Towards a better understanding of the geology of the Reed Lake area (part of NTS 63K10 and 63K11)

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Introduction

A multiyear field-mapping and data compilation project (bedrock mapping, geophysical data, drillcore logs, geochemistry) 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. Significant stratigraphic, geochemical and isotopic differences between arc-volcanic rocks in the Flin Flon and Snow Lake areas (Stern et al., 1995a) suggest that these two segments of the Flin Flon Belt 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 to the west and the Snow Lake segment to the east.

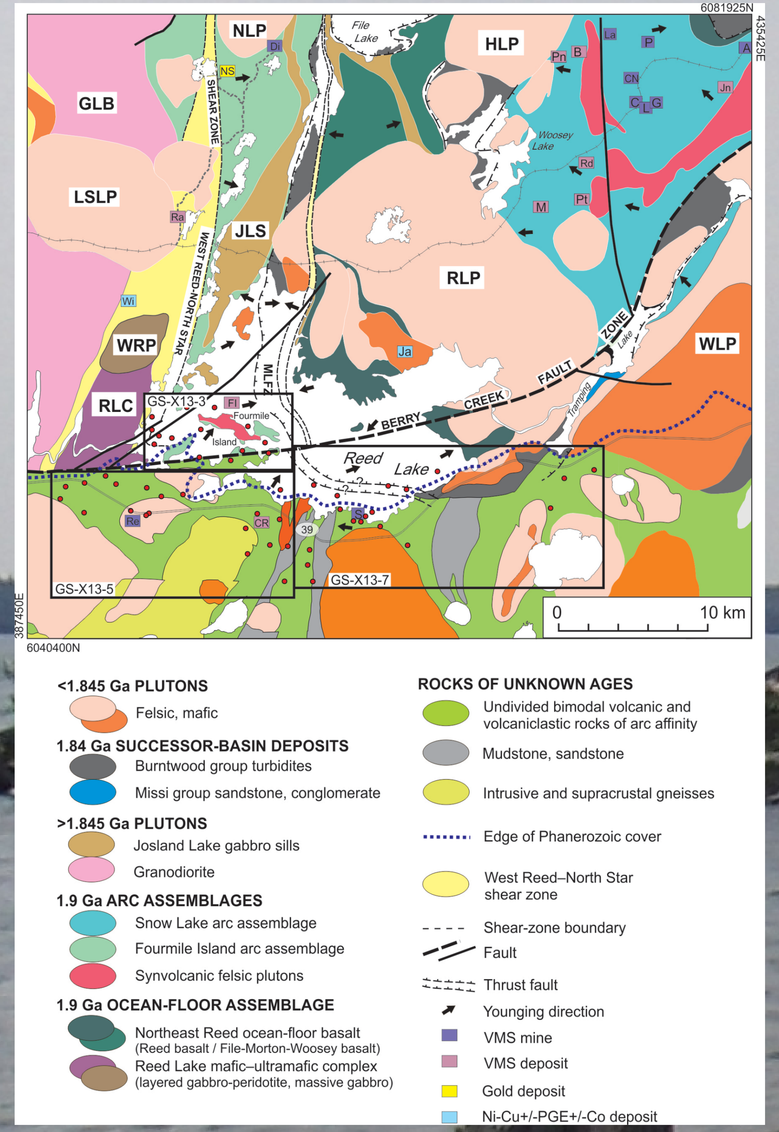
The Reed Lake area also includes the Fourmile Island assemblage (FIA), a bimodal succession of volcanic and volcaniclastic rocks of arc or arc-rift affinity that hosts several significant VMS deposits, including the currently producing Reed Cu-Zn deposit. Previous geological work (Leclair and Viljoen, 1997; Leclair et al., 1997) and geophysical data show that arc-affinity rocks extend south of Reed Lake beneath the Phanerozoic cover for a distance of more than 50 km. Therefore, a better understanding of the Reed Lake area has important implications for base-metal exploration of the sub-Phanerozoic basement.

