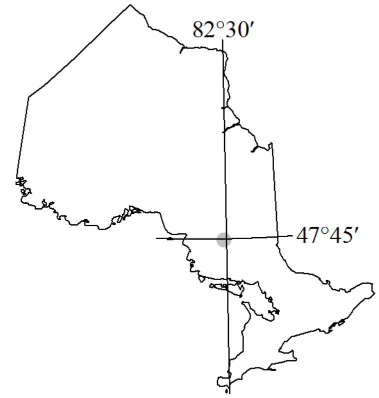
34. Lithological and Stratigraphic Relationships of the Swayze Area, Abitibi Greenstone Belt



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INTRODUCTION

This work is part of the multiyear Metal Earth project carried out by MERC (Mineral Exploration Research Centre, Laurentian University, Sudbury) to refine the geological knowledge of the Abitibi greenstone belt. The project is designed to attempt to understand why greenstone belts, such as the Abitibi, have many mineral deposits, whereas belts, such as those in the Wabigoon Subprovince to the west, have fewer deposits per unit area. Given the broad similarities in rock types at surface, the answer to the question likely lies in the mid to lower crust and/or the mantle. Therefore, Metal Earth is imaging the entire crust in the Swayze area along "transects" oriented perpendicular to the strike of major units and structures, using reflection seismic, magnetotelluric and gravity surveys. Geological mapping is also being done along the transects, to provide an up-to-date base for interpretation of the geophysical surveys.

The Swayze area is located within the western Abitibi Subprovince and is likely the westward extension of the Abitibi greenstone belt (Ayer et al. 2002). This article presents the preliminary results of Metal Earth 2017 transect research mapping in the Swayze area. The purpose is to improve the existing model for the belt (first proposed by Heather 2001) by 1) identifying and mapping critical rock units throughout the belt; 2) improving knowledge of the overall stratigraphy through detailed mapping of key rock units and their internal relationships; 3) establishing a "type" cross section along a north-south transect; and 4) evaluating the mineral potential of the area.

Despite the 1:50 000 scale geological maps of the Swayze area compiled by Heather (2001), there are still uncertainties concerning the geology of the area, as parts of the stratigraphic units have only been mapped through compilation or have been interpreted using geophysical data. Field observations during the 2017 mapping season show that the overall stratigraphy of the belt may be more complex than previously mapped and compiled by Heather (2001). Establishing an overall stratigraphy in the Swayze area is important from a regional perspective when relating and comparing formations in the Swayze area with those in the rest of the Abitibi greenstone belt. In light of this, finding zones with important sedimentary interfaces, and depositional gaps between and within volcanic units, can help constrain the stratigraphy and the autochthonous evolution of the Swayze area. These zones and gaps are also crucial time markers for syngenetic mineralization and related hydrothermal activity. At present, crystallization and depositional ages of important volcanic and sedimentary units are poorly constrained relative to other parts of the Abitibi greenstone belt. For example, large uncertainties exist in the depositional ages of the 2 successor basins in the Swayze area—the Timiskaming-type conglomerate basin and the Porcupine greywacke-dominated basin.

Summary of Field Work and Other Activities 2017,
Ontario Geological Survey, Open File Report 6333, p.34-1 to 34-8.

In terms of mineralization, the Swayze area has historically been seen as an area with less endowment relative to other parts of the Abitibi greenstone belt. However, recent development by IamGold Corporation at the Côté Gold deposit (Figure 34.1) indicates that the Swayze area has the potential for more exploration targets than previously thought. The Côté Gold project has an indicated resource of 8.65 million ounces of gold (Katz et al. 2017). The gold mineralization is associated with the Chester tonalite–diorite (~2740 Ma; *see* Figure 34.1) and the nature of the mineralization suggests a porphyry-like deposit (Katz et al. 2017). Other, smaller gold and silver mineral occurrences are evident within the large northwest-trending Timiskaming-type conglomerate unit in the Opeepeesway Lake area, 10 km to the northwest of the Côté Gold deposit. These smaller deposits are associated with younger (<2680 Ma) porphyry intrusions.

