Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA | COMMISSION GÉOLOGIQUE DU CANADA

DESCRIPTIVE NOTES

This preliminary Open File geological map presents results of bedrock mapping undertaken in the region during 1985, 1991, 1992 and 1994 field seasons. The objectives of the mapping were to upgrade the reconnaissance database, and to address some of the outstanding structural, metamorphic, and metallogenic problems in the region, in order to provide a framework for regional correlation and tectonic synthesis of rock units of this part of the Churchill Structural Province. Detailed accounts of bedrock geology covering the region were published in numerous GSC publications. The reader is referred to the references cited here for a comprehensive overview of the geology of this region.

PREVIOUS GEOLOGICAL MAPPING

The Rankin Inlet-Falstaff Island-Quartzite Island area represents a portion of an Archean and Paleoproterozoic granite-greenstone-gneiss terrane within the Churchill Structural Province of the Canadian Shield. The region was previously mapped by Bannatyne (1958), Bell (1885,1887), Lord (1953), Tyrrell (1898), Weeks (1932), and Wright (1967); the latter at a scale of one inch to eight miles. The results of more recent regional bedrock mapping in the map area and in the surrounding region were reported by Armitage et al. (1993), Bell (1968), Heywood (1973), Laporte (1975, 1983), Laporte and Frape (1973), LeCheminant et al. (1987), Reinhardt and Chandler (1973), Reinhardt et al. (1980), Tella (1993, 1994), Tella and Annesley (1987,1988), and Tella et al. (1986, 1989, 1990, 1992, 1993, 1994). Previous structural, stratigraphic, and geochronological studies in this and in adjoining regions outlined several crustal-scale, ductile, high-strain zones that separate and expose different levels of crust (Tella, 1993, 1994; Tella et al. 1990, 1993, 1994). Tectonic juxtaposition of some of these crustal segments is believed to have occurred in the Paleoproterozoic prior to emplacement of ca 1850 Ma granites, and involved reactivation of Archean ductile, high-strain zones. The highlights of structural work were summarized previously (see transect A-B, Figures 1,2 in Tella et al. 1992).

LITHOLOGY

The Rankin Inlet (55K/16)-Falstaff Island (55J/13)-Quartzite Island (55J/11) region is underlain by an Archean polydeformed metavolcanic - metasedimentary sequence, the Rankin Inlet Group (**Av** to **Agb**) and its metamorphic equivalents (**As**), and by Archean and/or Paleoproterozoic layered gneiss and migmatite (**Agn**). A Paleoproterozoic quartz-arenite sequence (**Pqs**, **Pq**; correlative with the Hurwitz Group) unconformably overlies the gneissic rocks (**Agn**). Post-tectonic Paleoproterozoic intrusive activity is recorded by granite plutons (**Pgr, Pg**). SSE-trending biotite lamprophyre dykes (**Plp**) and NW-trending Mackenzie dykes (**Pgb**) are present in a few localities.

The polydeformed and metamorphosed supracrustal sequence of the Rankin Inlet Group (**Av** to **Agb**) is composed of massive and pillowed mafic volcanic flows, interflow sediments, quartz-magnetite iron formation, and minor matic and felsic tuffs, pyroclastics, and volcanic breccia, and gabbro sills (**Agb**) (Tella et al. 1986). Two major cycles of volcanism with intervening conglomerate (**Acvg**) deposition are present within the maficvolcanic sequence. Chemically the volcanic rocks and associated gabbroic rocks are tholeiitic basalts. Ultramafic (komatiitic) sills (**Au**), in part containing Cu-Ni mineralization, occur within the matic volcanic sequence. A U-Pb zircon age of 2665+/-3 Ma (J.C. Roddick, GSC, personal communication, 1993) from the felsic volcanics (**Atv**), and Re-Os isotope geochronology of the Rankin Inlet Ni-Cu-PGE ores from the ultramafics (**Au**) (2748+/-92 Ma, 2776+/-88 Ma; Hulbert and Gregoire, 1993) confirm an Archean age for the Rankin Inlet Group.

