

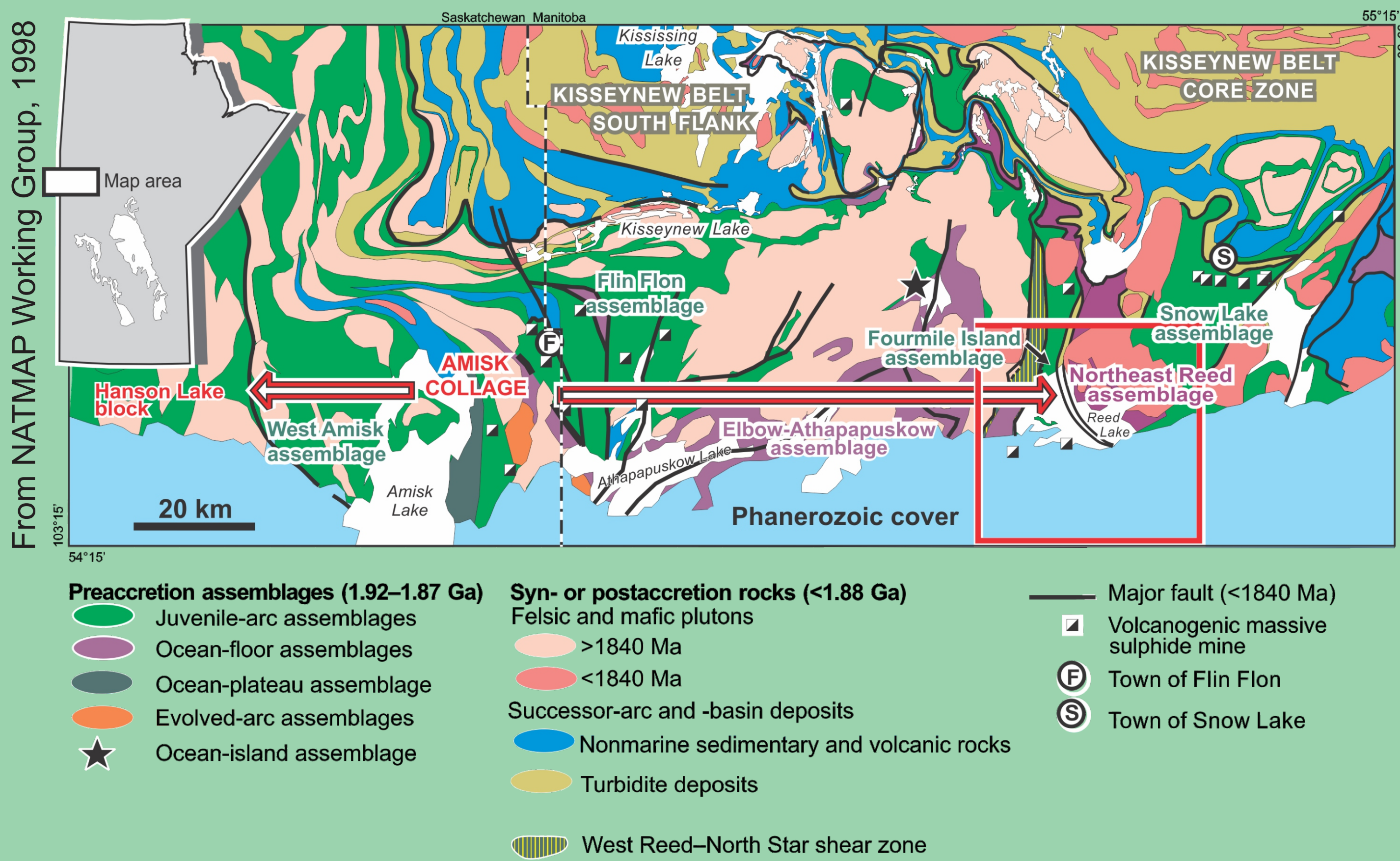


# Chemostratigraphy and distribution of volcanic rocks of the Fourmile Island assemblage, Flin Flon Belt, West-Central Manitoba