This mapping project was carried out in collaboration with the Ontario Geological Survey (OGS). In addition to the general transect research mapping in the Swayze area, data collection for 2 student theses was also part of this project: an MSc student is working on detailing the Jefferson prospect that is associated with the Old Woman River banded iron formation (BIF, *circa* 2735 Ma; *see* Figure 34.1); and a BSc student is examining a possible erosional unconformity between a conglomerate and a mafic rock.

LITHOLOGICAL UNITS AND KEY OUTCROPS

The following unit descriptions are listed in the order they are numbered on Figure 34.1.

1. Timiskaming-type Clastic Metasedimentary Rocks

Understanding the nature of the Timiskaming-type sedimentary rocks in the Swayze area is important, as it relates directly to the tectonic history of the area and the possible development of strike-slip basins in the region, as well as the potential for Archean lode gold deposits. The Swayze area contains one of the largest preserved conglomerate basins in the Abitibi Subprovince, designated the Opeepeesway Formation (*see* Figure 34.1). Very little field mapping or geochronology has been performed within this sedimentary basin, which brings up several questions. Is it part of the Timiskaming-type assemblage and, if so, can it be correlated with the Timiskaming (2677–2670 Ma) basins in the Timmins, Kirkland Lake and Larder Lake areas? So far, 2 detrital zircon ages from samples in the region suggest maximum deposition ages of 2688 Ma (van Breemen, Heather and Ayer 2006) and 2680 Ma (Davis 2016). During the 2017 field season, numerous outcrops along the shoreline of Opeepeesway Lake were mapped in detail, which included clast analysis, and sample collection for further geochronological and geochemical analysis. Preliminary results from the mapping indicate that both the clast types and the nature of the interbedded conglomeratic sandstone and arenite change laterally within the successor basin, which suggests that the Timiskaming-age sediments in the Swayze area reflect a very local source terrane. Two key outcrops on Opeepeesway Lake (Photo 34.1) demonstrate repetitive cross-bedded conglomeratic-sandstone and sandstone beds. These outcrops also contain the best indicators for a northward-younging direction within the basin.

2. Timiskaming-type Conglomerate and a Possible Erosional Unconformity with a Mafic Volcanic Rock

A predominantly clast-supported, polymictic conglomerate unit was found along the Doré Road transect (*see* Figure 34.1; Photo 34.2A). This conglomerate was discovered during transect mapping this field season and is a new occurrence that was previously mapped as banded iron formation (BIF) by Heather (2001). It consists of poorly sorted, randomly distributed clasts ranging from boulders (up to 0.7 m) to cobbles, pebbles, granules and medium- to coarse-grained sand. Observed clast types are, in decreasing order of abundance: tonalite, felsic volcanic, BIF, felsic to intermediate tuff, mafic volcanic and chert, as well as more exotic clasts of BIF chert breccia, and lapilli tuff with preserved accretionary