The main rock types, east of Meliadine Lake, are sheared and carbonatized mafic metavolcanics (chlorite schist, amphibolite), gabbro sills, and minor intercalated matic tuffs, pyroclastics (**Amv**), and grey-wacke (**Agw**). All rock types are fine- to medium grained, well layered, and massive to well cleaved. Altered metamafic rocks contain blue-green amphibole, chlorite, biotite and carbonate. They are locally garnetiferous adjacent to granite intrusions (**Pgr**).

Metasedimentary paragneiss belt (**As**), consisting of garnet+biotite +/- staurolite +/- andalusite +/- muscovite + plagioclase + quartz assemblages, is restricted to the northern margin of the Falstaff Island map area (NTS 55J/13). The belt extends to the northeast into the adjoining Chesterfield Inlet region (Tella, 1993) where the rocks within the belt are commonly fine- to medium- grained iron-rich pelites that are compositionally well banded with quartz, quartz+feldspar, and garnet+biotite +/- staurolite +/- aluminosilicate rich layers. Several discontinuous interlayers of silicate iron formation consisting of magnetite, garnet, grunerite, and hornblende occur in the paragneiss belt. They show prominent aeromagnetic anomalies (Geological Survey of Canada, 1966b).

The rocks within unit (**Agn**) comprise mixed assemblages of polydeformed, amphibolite grade orthogneiss, migmatite, minor proportions of metagreywacke and metavolcanic schist. The layered gneiss unit is locally cut by pegmatite and granitoid veins and dykes, and by biotite lamprophyre dykes (**Plp**).

The Paleoproterozoic quartz-arenite sequence (**Pqs, Pq**) is predominantly exposed on the Quartzite Island (55J/11) and to a lesser extent on the mainland (55K/16, 55J/13;Tella et al., 1986). The orientations of current ripple-axes in quartz-arenites from the mainland and from the Marble Island suggest sediment transport direction from the southwest and southeast respectively (Bell, 1968; Laporte, 1983; Tella et al., 1986). A thin (< 2m thick) quartz-mica schist (**Pqs**) is locally present beneath the white quartz-arenite and adjacent to the layered gneiss basement (**Agn**). These rocks are tentatively correlated with the Whitenck Member of the Lower Proterozoic Hurwitz Group (Bell, 1968) on the basis of lithological similarities.

Paleoproterozoic post-tectonic granites (**Pgr, Pg**) are exposed in the northwestern parts of the Rankin Inlet map area (55K/16). They are massive to weakly cleaved, pink to grey, and locally contain disseminated magnetite. The magnetite-rich character is reflected in a pronounced aeromagnetic signature (Geological Survey of Canada, 1966b). Southwest of Meliadine Lake, one of the granite bodies (**Pgr**) contains disseminated magnetite (<2%) and a few matic minerals (<10%), and is weakly foliated at the margins.

Lamprophyre dykes (**Plp**) are present throughout the region. They are dark grey to black, medium- to fine-grained rocks with large biotite/phlogopite phenocrysts (Tella et al. 1986; Digel, 1986). The dykes are locally folded adjacent to some of the late NW-trending brittle faults (Tella et al. 1986). They probably are related to the ca. 1.85 Ga alkaline igneous suite in the central Keewatin (LeCheminant et al. 1987).

Northwest trending gabbro dykes (**Pgb**), probably part of the 1.27 Ga Mackenzie swarm, were noted in a few localities. They are massive, unaltered, and coarse grained.