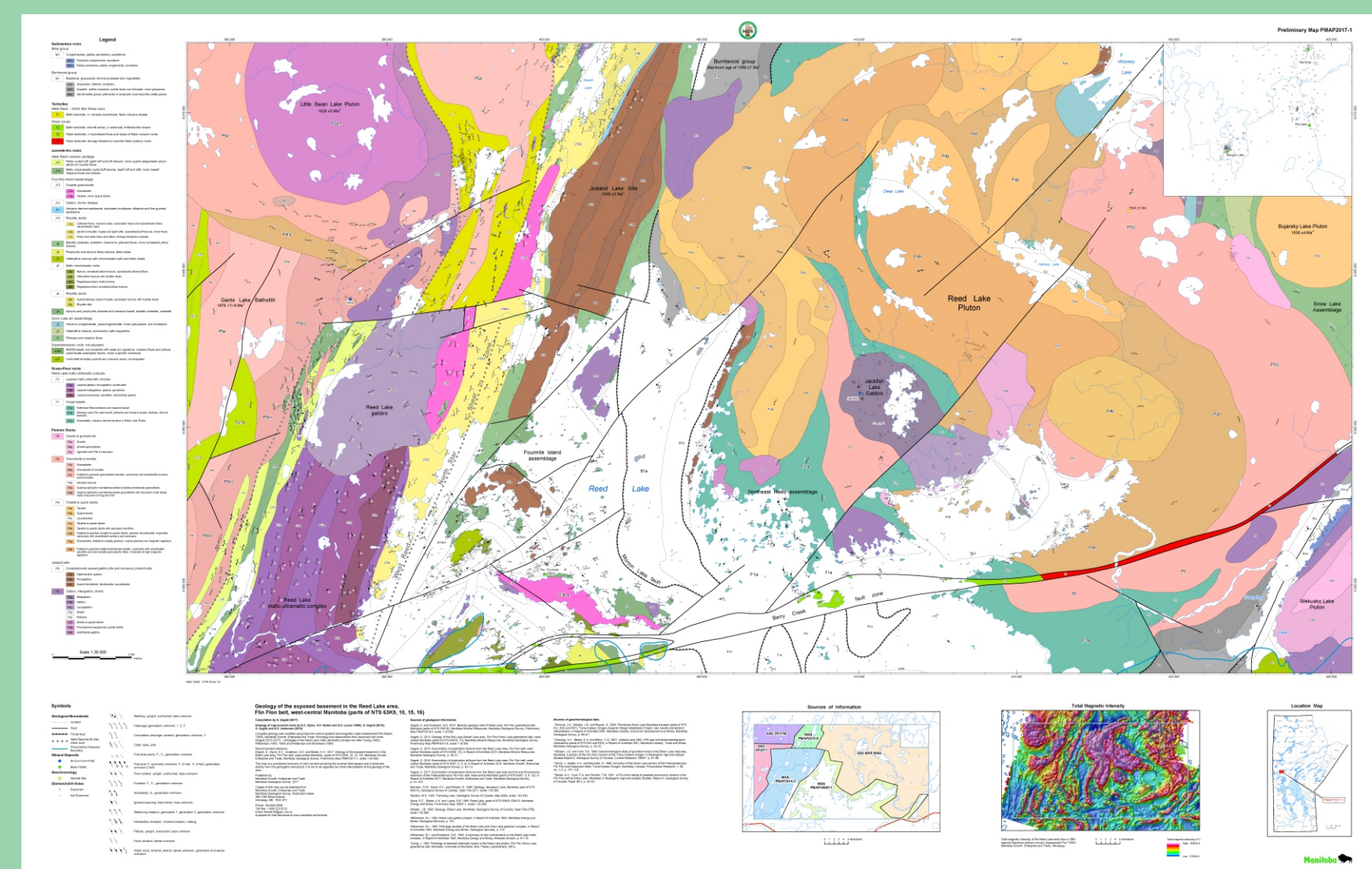
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## Introduction

