocks from the Wollaston Lake belt of Saskatchewan; Canadian Journal of Earth Sciences, v. 13, p. 355-364.

Delaney, G.D., Janovic, Z., MacNeil, A., McGowan, J., and Tisdale, D.
1997: Geological investigations of the Courtenay Lake-Cairns Lake fold belt and the Hills Lake embayment, Johnson River inlier, Wollaston domain, northern Saskatchewan; *in* Summary of Investigations, 1997, Saskatchewan Geological Survey, Saskatchewan Energy Mines, Misc. Rep. 97-4, p. 90-101.

Eade K.E.
1971: Geology of the Ennadai Lake map-area, District of Keewatin; Geological Survey of Canada, Paper 70-45, p. 19.

Eade K.E.
1973: Geology of the Nueltin Lake and Edehon Lake (west half) map-areas, District of Keewatin; Geological Survey of Canada, Paper 72-21, p. 29.

Fossenier, K., Delaney, G.D., and Watters B.R.
1995: Lithogeochemistry of volcanic rocks from the lower Proterozoic Courtenay Lake formation, Wollaston Domain; *in* Summary of Investigations 1995, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Misc. Report 95-4, p. 49-60.

Halden, N.M., Clark, G.S., Corkey, M.T., Lenton, P.G., and Schledewitz, D.C.P.
1990: Trace-element and Rb-Sr whole-rock isotopic constraints on the origin of the Chipewyan, Thorsteinson, and Baldock batholiths, Churchill province, Manitoba.; *in* Lewry, J.F. and Stauffer, M.R., eds., The Early Proterozoic Trans-Hudson Orogen of North America; Geological Association of Canada, Special Paper 37, p. 201-214.

Hoffman, P.F.
1990: Subdivision of the Churchill province and extent of the Trans-Hudson Orogen; *in* Lewry, J.F. and Stauffer, M.R. (eds.): The Early Proterozoic Trans-Hudson Orogen of North America; Geological Association of Canada, Special Paper 37, p.15-39.

Le Cheminant, A.N., Roddick, J.C., Tessier, A.C., and Bethune, K.M.
1987: Geology and U-Pb ages of early Proterozoic calc-alkaline plutons northwest of Wager Bay, District of Keewatin; *in* Current Research, Part 1A, Geological Survey of Canada, Paper 87-1A, p. 773-782.

Lewry, J.F. and Sibbald, T.I.I.
1977: Variation in lithology and tectonometamorphic relationships in the Precambrian basement of northern Saskatchewan; Canadian Journal of Earth Sciences, v. 14, p.1453-1467.

Lewry, J.F., Sibbald, T.I.I., and Rees, C.J.
1978: Metamorphic patterns and their relation to tectonism and plutonism in the Churchill province in northern Saskatchewan; *in* Metamorphism in the Canadian Shield, Geological Survey of Canada, Paper, 78-10, p.139-154.

Lewry, J.F. and Sibbald, T.I.I.
1980: Thermotectonic evolution of the Churchill province in northern Saskatchewan; Tectonophysics, v. 68, p. 45-82.

Lewry, J.F., Sibbald, T.I.I., and Schledewitz, D.C.P.
1985: Variation in character of Archean rocks in the western Churchill province and its significance; *in* Ayres, L.D., Thursont, P.C., Card, K.D., and Weber W. (eds): Evolution of Archean Supracrustal Sequences; Geological Association of Canada, Special Paper 28, p. 239-261.

Lewry, J.F., Macdonald, R., Livesey, C., Meyer, M., Van Schmus, W.R., and Bickford, M.E.
1987: U-Pb geochronolgy of accreted terranes in the Trans-Hudson Orogen in northern Saskatchewan, Canada; *in* Pharoh, T.C., Beckinsle, R.D., and Eickard, D. (eds.): Geochemistry and Mineralization of Proterozoic Volcanic Suites; Geological Society of London, Special Publication 33, p. 147-166.

Lewry, J.F. and Collerson, K.D.
1990: The Trans-Hudson Orogen: extent, subdivision, and problems; *in* Lewry, J.F. and Stauffer, M.R. (eds.): The Early Proterozoic Trans-Hudson Orogen of North America; Geological Association of Canada, Special Paper 37, p. 1-14.

Loveridge, W.D., Eade, K.E., and Roddick, J.C.
1987: A U-Pb age on zircon from a granite pluton, Kamilukuak Lake area, District of Keewatin, estabishes a lower limit for the age of the Christopher Island formation, Dubawnt group; *in* Radiogenic Age and Isotopic Studies: Report 1; Geological Survey of Canada, Paper 87-2, p. 67-71.