STRUCTURE AND METAMORPHISM

Previous stratigraphic and structural studies (Borradaile et al. 1989; Tella et al. 1986) in the Rankin Inlet Group established that the sequence forms an F1 homocline which is folded into a SE-plunging F2 syncline. Between Rankin Inlet and Thomson Island, stratigraphic and structural facing reversals suggest two structural discordances within the upper volcanic cycle of the Rankin Inlet Group (Tella et al. 1986). These discordances have been interpreted as two interleaving thrusts with opposing vergence (northeast and southwest). The orientation of regionally pervasive pre-F2 mineral stretching lineations supports the model. Strain estimates based on deformed lava pillows reveal that the Rankin Inlet Group stratigraphy is thinned to about 12-23% of its original thickness on the flanks of the major F2 fold (Tella et al., 1986; Borradaile et al., 1989).

East of Meliadine Lake, the Archean sequence forms part of an ESE-trending northern limb of a regional F2 synycline. There the Pyke Fault Zone represents one of several limb-parallel, ductile, high-strain zones that shows apparent dextral sense of displacement. The aeromagnetic signature (Geological Survey of Canada, 1966b) associated with the Pyke Fault Zone wraps around the regional F2 syncline beyond the map area to the northwest, and is in part conformable with the F2 fold limbs. On the basis of structural similarities to the thrusts recognized in the upper volcanic cycle, the Pyke Fault Zone is interpreted as a pre-F2 ductile thrust that was subsequently folded by F2. Northeast plunging mineral stretching lineations together with apparent dextral strike-slip component of displacement suggest a northside-down dip-slip component of displacement on the fault zone.

The contacts between the Paleoproterozoic quartz-arenite sequence with the Rankin Inlet Group and with the orthogneiss and migmatite (**Agn**) are for the most part tectonic. On Marble Island, this contact is marked by east-trending, southerly directed, high angle imbricate thrusts, and the bedding is locally overturned to the south. Similar basement-cover contact relations have also been observed elsewhere on the mainland, especially east- and southeast of Atulik Lake. There the Archean metavolcanic rocks within the Pyke Fault Zone are in thrust contact with the Paleoproterozoic quartz-arenite sequence, suggesting Proterozoic reactivation of an Archean Fault Zone.

North- and northwest-trending brittle faults, some characterized by pronounced topographic lineaments, affected both Archean and Paleoproterozoic rock units.

The metamorphic grade of the Rankin Inlet Group is greenschist to lower amphibolite facies. The deformation and metamorphism are considered to be Archean. Rocks within unit (**As**) were metamorphosed under mid-amphibolite facies conditions. They are considered to be higher grade equivalents of aluminous and iron-rich sedimentary successions of the Rankin Inlet Group (Tella et al. 1986). Thermobarometric calculations from the Chesterfield Inlet region yielded P-T estimates of ca 3.4kb and 6350C for the assemblages in this unit (Tella et al., 1989). Paleoproterozoic supracrustal rocks are unmetamorphosed.

ECONOMIC GEOLOGY

Several quartz and quartz-carbonate-chlorite veins, some containing arsenopyrite, pyrite, and chalcopyrite mineralization, occur within and transecting the metamatic rocks of the Rankin Inlet Group. Pyritiferous gossans, with or without sphalerite, are spatially related to late NE- and E- trending brittle faults. Multiple bands of gold-bearing, quartz-magnetite iron formation (**Alf**) are present north of Atulik Lake. They show pronounced aeromagnetic signatures (Geological Survey of Canada, 1966 a,b). Numerous mineral exploration assessment reports on this region are available from DIAND office, NWT Geology Division, Yellowknife, NWT.

