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NATMAP CARTNAT
Canada's National Geoscience Mapping Program
Le Programme national de cartographie géoscientifique du Canada

101°24′ 20′ 15′ 10′ 05′ 101°00′ 55′ 50′ 100°45′
54°54′ 50′ 45′ 40′ 35′ 54°33′

PHANEROZOIC
ORDOVICIAN
- O1 — *RED RIVER FORMATION*
- O1a — *Dolomite*

PALEOPROTEROZOIC
SHEAR ZONE ROCKS, TECTONITES
- T2 — *FELSIC TECTONITE, FELSIC PHYLLONITE, FELSIC MYLONITE*
- T2a — *Felsic mylonite, felsic tectonite*
- T2b — *Felsic phyllonite, quartz-sericite +/- carbonate schist*
- T2c — *Sheared/mylonitic felsic plutonic rocks*
- T1 — *MAFIC TECTONITE, MAFIC PHYLLONITE, MAFIC MYLONITE*
- T1a — *Mafic mylonite, mafic tectonite*
- T1b — *Mafic phyllonite, chlorite +/- carbonate +/-magnetite schist*
- T1c — *Mafic phyllonite-carbonate cataclasite, breccia*
- T1d — *Silicified +/- carbonitized mafic tectonite*

SUCCESSOR ARC PLUTONS, SUCCESSOR ARC MINOR INTRUSIONS, MINOR INTRUSIONS OF UNKNOWN AGE
- P14 — *DYKE COMPLEX*
- P14a — *Diabase, andesite, rhyolite, leucotonalite, porphyry*
- P13 — *RHYOLITE, DACITE DYKES*
- P13a — *Rhyolite, dacite*
- P13b — *Quartz porphyry, quartz-feldspar porphyry*
- P12 — *MAFIC AND INTERMEDIATE PORPHYRY DYKES*
- P11 — *PEGMATITE, APLITE*
- P10 — *SYENITE - MONZONITE. Equigranular to porphyritic*
- P9 — *GRANITE - GRANODIORITE. Equigranular*
- P8 — *GRANODIORITE - TONALITE*
- P8a — *Equigranular*
- P8b — *Porphyritic*
- P8c — *With abundant xenoliths*
- P7 — *MONZODIORITE - QUARTZ MONZODIORITE*
- P6 — *TONALITE - QUARTZ DIORITE*
- P6a — *Equigranular*
- P6b — *Quartz phyric*
- P6c — *Porphyritic*
- P6d — *Leucotonalite*
- P6e — *With abundant xenoliths*
- P5 — *QUARTZ DIORITE*
- P5a — *Equigranular*
- P5b — *With abundant xenoliths*
- P4 — *DIORITE, MELADIORITE - QUARTZ DIORITE*
- P4a — *Porphyritic*
- P4b — *Magnetiferous*
- P4c — *With abundant xenoliths*
- P3 — *DIABASE, BASALT*
- P3a — *Diabase*
- P3b — *Basalt, porphyritic basalt*
- P2 — *GABBRO, MELAGABBRO, GABBRO PEGMATITE*
- P2a — *Equigranular*
- P2b — *Porphyritic*
- P2c — *Melagabbro*
- P2d — *With abundant xenoliths*
- P1 — *PYROXENITE, PERIDOTITE*
- P1a — *Pyroxenite, melagabbro*

AMISK COLLAGE
JUVENILE ARC
- J6 — *HYPABYSSAL INTRUSIONS. Rhyolite, dacite*
- J5 — *FELSIC VOLCANICLASTIC ROCKS. Felsic tuff, lapilli tuff, breccia*
- J4 — *INTERMEDIATE VOLCANICLASTIC ROCKS. Intermidiate tuff,lapilli tuff, breccia*
- J3 — *MAFIC VOLCANICLASTIC ROCKS. Heterolithologic breccia, dominantly mafic fragments*
- J2 — *RHYOLITE, DACITE*
- J2a — *Aphyric rhyolite and dacite flows, flow breccia*
- J2b — *Porphyritic rhyolite and dacite flows, flow breccia*
- J1 — *BASALT, BASALTIC ANDESITE*
- J1a — *Aphyric pillowed and massive basalt, basaltic andesite*
- J1b — *Porphyritic pillowed and massive basalt, basaltic andesite*