The main objective of the project is to produce a revised geological map for the Reed Lake area and its immediate sub-Phanerozoic basement. A preliminary version of the updated geology for the Reed Lake area is presented here.

Geological context

The Reed Lake area is located in the central part of the FFB 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 exposed portion of FFB at Reed Lake contains several distinct panels of juvenile-arc assemblage, which are separated by major faults; some panels also contain ocean-floor assemblage, Burntwood group sedimentary rocks and plutonic rocks (Figure to the right). The juvenile-arc assemblages are internally complex due to faulting and folding (e.g., Bailes and Syme, 1989), but are typically bimodal and include a wide range of arc-related volcanic, volcaniclastic and synvolcanic intrusive rocks (Bailes and Syme, 1989; Syme and Bailes, 1993; Stern et al., 1995a; Lucas et al., 1996; Bailes and Galley, 2007). Ocean-floor assemblages are composed mainly of mid-ocean-ridge–like basalt and related kilometre-scale, layered, mafic–ultramafic intrusions (Syme and Bailes, 1993; Stern et al., 1995b). Voluminous successor-arc plutons and coeval volcanic and sedimentary rocks, formed between 1.88 and 1.83 Ga, occur throughout the Reed Lake area and include the Schist-Wekusko assemblage, the Missi group and the Burntwood group. The Missi group is characterized by thick packages of fluvial-alluvial conglomerate and sandstone, whereas the basinal-marine Burntwood group comprises turbiditic greywacke, mudstone and rare conglomerate.



Project objectives and methodology

In 2015, two weeks were spent examining key shoreline outcrops previously mapped by Syme, Bailes and Lucas (1995b). However, the main focus of the 2015 field activities was the examination of recent and historical drillcore of Paleoproterozoic bedrock from the southern portion of Reed Lake and the sub-Phanerozoic area immediately to the south. A total of 44 drillcores were examined, documented and sampled to complement a set of 9 drillcores that were examined in 2013-2014.

This work is a component of the larger project aimed at updating the geology of the Reed Lake area. The objectives of the drillcore component are to: (i) better document the stratigraphy of Paleoproterozoic supracrustal rocks in the Reed Lake area; (ii) investigate the geological setting of volcanogenic massive sulphide deposits hosted by these rocks; and (iii) characterize the nature and intensity of associated hydrothermal alteration, which can serve as an important exploration tool. Data from the drillcore examination program will also help at verifying the geophysical and geological domains delineated using geophysical surveys.

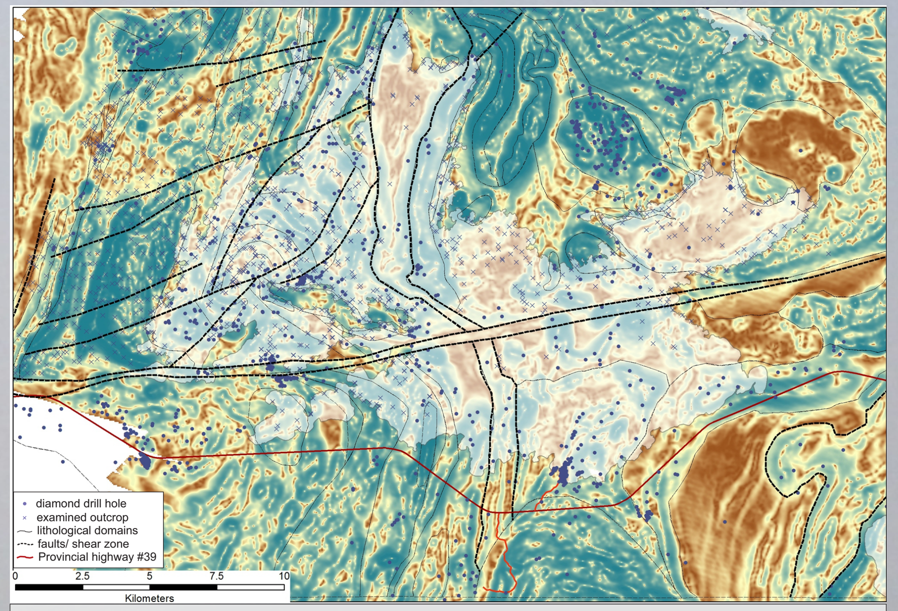
The preliminary version of the reinterpreted geology of the Reed Lake presented here was generated using surface data combined with information from a small subset of examined drillcore and an initial rough analysis of available aeromagnetic data.

