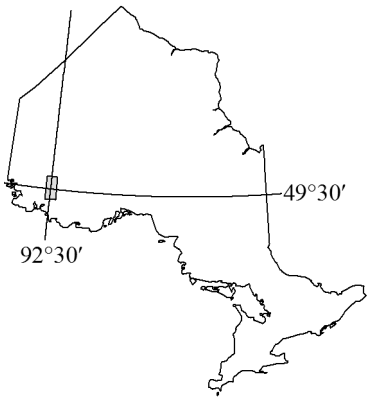
# 37. Preliminary Regional Interpretation and Sampling for Modelling and Prospectivity Analysis of the Western Wabigoon Subprovince

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## INTRODUCTION

As part of the Metal Earth project, directed by the Mineral Exploration Research Centre (MERC), field work was conducted in the western Wabigoon Subprovince during the summer of 2018. The Metal Earth project aims to investigate why Archean greenstone belts, such as those in the Abitibi Subprovince and the western Wabigoon Subprovince, have heterogeneous mineral endowment despite having similar rock types and genetic histories. To support the investigation, Metal Earth has carried out geophysical surveys along "transects", oriented perpendicular to the strike of major lithologic packages and structures, using reflection seismic, magnetotelluric and gravity methods. To complement these data sets, geological mapping was conducted within a 20 km wide zone along each transect.

The thematic project presented in this summary seeks to integrate geological and geophysical data into a three-dimensional (3-D) model of the western Wabigoon Subprovince, to identify the factors influencing the subprovince's mineral potential. What geological and geophysical factors differ between the level of endowment of the western Wabigoon *vis a vis* the Abitibi Subprovince? Note that the Abitibi Subprovince is better constrained in terms of geophysical, geochemical, geochronological and geological data compared to the western Wabigoon Subprovince.

This report summarizes preliminary observations from field work and sampling to constrain integrated geological and geophysical mapping and explore factors contributing to mineral endowment in a 140 by 100 km area within the central part of the western Wabigoon Subprovince. Data collected during this, and 4 subsequent field seasons, will support regional-scale 3-D models, and both knowledge-based and data-driven prospectivity analysis in the subprovince. In addition to exploring factors contributing to mineral endowment in the subprovince, this work will develop an improved method of mineral exploration for Precambrian greenstone belts that integrates disparate data sets and incorporates uncertainty analysis.

## REGIONAL GEOLOGY

The Superior Province is composed of variably endowed Archean greenstone belts that host diverse precious-metal and base-metal deposits. Deposit styles range from fault-hosted gold-bearing veins (Robert and Brown 1986; Neumayr, Hagemann and Couture 2000; Olivo and Williams-Jones 2002; Olivo, Chang and Kyser 2006; Dubé et al. 2007), intrusion-related deposits (Morasse et al. 1995; Robert 2001; Helt et al. 2014) and volcanogenic massive sulphide deposits (Dubé et al. 2007; Mercier-Langevin et al. 2014). In general, these deposits are the result of volcanic construction and tectonic activity, as newly formed, small lithospheric fragments were accreted and amalgamated between 2.72 and 2.68 Ga (Percival 2007).

*Summary of Field Work and Other Activities, 2018,*
*Ontario Geological Survey, Open File Report 6350, p.37-1 to 37-7.*