OCEAN FLOOR
- F7 — *MODALLY LAYERED MAFIC - ULTRAMAFIC COMPLEXES*
- F7a — *Gabbro, gabbro pegmatite, leucogabbro*
- F7b — *Layered gabbro, leucogabbro, anorthosite*
- F7c — *Pyroxenite, peridotite, serpentinite*
- F7d — *Layered pyroxenite, peridotite, subordinate gabbro*
- F6 — *GABBRO, DIABASE*
- F5 — *MAFIC VOLCANICLASTIC ROCKS*
- F5a — *Mafic tuff, lapilli tuff, breccia*
- F5b — *Heterolithologic breccia*
- F4 — *MOEN BAY BASALT. Aphyric and prophyritic pillowed and massive basalt*
- F3 — *CLAW BAY BASALT - CENTRE LAKE MAFIC TECTONITE*
- F3a — *Pillowed basalt, diabase*
- F3b — *Flattened pillow basalt, layered to laminated mafic tectonite, diabase*
- F2 — *MCDOUGALLS POINT BASALT. Aphyric and porphyritic pillowed and massive basalt, diabase*
- F1 — *ATHAPAPUSKOW BASALT. Pillowed and massive basalt, diabase*

OCEAN ISLAND
- I1 — *LONG BAY VOLCANIC CONGLOMERATE. Basaltic conglomerate, sandstone*

UNKNOWN AFFINITY
- U1 — *MAFIC SUPRACRUSTAL ROCKS*
- U1a — *Mafic supracrustal rocks of unknown affinity*
- U1b — *Laminated fine grained mafic gneiss derived from U1a*

- *Geological boundary*
- *Shear zone boundary*
- *Fault (approximate)*
- *Fault (inferred)*
- *Bedding, top unknown (inclined, overturned)* 65, 75
- *Bedding, top known (inclined)* 65
- *Pillow, top known (inclined, overturned)* 75, 65
- *Flow contact, top known (inclined)* 65
- *Igneous layering, top known (inclined)* 65
- *Igneous layering, top unknown (inclined)* 65
- *Foliation; generation unknown* 75
- *generations 1 - 6* 65, 75, 85
- *Stretching lineations generations 2 - 5* 65, 75, 85
- *Intersection lineation generation 5* 75
- *Fold axis generations 2 - 6* 65, 75, 85
- *fold asymmetry (S,Z,U)*
- *Joint (inclined)* 65
- *Dextral shear* 60, 75

Elbow Lake
Claw Lake
Third Cranberry Lake
Second Cranberry Lake
First Cranberry Lake
Iskwasum Lake
Simonhouse Lake
ELBOW LAKE SHEAR ZONE
ISKWASUM LAKE SHEAR ZONE

DESCRIPTIVE NOTES

The Elbow-Cranberry-Iskwasum lakes area, which comprises the central Flin Flon Belt in the southeastern Trans-Hudson Orogen, hosts 1.92-1.88 Ga arc, ocean floor and ocean island tectonostratigraphic assemblages, forming the eastern portion of the Amisk collage (Stern et al., 1995a; 1995b). For a more complete description of lithologies than is provided in the legend, see Syme (1992, 1993, 1994), Whalen (1993), and Morrison and Whalen (1995). These assemblages are typically bounded by shear zones or faults (Syme, 1990; Ryan and Williams, 1996a), and locally preserve stratigraphic discontinuities. Six generations of ductile structural fabrics and a generation of brittle-ductile to brittle features developed during a deformation history in excess of 180 Ma (Ryan and Williams, submitted manuscript). Structural boundaries developed at different intervals, from initial intraoceanic accretion (c.f. Lucas et al. 1996) to post-orogenic brittle faulting. Boundaries vary, with age, in character and tectonic significance (Ryan and Williams, submitted manuscript). The relative timing of fabric development to metamorphic mineral paragenesis is key to distinguishing the different generations of structures.