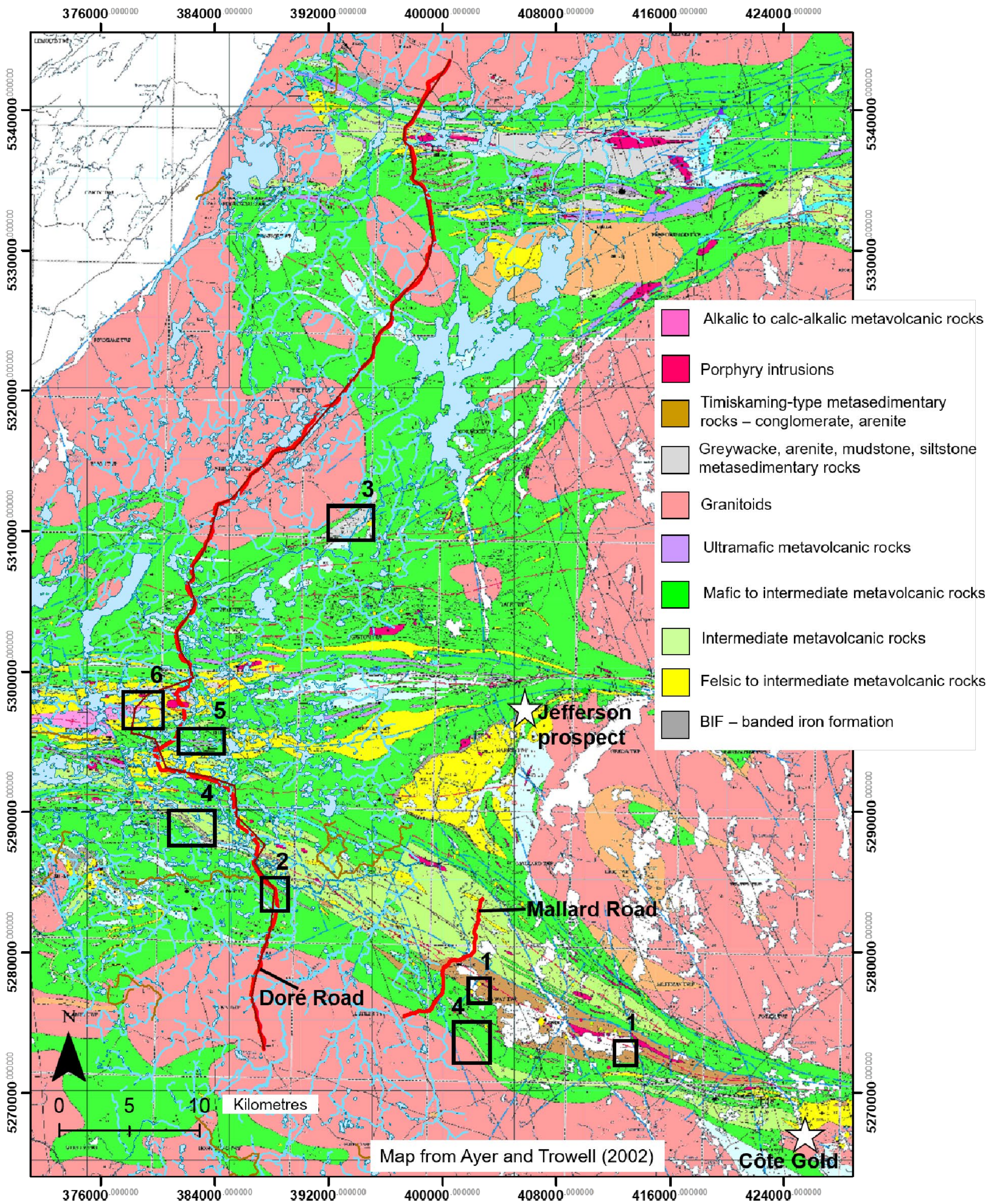

Figure 34.1. Geology of the Swayze area (*from* Ayer and Trowell 2002) with selected key rock types and the 2 transect roads; numbers refer to the outcrops and rock types described in the text. Pen (13 cm) for scale. Universal Transverse Mercator (UTM) co-ordinates are provided using North American Datum 1983 (NAD83) in Zone 17.

lapilli. A sandy, clast-free bed was found within the conglomerate and samples were collected for geochronological analysis. The detrital zircon ages from this bed will be important for correlating this unit with the Opeepeesway Formation.

Photo 34.1. Outcrop photos of the Timiskaming-type metasedimentary rocks from Opeepeesway Lake, illustrating beds of conglomerate, conglomeratic sandstone and sandstone. Multiple sets of cross-bedding indicate a general northward-younging direction. Note the more mafic nature of the sandy matrix in outcrop B relative to outcrop A. Pen (13 cm) for scale.