Active exploration for gold is being undertaken in the Meliadine Lake region (55K/16, 55J/13) approximately 20 km north of the settlement of Rankin Inlet. Several horizons of gold-bearing iron formation have been traced over a strike-length of 65 km along the Pyke Fault Zone within and beyond the map area. Two mineralogically distinct, and structurally controlled epigenetic lode gold deposit types have been recognized in lithologically and geophysically distinct oxide iron formation of the Rankin Inlet Group (Miller and Balog, 1993). They include: 1) pyrrhotite-rich lode gold in banded quartz-magnetite iron formation having a strong magnetic signature, and 2) pyrite+arsenopyrite lode gold in lean, siliceous iron formation which shows a lower magnetic susceptibility compared to the banded iron formation. Alteration associated with the pyrrhotite-rich lodes is signaled by the presence of discordant and concordant quartz+carbonate veins and by the overprinting hydrothermal minerals: hornblende, biotite, calcite, grunerite, and allanite. Partial to complete sulphidization (pyrrhotite after magnetite) accompanied replacement of iron oxide by Fe-Mg silicates. The alteration assemblage suggests that gold mineralization is associated with Ca, K, S, Au, As and minor Na and CO2 metasomatism (Armitage et al. 1993). Alteration associated with the pyrite+arsenopyrite-rich lodes is marked by calcite+quartz vein systems and replacement of oxide iron formation by hornblende, grunerite, calcite, biotite, and quartz. Sulphides + gold are present as disseminations and as vein systems in the iron formation and, less abundantly, in adjacent wallrocks. The metasomatic/hydrothermal fluid carried CO2, K, S, Au, and As (Miller and Balog, 1993). Preliminary gechronology of samples from one of the early thrust faults suggest reactivation of the fault and emplacement of gold-bearing fluids during Paleoproterozoic (ca 1780+/-25 Ma, hornblende; Miller et al. 1995). Tectonic juxtaposition of the Rankin Inlet Group metavolcanics with the Lower Proterozoic quartz-arenites east of Atulik Lake provides an independent structural evidence for Proterozoic reactivation of the Pyke Fault Zone.

ACKNOWLEDGMENTS

The following field assistants, staff, industry representatives, and expediting services are thanked for their assistance in:

Bedrock mapping-
1985: I.R. Annesley, G.J. Borradaile, S.G. Digel, J.R. Henderson,M.N. Henderson, J.K.W. Lee
1991: A.E. Armitage, B.E. Seemayer, A. Meldrum
1992: A.E. Armitage, G. DeSchutter
1994: S. Alvarado

Fieldlog database-
1991,1992: A.E. Armitage, B.E. Seemayer, G. DeSchutter

Geochronology-
1993: J.C. Roddick, CGD

Fieldlog and AutoCAD consultations-
1992,1993,1994: B. Brodaric and K. Baker, CGD

Industry-
1992,1993,1994: Glen Dixon of Cumberland Resources, Phil Mudry and Mark Balog of Comaplex Minerals for providing access to drill core, and logistical support.

Polar Continental Shelf Project-
Helicopter support (1991, 1992)

Expediting Services-
1985: Airut Enterprises Ltd.
1991-94: M & T Enterprises Ltd.

REFERENCES

Armitage, A.E., Tella, S., and Miller, A.R.
1993: Iron-formation hosted gold mineralization and its geological setting, Meliadine Lake area, District of Keewatin, Northwest Territories; *in* Current Research, Part C, Geological Survey of Canada, Paper 93-1C, p.187-195.

Bannatyne, B.B.
1958: The geology of the Rankin Inlet area and North Rankin Nickel Mines Limited, Northwest Territories; unpublished M.Sc. Thesis, University of Manitoba, Winnipeg.

Bell, Robert
1885: Observations on the geology, mineralogy, zoology and botany of the Labrador coas, Hudson's Strait and Bay, made in 1885; Geological Survey of Canada, Annual Report, Part DD, p. 1-20.
1887: Marble Island and the northwest coast of Hudson's Bay; *in* Proceedings of Canadian Institute, 3rd Series, v. 4, 1885-86, p. 192-204.

Bell, R.T.
1968: Preliminary notes on the Proterozoic Hurwitz Group, Tavani (55K) and Kaminak Lake (55L) areas, District of Keewatin; Geological Survey of Canada, Paper 68-36.

Borradaile, G., Tella, S., and McArthur, J.
1989: Magnetic fabric as a kinematic indicator of faults: a test case; Annales Tectonicae, vol. III, n.1, p.3-11.

