Geology of the Exposed Basement in the Reed Lake Area, Flin Flon Belt, West-Central Manitoba (Part of NTS 63K9, 10, 15, 16)

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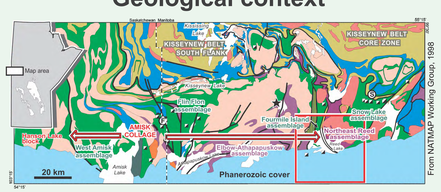
Introduction

The Flin Flon belt in the Reed Lake area, and its extension to the south under Phanerozoic sedimentary rocks, has significant potential to host additional VMS deposits. Despite the presence of several economic deposits, the geological setting of VMS deposits in the Reed Lake area is not well understood. Discovery of the Reed VMS deposit in 2007 deposit has resulted in renewed interest in the geology of Reed Lake area.

In order to gain a better understanding of the geological framework and mineral potential of the Reed Lake area and its sub-Phanerozoic basement, a multiyear field-mapping and compilation project was initiated in 2013. To complement data acquired through geological mapping, a drillcore examination and sampling component was added to the project in 2015. The drillcores provide essential information in areas that lack surface exposure.

A compilation of geological data from surface mapping and drillcore was integrated with regional geochemistry and airborne geophysical surveys to produce **two new preliminary maps**, one for the exposed Flin Flon belt in the Reed Lake area – (**PMAP2017-01**; **this poster**) and the other for its sub-Phanerozoic extension to the south – (**PMAP2017-02**; **poster T8**).

Geological context



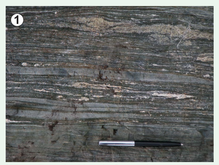
Preaccretion assemblages (1.92–1.87 Ga)
- Juvenile-arc assemblages
- Ocean-floor assemblages
- Ocean-plateau assemblage
- Evolved-arc assemblages
- Ocean-island assemblage

Syn- or postaccretion rocks (<1.88 Ga)
Felsic and mafic plutons
- >1840 Ma
- <1840 Ma

Successor-arc and -basin deposits
- Nonmarine sedimentary and volcanic rocks
- Turbidite deposits
- West Reed–North Star shear zone
- Major fault (<1840 Ma)
- Volcanogenic massive sulphide mine
- Town of Flin Flon
- Town of Snow Lake

Paleoproterozoic rocks in the Reed Lake area are a component of a larger tectonic collage of volcano-plutonic and sedimentary rocks assembled during the closure of an ancient ocean (ca. 1.9–1.8 Ga) and collectively termed the 'Flin Flon belt' (FFB). Previous workers (Stern et al., 1995) recognized that significant stratigraphic, geochemical and isotopic differences exist between arc-volcanic rocks in the Flin Flon (Amisk collage) and Snow Lake areas, suggesting that these two segments of the FFB formed in distinct tectonic settings (Lucas et al., 1996). The Reed Lake area represents a critical bridge between these two segments, as it lies at the boundary between the Amisk collage sensu stricto and the Snow Lake segment.

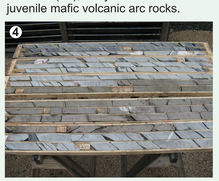
One of the key geological units of the Reed Lake area, the Fourmile Island assemblage (FIA), is a bimodal succession of volcanic and volcaniclastic rocks of arc or arc-rift affinity that are known to host several VMS deposits. Metavolcanic rocks of the Fourmile Island Assemblage (FIA) are exposed at surface on western Reed Lake where they form a greater than 5.5 km thick sequence of subaqueous bimodal volcanic rocks. The Fourmile Island Assemblage is currently interpreted (Zwanzig and Bailes, 2010) as a back-arc - rift succession formed at about 1.89 Ga during opening of an ocean basin.



West Reed - North Star shear zone: Mafic tectonites (**T1**), probably derived from andesitic plagioclase-phyric lapilli tuff, note the intense flattening and stretching of the fragments.

West Reed volcanic package: heterolithic felsic breccia tuff (**J15**), a band of moderately flattened rhyolitic fragments define crude bedding perpendicular to flattening direction.

