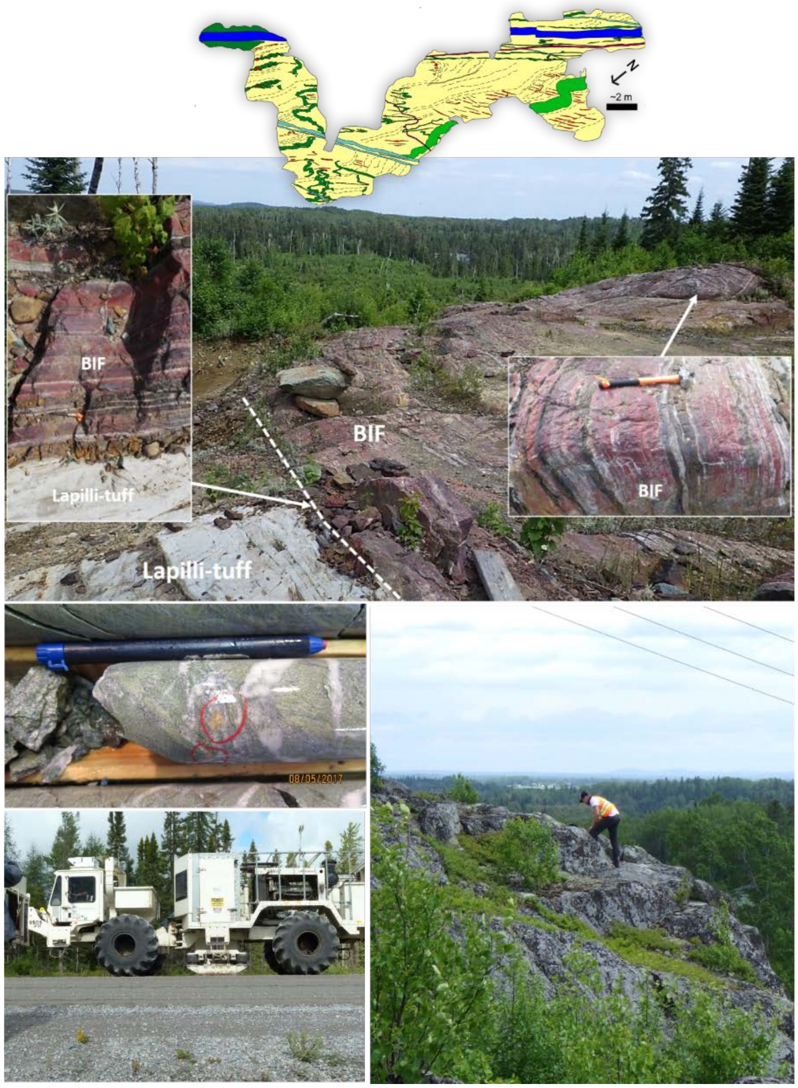
METAL EARTH

MERC
Mineral Exploration Research Centre
AT THE HARQUAIL SCHOOL OF EARTH SCIENCES

2017 Field Trips Guide

Transects:

Malartic – Rouyn Noranda – Larder Lake - Swayze



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 # MERC-ME-2017-001

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Introduction

Metal Earth is the only geoscience project funded by the Canada First Research Excellence Fund, a federal government initiative, designed to make world leaders of Canadian academic research teams. The premise of the project is to explain why some Archean greenstone terranes are rich in mineral deposits while other, similar terranes are much less endowed in spite of broadly similar geology at surface. Given the geological similarities at surface, the contrasting endowment must a function of processes in the lower crust or the upper mantle. To understand why the differences in metal endowment, Metal Earth will combine an updated overview of the geology at surface with imaging techniques to better understand the mid to lower crust and upper mantle. The project will use the reflection seismic technique to image major structures and rock units through the crust, magnetotellurics to measure the electrical conductivity of major crustal units and gravity surveys. The geophysical surveys will be done on so-called “transects” or linear zones 1-2 km wide. We have mapped the transects in order to have up-to-date, robust geological overviews to aid us in interpretation of the geophysical data. This year we have mapped four transects: Malartic, Rouyn-Noranda, Larder Lake, and Swayze, all in the Abitibi subprovince. Next year we will complete transect mapping in the Abitibi subprovince and move westward to the Wabigoon Subprovince, our example of a poorly endowed Archean terrane.