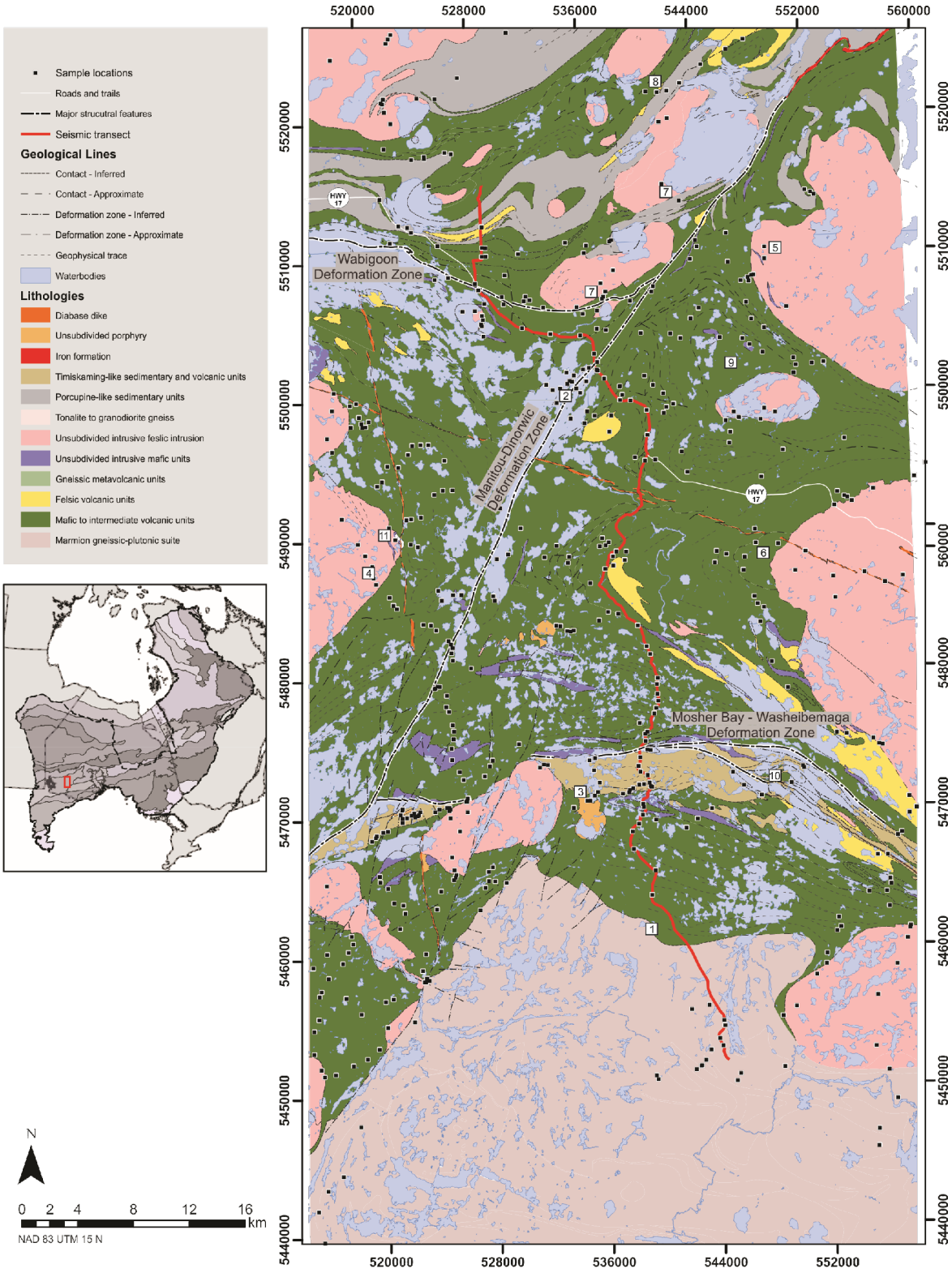


**Figure 37.1.** Regional geology of the area around Metal Earth's geophysical transect near Dryden, Ontario (geology *modified from* Blackburn 1978). Areas of interest (numbers 1 to 11 in white boxes) are described in Table 37.1. Map interpretations were compiled from legacy Ontario Geological Survey maps, airborne geophysical maps and new field observations. Universal Transverse Mercator (UTM) co-ordinates are given in North American Datum 1983 (NAD83), Zone 15N. Inset map shows location of the map area relative to Superior Province subprovinces (*modified from* Montsion, Thurston and Ayer 2018).