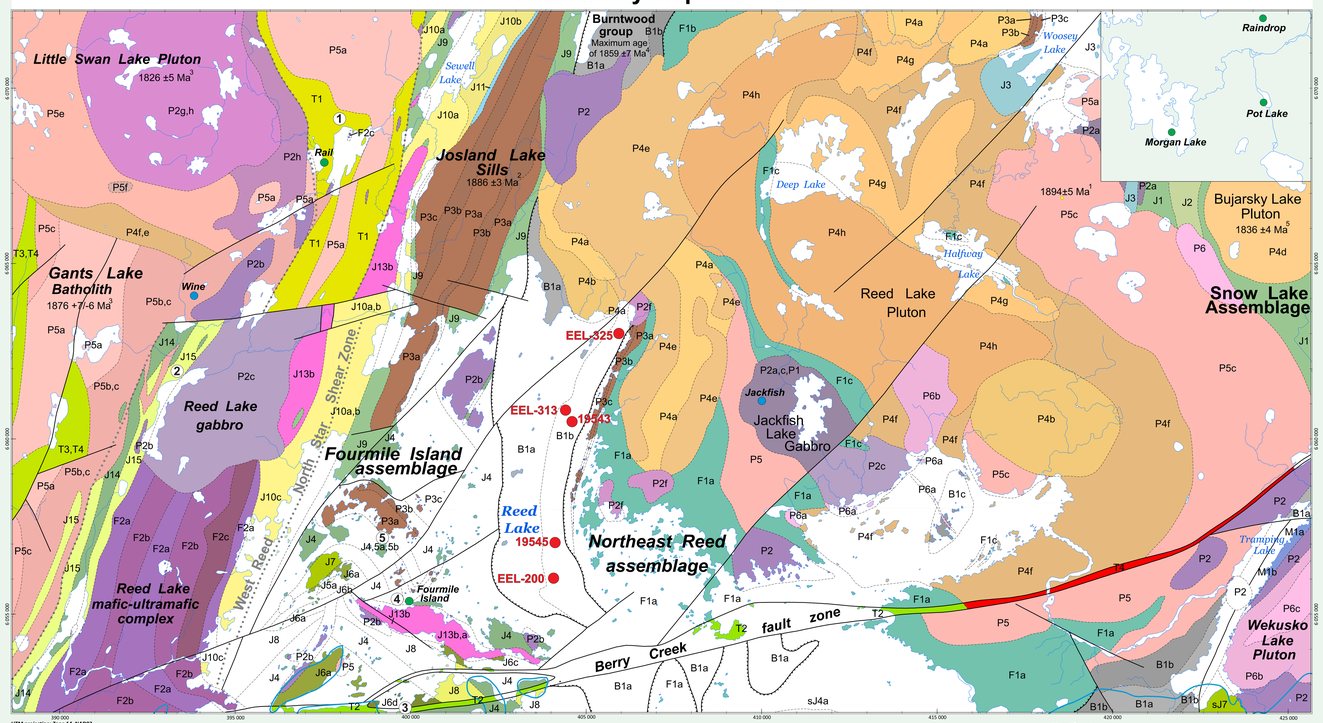
Berry Creek shear zone: mafic tectonite (**T2**), likely derived from juvenile mafic volcanic arc rocks.



Fourmile Island VMS Deposit: solid sulphide lens of the Fourmile Island deposit (Po>Py>>Cpy) hosted by chlorite-carbonate altered andesite.

Pillowed andesite (**J4**) showing preferential strong pervasive silica replacement.

Preliminary Map PMAP2017-1



Sedimentary rocks
Missi group
- M1 Conglomerate, pebbly sandstone, sandstone
- M1a Polymictic conglomerate, sandstone
- M1b Pebbly sandstone, pebble conglomerate, sandstone

Burntwood group
- B1 Mudstone, greywacke, derived gneisses and migmatites
- B1a Greywacke, siltstone, mudstone
- B1b Graphitic, sulfidic mudstone, sulfide facies iron formation, minor greywacke
- B1c Garnet-biotite gneiss psilllmanite or andalusite, local staurolite, biotite gneiss

Tectonites
West Reed - North Star Shear zone
- T1 Mafic tectonite, +/- variably mylonitized, felsic intrusive sheets

Berry Creek Shear zone
- T2 Mafic tectonite: chlorite schist, ± carbonate, brittle/ductile shears
- T3 Felsic tectonite: ± mylonitized flows and dykes of felsic volcanic rocks
- T4 Felsic tectonite: strongly foliated to mylonitic felsic plutonic rocks

Juvenile-Arc rocks
West Reed volcanic package
- J15 Felsic crystal tuff, lapilli tuff and tuff breccia; minor quartz-plagioclase–phyric dacitic to rhyolitic flows
- J14 Mafic volcaniclastic rocks (tuff breccia, lapilli tuff and tuff); minor basalt: massive flows and pillows