In this field trip guidebook, we will provide an overview of the major results of our mapping of the four transects done in 2017. The one day field trips for each transect will provide a sketch of the major new relationships uncovered and their relationship to mineral deposits.

Note that all GPS data is in North American Datum 1983.

Superior Craton

The Superior Craton is the world’s largest Archean craton, extending from the Trans-Hudson orogen along the Manitoba-Saskatchewan boundary eastward to the Labrador Trough of northeastern Quebec and from the northernmost tip of Quebec at Ungava Bay to the Minnesota River Valley Terrane in Minnesota. It consists of east-striking metavolcanic-granitoid subprovinces (e.g. Abitibi, Uchi) separated by subprovinces (e.g., Pontiac, English River) dominated by metasedimentary and gneissic rocks (Robert et al., 2005). These province-scale faults exert key controls on the formation of deposits since they act as conduits for the flow and migration of ore-forming fluids. In addition, post-mineralization deformation can subsequently modify geometry and metal grade of ore deposits. Numerous world-class gold, volcanogenic massive sulfide, and less-known magmatic nickel-copper deposits are spatially associated with east-striking subvertical crustal-scale fault zones along the subprovince boundaries (e.g., Cadillac-Larder Lake Fault Zone), or along the contact zones (Porcupine-Destor-Manneville Fault Zone) between metavolcanic and metasedimentary rocks within subprovinces (Robert and Poulsen, 1997; Hannington et al, 1999). Rocks of the Superior Province range in age from ~3.8 Ga greenstones along the east shore of Hudson Bay to Neoarchean rocks at 2.5 Ga. The conventional view of the architecture of the craton is based upon a plate tectonic interpretation in which micro-continental fragments about 3 Ga in age are separated by younger oceanic crust (granite-greenstone terranes) and zones of orogenic flysch (sedimentary rocks deposited early in a continental collision event) or sedimentary subprovinces. The principal evidence for the plate tectonic model is the long, linear form of the various subprovinces and the younging of the ages of volcanism, plutonism and subprovince-bounding shear zones southward from the 3 Ga North Caribou terrane. It is important to note that this pattern is also explicable by an old micro-continent having a series of terranes accreted against it .At the level of the Superior craton as a whole, the Abitibi-Wawa terrane is the southern-most and youngest granite-greenstone terrane and is isotopically juvenile. It is bounded to the south by the Pontiac subprovince, a metasedimentary terrane.