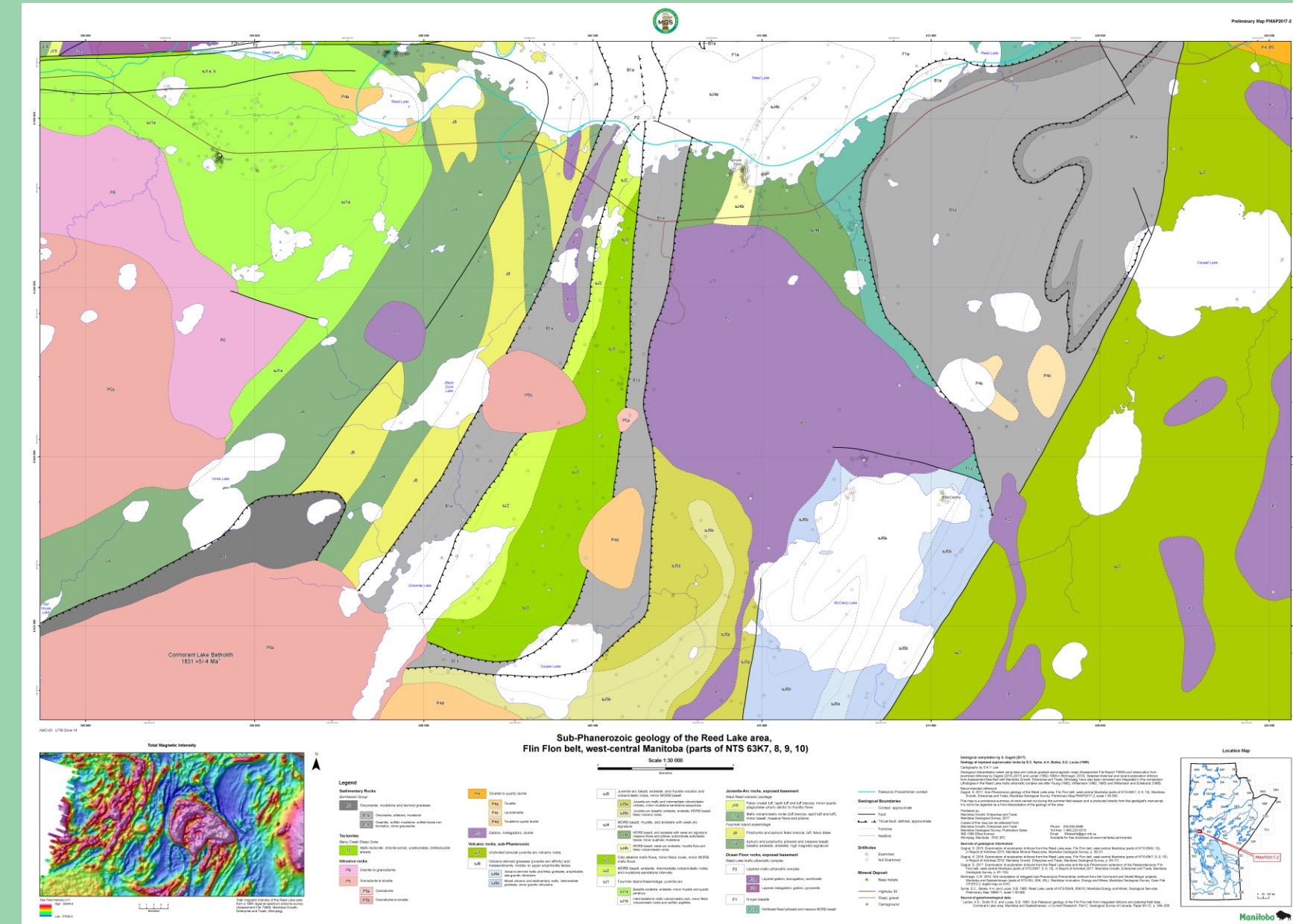
The Flin Flon belt in the Reed Lake area, and its extension to the south under Phanerozoic sedimentary rocks, has significant potential to host additional VMS deposits. Despite the presence of several economic deposits, the geological setting of VMS deposits in the Reed Lake area is not well understood.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



A compilation of geological data from surface mapping and drillcore was integrated with Manitoba Geological Survey (MGS) regional geochemistry and industry airborne geophysical surveys to produce **two new preliminary maps** in 2017 (**PMAP2017-01** and **PMAP2017-02**). A collaboration agreement with Hudbay has provided access to Hudbay's extensive whole-rock geochemistry database for the Reed Lake area.



The 2017 new preliminary maps provided a more precise understanding of the geology of the Reed Lake area. However the internal unit distribution and stratigraphy of the Fourmile Island assemblage (**FIA**), a volcanogenic massive sulphide (**VMS**)-hosting sequence of bimodal volcanic and volcanoclastic rocks was not completely understood and further work was required.