Fourmile Island assemblage
- J13 Tonalite–granodiorite
- J13a Granodiorite
- J13b Tonalite, minor quartz diorite
- J12 Gabbro, diorite, diabase
- J11 Volcanic-derived sediments: laminated mudstone, siltstone and fine grained sandstone
- J10 Rhyolite, dacite
- J10a Coherent flows, massive lobes, autoclastic facies and subordinates felsic volcaniclastic rocks
- J10b Dacitic to rhyolitic crystal and lapilli tuffs, subordinate tuff breccia, minor flows
- J10c Felsic and mafic flows and dikes, strongly foliated to mylonitic
- J9 Basaltic andesite, andesite: massive to pillowed flows, minor amoeboid pillow breccia
- J8 Porphyritic and aphyric felsic breccia, felsic dikes
- J7 Heterolithic breccia with intermediate-mafic and felsic clasts
- J6 Mafic volcaniclastic rocks
- J6a Aphyric, amoeboid pillow breccia, subordinate pillowed flows
- J6b Heterolithic breccia with rhyolite clasts
- J6c Plagioclase-phyric mafic breccia
- J6d Plagioclase-phyric amoeboid pillow breccia
- J5 Rhyolite, dacite
- J5a Quartz-feldspar–phyric rhyolite, autoclastic breccia with rhyolite clasts
- J5b Rhyolite dike
- J4 Aphyric and porphyritic pillowed and massive basalt, basaltic andesite, andesite

Snow Lake arc assemblage
- J3 Volcanic conglomerate, paraconglomerate, minor greywacke, and mudstone.
- J2 Heterolithic breccia, dominantly mafic fragments
- J1 Pillowed and massive flows

Subphanerozoic units: not exposed
- sJ4a MORB basalt, and andesite with weak arc signature: massive flows and pillows, subordinate autoclastic facies, minor sulphidic mudstone
- sJ7 Undivided bimodal juvenile-arc volcanic rocks, not exposed

Ocean-Floor rocks
Reed Lake mafic-ultramafic complex
- F2 Layered mafic-ultramafic complex
- F2a Layered gabbro, leucogabbro, anorthosite
- F2b Layered melagabbro, gabbro, pyroxenite
- F2c Layered pyroxenite, peridotite, subordinate gabbro
- F1 N-type basalts
- F1a Northeast Reed pillowed and massive basalt
- F1b Wooseyy Lake-File Lake basalt, pillowed and massive basalt, diabase, derived tectonite
- F1c Amphibolite, volcanic derived enclave in Reed Lake Pluton

Plutonic Rocks
- P6 Granite to granodiorite
- P6a Granite
- P6b Granite–granodiorite
- P6c Agmatite with P2b,d inclusions
- P5 Granodiorite to tonalite
- P5a Granodiorite
- P5b Granodiorite to tonalite
- P5c Foliated to gneissic granodiorite–tonalite, commonly with amphibolite screens and inclusions
- P5d Intrusion breccia
- P5e Quartz-porphyritic hornblende-biotite to biotite-hornblende granodiorite
- P5f Quartz-porphyritic hornblende-biotite granodiorite with abundant small tabate mafic inclusions of P2g and P2h
- P4 Tonalite to quartz diorite
- P4a Tonalite
- P4b Quartz-diorite
- P4c Leucotonalite
- P4d Tonalite to quartz diorite
- P4e Tonalite to quartz diorite with abundant xenoliths
- P4f Foliated to gneissic tonalite to quartz diorite, gneissic leucotonalite, migmatite; commonly with amphibolite screens and inclusions
- P4g Granodiorite, foliated to weakly gneissic, coarse grained, low magnetic signature
- P4h Foliated to gneissic biotite-hornblende tonalite, commonly with amphibolite xenoliths and late tonalite-granodiorite dikes, moderate to high magnetic signature

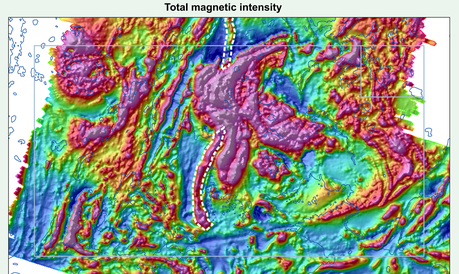
Josland sills
- P3 Compositionally layered gabbro sills and intrusions (Josland sills)
- P3a Gabbronorite, gabbro
- P3b Ferrogabbro
- P3c Quartz ferrodiorite, ferrotonalite, leucotonalite
- P2 Gabbro, melagabbro, diorite
- P2a Melagabbro
- P2b Gabbro
- P2c Leucogabbro
- P2d Diorite
- P2e Diabase
- P2f Diorite to quartz diorite
- P2g Fine-grained equigranular quartz diorite
- P2h Hornblende gabbro

Symbols
Geological Boundaries
- Contact
- Fault
- Thrust fault
- West Reed-North Star shear zone
- Precambrian-Paleozoic Boundary

Mineral Deposits
- Ni-Cu+/-Co+/-PGE
- Base metals

Geochronology
- Sample Site

Total magnetic intensity



Total magnetic intensity of the Reed Lake area from a 1995 regional Spectrem airborne survey (Assessment File 73859, Manitoba Growth, Enterprise and Trade, Winnipeg)