**Table 37.1.** Descriptions of areas of interest identified through geophysical interpretation and investigated during field work in the summer of 2018. The numbers in the table are keyed to Figure 37.1.

| Area | Area of Interest | Description |
|---|---|---|
| 1 | The contact between the Marmion terrane | There is uncertainty related to the nature of the contact between the older and higher-metamorphic-grade Marmion terrane south of the western Wabigoon Subprovince. This contact was located and examined; however, further thin section, geochemical and field work is required to draw definite conclusions. |
| 2 | Location of the Manitou–Dinorwic deformation zone in Dinorwic Lake | Although many maps indicate a shear zone or fault with a single line on a map, many of these features, including the Manitou–Dinorwic deformation zone (MDDZ), are more accurately represented as a broad zone. Field work across this geographically extensive feature identified the extent of deformation. Additionally, east-to-west movement associated with the earlier Wabigoon shear zone was found to be overprinted by the northeast-southwest fabric of the MDDZ. |
| 3 | Nature of the contact between the Thunder Cloud porphyry and the Stormy Lake group metasedimentary rocks | The nature of the contact between the Thunder Cloud porphyry and overlying sedimentary rocks constrains the timing and environment of deposition for these Timiskaming- and Porcupine-type sediments. Field observations indicate that the contact is erosional and the sediments were deposited unconformably above the Thunder Cloud porphyry. |
| 4 | Contacts and compositional variations in the Atikwa Batholith | The Atikwa Batholith is one of the largest intrusions in the western Wabigoon Subprovince. Its relationship to surrounding greenstone units and its location are valuable pieces of evidence to explain the tectonic setting and timing of adjacent greenstone belts. In 2018, issues with access prevented a full investigation of this contact. In 2019, further work will be done to better characterize this key contact. |
| 5 | Zonation in the Basket Lake batholith | There are 3 distinct magnetic highs that may indicate a zonation or pulse pattern within the Basket Lake batholith. Identifying these zones in the field and characterizing them by composition may provide information about magma evolution and intrusion history. In the field, these zones were identified using a handheld magnetic susceptibility meter, thereby correlating geophysical interpretations with field observations. These interpretations and observations provide evidence for zonation in the batholith. |
| 6 | Metamorphic halo of the Revell batholith | The northern extent of the Revell batholith is associated with gold mineralization according to Parker (1989); therefore, characterizing the contact of this batholith is important for understanding mineralization in the WWS. In the field, the northern contact of this regional intrusion is sharp, with some alteration of the greenstone units that surround it, indicating that there was fluid flow during or after emplacement. |
| 7 | Extent and nature of the Heartland Lake and Sandybeach stocks | These 2 intrusive bodies are located near the Wabigoon shear zone (WSZ). Their relationship to this zone may provide relative timing information for emplacement versus regional deformation. This may also have implications for gold mineralization. Some work was done in the field in 2018 to resolve the location and nature of the intrusive contact; however, geochemical, geochronological and thin section analyses are required before any conclusions can be reached. |
| 8 | Extent of the pegmatite dike network around the Ghost Lake Pluton | North of the WSZ, the Ghost Lake Pluton is associated with rare metal mineralization, including lithium, columbite-tantalite and beryl in pegmatites (Brand et al. 2009; Breaks and Moore 1992). Mapping the extent and location of the pegmatites is significant to understanding the intrusive history and timing of regional mineralization. |
| 9 | Pressure shadow north of the Melgund Lake Stock | There is a distinct zone of low magnetic intensity northwest of the Melgund Lake Stock. While visiting this area in the field, no distinction between these and adjacent units was identified. Further geochemical and thin section work is required to resolve this anomaly. |
| 10 | Positive (iron formation?) anomalies near Stormy Lake | There is a strong positive magnetic anomaly along the northern fault contact of Stormy Lake group sedimentary rocks. This was interpreted to be banded iron formation; however, dense forest and swamps prevented access to these areas. In 2019, additional effort will be made to visit these sites and make observations about the lithology and its contact. |
| 11 | Strongly remanent circular anomaly (kimberlite?) near Snowfall Lake | A strongly negative magnetic anomaly is contained within an alteration zone within the easternmost extent of the Atikwa Batholith. The site of the anomaly is near a linearly extensive intrusive body, likely located along a regional-scale tectonic structure, and displays a strongly positive magnetic remanence. The location and adjacent features indicated that this was a prospective area for a kimberlite pipe. An examination of the centre of this anomaly revealed only a weakly magnetic tonalite. Therefore, the source of the remanent magnetic anomaly may be concealed or at depth. |