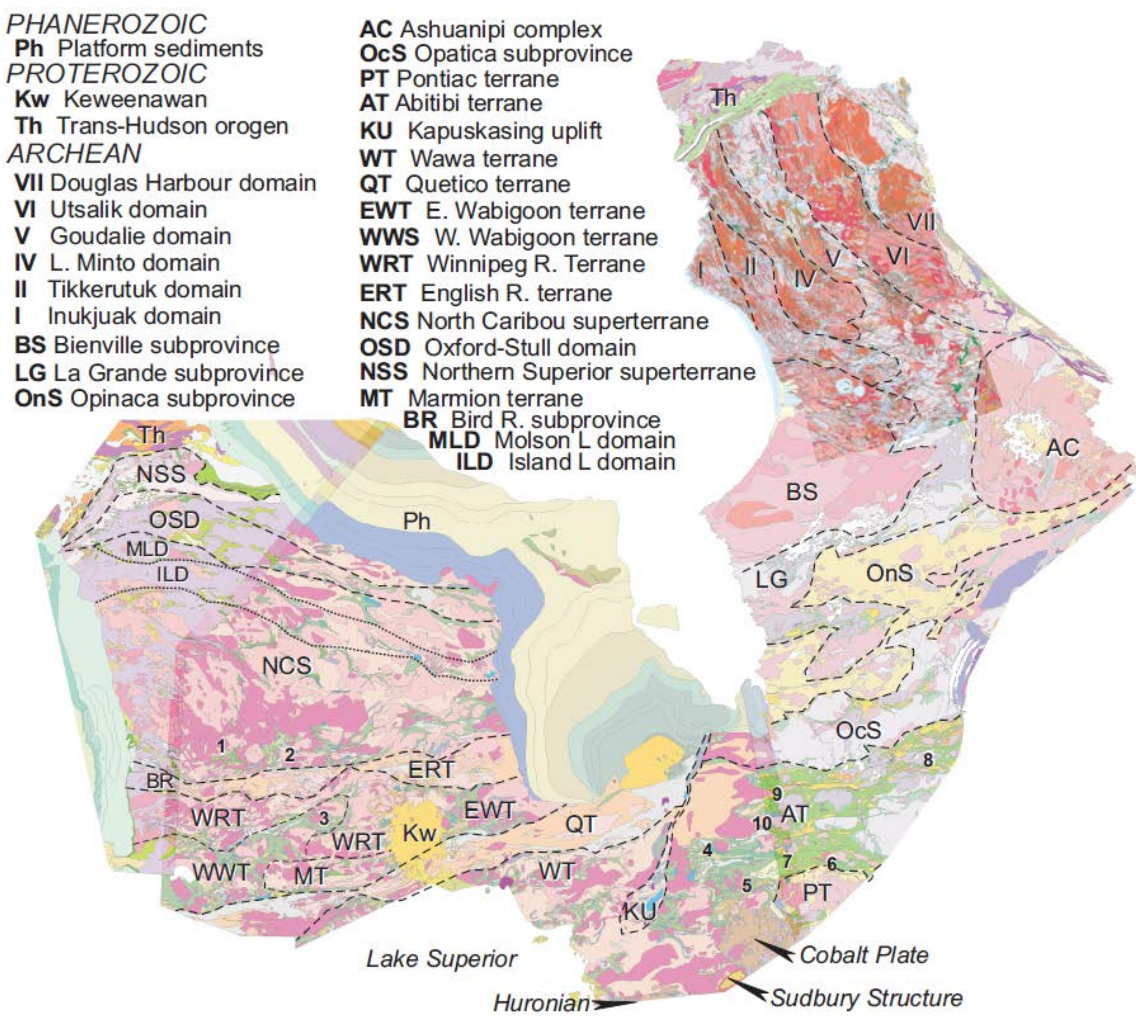

Fig. I-1: Overview of Superior Province Geology (after Percival 2007)

Abitibi-Wawa Terrane

The Abitibi-Wawa terrane consists of the Abitibi greenstone belt which extends from the Grenville Front in the Chibougamau area westward to the Kapuskasing Structural Zone, a west dipping thrust which has brought mid-crustal units to surface. To the west of the Kapuskasing zone, the terrane continues to the western limit of the Superior craton and includes several isolated greenstone belts including the Wawa or Michipicoten belt. The Abitibi greenstone belt is divided into seven volcanic stratigraphic episodes (see

Thurston et al., 2008, and references therein) based on similarity of age intervals, stratigraphy and geochemistry (Figure 1; Table 1).

Table 1

Time Interval	Selected Stratigraphic Units (Quebec)	Assemblage Names
Pre 2750 Ma	Fecteau Fm, des Vents Fm	Not named
2750-2735 Ma	Gemini-Turgeon	Pacaud
2734-2724 Ma	Lac Watson Grp (S); Mine Hunter Grp.; Joutel Fm	Deloro
2723-2720 Ma	Lac Watson Grp. (N); Dussieux Fm.	Stoughton-Roquemaure
2719-2711 Ma	Malartic Grp.; Lamotte-Vassan Fm.;	Kidd-Munro
2710-2704 Ma	Piché Grp.; Val d'Or Fm.;	Tisdale
2704-2697 Ma	Blake River Grp. Louvicourt Grp.	Blake River