0 1 2 3 4 5 Kilometres

Total magnetic intensity (nT)
High : 62804.9
Low : 57800.6

Burntwood group: Sedex potential

A high magnetic trend (white dashed line on Total Magnetic Intensity map) that parallels the Burntwood group sediments (**B1a**) in central Reed Lake was investigated. This magnetic anomaly also coincides with a strong conductor. One drillcore (**EEL-313**) was re-examined and showed Burntwood group rocks with higher proportion of mudstone than usual and a 30 feet long mineralized interval (10-25 % graphite and 1-3% pyrite). No other drillcore drilled through this anomaly has been preserved but historical logs are still available and have been reviewed. Historical logs consistently indicates that the anomaly is caused by graphitic argilite with variable amount of pyrite and lesser pyrrhotite.

Some examples from historical log descriptions:
EEL-325: 560 ft of mineralized seds including 138 ft of **massive py** and **5-20% po**
19543: 160 ft of slate followed by 240 ft of "**mineralized iron formation**"
19545: mineralized argillite, includes 2 **iron formations** (20 ft and 100 ft thick)
EEL-200: 500 ft of **variably mineralized graphitic argillite**

A few drill logs describe a progression from a greywacke with minor argillite to a mineralized graphitic argillite. Based on historical logs, this anomaly has been interpreted to represent a graphitic, sulfidic mudstone, with iron formations and minor greywacke (**B1b**). The progression from greywacke with minor argillite to graphitic, sulphidic argillite with iron facies formation indicates that this unit represent a previously undocumented facies transition within the Burntwood group.

EEL-313: greywacke and graphitic argilite with randomly oriented andalusite, likely due to contact metamorphism from gabbro sills less than 1000 m to the east

Recognition that thick graphitic and sulphide-rich argillite with significant **lateral continuity** occurs within Burntwood rocks has important economic implications.
The presence of graphite and sulfur indicate changes of the basin chemical conditions to an **anoxic and H_2S-rich environment**. Such sulfur-rich anoxic basin could represent a chemical trap for oxidized hydrothermal fluids released from seafloor vents, possibly focused along a fault, in a similar manner to **Sedex** deposits.

The Bur deposit, 24 km NE of Snow Lake, is a stratiform Zn-Cu-Pb massive sulphide deposit with an unusual setting compare to other massive sulphide deposits from the area. Fedikow (1991) described the the Bur as stratabound sulphides hosted by amphibolite-facies greywacke and graphitic argillite interpreted to be part of the Burntwood group. The occurrence of stratabound sulfide facies at Reed Lake provides an example for the geological setting of the Bur deposit in Burntwood group rocks.

Based on the presence of laterally extensive stratabound sulfides at Reed Lake and the occurrence of the Bur deposit, it is suggested that the Burntwood group should be considered prospective for additional stratabound massive sulphide mineralization of the Sedex-type.

Acknowledgements

The project has been facilitated by the co-operation of Hudbay Minerals Inc., Royal Nickel Corporation (formerly VMS Ventures Inc.) and Rockcliff Metals Corporation that provided access to recent drillcores, permitted sampling and shared some of their own data. This co-operation has significantly expanded the scope of the drillcore examination program and will contribute to our better understanding of the geology of the sub-Phanerozoic basement of Reed Lake.

References

Fedikow, M. A. F. 1991: Sediments-hosted Zn-Cu (Bur zone) and Zn-Pb-Ag (Kobar/Ruby) massive sulphide type deposits, Snow Lake area (NTS 63J/13); in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1991, p. 43-46 **Lucas, S.B., Stern, R.A., Syme, E.C., Reilly, B.A. and Thomas, D.J. 1996:** Intraoceanic tectonics and the development of continental crust: 1.92–1.84 Ga evolution of the Flin Flon belt, Canada; Geol. Soc. of America Bull., v. 108, no. 5, p. 602–629. **Stern, R.A., Syme, E.C., Bailes, A.H. and Lucas, S.B. 1995:** Paleoproterozoic (1.90–1.86 Ga) arc volcanism in the Flin Flon Belt, Trans-Hudson Orogen, Canada; Contributions to Mineralogy and Petrology, v. 119, no. 2–3, p. 117–141. **Zwanzig, H. V. and Bailes, A. H. 2010:** Geology and geochemical evolution of the northern Flin Flon and southern Kisseynew domains, Kississing–File lakes area, Manitoba (parts of NTS 63K, N); Manitoba Innovation, Energy and Mines, Manitoba GeologicalSurvey, Geoscientific Report GR2010-1, 135 p.