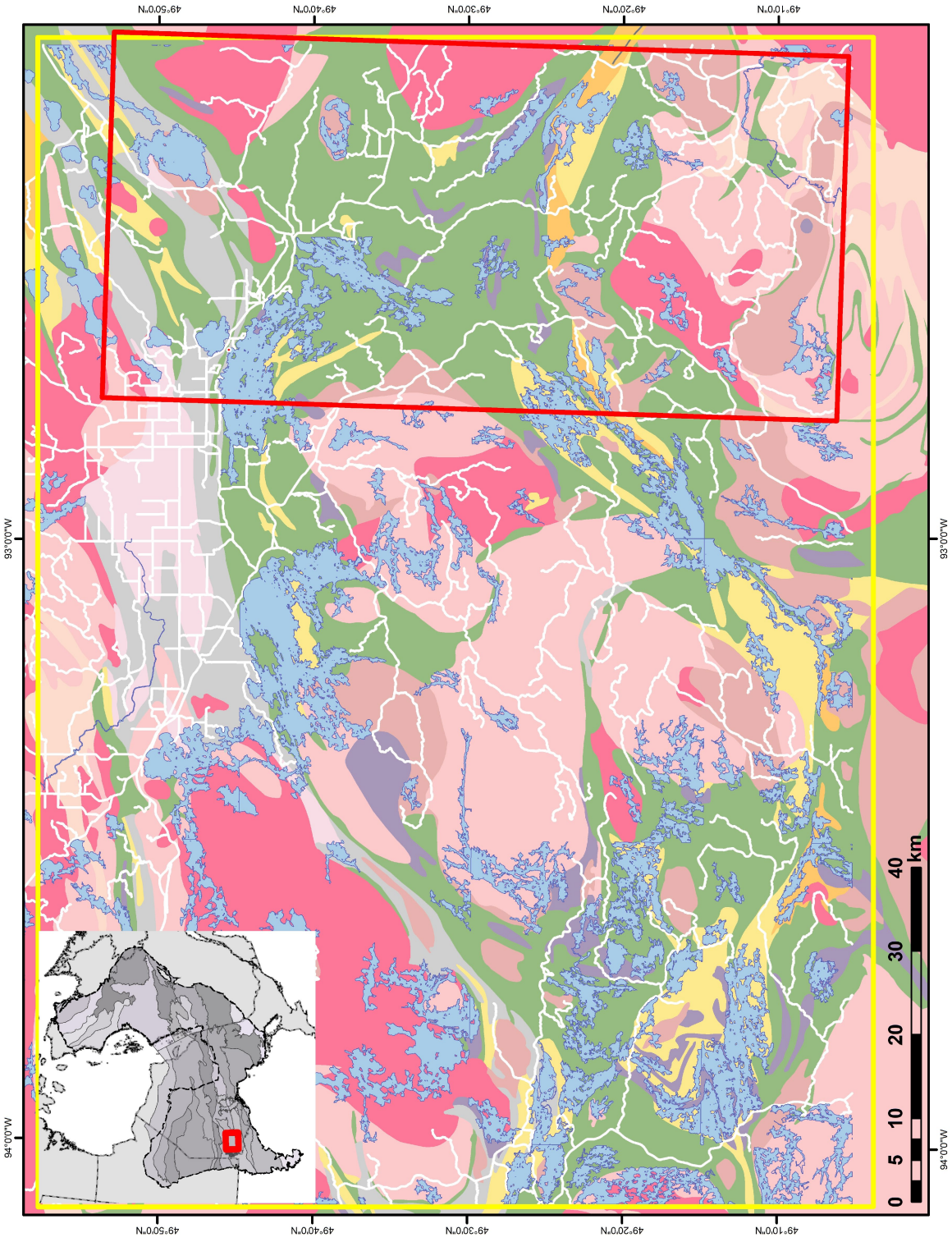


**Figure 37.2.** Extent of future, subprovince-scale (area outlined in yellow) and Dryden seismic transect (area outlined in red) 3-D geological models, superimposed on a geologic map of the Kenora District (Ontario Geological Survey 2011). Inset map shows location of the map area relative to the Superior Province subprovinces (*modified from* Montsion, Thurston and Ayer 2018).