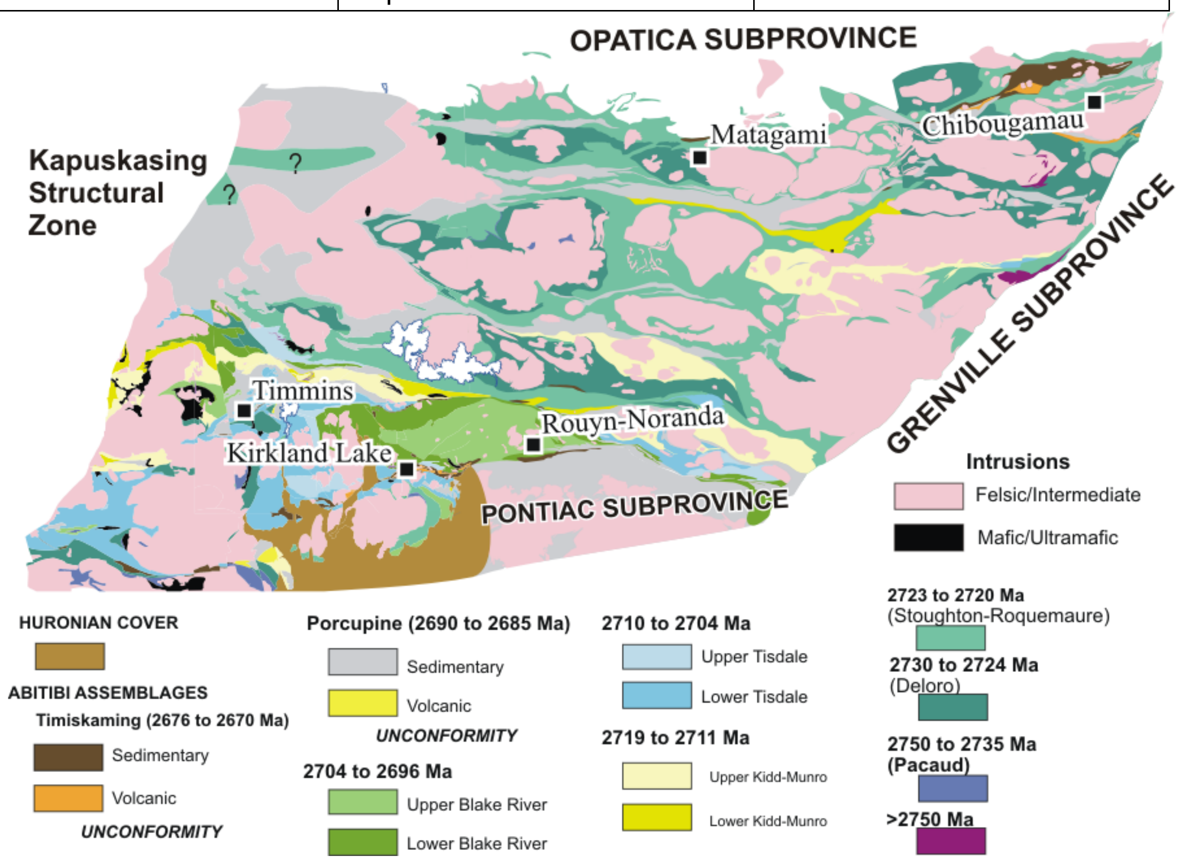

Fig. I-2: Overview of Abitibi greenstone belt with volcanic episodes displayed by age (Thurston et al., (2008).

Pontiac Subprovince

There are 4 metasedimentary terranes within the Superior craton, the English River, Quetico, Opinaca and Pontiac subprovinces. The Pontiac subprovince is about 2500 km^2 and is bounded to the north by the Abitibi subprovince and to the south by the Proterozoic Grenville Province and to the southeast by the Paleoproterozoic Huronian Supergroup. The major rock types are metamorphosed greywacke, siltstone, mudstone (± carbonaceous units) and minor conglomerate all interpreted as turbidite sequences. Metamorphic grade increases to the south with kyanite and sillimanite taking over from white mica and chlorite typical of greenschist grade conditions. The provenance of the detritus is based in part on the presence of clasts of igneous and metasedimentary rocks typical of the Abitibi-Wawa subprovince to the north. This is reinforced by the observations of detrital and magmatic zircons with U-Pb ages (2750-2685 Ma) typical of the Abitibi-Wawa subprovince, however, Davis (2002) reports some detrital grains >2750 Ma. The Pontiac is cut by the 2682 ± 1 Ma Lac Fournière pluton (Davis, 2002; Frieman et al., 2017).

