New whole-rock geochemistry data and their implication for the tectonic evolution of the West Reed Lake area (part of NTS 63K10).

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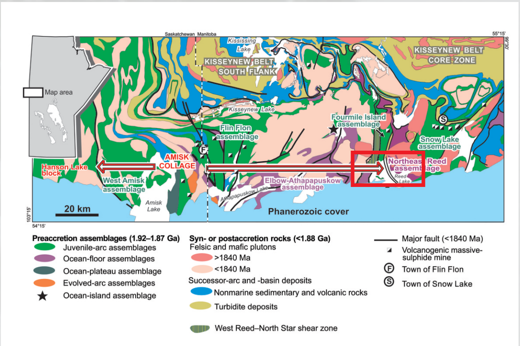
Introduction

A multi-year field mapping and compilation project was initiated in 2013 to revisit and expand our geoscience knowledge of the Reed Lake area, a critical component for understanding the tectonic evolution of the Flin Flon belt (FFB) as a whole and an area with high mineral potential.

The project is three-fold: 1) conducting new field mapping (see **poster T12**) inland from Reed Lake and re-visit key shoreline exposures, 2) compile geology from earlier work and use geophysical data for extrapolation, and 3) acquisition of new whole-rock geochemical, Sm/Nd and U/Pb data to establish tectonic setting, test for within unit variation of the rock geochemical character as well as allow for regional correlation. This poster presents a subset of data collected to date by MGS. Data used include previously published, unpublished and new research-grade isotopic and whole-rock geochemistry data.

A large portion of the supracrustal rocks in the Reed Lake area lie under water and surface exposure tend to be of poor quality due to a mature forest with abundant moss and lichen covering rocks. Geochemical comparison of samples will help refining our understanding of unit distribution and stratigraphy in the Reed Lake area.

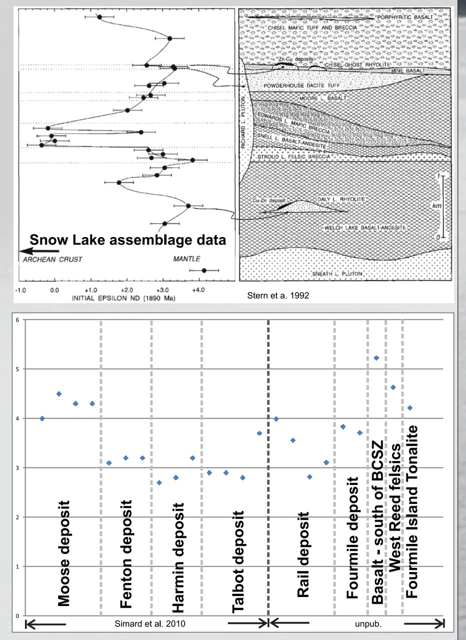
Project Location



The Reed Lake area is located in the central part of the Flin Flon belt, which consists of a collage of distinct Paleoproterozoic (1.92–1.88 Ga) tectonostratigraphic assemblages and minor Archean crustal slices that were juxtaposed during a period of 1.88–1.87 Ga intraoceanic accretion (Lucas and Stern, 1994; Stern and Lucas, 1994) to form the 'Amisk collage' (Lucas et al., 1996). Paleoproterozoic assemblages within the Amisk collage are subdivided into juvenile-arc, ocean-floor, ocean-plateau and evolved-arc (David and Syme, 1994). The Amisk collage formed the basement to widespread postaccretion magmatism, between 1.87 and 1.83 Ga which produced voluminous calcalkaline plutons and calcalkaline–alkaline volcanic rocks (Lucas et al., 1996). Younger sedimentary and subordinate volcaniclastic and volcanic rocks (1.85–1.83 Ga Missi calcalkaline–alkaline volcanic rocks (Lucas et al., 1996). Younger sedimentary and subordinate volcaniclastic and volcanic rocks (1.85–1.83 Ga Missi and Burntwood groups) may represent depositional basins that formed contemporaneously with post-accretion ('successor') arc magmatism and deformation (Ansdell et al., 1995; Lucas et al., 1996).