In order to refine our geological interpretation of the Reed Lake area, geological data from bedrock mapping and drillcore examination will be integrated with geochemical, geophysical and geochronological data. Examination of the geophysical data will entail a detailed analysis of company-owned high-resolution aeromagnetic data using both traditional and more recent techniques for analyzing and displaying geophysical data,such as vertical and horizontal gradients, and 'Slope' and 'maxima' analyses. More than 1000 drillholes, contained in both nonconfidential and confidential files, have been drilled in the study area during the past century.

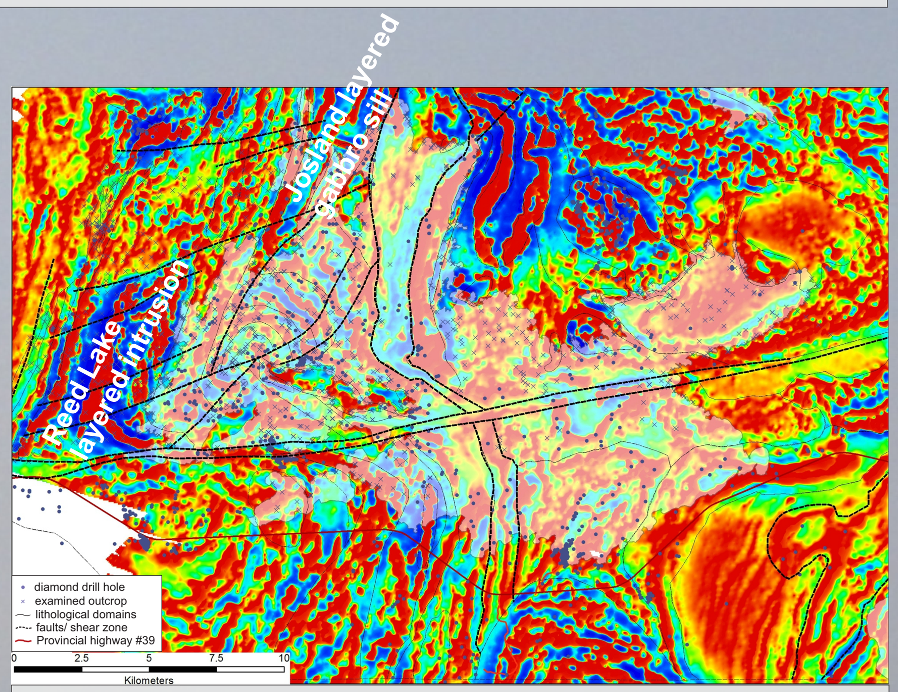
Geophysics and drillcore logs: tools to aid geological reinterpretation

The geology of the Reed Lake area and its immediate subphanerozoic basement has been revised using recent bedrock mapping data (Gagne, 2013; Gagne and Anderson, 2014; Gagne unpublished), data from the 1995 geological mapping by Symes, Bailes, and Lucas, available detailed aeromagnetic survey data (Assessment File 73859, Manitoba Mineral Resources, Winnipeg) and descriptions from selected historical exploration drill logs available online through the iMaQs system (http://www.manitoba.ca/iem/mines/imaqs/index.html). A total of 54 drillholes have been examined throughout the area in order to collect samples for whole-rock geochemistry and to get familiar with the rocks describe in the historical drillcore logs. The new geological unit boundaries have been constrained using observed surface geology, drillcore description and geophysical signature.

The geology of Reed Lake shoreline and the east side of the Reed Lake has not been changed very much. The proposed new geological interpretation affects mostly the western portion of Reed Lake and its immediate subphanerozoic basement. This new interpretation is preliminary as several drillcore description still remain to be consulted and more whole-rock geochemistry results are still pending.