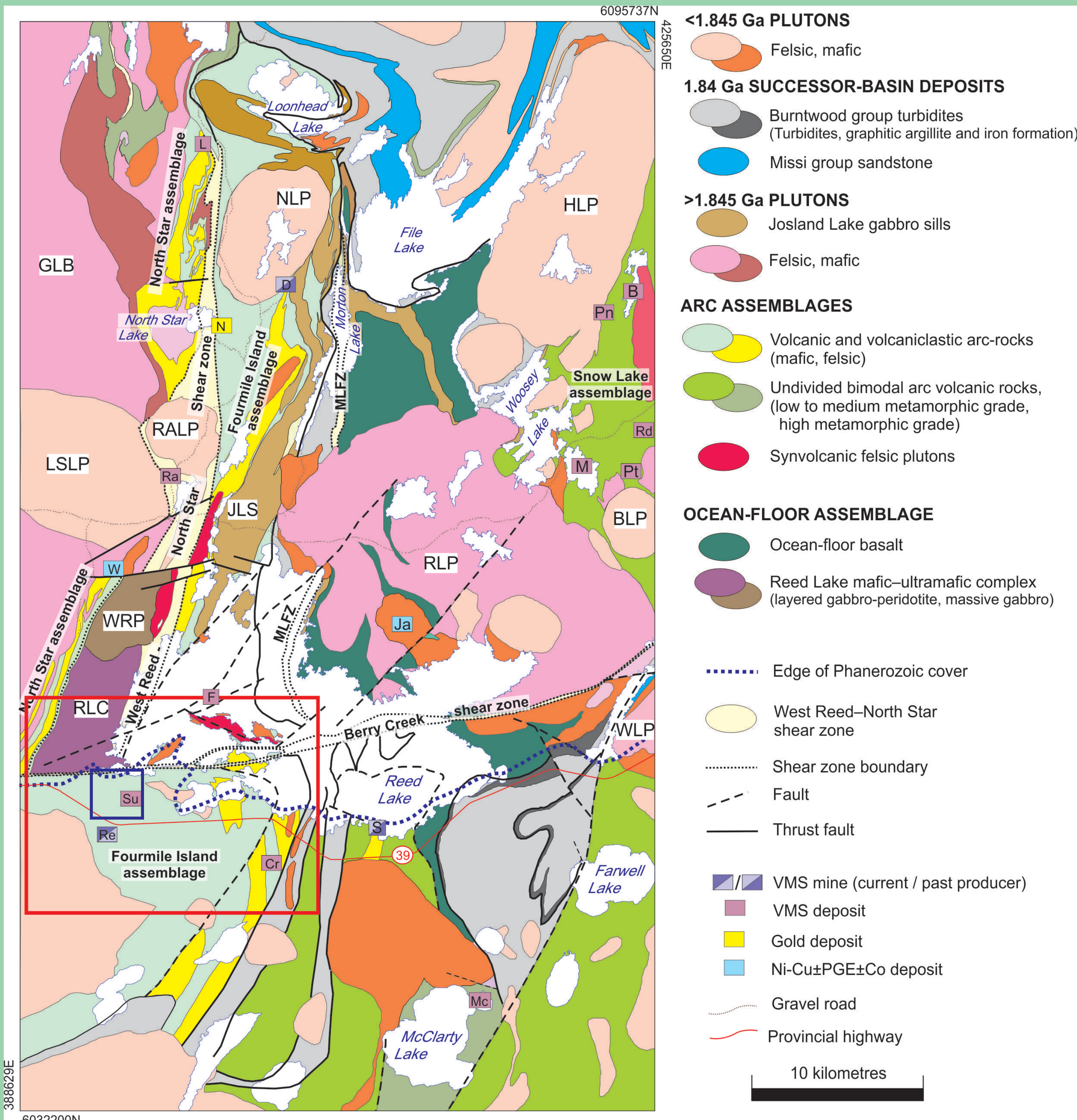


Recent work by the Manitoba Geological Survey has shown that the bimodal volcanic rocks of the FIA reflected the presence of a few characteristic trace elements signatures, hence suggesting that a stratigraphy of the FIA could be established.

The 2018 research efforts focused on the Fourmile Island and Reed Mine area where the bulk of Hudbay's data came from.