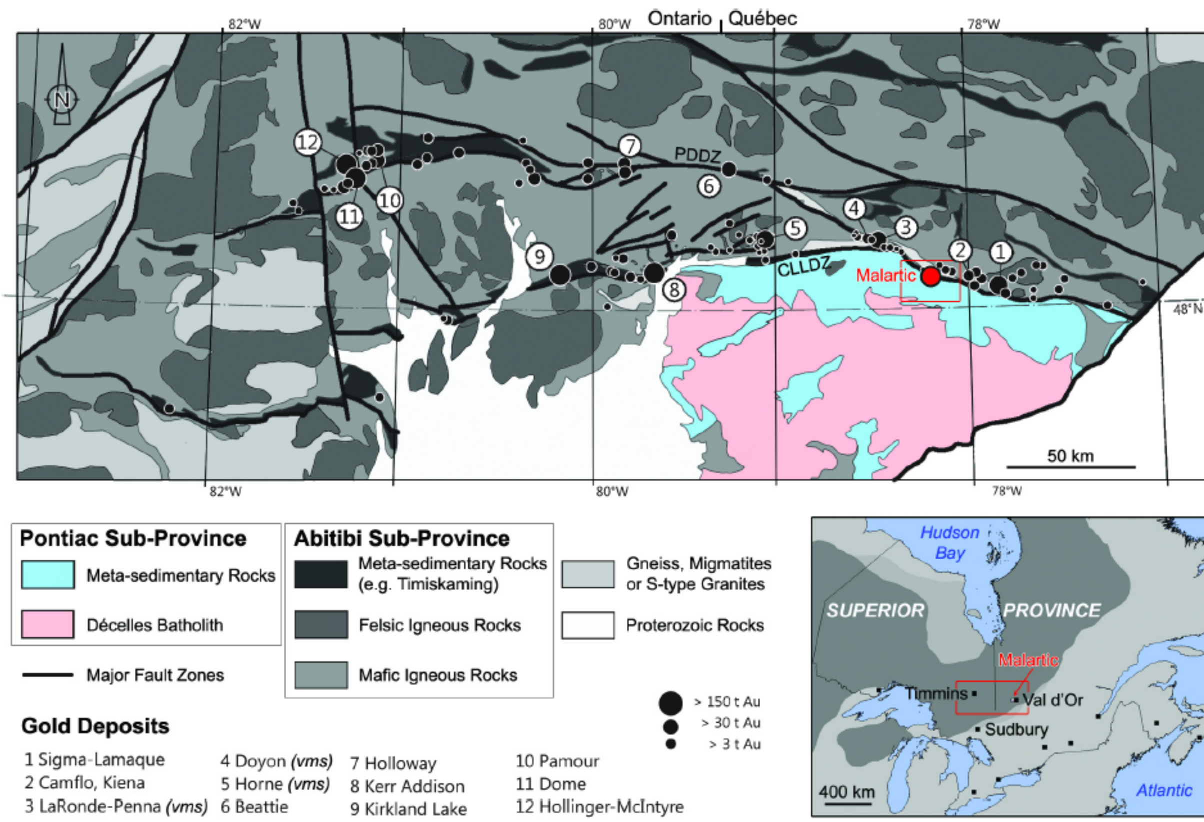

Fig. I-3 The Pontiac subprovince from Perrouty et al., (2017).

Thus, the Pontiac sedimentary rocks were deposited after the Porcupine assemblage, but before the Timiskaming assemblage in the Abitibi subprovince (Mortensen and Card, 1993; Davis, 2002). Depending on the preferred tectonic model, the sedimentary rocks of the Pontiac Subprovince likely formed as a foreland basin or accretionary prism in response to subduction or subduction-like processes (e.g., White et al., 2003; Percival et al., 2012; Frieman et al., 2017), or in basins formed as a result of transient uplift and erosion during subcretion, followed by post-orogenic collapse (e.g., Calvert et al., 2004, Bedard and Harris, 2017). However, Card (1990) and Feng et al., (1992) postulate that the Pontiac subprovince and the Abitibi-Wawa terranes are unrelated blocks which were later tectonically juxtaposed. This model is supported by the presence of ca. 2.9 Ga zircons, a lower εHf in zircon and a lower Lu/Hf ratio in zircon compared with Wawa-Abitibi rocks. Camiré et al., (1993) indicate that the composition of the Pontiac metasediments is not consistent with the composition of major Abitibi-Wawa terrane units. The youngest detrital zircon yields a U-Pb age of 2685.3±3.0 Ma (Davis 2002) and 2682.7±1.9 Ma Mortensen and Card (1993). The supracrustal rocks are intruded by several felsic plutons: the aforementioned Lac Fournière pluton, the 2679-2676 Ma Sladen intrusion (Helt et al., 2014; De Souza et al., 2015, 2016), and the 2668-2663 Ma Décelles Batholith (Mortensen and Card, 1993).