Sm/Nd isotopes

New unpublished Sm/Nd isotope data from the Rail and Fourmile deposit hosting-sequences and a few samples from the FIA yielded εNd (1900 Ma) values ranging from +2.8 to +5.2. These positive εNd values suggest a juvenile magma source with minimum to no involvement of continental crust in the magma genesis. These values are very similar to data obtained from four other subphanerozoic deposits (Moose, Fenton, Harmin and Talbot Lake) that yielded εNd (1850 Ma) values ranging from +2.7 to +3.2, although they display a narrower range of values. These data also overlap with values from the Snow Lake assemblage. However, data from Snow Lake spans a broader range of values and present indication for more crustal contribution to the parental magma, as evidenced by ~0.0 εNd values from the Snell Basalt.

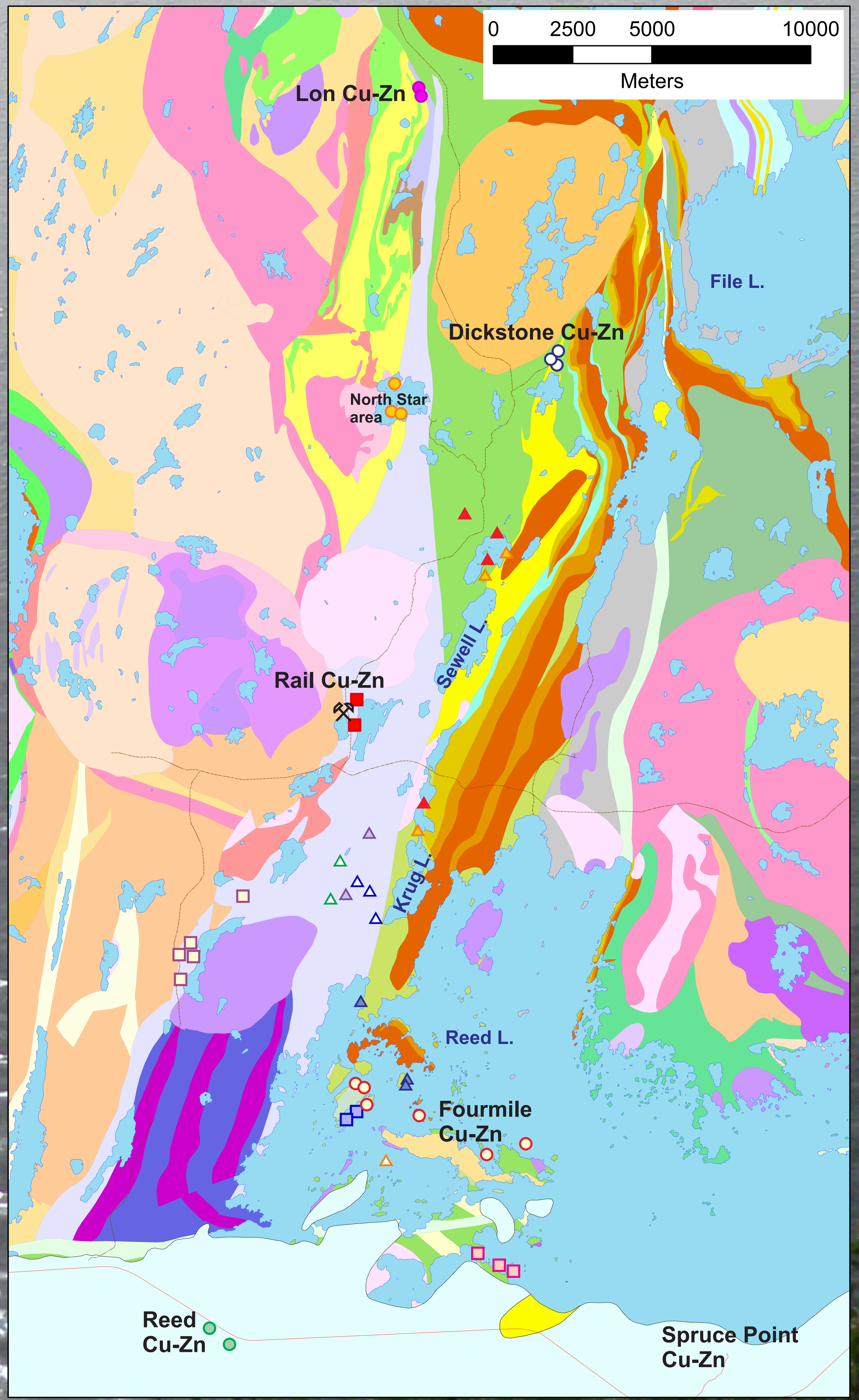


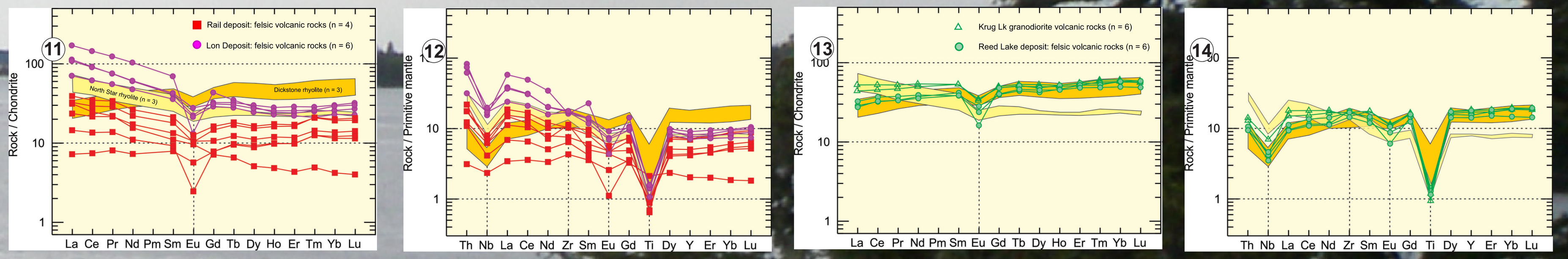
Felsic volcanic rocks: geochemistry - part II

Felsic rocks from the **Lon** and **Rail** deposits (**Fig. 11 & 12**) display moderately negative slopes, indicating LREE enrichment. This is distinct from the Dickstone rhyolite which has slightly positive slope. However, rocks from the North Star area also show a similar slope on the trace element pattern with similar anomalies. Felsic rock from the Rail deposit present a broad range of REE content, which may be explained by sampling of dikes that could not be recognized due to the tectonized nature of the rocks.

Krug L. granodiorite: Two samples of biotite granodiorite-granite (unit 9c) occurring with the felsic volcanic rocks west of Krug Lake were also analyzed. The geochemical signature of the biotite granodiorite (**Fig.13 & 14**) is very similar to that of host felsic volcanic rocks, suggesting that it may represent a synvolcanic intrusion sourced from a similar parent magma.

Felsic rocks from the **Reed** deposit, a few kilometres south of the Berry Creek shear zone (BCSZ), displays a slightly enriched HREE profile, with a small negative Eu anomaly, (**Fig.13**) as well as a positive Th and negative Nb anomalies, and strongly depleted Ti (**Fig.14**). These chemical characteristics are very similar to that of the Dickstone rhyolite and suggest that rocks south of the BCSZ maybe correlative with the FIA.