Slope gradient extracted from total magnetic field (AF 73859). Brown domains represent areas of small slope gradient and yellow to blue areas represent respectively moderate to steep magnetic gradient.

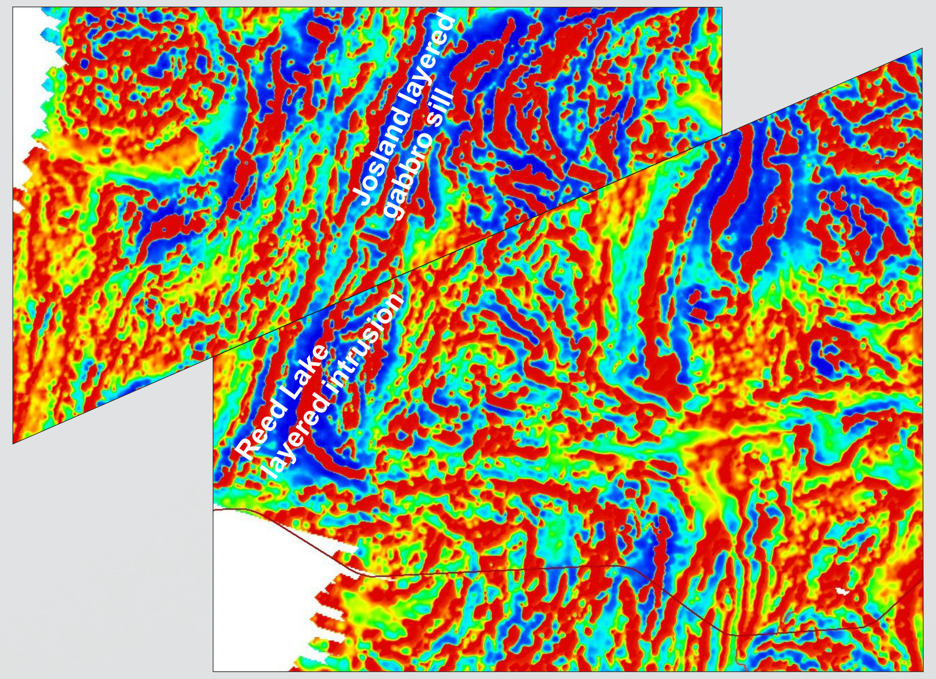


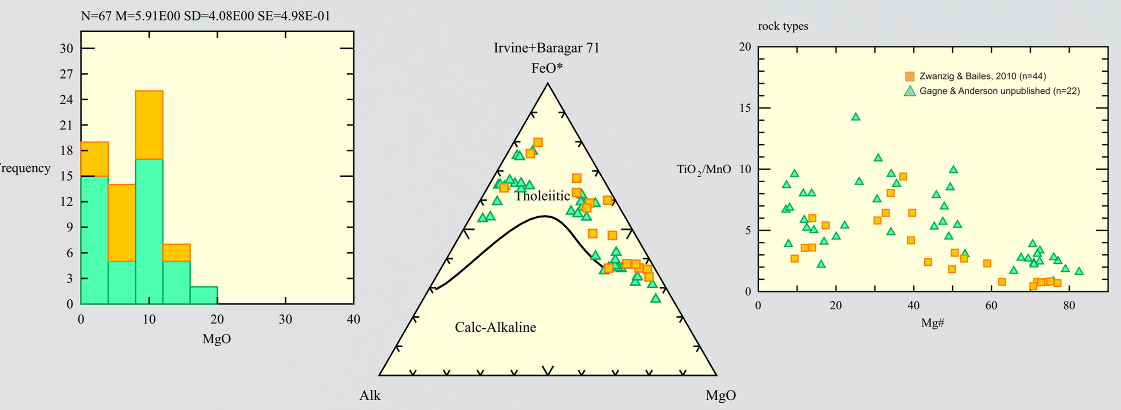
First vertical derivative calculated from total magnetic field. (AF 73859) Blue domains represent low magnetic and yellow to red areas represent respectively moderate to high magnetic intensity.