Desrochers and Hubert (1996) and Fallara et al., (2000) report the presence of iron formation and Perrouty et al., (2017) found iron-rich amphibolite and iron-rich garnetite in the Pontiac. Metasedimentary terranes through the Superior craton contain metavolcanic units (e.g., English River (Breaks 1991) Quetico (Williams 1991)and the Pontiac Subprovince Piché Group (Simard, Gaboury et al. 2013). Within the Pontiac subprovince the volcanic units are mafic-ultramafic flows which are parallel to the bedding in the metasedimentary rocks.

The deformation history of the northern part of the Pontiac Subprovince includes three main deformation events. The D_1 event produced isoclinal folding and an S_1 pressure-solution cleavage, mainly subparallel to bedding (Derry, 1939; Camiré and Burg, 1993; Perrouty et al., 2017). D_2 resulted in open to tight F_2 folds, locally accompanied by a penetrative S_2 biotite foliation on average trending E-W to NW-SE (Camiré and Burg, 1993; Benn et al., 1993; Perrouty et al., 2017). D_3 is characterized by a non-penetrative S_3 crenulation cleavage and conjugate kinks (Benn et al., 1993; Perrouty et al., 2017).

The 18.6 Moz Canadian Malartic gold deposit (measured, indicated, inferred and past production), located 30 km west of Val d'Or is the only known world-class gold deposit in the Pontiac Subprovince (Gervais et al., 2014). The gold mineralizing events consist of an early magmatic-hydrothermal episode and a main hydrothermal synkinematic episode during D_2 with a molybdenite Re-Os age of 2664 ± 11 (De Souza et al., 2016). The rheological contrast between Pontiac metasedimentary rocks and structurally controlled felsic-intermediate intrusive bodies facilitated the propagation of the local Sladen Fault Zone and allowed for connectivity with the regional Cadillac Lader Lake Deformation Zone, resulting in an increased gold endowment of the Canadian Malartic deposit (Perrouty et al., 2017).

The Pontiac Subprovince is also host to a number of other types of economic mineral occurrences, including greywacke hosted Qtz-Py-Gn-Ag veins, Qtz-Ccp-Bn veins southwest of the Lac Fournière, and beryl associated with Qtz-Bi-Tur-Mo veins in a pegmatite dike at the margin of the Dècelles Batholith (Perrouty et al., 2017 and references therein).

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Stratigraphic and Structural Setting of Gold and Nickel Deposits in the Southern Abitibi and Pontiac Subprovinces, Malartic, Quebec

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Excursion Leaders: Xiaohui Zhou and Bruno Lafrance

Jérémie Rivest, one of Malartic transect mapping crew, is investigating a mafic flow south of Amos

Introduction

The Introduction to the guidebook as a whole has provided an overview of the Superior Province, the Abitibi and Pontiac subprovinces. This field trip guide highlights preliminary results from the first field season in the Malartic transect (Figure 1). During this field trip, we examine the stratigraphic and structural setting of vein-type and disseminated gold deposits hosted in metasedimentary and metavolcanic rocks (Pontiac, Cadillac, Timiskaming and Piché Group) at or near the Cadillac-Larder Lake Fault, as well as little-known nickel-copper mineralization (Cubric Showing) in metavolcano-sedimentary rocks (Malartic Group) at the Southern Manneville Fault.