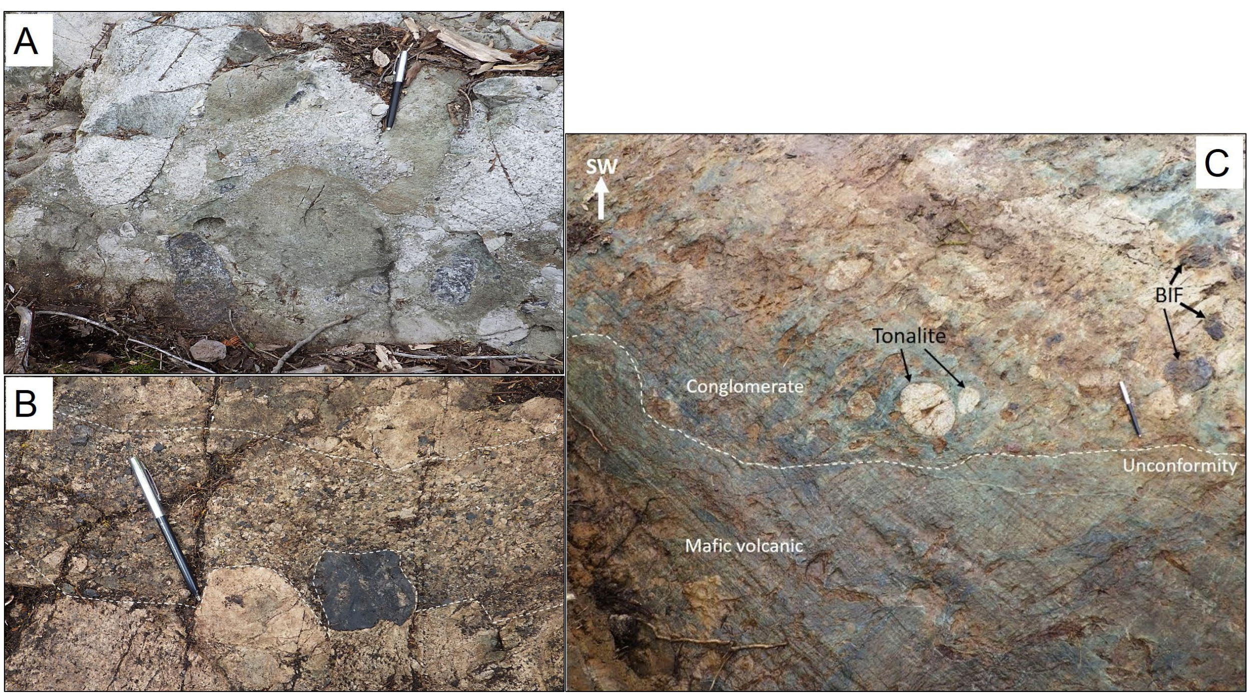

Photo 34.2. Outcrop photos of the Timiskaming-type conglomerate discovered along the Doré Road, illustrating **A**) boulder-sized clasts and **B**) granule beds. **C**) The possible erosional unconformity between the conglomerate and a mafic volcanic unit is visible. Pen (13 cm) for scale.

A mafic (likely metavolcanic) rock is found in direct contact with the conglomerate (Photo 34.2C). This is likely an erosional unconformity, which strikes southeast. One possibility is that the mafic unit may belong to the Marion or Chester group (2735–2725 Ma or 2735–2750 Ma, respectively), but this is still uncertain. If this is an erosional contact, the younging direction here is southwest.