Brodaric, B. and Fyon, J.A.
1989: OGS FIELDLOG: A Microcomputer-based Methodology to Store, Process and Display Map-related data; Ontario Geological Survey, Open File Report 5709, 73p. and 1 magnetic diskette.

Geological Survey of Canada
1966a: Marble Island; Geophysical Series (Aeromagnetic) Map 7295G.
1966b: Tavani; Geophysical Series (Aeromagnetic) Map 7296G.

Digel, S.G.
1986: A petrographic and geochemical study of a lamprophyre dyke swarm in the Churchill Province, Rankin Inlet Area, District of Keewatin, NWT; unpublished B.Sc. Thesis, Queen's University, Kingston, Ontario, Canada, 44p.

Heywood, W.W.
1973: Geology of Tavani map-area,District of Keewatin; Geological Survey of Canada Paper 72-47.

Hoffman, P.F.
1988: United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia; Annual Review of Earth and Planetary Sciences, v.16, p.543-603.

Hulbert, L.J., and Gregoire, D.C.
1993: Re-Os isotope systematics of the Rankin Inlet Ni ores: an example of the application of ICP -MS to investigate Ni-Cu-PGE mineralization and the potential use of Os isotopes in mineral exploration. The Canadian Mineralogist, Journal of the Mineralogical Association of Canada, volourne 31, part 4, p. 861-876.

Laporte, P.J.
1975: Geology of the Rankin Inlet area; unpublished M.Sc. Thesis, Brock University, Ontario, 147p.
1983: Geology of the Rankin inlet area, District of Keewatin, Northwest Territories, NTS 55k/16, parts of 55J/13, K/9. Open File Report 1983-4, Department of Indian Altairs and Northern Development, Canada.

Laporte, P.J., and Frape, S.K.
1973: Geology, Rankin Inlet, District of Keewatin, Northwest Territories, Geological Survey of Canada, Open File 179.

LeCheminant, A.N., Miller, A.R. and LeCheminant, G.M.
1987: Early Proterozoic alkaline igneous rocks, District of Keewatin, Canada; *in* Petrogenesis and Mineralization of Proterozoic Volcanic Suites; editors: Pharaoh, T.C., Beckinsale, R.D. and Rickard, D. Geological Society Special Publication, No.33, pp.219-240.

Lord, C.S.
1953: Geological notes on Southern District of Keewatin, Northwest Territories; Geological Survey of Canada, Paper 53-22, 11 p.

Miller, A.R. and Balog, J.M.
1993: Contrasting oxide iron formation-hosted lode gold deposit types in the Meliadine trend, Rankin Inlet Group, Churchill Province, with emphasis on alteration assemblages; Abstract, Exploration Overview, 21st Annual Geoscience Forum, 1993, Yellowknife, NWT.

Miller, A.R., Balog, M.J., and Tella, S.
1995: Oxide iron-formation hosted lode gold, Meliadine Trend, Rankin Inlet Group, Churchill Province, Northwest Territories; *in* Current Research, 1995-C, Geological Survey of Canada, Paper 95-C, *in* press.

Reinhardt. E.W. and Chandler, F.W.
1973: Gibson-MacQuiod Lake map area, District of Keewatin; *in* Report of Activities, Part A, Geological Survey of Canada, Paper 73-1A, p.162-165.

Reinhardt, E.W., Chandler, F.W., and Skippen, G.B.
1980: Geological map of the MacQuiod Lake (NTS 55M, E1/2) and Gibson Lake (NTS 55N, W1/2) map area, District of Keewatin, Geological Survey of Canada, Open File 703; compiled by G.B. Skippen.

Tella, S.
1994: Geology, Gibson Lake east-half, District of Keewatin, Northwest Territories, Geological Survey of Canada, Open File 2737, scale 1:250,000.
1993: Geology, Chesterfield Inlet, District of Keewatin, Northwest Territories, Geological Survey of Canada Open File 2756, scale 1:250,000.