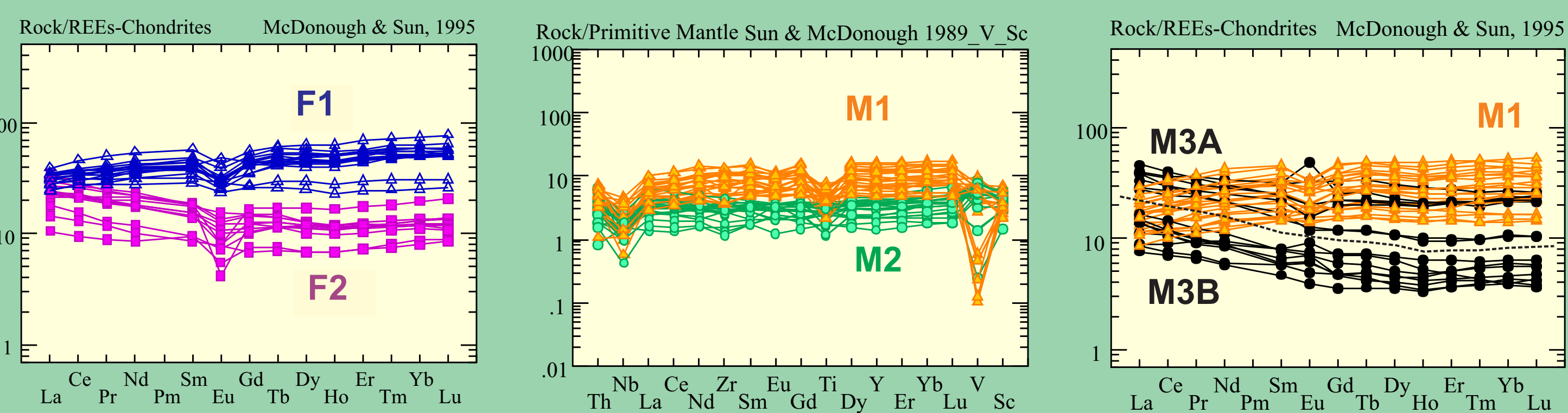
## Geology of the Reed Lake area

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). Recent MGS work has identified several distinct lithotectonic packages of volcanic rocks in the Subphanerozoic portion of the FFB south of Reed Lake. New geochemical, isotopic and geochronological data has also shown that the North Star assemblage represents a distinct package of bimodal volcanic rocks with an arc-signature that formed at around the same time than the main VMS-hosting sequence of Snow Lake and Flin Flon were deposited. For more detail see **2018 Report of activities GS2018-5**.