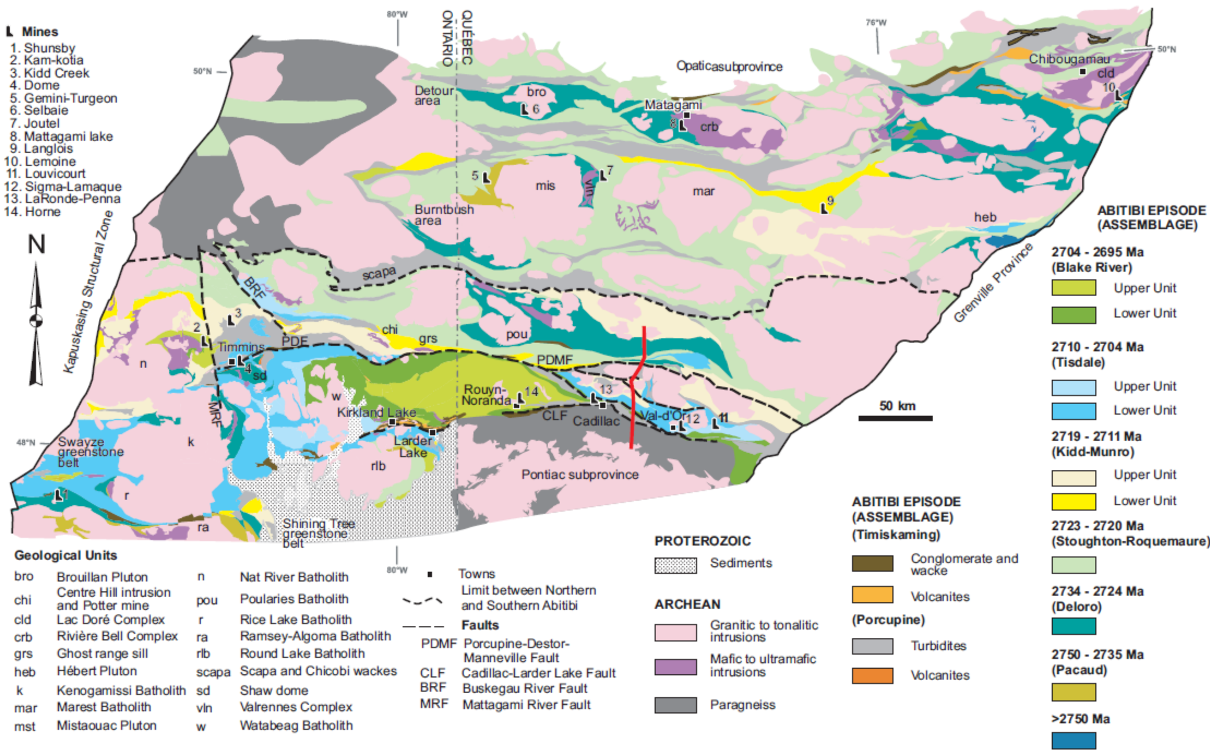


Fig II-1: Lithostratigraphic map of the Abitibi Greenstone belt after Thurston et al., (2008) with the transect line shown in red.

Abitibi and Pontiac Subprovinces in the La Motte-Malartic Area:
In the La Motte-Malartic area (Figure 2, 3), the 2714 Ma (Pilote et al., 1999) La Motte-Vassan Formation of the Malartic Group composed predominantly of komatiites and basalts corresponds to upper Kidd-Munro assemblage.