Is the Reed Lake mafic layered complex a southern extension of the Josland sill?

Geological bedrock mapping at 1: 20 000 scale west of Reed Lake (Gagne and Anderson, 2014) identified a series of northeast striking and subvertical discrete dextral shear zones in the southern half of Krug Lake. These ductile shear zones are interpreted to part of the third deformation episode (D3) of Gagne and Anderson (2014). The Berry Creek shear zone, a salient feature on any geophysical map of this area has the same orientation and was also interpreted to have developed syn D3 to early D4. A detailed examination of the aeromagnetic data reveals that a series of these discrete shear zones also cuts through the Reed Lake layered mafic intrusion.

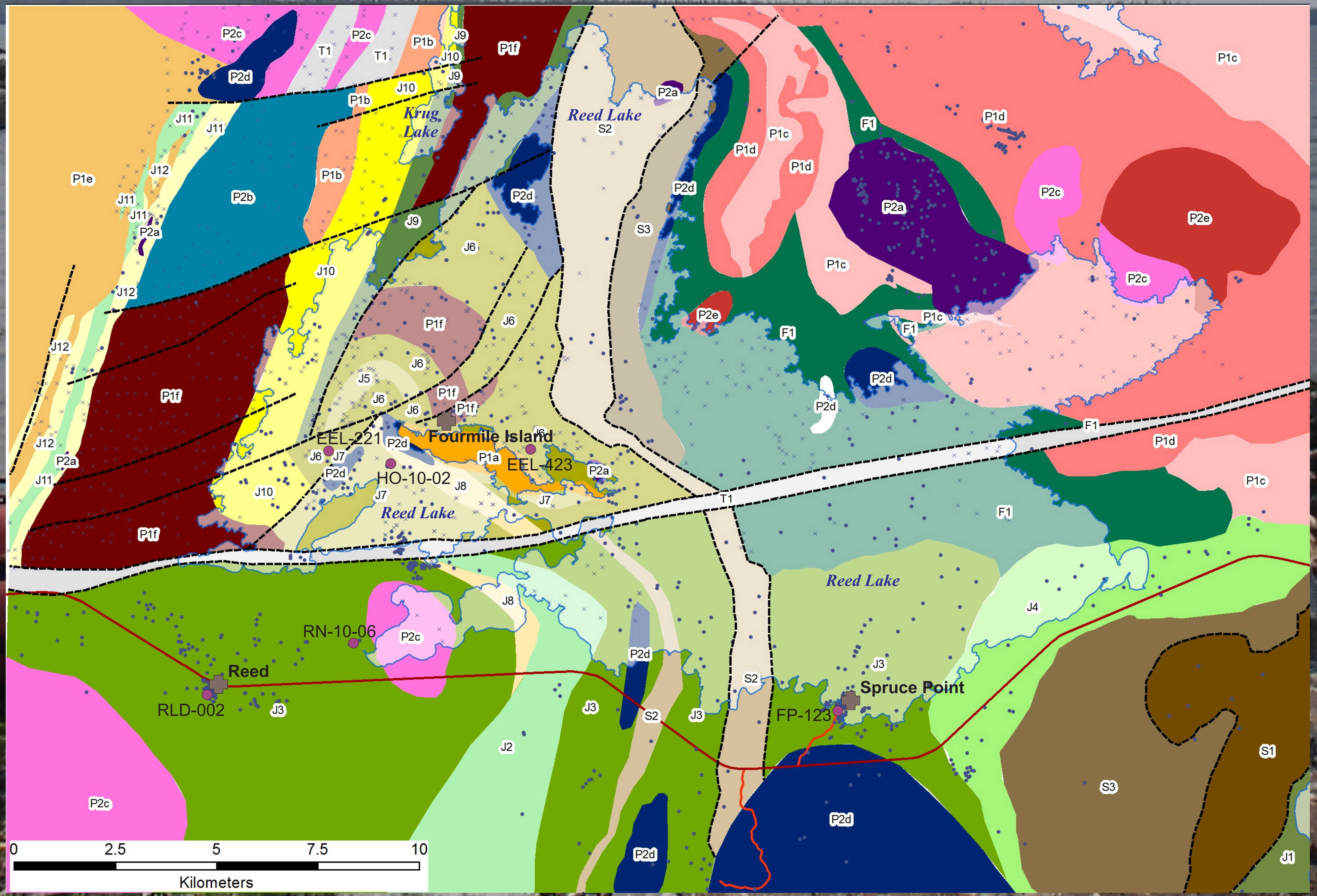
Examination of the geophysical data shows a fault truncating the north end of the Reed Lake layered mafic intrusion and the south end of the Josland sill. Reconstruction along the fault orientation shows that the geophysical signature of the two layered body is a nearly perfect match. The two intrusions show the same anomalies with the same width and the exact same strike (see figure to the right).