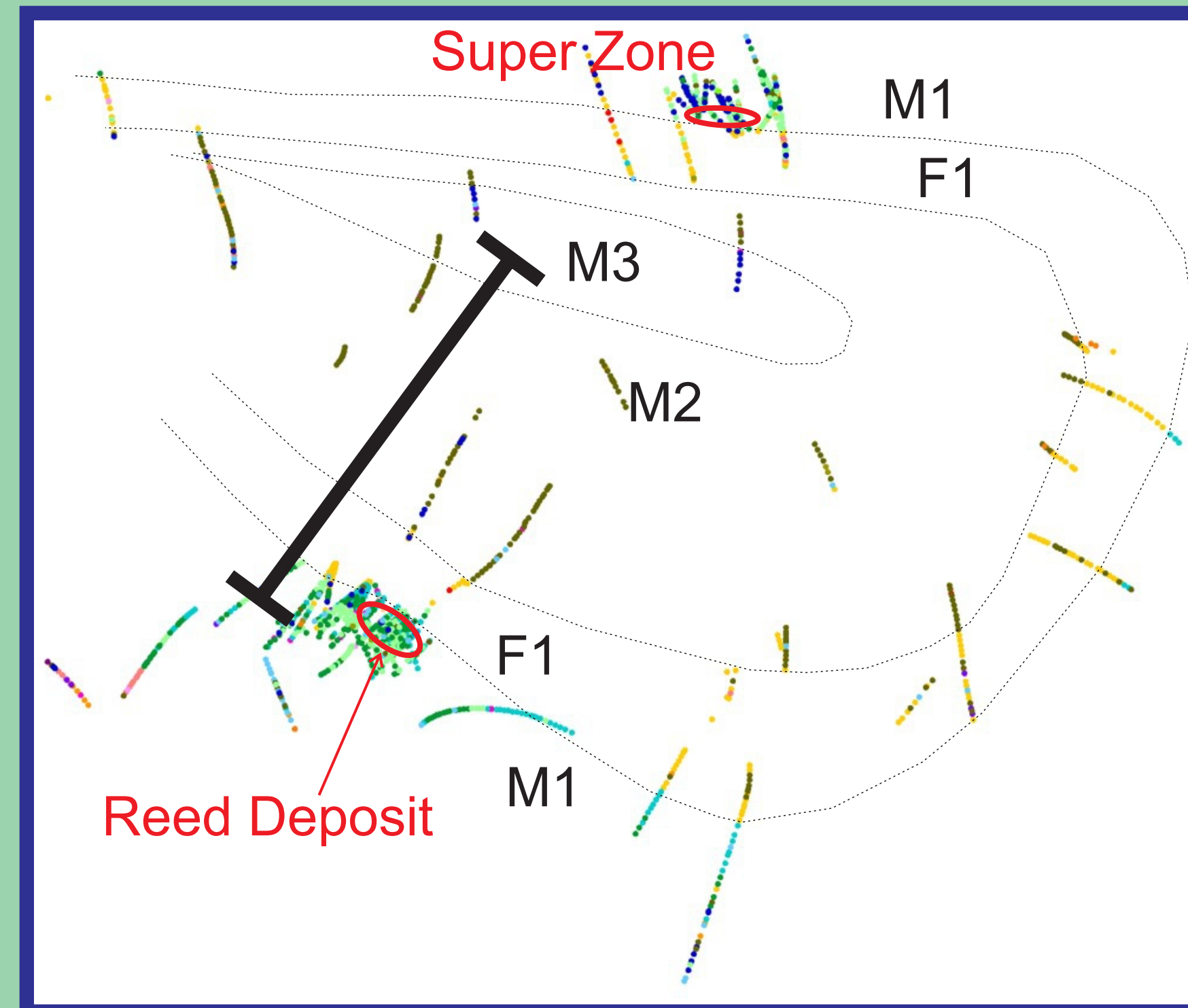
## Geochemistry

Outcrops and drill core samples from the FIA collected by MGS show a few distinct signatures that seems to be consistent and may allow to map units using trace element signature. The FIA shows 2 dominant distinct signatures for rhyolitic and dacitic rocks, referred to as **F1** and **F2** (see below for trace element signature). Mafic volcanic rocks can be subdivided in four subsets that have a distinct, yet consistent trace element geochemical signature and are referred here as **M1**, **M2**, **M3A** and **M3B**.



## Drill holes geochemistry (Hudbay) & geology of the Reed Mine area

During definition and exploration drilling near the Reed deposit, Hudbay collected a large quantity (~ 1400 samples) of whole-rock geochemical analyses with trace element data. The dataset was parsed to focus on volcanic and volcanoclastic rocks only and the trace element signature of individual samples was observed and classified in distinct groupings. The bulk of Hudbay's FIA samples also presented the same subsets as the MGS dataset. On the map to the right, Hudbay's samples from the Reed Mine area were color-coded based on their subset identity (F1, F2, M1, M2, M3A and M3B) and drawn along the drillhole traces. The map to the right outlines a fold structure. It is interpreted to be a synclinal fold, based on some facing directions observed in drillcore and the asymmetric alteration around the deposit (Bailes, 2010, Hudbay's internal report)