3. Porcupine-type Clastic Metasedimentary Rocks

Relative to the Timiskaming-type basin that is dominated by conglomerate and conglomeratic sandstone deposited in an alluvial-fluvial environment, the sediment assemblage in the northern Swayze area (*see* Figure 34.1) is dominated by marine-facies greywacke, siltstone, arenites and conglomerate, similar to the Porcupine assemblage in the main Abitibi greenstone belt. These successor basins are preserved in the northern part of the belt, and are poorly constrained with respect to depositional age and provenance. The monotonous greywackes and arenites often lack sedimentary structures, but low-angle cross-bedding in a silty sandstone and erosional scouring of arenite into underlying beds indicate a northward-facing direction for the sediment pile (*see* Figure 34.1). Unlike the Timiskaming-type sediments, intercalated rhyolite and tuffaceous phases are found within the Porcupine sediment assemblage, demonstrating that volcanism was active during basin development.

4. Banded Iron Formation

Two major banded iron formation (BIF) occurrences were observed on the transect (*see* Figure 34.1). Banded iron formation commonly marks the top of a mafic to felsic volcanic cycle, therefore, these occurrences are important to improving the stratigraphic and structural model for the Swayze area of the Abitibi greenstone belt.

A unit of oxide-facies magnetite BIF is found east of the Mallard Road transect (Figure 34.2) and a unit of oxide-facies jasper-magnetite BIF is exposed on the Doré Road transect (Photo 34.3). The former can be traced for up to 2 km along strike (northwest-southeast) and has a thickness of over 15 m. However, in 2 places, the unit is isoclinally folded, with near-vertical fold axes. These structures are likely related to the intrusion of the nearby Ramsey–Algoma granitoid complex. The BIF is capped on the south by a 50 to 100 m thick, highly strained mafic volcanic unit with multiple crosscutting quartz and feldspathic veins and, on the north, by a 300 m thick rhyolite unit (*see* Figure 34.2). On a more detailed scale, the BIF is truncated to the north by several chert breccia beds (5 to 10 cm thick) with flattened chert clasts. A 10 m thick, potentially siliciclastic, bed lies between the chert breccia and the rhyolite (*see* Figure 34.2). This BIF and the lithological association visible in the outcrop makes this site a potential target for volcanogenic massive sulphide (VMS)-style base metal mineralization. More work should be carried out in the area to investigate the potential for this type of deposit. Samples of the rock types in the outcrop along the Mallard Road transect have been collected, and a sample of the felsic volcanic rock that is interbedded with the BIF will be analyzed to determine the age of deposition of this BIF. The BIF was mapped by Heather (2001) as being between the Arbutus and Yeo formations (equivalent to the Pacaud assemblage) and, as such, older than the Old Woman River BIF that caps the Marion Group (2735–2725 Ma, equivalent to the Deloro assemblage).

The second unit of BIF is well exposed on the Mortimer–Magnan Jasper property, about 4 to 5 km west of the Doré Road. It is approximately 20 m thick and can be traced approximately 80 to 100 m along strike (*see* Photo 34.3). It is composed of alternating micro- and meso-bands of jasper, chert and magnetite. Many small brittle thrust faults are evident throughout the outcrop. This BIF is an important marker horizon on the transect. It was mapped by Heather (2001) as the Heenan Iron Formation, which lies near the southern contact between the Heenan Formation and undifferentiated mafic metavolcanic rocks. The Jasper BIF is in direct contact with a felsic volcaniclastic unit, which is adjacent to tuff and tuff breccia (*see* Photo 34.3). Samples of the felsic volcaniclastic on either side of and within the BIF were collected for geochronological analysis. As the deposition of BIF represents a period of volcanic hiatus, it may represent an important gap in the volcanic stratigraphy in the area, increasing the potential for syngenetic base metal mineralization as a consequence of the higher activity of hydrothermal fluids (e.g., Thurston et al. 2008). This BIF can possibly be correlated with other, similar, BIFs in the Swayze area and in the Abitibi greenstone belt, thus helping to constrain the age of the overall stratigraphy in the Abitibi Subprovince. Younging indicators are scarce in this outcrop, therefore, the younging direction for the sequence is still uncertain.