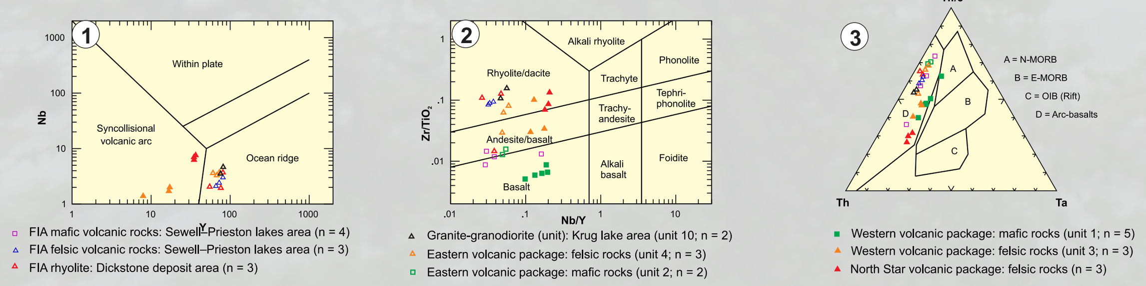


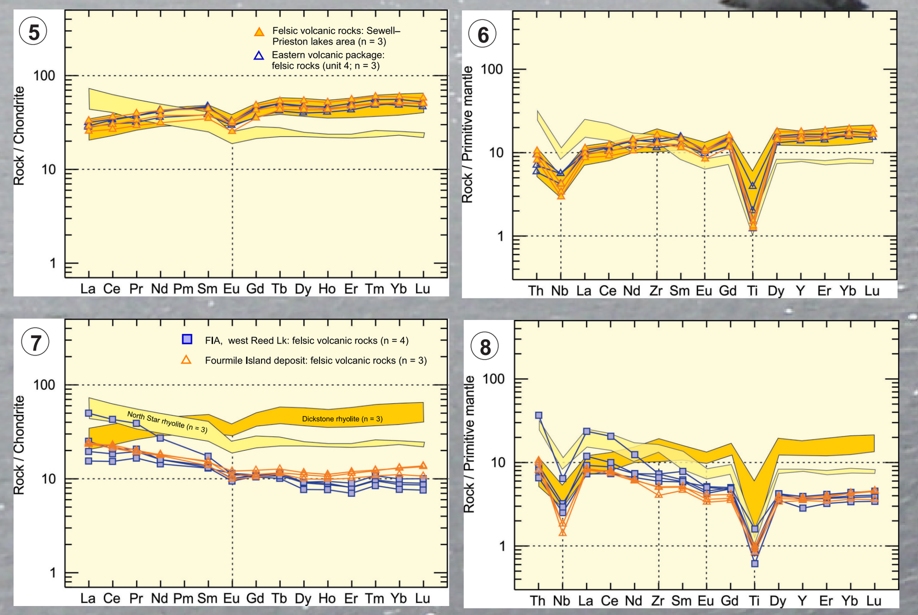
Volcanic rocks: Composition and Tectonic setting

The plots below are aimed at comparing the geochemical signature between the eastern and western volcanic packages of the west Reed Lake area and some keys reference units.

Mafic volcanic rocks: The mafic samples from the western volcanic package consist of basalt and show evidence of a weak arc affinity, transitional to typical normal mid-ocean-ridge basalt (N-MORB). Basalt in the western volcanic package shows some similarities to mafic rocks of the FIA in terms of tholeiitic subalkaline character. However, it is more mafic with a signature that is distinctly transitional to N-MORB. Mafic samples from the eastern volcanic package plot near the boundary between the andesite and basalt fields on a Zr/TiO2 versus Nb/Y diagram (**Fig. 1**). On a Th-(Hf/3)-Ta discrimination diagram (**Fig. 2**), the basaltic andesite–andesite shows a primitive volcanic-arc affinity. On both discriminant diagrams, mafic rocks from the western and eastern volcanic packages plot in the arc field but define distinct clusters. Unaltered andesite from the eastern volcanic package is subalkaline and tholeiitic in character,