The diagrams above show similarities in major element signatures between the Reed Lake layered mafic intrusion and the Josland sill. The frequency distribution histogram of the MgO composition of the samples show that both intrusion span similar compositional range. The diagram from Irvine & Baragar show that both intrusions share a tholeiitic affinity. Finally, on a TiO2/Mno vs Mg#, both intrusions present the same data spread.

Mapping and whole-rock data from Zwanzig and Bailes (2010) and Williamson and Eckstrand (1995) show that the two intrusions also share several geochemical similarities. Both intrusions are Fe-enriched rocks of tholeiitic affinities that show a westward fractionation of the units.



Map Legend

Sedimentary rocks
- S3 Mudstone; graphitic, minor sulphide facies iron formation
- S2 Burntwood Group: greywacke, mudstone
- S1 Psammitic gneiss; Bt-Mus-Qtz-Pl+/-Grt

Intra-tectonic intrusions
- P2e Diorite to quartz diorite
- P2d Gabbro, diorite, quartz diorite
- P2c Little Swan Lake pluton: Granodiorite to tonalite
- P2b Reed Lake gabbro, minor leucogabbro
- P2a Gabbro, melagabbro

early-tectonic to synvolcanic intrusions
- P1f Josland sill: layered gabbro, leuco-gabbro, quart-diorite
- P1e Gants Lake batholith: tonalite
- P1d Tonalite to quartz-diorite
- P1c Foliated to gneissic tonalite ot granodiorite
- P1b Ocean-floor basalt
- P1a basalt

Tectonites
- T1 Strongly layered, foliated to mylonitic mafic tectonite

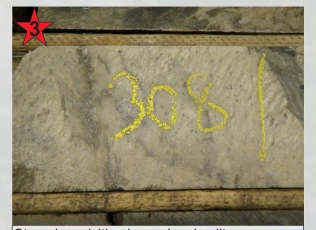
Juvenile arc-rocks
- J12 Rhyolite-dacite: volcaniclastic rocks; minor flows
- J11 Mafic volcaniclastic rocks and minor basaltic flows
- J10 Dickstone formation: dacite-rhyolite flows; minor tuffs
- J9 Preaston formation: pillowed flows, minor volcaniclastic
- J8 Felsic volcaniclastic rocks: felsic breccia and felsic dikes
- 29 Mafic volcaniclastic rocks: breccia, minor heterolithic breccia
- J6 Basaltic andesite - andesite: pillowed and massive flows
- J5 Intermediate volcaniclastic rocks: heterolithic breccias
- J4 Interbedded undivided juvenile arc-rocks (felsic-mafic) and sedimentary rocks with minor iron formations
- J3 Undivided juvenile arc-rocks: felsic-mafic volcanic to volcaniclastic rocks, locally altered, minor sediments
- J2 Basalt: massive to pillowed flow, magnetite-bearing
- J1 Amphibolite facies felsic-mafic volcanic and volcaniclastic rocks interbedded with minor psammitic to pelitic sediments

Ocean-floor rocks
- F1 Ocean-floor basalt

Drillcore photos

Variably silicified and sericitized massive quartz-phyric rhyolite from the sequence hosting the Fourmile Island deposit.