5. Komatiites

On the Doré Road, moderate green to dark green komatiites stand out as a 2 to 3 m high and 60 m wide exposure across both sides of the road. The rocks exhibit locally well-developed, randomly oriented spinifex texture, and minor serpentinization. On the eastern side of the outcrop, pillowed komatiitic basalts can be recognized; these give a southward-younging facing direction. Hyaloclastites were observed locally and these, together with the well-developed pillows, indicate a subaqueous emplacement for these ultramafic volcanic flows. The komatiites were mapped by Heather (2001) as Newton Formation, Swayze Group (equivalent to the Blake River assemblage (*circa* 2704–2695 Ma) of Thurston et al. 2008) and are herein interpreted as being deposited contemporaneous with the supracrustal package as opposed to being later intrusive sills. Komatiites are very important stratigraphic markers, and knowledge of their emplacement history and depositional environment are crucial in understanding the stratigraphy in the Swayze area, and in the regional correlation in the Abitibi greenstone belt.

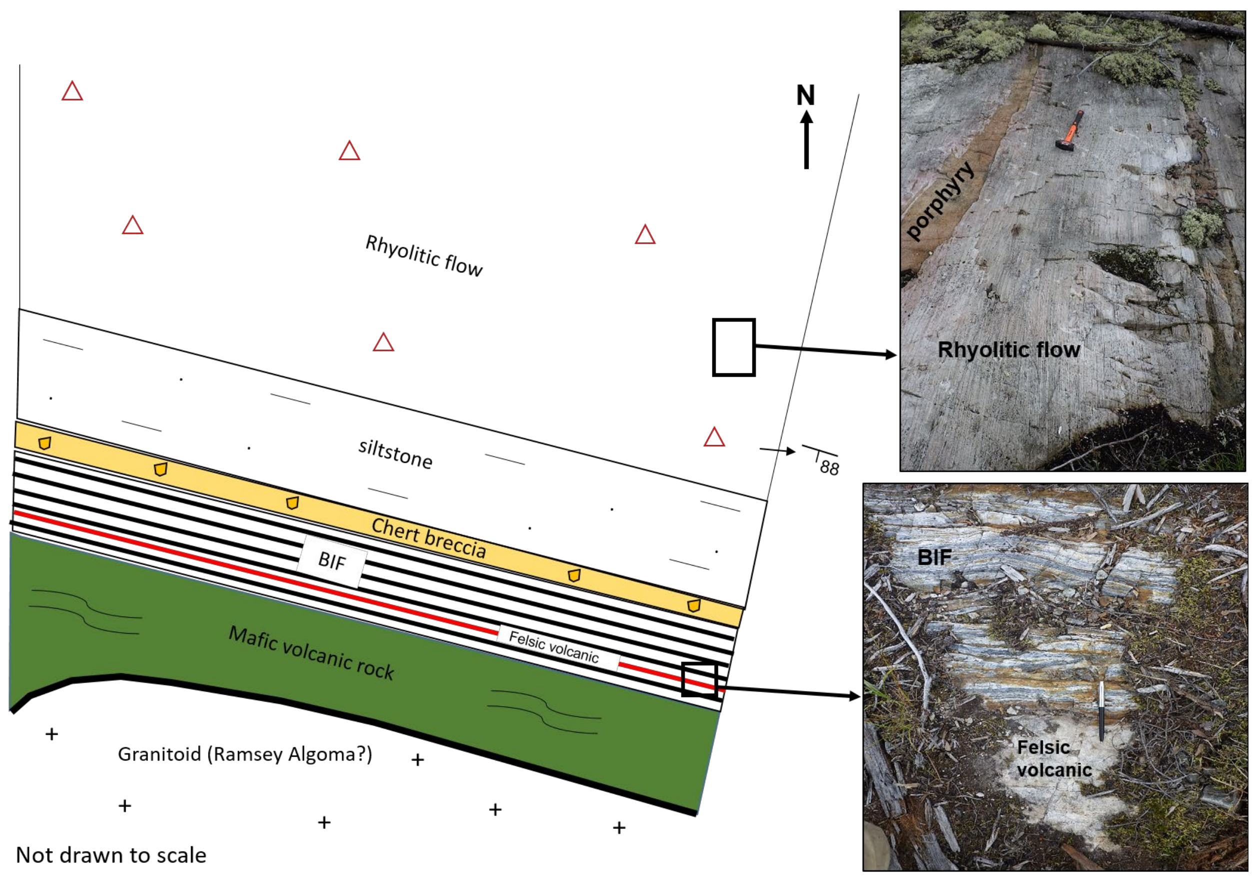

Figure 34.2. Sketch map and outcrop photos of the banded iron formation ("BIF") and associated rock types along the Mallard Road transect. Pen (13 cm) and hammer (40 cm) for scale. Strike (155°) and subvertical (88°) dip shown for the rhyolitic flow.

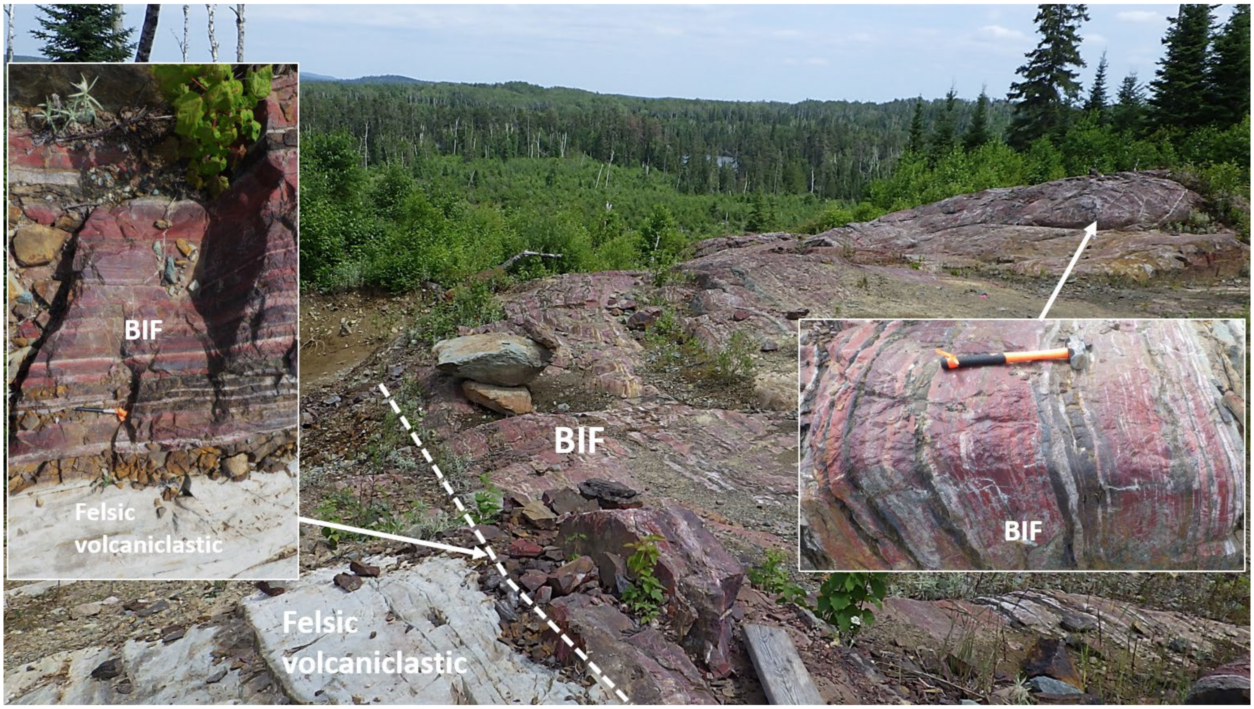

Photo 34.3. Outcrop photos of the jasper-magnetite banded iron formation along the Doré Road transect. Main photo is taken looking east. The dashed line represents the contact between the banded iron formation ("BIF") and the lapilli tuff. Pen (13 cm) and hammer (40 cm) for scale.