Tella, S. and Annesley, I.R.
1987: Precambrian geology of parts of the Chesterfield Inlet map area, District of Keewatin; *in* Current Research, Part A, Geological Survey of Canada, Paper 87-1A, p. 25-36.
1988: Hanbury Island Shear Zone, a deformed remnant of a ductile thrust, District of Keewatin, N.W.T.; *in* Current Research, Part C, Geological Survey of Canada Paper 88-1C, p.283-289.

Tella, S., Roddick, J.C., and Schau, M.
1994: Geochronological constraints on the tectono-metamorphic history of the allochthonous Uvauk Anorthosite-Gabbro-Granulite Complex, Central Churchill Province, District of Keewatin, N.W.T., Canada; Abstract, *in* Program with Abstracts, Geological Association of Canada and Mineralogical Association of Canada, Annual Meeting . Waterloo 94, p.111.

Tella, S., Schau, M., and Roddick, J.C.
1994: Significance of Juxtaposed mid-crustal mylonite zones of contrasting ages, Uvauk complex, central Churchill Province, District of Keewatin, N.W.T., Canada; Abstracts with Programs, Geological Society of America, vol.26, GSA Annual Meeting, Seattle.

Tella, S., Annesley, I.R., Borradile, G.J., and Henderson, J.R.
1986: Precambrian geology of parts of Tavani, Marble Island and Chesterfield Inlet map areas, District of Keewatin, N.W.T.; Geological Survey of Canada, Paper 86-13, 20 p.

Tella, S., Roddick, J.C., Bonardi, M., and Berman, R.G.
1989: Archean and Proterozoic tectonic history of the Rankin Inlet - Chesterfield Inlet region, District of Keewatin, N.W.T., Abstract, Geological Society of America, Abstracts with programs, vol.21, No.6, p.22.