Loveridge, W.D., Eade, K.E., and Sullivan, R.W.
1988: Geochronological studies of Precambrian rocks from the southern District of Keewatin; Geological Survey of Canada, Paper 88-18, p. 36.

MacNeil, A., Delaney, G.D., and Ansdell, K.
1997: Geology of the Courtenay Lake formation in the Cook Lake area, Wollaston domain, northern Saskatchewan; *in* Summary of Investigations 1997, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Misc. Report 97-4, p.115-120.

Meyer, M.T., Bickford, M.E., and Lewry, J.F.
1992: The Wathaman batholith: an early Proterozoic continental arc in the Trans-Hudson orogenic belt, Canada; Geological Society of America Bulletin, v. 104, p.1073-1085.

Money, P.L.
1965: The geology of the area around Needle Falls, Churchill River, comprising the Eulas Lake area (west half), Sandfly Lake area (east half), and Black Island area (west half); Saskatchewan Department of Mineral Resources Report 88, p. 70.

Patterson, J.G. and Heaman, L.M.
1991: New geological limits on the depositional age of the Hurwitz group, Trans-Hudson hinterland, Canada; Geology, v. 19, no. 11, p. 1137-1140.

Peck, D.C., Cameron, H.D.M., and Hosain, I.T.
1994: Mineral resource studies in proposed endangered spaces, ES-A and ES-C, northwest Manitoba; *in* Report of Activites,1994,Manitoba Department of Energy and Mines, p. 5-10.

Ray, G.E. and Wanless, R.K.
1980: The age and geological history of the Wollaston, Peter Lake, and Rottenstone domains in northern Saskatchewan; Canadian Journal of Earth Sciences, v. 17, p. 333-347.

Schledewitz, D.C.P.
1986: Geology of the Cochrane and Seal rivers area; Manitoba Energy and Mines, Geological Services; Geological Report GR80-9, p. 139.

Soonawala, N.M.
1980: Helicopter-scintillometer and lake sediment surveys, Kasmere-Munroe Lake area, northwest Manitoba; Manitoba Mineral Resources Division, Economic Geology Report ER80-2, 35 p.

Stauffer, M.R. and Lewry, J.F.
1993: Regional setting and kinematic features of the Needle Falls shear zone, Trans-Hudson Orogen; Canadian Journal of Earth Sciences, v. 30, p.1338-1354.

Tella, S., Heywood, W.W., and Loveridge, W.D.
1985: A U-Pb age on zircon from a quartz syenite intrusion, Amer Lake map area, District of Keewatin, NWT; *in* Current Research, Part B, Geological Survey of Canada, Paper 85-1B, p. 367-370.

Van Schmus, W.R., Bickford, M.E., Lewry, J.F., and Macdonald, R.
1987: U-Pb geochronology in the Trans-Hudson Orogen, northern Saskatchewan, Canada; Canadian Journal of Earth Sciences, v. 24, p. 407-424.

Van Schmus, W.R. and Schledewitz, D.C.P.
1986: U-Pb zircon geochronology of the Big Sand Lake area in northern Manitoba; *in* Report of Activities, 1986, Manitoba Department of Energy and Mines, Report of Field Activities, 1986, p. 207-210.

Weber, W., Schledewitz, D.C.P., Lamb, C.F., and Thomas, K.A.
1975a: Geology of the Kasmere Lake-Whiskey Jack Lake (north half) area (Kasmere project); Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Geological Services Branch, Publication 74-2, p. 163.

Weber, W., Anderson, R.K., and Clark, G.S.
1975b: Geology and geochronology of the Wollaston Lake fold belt in northwestern Manitoba; Canadian Journal of Earth Sciences, v. 12, p. 1749-1759.

Synoptic geology by D.C.P. Schledewitz, W. Weber, C.F. Lamb and K.A. Thomas

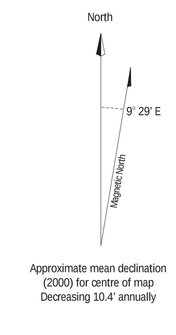
Compilation by D.C.P. Schledewitz and D. Lindal