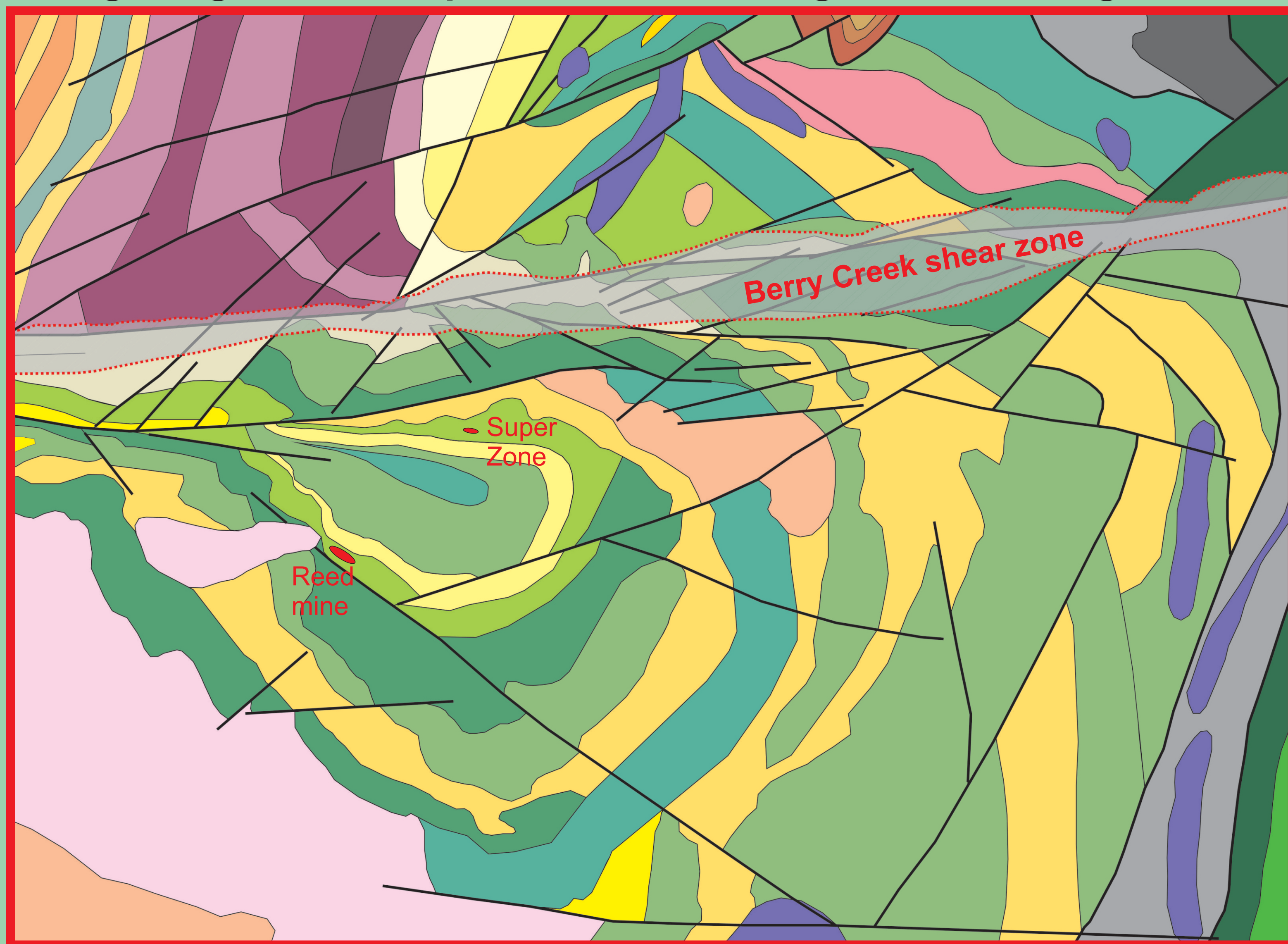


According to the sequence of rocks observed through the Reed Mine syncline (bold black line on map to the left), which is interpreted to be intact (i.e. not disrupted by faulting), the simplified stratigraphy for the FIA would include (see schematic column to the right) the following units, bottom to top: M1, F1, M2, and M3 (A and B; their stratigraphic position relative to one another has not been resolved). Rhyolitic rocks with an F2 signature have been observed to sit within the M3A,B sequence of mafic volcanic rocks at Reed Lake and have been displayed in such manner on the schematic section. The Reed VMS deposit occurs within the M1 mafic volcanic rocks, near its upper contact.