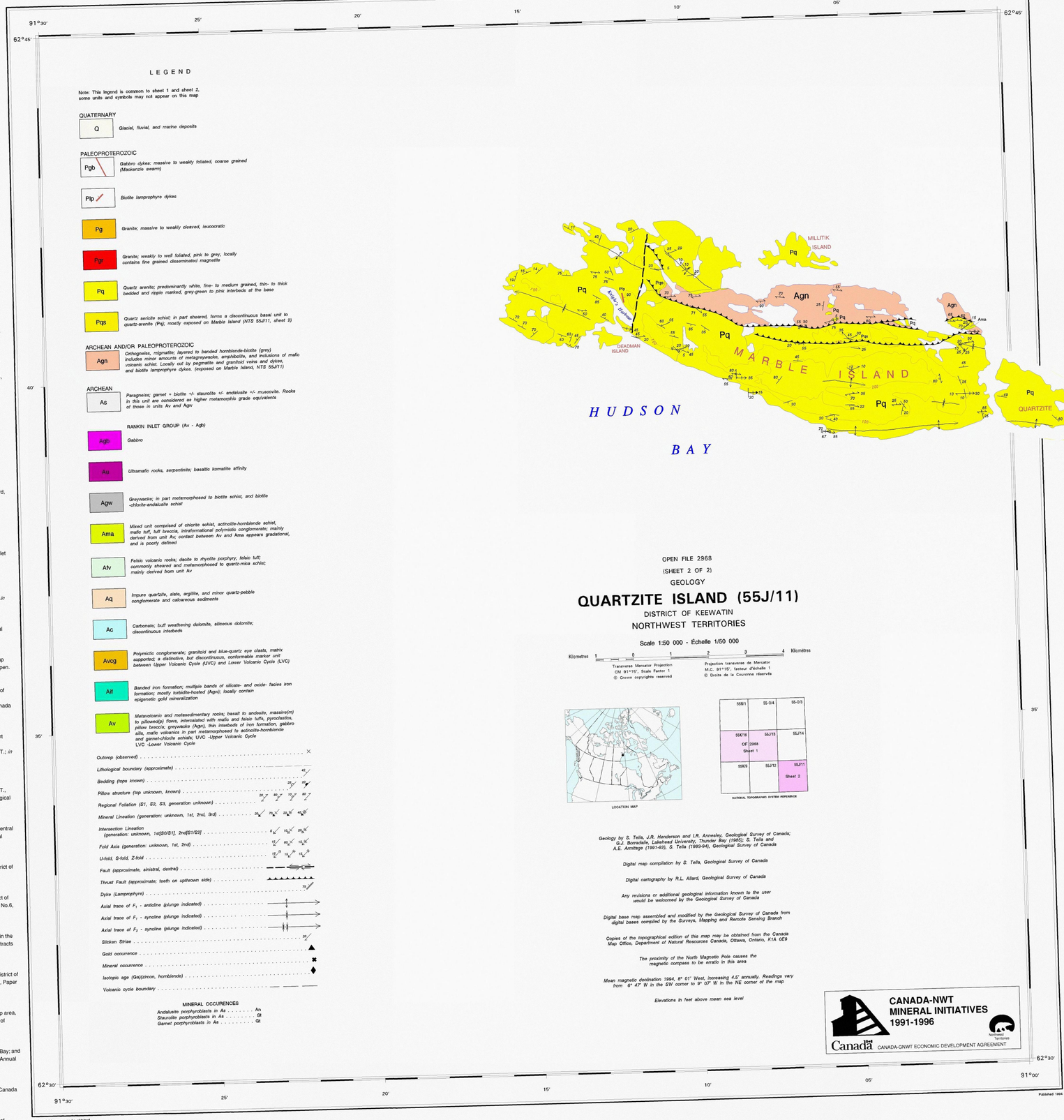
Tella, S., Schau, M., Armitage, A.E., Seemayer, B.E., and Lemkow, D.
1992: Precambrian geology and economic potential of the Meliadine Lake - Barbour Bay region, District of Keewatin, Northwest Territories; *in* Current Research, Part C; Geological Survey of Canada, Paper 92-1C, p. 1-11.

Tella, S., Schau, M., Armitage, and Loney, B.C.
1993: Precambrian geology and economic potential of the northeastern parts of Gobson Lake map area, District of Keewatin, Northwest Territories; *in* Current Research , Part C; geological Survey of Canada, Paper 93-1C; p.197-208.

Tyrrell, J.B.
1898: Report on the Doobaunt, Kazan, and Ferguson Rivers, and the north-west coast of Hudson Bay; and on two overland routes from Hudson Bay to Lake Winnipeg; Geological Survey of Canada Annual Report (n. ser.), v. 9, 1896, Part F, pp. 1-218.

Weeks, L.J.
1932: Rankin Inlet area, west coast of Hudson Bay, Northwest Territories; Geological Survey of Canada Summary Report 1931, Part C, p. 37-46.

Wright, G.M.
1955: Geological notes on central District of Keewatin, Northwest Territories; Geological Survey of Canada, Paper 55-17.
1967: Geology of the southeastern barren grounds, parts of the District of Mackenzie and Keewatin; Geological Survey of Canada, Memoir 350, 91.



Copies of this map may be obtained from the Geological Survey of Canada 601 Booth Street, Ottawa, Ontario K1A 0E8 3303-33rd Street, N.W., Calgary, Alberta T2L 2A7

OPEN FILE DOSSIER PUBLIC 2968 GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA OTTAWA 12/1994

Sheet 2 of 2

Recommended citation:
Tella, S.
1994: Geology, Rankin Inlet (55K/16), Falstaff Island (55J/13) and Quartzite Island (55J/11), District of Keewatin, Northwest Territories, Geological Survey of Canada, Open File Map 2968, scale 1:50 000

Canada