Felsic volcanic rocks: Felsic volcanic and volcaniclastic samples from the western volcanic package plot within the rhyolite/dacite and the andesite fields on a Zr/TiO2 versus Nb/Y diagram (**Fig. 1**). On a Th-(Hf/3)-Ta discrimination diagram (**Fig. 2**), the rhyolite-dacite shows a weak arc affinity to transitional N-MORB in a similar manner to the basalt of the western volcanic package. On a Nb versus Y discriminant diagram (**Fig. 3**), the felsic rocks plot in the syncollisional volcanic-arc field similar to the North Star rhyolite, which also occurs on the west side of the WRNS shear zone. Felsic samples from the eastern volcanic package plot in the rhyolite/dacite field on a Zr/TiO2 versus Nb/Y diagram (**Fig. 1**), except for one sample that falls in the andesite field. On a Th-(Hf/3)-Ta discrimination diagram (**Fig. 2**), the rhyolite-dacite shows a definite volcanic-arc affinity similar to that of the Dickstone rhyolite and Sewell Lake felsic volcanic rocks. On a Nb versus Y discriminant diagram (**Fig. 3**), the felsic rocks from the eastern volcanic package, the Dickstone rhyolite and the Sewell- Prieston Lake felsic volcanic rocks all distinctly plot in the ocean-ridge field. Zwanzig and Bailes (2010) interpreted the geochemistry of the FIA to indicate a transition from arc to arc-rift environment.

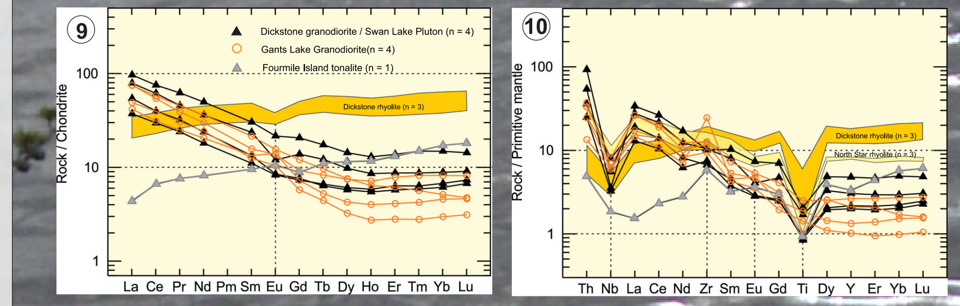




Felsic volcanic rocks: geochemistry-part I

Rocks from the eastern volcanic package and the Sewell-Prieston lakes area display a slightly enriched HREE profile, with a small negative Eu anomaly, on a chondrite-normalized trace-element diagram (**Fig.5**). On a primitive mantle–normalized incompatible trace-element diagram (**Fig.6**), the signature includes positive Th and negative Nb anomalies, and strongly depleted Ti. These chemical characteristics are very similar to published data from the Dickstone formation (Zwanzig and Bailes, 2010), indicating that the eastern volcanic package is very similar in geochemical character to the felsic rocks hosting the Dickstone mine and is thus likely correlative with the FIA.

Felsic samples from islands in the west portion of Reed Lake display a consistent signature that is also very similar to that of samples from the Fourmile deposit. The geochemical characteristics of the west Reed Lake and the Fourmile deposit felsics include lower REE content and a negative slope on a chondrite-normalized trace-element diagram (**Fig.7**). On a primitive mantle–normalized incompatible trace-element diagram (**Fig.8**), the signature includes positive Th and negative Nb anomalies, and strongly depleted Ti also with a negative slope. These chemical characteristics are distinct from the Dickstone formation rhyolite, but show the same arc-signature.



Felsic intrusive rocks: geochemistry

Rocks from the Gants Lake batolith, the Dickstone granodiorite and the Swan Lake pluton display very similar trace element patterns (**Fig. 9 & 10**), that include a moderate REE content with negative slopes, on a chondrite-normalized trace-element diagram **(Fig. 9**), that signature is typical of the successor arc plutons from the Flin Flon belt. One sample from the Fourmile island tonalite shows a distinct signature with a much lower REE content and a moderately positive slope. The pattern of the Fourmile tonalite has a slope similar to that of the Dickstone rhyolite, but with much lower REE content.