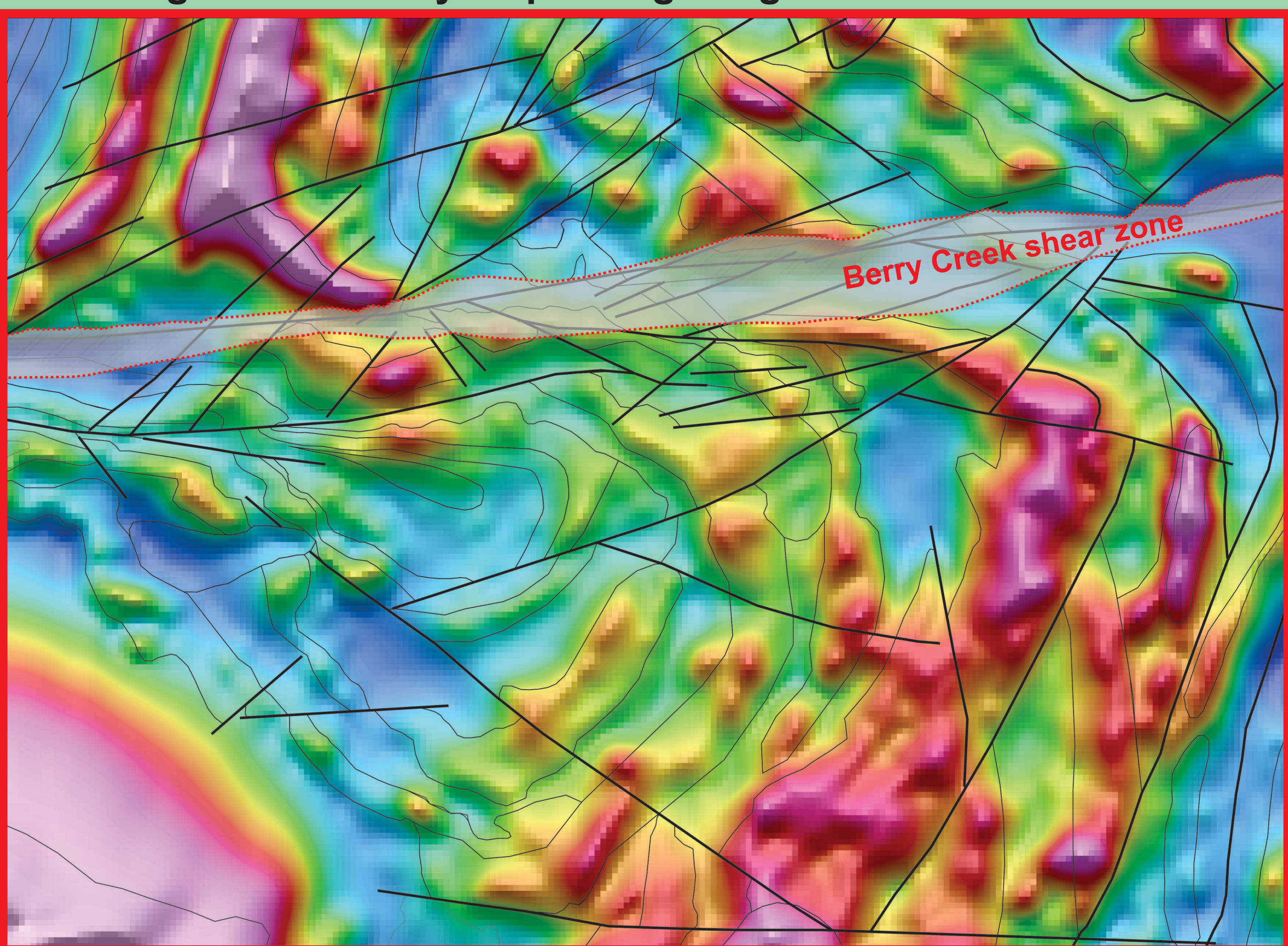


## Geological re-interpretation of SW Reed Lake and the Reed Mine area aided by airborne geophysical and whole-rock geochemical data

### FIA geological re-interpretation based on geochemical signature



### Total magnetic intensity map with geological contacts and faults



### Legend

#### Intrusive rocks

- Late granite - granodiorite
- Late granodiorite - tonalite
- Late gabbro - diorite
- Gants Lake batholith
- Fourmile Island intrusion
- Tonalite, granodiorite
- Josland Lake sills
- Gabbro, gabbro
- Ferrogabbro
- Gabbro, gabbro

- Reed Lake mafic - ultramafic pluton
- Layered gabbro, leucogabbro, anorthosite
- Layered melagabbro, gabbro, pyroxenite
- Layered pyroxenite, peridotite, subordinate gabbro

#### Tectonites

- Felsic tectonites, FIA-like geochemical signature
- Mafic tectonites, subordinate felsic tectonites

#### Volcanic rocks

- Basalt, ocean-floor signature (MORB)
- Basalt, andesite, calc-alkaline signature
- North Star assemblage
- Rhyolite, dacite flows and volcanoclastic facies
- Basalt, andesite flows and volcanoclastic facies
- Fourmile Island assemblage
- Felsic volcanic rocks of undetermined geochemistry
- Mafic volcanic rocks of undetermined geochemistry
- Rhyolite, dacite with F2 trace element signature
- Basalt, andesite with M3 trace element signature
- Basalt, andesite with M2 trace element signature
- Rhyolite, dacite with F1 trace element signature
- Basalt, andesite with M1 trace element signature
- Burntwood group rocks
- Mudstone, siltstone, sandstone
- Graphitic mudstone, sulphide facies iron formations

## Economic implications

### VMS mineralization:

- New geological interpretation and stratigraphy for the volcanic rocks of the Fourmile Island assemblage will allow to better target exploration for VMS deposits, which are stratigraphically controlled.

- Large areas of prospective rocks are virtually unexplored.

- The Reed mine horizon wraps around the syncline and can be traced through the Super Zone. VMS deposits often cluster along synvolcanic faults and the area between the Reed Mine and the Super Zone should be considered highly prospective.

**Gold mineralization:** Late sinistral brittle deformation along the Berry Creek shear zone (BCSZ) is evidenced by the presence of several smaller faults oriented 15-30° counterclockwise to the BCSZ and display sinistral displacements similar to Riedel shears. There are several gold occurrences along the BCSZ and riedel shears represent favorable structures for emplacement of gold mineralization.

**Acknowledgements:** The geological re-interpretation of the Reed mine has been made possible through collaboration with Hudbay Minerals Inc. that shared their geochemical 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.