Solid sulphides from a copper-rich lens of the Reed Lake deposit. Main sulphides are pyrrhotite and chalcopyrite.



Strongly sericitized massive rhyolite.

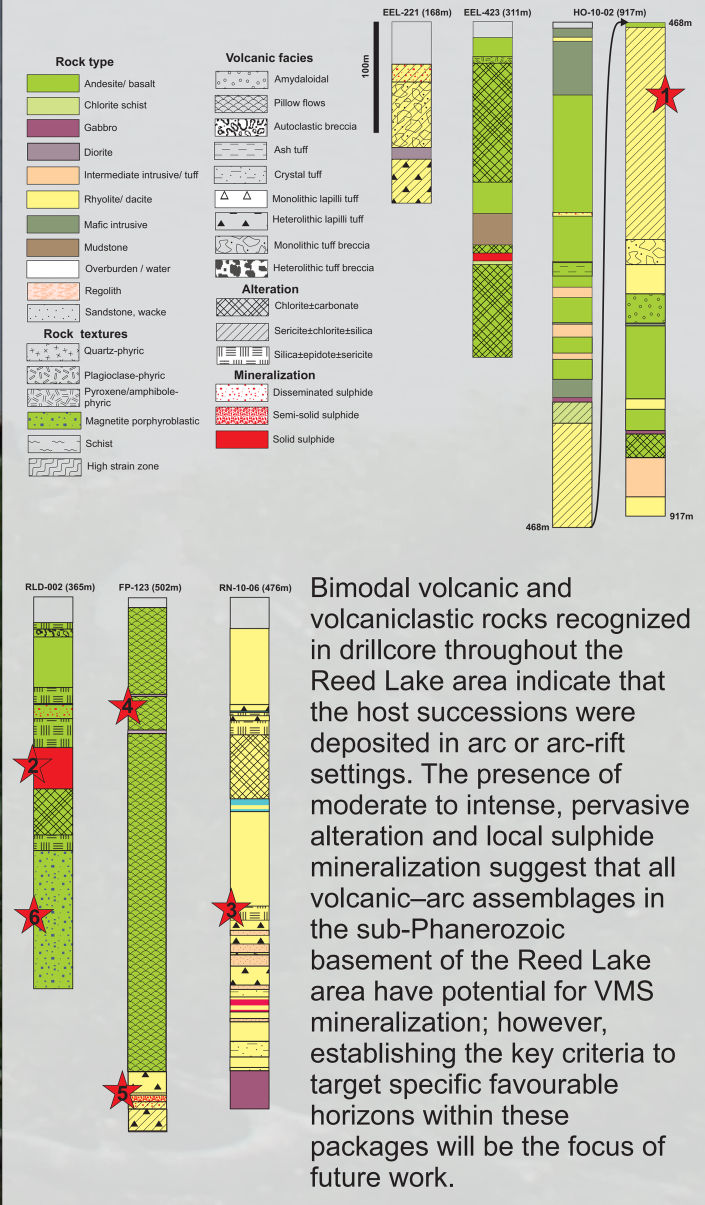
Weakly chloritized aphyric pillowed andesite flows from the hangingwall of the Spruce Point deposit.

Felsic lapilli tuffs from the Spruce Point deposit. The drillcore shows a progression (from top to bottom) from weakly sericitzed to strong sericite + sulphide alteration.

Silicified (left) and chloritized (right) andesite from the footwall of the Reed deposit.

Schematic cross-sections from selected drillcores

This section presents cross-sections from selected representative drillcores examined. The cross-sections allow to display the bimodal and variable nature of the volcanic stratigraphy of the Reed Lake area as well as the widespread nature of alteration throughout the area.



Bimodal volcanic and volcaniclastic rocks recognized in drillcore throughout the Reed Lake area indicate that the host successions were deposited in arc or arc-rift settings. The presence of moderate to intense, pervasive alteration and local sulphide mineralization suggest that all volcanic–arc assemblages in the sub-Phanerozoic basement of the Reed Lake area have potential for VMS mineralization; however, establishing the key criteria to target specific favourable horizons within these packages will be the focus of future work.