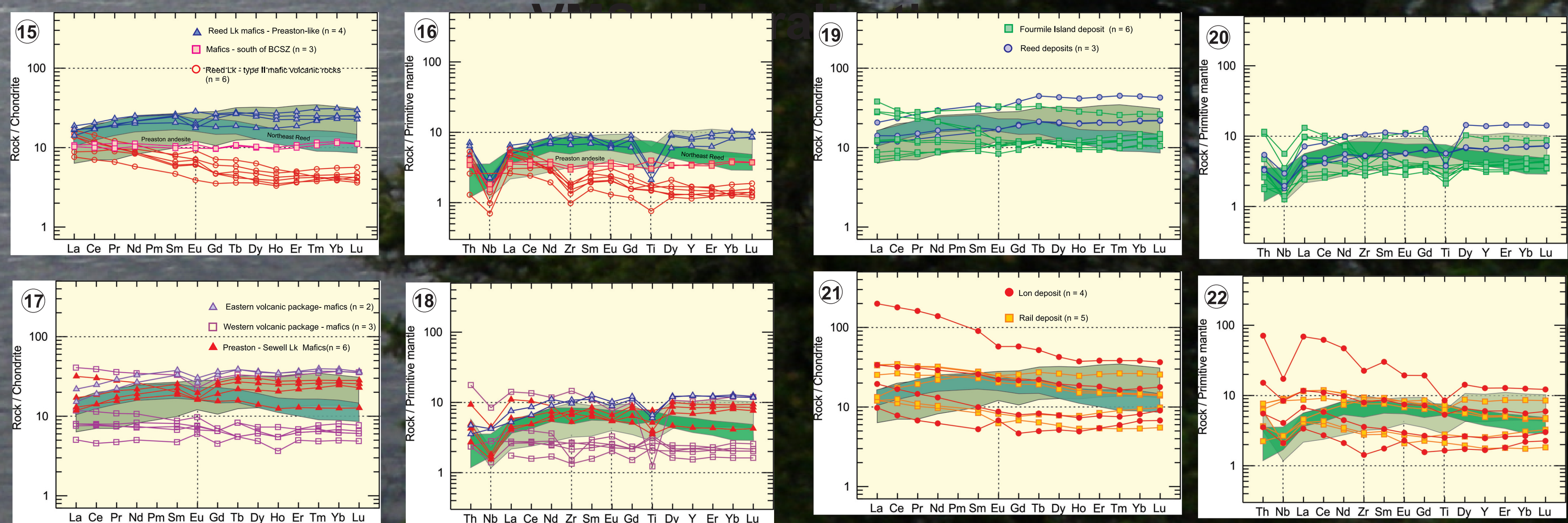
Mafic volcanic rocks: geochemistry

Reed Lake shoreline: Samples of mafic volcanic rocks collected along Reed Lake shoreline (Syme & Bailes, 1996; this study) reveal 3 distinct geochemical signatures (**Fig. 15** and **16**). There is a series of samples that show a Preaston-like signature, then samples from around Fourmile Island and south of the Berry Creek shear zone (BCSZ) show two other distinct geochemical signatures.

Eastern volcanic package: Mafic volcanic rocks displays a slightly enriched heavy rare-earth-element (HREE) profile, with a small negative Eu anomaly, on a chondrite-normalized trace-element diagram (**Fig.17**). On a primitive mantle–normalized incompatible trace-element diagram (**Fig.**18), the mafic rock signature includes distinct positive Th and negative Nb anomalies, and depleted Ti. These chemical characteristics are very similar to those of other samples collected in 2013 from the Sewell–Preaston lakes area (also shown on **Fig.17** and **18**) and to published data from the Preaston formation (Zwanzig and Bailes, 2010), indicating that the eastern volcanic package is very similar in geochemical character to the rocks hosting the Dickstone mine and is thus likely correlative with the FIA.