Contact metamorphism (M_1), related to the 1.876-1.864 Ga (Whalen and Hunt, 1994) plutonism, reached amphibolite facies in <1 km wide contact aureoles. Regional metamorphism (M_2) associated with the Hudsonian Orogeny is generally considered to have peaked between 1.820-1.805 Ga (Parent et al. 1995; David et al., 1996) in the Amisk collage. Mafic rocks contain the upper greenschist M_2 assemblage of chlorit-actinolite ± biotite east of the Elbow Lake shear zone (ELSZ) at Elbow Lake. A sharp eastward increase to epidote-amphibolite facies is marked by a change in plagioclase composition from albite to oligoclase, coincident with the disappearance of chlorite, and by the presence of pargasitic hornblendes and ferro-tschermakites. M_2 increases to amphibolite facies northwards, and decreases southwards to upper greenschist facies at Iskwasum Lake. West of the ELSZ, the grade of M_2 varies from amphibolite facies in the north, to actinolite bearing upper greenschist west of Elbow Lake, and to middle greenschist facies (chlorite ± magnesian chloritoid ± actinolite) in the area between southwest Elbow Lake, First Cranberry Lake and Iskwasum Lake. Variable amounts of hornblende (10-80%) in mafic tectonites/gneisses south of the ELSZ on the south side of First Cranberry Lake indicate a sharp increase to amphibolite facies southwest toward the Barry Creek shear zone (BCSZ). Chlorite is ubiquitously associated with deformation that occurred on the retrograde part of the M_2 cycle, making it a key mineral for identifying deformation fabrics that post-date the peak of M_2. Carbonate is a ubiquitous matrix mineral group in retrograde shear zones, and is probably the product of the plagioclase break down during retrogression. The position of metamorphic isograds is poorly constrained in map view, and even more so in three dimensions.

The earliest fabrics preserved in the central Flin Flon Belt comprise S_1 mylonites in the southern Elbow Lake area. S_1 mylonites are cross cut by 1.868 Ga dykes (Arsdell and Ryan, 1997), and are interpreted as being related to early accretion within the collage (Ryan and Williams, submitted manuscript). Regional metamorphism has largely obliterated the S_1 mylonite assemblage. A mafic-ultramafic complex within the ocean floor assemblage, interpreted as layer 3 of a dismembered ophiolite (Stern et al., 1995b), is situated east of the S_1 shear zone. Contacts between the ultramafic rocks and basalts are generally not exposed, and are interpreted as being narrow S_1 shear zones and/or faults (10's of metres wide), as opposed to intrusive contacts.

S_2 formed during 1.860-1.840 Ga generally east-west regional shortening of the Amisk collage (Lucas et al., 1996; Ryan and Williams 1996b). S_2 varies in intensity from a weak flattening of pillows west of Elbow Lake to tectonic or gneissic layering adjacent to the larger plutons, and is best developed along the eastern side of the ELSZ from northeast Elbow Lake to the southern limit of the greenstones. S_2 is developed moderately to weakly along the First and Second Cranberry lakes, but strongly on the south side of First Cranberry Lake. It typically forms a differentiated crenulation cleavage where it overprints a bedding fabric or S_1. In plutonic rocks, S_2 is defined by inequant quartz and feldspar grains, or a gneissic layering. At the map scale, the trend of S_2 is controlled largely by the shape of plutons, many of which are slightly elongate in a north/south direction, and by subsidiary, large scale folds. S_2 is overprinted by M_2 minerals.

The Iskwasum Lake shear zone (ILSZ) is the most extensive F_2 structure, trending south-southwestward from Elbow Lake, to southeastward through Iskwasum Lake. At Elbow Lake, S_2 is only locally preserved due to reactivation of the foliation by later deformation. The ILSZ sweeps into an east-west orientation near the BCSZ to the south. S_2 can be distinguished from early and later fabrics because of its unique relationship to regional metamorphism. S_2 mylonites preserve syn-metamorphic dynamic recrystallization features, which are locally weakly annealed, and are defined by, but are not overgrown by the peak assemblage. The ILSZ reactivates the S_1 structure(s) and dominates the western boundary of the mafic complex.

Fourth generation structures (F_4) are manifest by the Claw Bay shear zone on the eastern side of Elbow Lake, and by a 5 km scale east-west-trending regional fold in the southern part of Iskwasum Lake. These structures cannot be correlated directly, but are grouped because of their similar time relationships to S_2 and S_3. The large fold at Iskwasum Lake is interpreted as having formed during dextral shear along the BCSZ.