Photo 34.4. Close-up of the possible Timiskaming-age breccia of likely volcanic origin. Pen (13 cm) for scale.

6. Volcanic Breccia

A possible volcanic breccia unit found along the Doré Road transect (*see* Figure 34.1) represents an extraordinary breccia, which contains subangular, chaotically distributed fragments of up to 1 m in size (Photo 34.4). Some of these fragments have retained relict fabric, indicating either deformation or flow structures prior to rip-up and deposition (*see* Photo 34.4). The breccia consists of only a few types of fragments, which could indicate a very local source. The unit is partly traceable for at least 1.5 km toward the east-southeast, where it is adjacent to a phenocryst-bearing felsic volcanic unit (*circa* 2695 Ma). A sample analyzed by Ayer et al. (2005) yielded a Timiskaming age of 2670±2 Ma. As such, it is one of the youngest supracrustal rocks in the Swayze area of the Abitibi greenstone belt. This breccia could be associated with the alkaline magmatism also known from the Kirkland Lake and Larder Lake areas (Thurston et al. 2008).

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REFERENCES

Ayer, J., Amelin, Y., Corfu, F., Kamo, S., Ketchum, J.F., Kwok, K. and Trowell, N.F. 2002. Evolution of the southern Abitibi greenstone belt based on U-Pb geochronology: Autochthonous volcanic construction followed by plutonism, regional deformation and sedimentation; Precambrian Research, v.115, p.63-95.

Ayer, J.A., Thurston, P.C., Bateman, R., Dubé, B., Gibson, H.L., Hamilton, M.A., Hathway, B., Hocker, S.M., Houlé, M.G., Hudak, G., Lafrance, B., Lesher, C.M., Ispolatov, V.O., MacDonald, P.J., Péloquin, A.S., Piercey, S.J., Reed, L.E. and Thompson, P.H. 2005. Overview of results from the Greenstone Architecture Project: Discover Abitibi initiative; Ontario Geological Survey, Open File Report 6154, 146p.

Ayer, J.A. and Trowell, N.F. 2002. Geological compilation of the Swayze area, Abitibi greenstone belt; Ontario Geological Survey, Preliminary Map P.3511, scale 1:100 000.

Davis, D.W. 2016. Geochronology of rocks from northwest Ontario 2015-16, Part 2: LA-ICP-MS Geochronology; internal report prepared for the Ontario Geological Survey, Jack Satterly Geochronology Laboratory, University of Toronto, Toronto, Ontario, 100p.

Heather, K.B. 2001. The geological evolution of the Archean Swayze greenstone belt, Superior Province, Canada; unpublished PhD thesis, Keele University, Keele, Staffordshire, United Kingdom, 370p.

Katz, L.R., Kontak, D.J., Dubé, B. and McNicoll, V. 2017. The geology, petrology, and geochronology of the Archean Côté Gold large-tonnage, low-grade intrusion-related Au(-Cu) deposit, Swayze greenstone belt, Ontario, Canada; Canadian Journal of Earth Sciences, v.54, p.173-202.

Thurston, P.C., Ayer, J.A., Goutier, J. and Hamilton, M.A. 2008. Depositional gaps in Abitibi greenstone belt stratigraphy: A key to exploration for syngenetic mineralization; Economic Geology, v.103, p.1097-1134.

van Breemen, O., Heather, K.B. and Ayer, J. 2006. U-Pb geochronology of the Neoarchean Swayze sector of the southern Abitibi greenstone belt; *in* Geological Survey of Canada, Current Research 2006-F1, p.1-32.

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