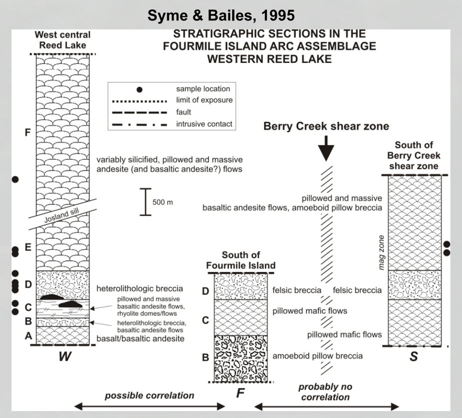
Western volcanic package: The basalt is subalkaline and tholeiitic, and displays a slightly negative slope on a chondrite-normalized trace-element diagram (**Fig. 17**) indicating light rare-earth-element (LREE) enrichment. On a primitive mantle–normalized incompatible trace-element diagram (**Fig. 18**), the basalt shows an almost flat profile with variable Nb, Zr and Ti anomalies. Like its felsic counterpart, the mafic volcanic rocks of the western volcanic package have a geochemical signature distinct from the FIA rocks.

VMS deposit-hosting sequences: Unlike shoreline samples from south of the BCSZ (**Fig. 15** and **16**), the mafic volcanic rocks of the **Reed deposit** (**Fig. 19** and **20**), also south of the BCSZ, show a trace element patterns very similar to that of the Preaston Formation. Similarly, the felsic rocks associated with the Reed Lake deposit also reveal a geochemical signature typical of the FIA (Dickstone rhyolite-like signature). Andesitic rocks from the **Fourmile deposit** show a range of signature with most of the samples sharing a chemical character similar to that of the samples from South of the BCSZ. These data combined to the distinct signature of the felsic rocks associated to the **Fourmile deposit** (**Fig. 7** and **8**) point towards a distinct stratigraphic setting for this deposit. As expected from their location, respectively along the of the west margin of the WRNS and west of the WRNS in a distinct package of bimodal arc-rocks, the **Rail** and the **Lon** deposits (**Fig. 21** and **22**) show trace element patters that differs from the typical Preaston-type FIA signature. Further work is needed to better constrain the chemical character of these deposit, a task made difficult by the high level of strain of the **Rail** deposit and the significantly higher metamorphic grade of the **Lon** host sequence.



Conclusions

The Reed Lake region is host to several deposits, three of which are hosted in the Fourmile Island assemblage (Dickstone, Fourmile, and Reed). The Dickstone and the Reed deposits may sit at a comparable stratigraphic level as indicated by the very similar chemical character of both the felsic and mafic rocks associated with these two deposits. The sequence associated to the Fourmile deposit show a distinct geochemical signature, suggestting that it may represent a different stratigraphic level within the FIA sequence. The distinct signature of the rocks hosting the Fourmile deposit have also been observed on shoreline exposure nearby Fourmile Island. Futher work is required to determine the exact relationship between the two distinct signatures. However, stratigraphic sections (see figure to the right) by Syme & Bailes (1995) suggest that the Fourmile Island deposit hosting-sequence may represent a higher level in the FIA stratigraphy.



Additional samples need to be collected from both the western volcanic package and the North Star area in order to the refine the stratigraphy and the tectonic setting, as well as characterizing the chemical character of these rocks. The fact that the western volcanic package is intruded to the west by tonalite–granodiorite of the Gants Lake batholith (1876 +7/-6 Ma), whereas the eastern package is intruded by the 'type' Josland Lake sill (1886 ±3 Ma), indicate that both packages are part of the early 'juvenile arc' assemblage. The presence of arc-affinity rocks on both sides of the RLC contradicts previous interpretations of a fundamental tectonic boundary in this location, previously thought to separate rocks of oceanic affinity (including the RLC) on the west from rocks of arc affinity on the east; any such boundary must lie farther west of the study area.

These preliminary data for the Reed Lake volcanic rocks suggest that it maybe possible to refine the stratigraphy of the FIA using detailed whole-rock gechemistry. Follow-up sampling and analyses will help further constrain the chemo-stratigraphy of the FIA sequence and refine the stratigraphic position of the various VMS deposits. Finally, by characterizing the stratigraphy of the FIA using high-quality whole-rock analysis it may become possible to determine if the rocks north and south of the BCSZ can be correlated. A positive correlation may also provide insights on the net offset along the BCSZ.

References:

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