Fifth generation structures (F_5) comprise the second ubiquitous regional foliation (S_5) across the eastern Amisk collage. In contrast to S_2, however, S_5 trends consistently between north and northeast. S_5 fabrics occur either as ultra-mylonitic shear zone fabrics (e.g. the ELSZ), or as a regionally penetrative crenulation cleavage developed in the wall rocks. Similar to S_2, the local orientation of S_5 is strongly influenced by the large plutons. The ELSZ is the most regionally significant F_5 structure in the map area and varies in width from about 2500 m in central Elbow Lake, to 10's m elsewhere. This narrowing is controlled predominantly by rheology, but may also be due to thickening and thinning along late stage faults. Even where S_5 is sub-parallel to earlier fabrics, it is easily distinguished by its retrograde nature. Where S_5 is the first foliation in fine grained chloritic wall rocks, it generally forms a "slaty cleavage", or it may be defined by flattened primary features (e.g. pillows). S_5 shear zones in mafic rocks are generally characterized by chloritic phyllonites, whereas in granitoids it is characterized by a finely spaced dominant cleavage. Abundant intrafolial carbonate and iron oxide staining are ubiquitous in all rocks containing S_5 fabrics. The age of S_5 is unknown because it is not cut by datable igneous bodies or minerals. It must, however, be younger than 1.820-1.805 Ga because it overprints the peak M_2 mineral assemblage.

Sixth generation structures (F_6) occur along the BCSZ in the southern extremity of the map area. In the southern Iskwasum Lake area, isoclinal F_6 folds overprint S_5 tectonites that were deflected into an eastfwest orientation during F_6 deformation. The folds vary in size from 1-10's m, and have a strong east-west axial plane crenulation cleavage (best developed in the chlorite rich layers). Ryan and Williams (submitted manuscript) interpreted F_6 folds as a discrete set of structures associated with the reactivation of the BCSZ by sinistral shear. In the southern First Cranberry Lake area, S- and Z- asymmetric F_6 folds occur in S_5 mafic tectonites, and have an east-west-trending S_6 axial plane fabric.

A variety of late deformational features comprise the seventh generation of structures (F_7), developed under brittle-ductile and brittle conditions. The most prominent faults are displayed on the map. They are generally not well exposed, and are established predominantly from lineament analysis of aerial photographs. The Grass River fault (GRF) is a discrete brittle- ductile structure forming a prominent lineament from the west side of Elbow Lake, southward through the Grass River to Third Cranberry Lake, then southwestward along the western shore of the Second Cranberry Lake. It is a narrow (1-2 m wide) bresciated zone for most of its exposed length, but is as wide as 200 m in the segment between Elbow Lake and Third Cranberry Lake. The wider segment is distinctively brecciated, with approximately equal proportions of clasts and carbonate matrix. Locally along the margins of the GRF, slivers of pre-existing chloritic phyllonite, which are similar in character to the ELSZ, occur between the breccia and the undeformed wall rocks. The GRF may have reactivated part of an S_5 shear zone, possibly explaining the greater width of the GRF in that region. Brittle deformation in the Flin Flon Belt probably continued beyond 1.700 Ga (Fedorovich et al. 1995).

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OPEN FILE 3460

GEOLOGY

STRUCTURAL GEOLOGY CENTRAL FLIN FLON BELT

MANITOBA

Scale 1:50 000 - Échelle 1/50 000

Kilometres 1 0 1 2 3 4 Kilomètres

Universal Transverse Mercator Projection

Projection transverse de Mercator

Sources of information depicted on this map: J.J. Ryan: structural geology within and adjacent to the Elbow Lake shear zones; E.C. Syme: geological base map compilation (see references)

Geological compilation co-ordinated through the auspices of the NATMAP Shield Margin Project (S.B. Lucas, Project Leader)

Digital cartography by: L.E. Chackowsky and B. Lenton, Manitoba Energy and Mines (base map), J.J. Ryan, GIS Lab, Department of Geology, University of New Brunswick (structural geology) D. Kurfurst, Geoscience Information Division

Electrostatic plot produced by Geoscience Information Division

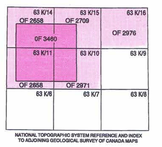
Any revisions or additional geological information known to the user would be welcomed by Geological Survey of Canada

Digital base map from data compiled by Geomatics Canada, modified by Geoscience Information Division

Copies of topographic maps for this area may be obtained from Canada Map Office, Natural Resources Canada,Ottawa, Ontario, K1A 0E9

Mean magnetic declination 1997, 9°43'E, decreasing 7.9' annually


LOCATION MAP



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

Manitoba

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OTTAWA
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