The western Wabigoon Subprovince (WWS) is composed of structurally complex, generally northeast-trending, Neoarchean belts that display low metamorphic grades relative to the gneissic and plutonic rocks of the Mesoarchean Winnipeg River and Marmion terranes, which bound the Wabigoon Subprovince to the north and south, respectively (Tomlinson et al. 2004; Percival et al. 2004). The WWS is composed of mafic volcanic successions (2750–2715 Ma), Porcupine-type turbiditic successions (2715–2710 Ma), and Timiskaming-type conglomeratic successions (~2703–2696 Ma) (Beakhouse et al. 1995; Corcoran and Mueller 2007). These supracrustal rocks were variably intruded by tonalitic to granitic plutons, 2750–2680 Ma in age (Davis 2005).

Although the WWS is much less endowed compared to the Abitibi Subprovince, it nevertheless hosts several deposits and developed prospects with a variety of metal resources (gold, silver, nickel, copper, zinc, lead, iron, lithium, molybdenum, uranium, thorium). In the last century, exploration in the region has resulted in an abundance of data, as both public and private stakeholders conducted investigations at various scales. When compiled, the resulting database will provide valuable geologic information; however, the WWS is still a greenfield environment and requires further observations, interpretations and sampling to better understand its geologic history and provide the necessary framework for 3-D modelling and prospectivity analysis.

## FIELD WORK

The focus of the 2018 field work was to investigate regionally significant features identified from interpretation of structures using aeromagnetic data (areas of interest identified are listed in Table 37.1), to improve on geophysical interpretations using field observations, and to gather regionally representative samples for prospectivity analysis.

Interpretations from geophysical data were integrated with field observations to produce a regional-scale geological map of an 80 by 40 km area south of Dryden, Ontario, along Metal Earth's Dryden–Stormy Lake transect (Figure 37.1). Field investigations were also carried out to refine topological relationships of major structures and relative timing of large felsic to intermediate intrusions. Further field work in 2019 is required to draw conclusions about these relationships.

In addition to producing a preliminary geological map, a suite of representative rock samples was collected throughout the area. Sample locations are indicated by black squares in Figure 37.1. These samples will be analyzed for lithogeochemistry and used in regional-scale prospectivity analysis.

## FUTURE WORK

Over the next 4 years, a subprovince-scale 3-D model will be generated for a 140 by 100 km area (indicated by yellow box in Figure 37.2) with modelling depth extending to the Moho (~40 km). The 3-D model developed will be constrained using geophysical interpretations and inversions, as well as field observations, and legacy data and maps. Based on the 3-D models and available data, a suite of prospectivity maps will be generated. To support these products, the geometry of regionally significant structures will be constrained through further field work, and additional samples will be collected in areas where data are currently sparse.

## RELEVANCE

This project will attempt to establish a method of integrative exploration for greenstone belts, which can be used to highlight prospective targets and evaluate their associated uncertainty. This is anticipated to be an innovative tool that can be used to evaluate globally distributed greenstone belts for undiscovered base-metal and precious-metal deposits. By improving upon current methods of exploration and

quantifying uncertainty, exploration programs can be designed to be more efficient when working in underexplored and complex Precambrian terranes. Although there are other, similar, tools available for regional exploration, they often only utilize two-dimensional analysis and do not incorporate uncertainty calculations (Porwal, Carranza and Hale 2003; Porwal et al. 2015; Yu et al. 2012; Bérubé et al. 2018). The method being developed in this study will enhance these tools and integrate 3-D data as well as uncertainty analysis.

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