Digital CAD drafting by B. Lenton

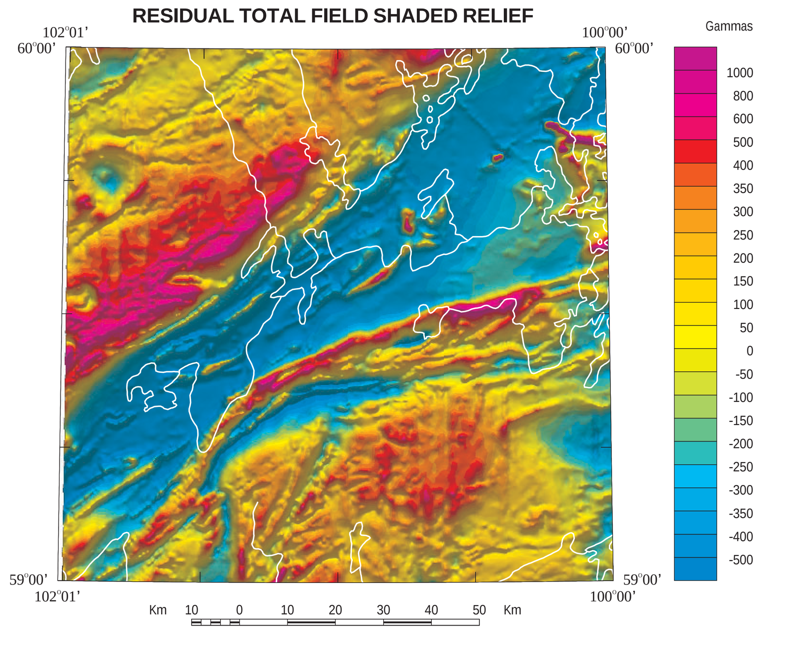
GIS cartography by L. Chackowsky

Suggested reference:
Manitoba Industry, Trade and Mines 2000: Kasmere Lake; Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Bedrock Geology Compilation Map Series, Map NTS 64N, scale 1: 250 000.

Published by:
Manitoba Industry, Trade and Mines
Manitoba Geological Survey, 2000



RESIDUAL TOTAL FIELD SHADED RELIEF



SYMBOLS

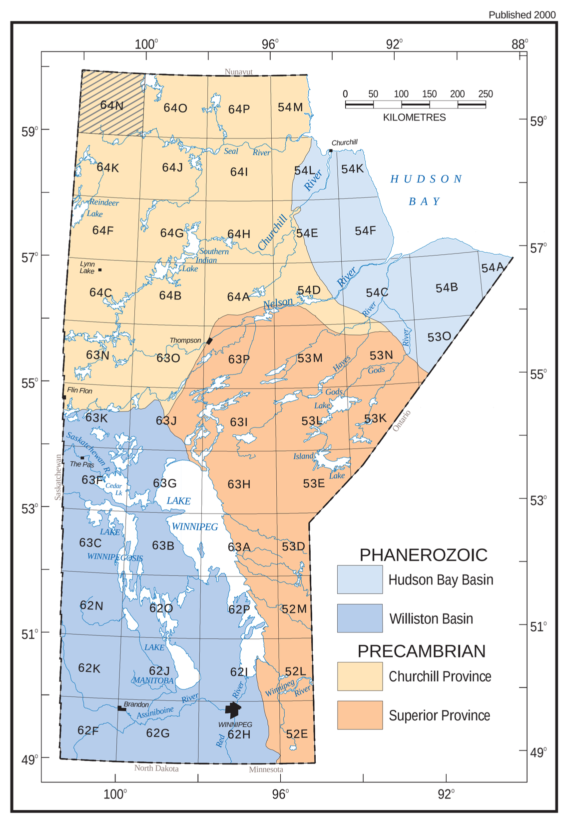
- Contact: defined or approximate
- Contact: gradational
- Contact: inferred from aeromagnetic data
- Contact: inferred: under water
- Contact: assumed
- Fault: defined or approximate
- Fault: assumed
- Domain boundary
- Esker
- Area of little or no Precambrian outcrop
- Bedding, tops unknown; inclined, vertical, dip unknown
- Bedding, tops unknown and parallel schistosity; inclined, vertical, dip unknown
- Metamorphic layering; inclined, vertical, dip unknown
- Schistosity; inclined, vertical, dip unknown
- Metamorphic layering and parallel gneissosity; inclined, vertical, dip unknown
- Metamorphic layering and parallel schistosity; inclined, vertical, dip unknown
- Gneissosity; inclined, vertical, dip unknown
- Cataclastic foliation, vertical, dip unknown

BEDROCK GEOLOGY COMPILATION MAP SERIE

KASMERE LAKE

NTS 64N

INDEX MAP AND MAJOR TECTONIC DIVISIONS



Manitoba