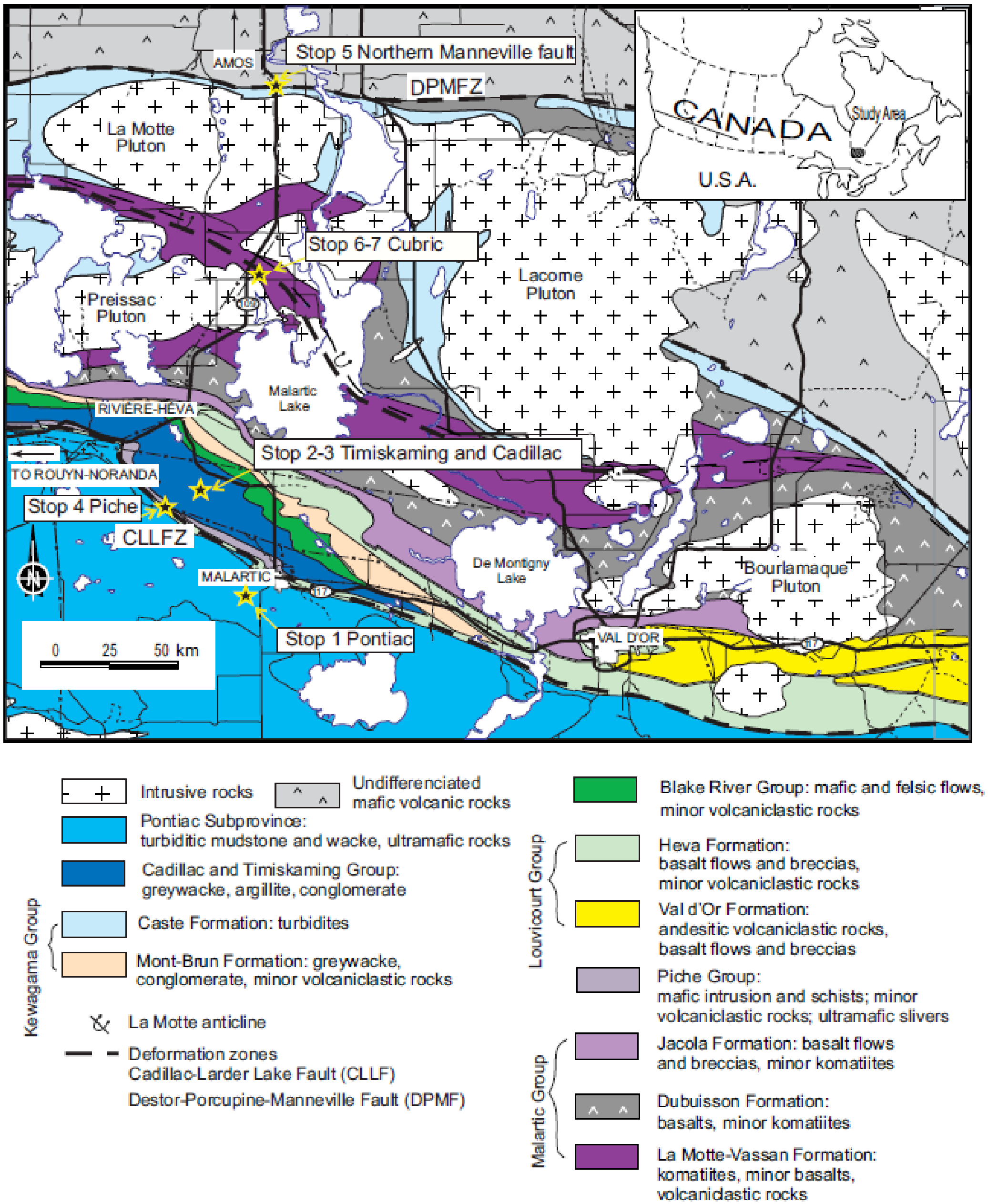


Fig. II-2: Simplified geological map of the Abitibi and Pontiac subprovinces in the La Motte Malartic area. Field trip stops ae indicated. After Mueller et al., (2008)

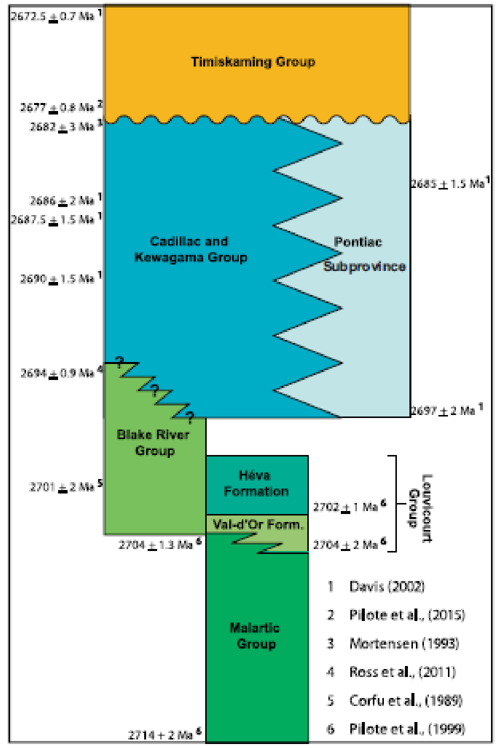


Fig. II-3: Stratigraphic chart of the transect area with relevant isotopic ages. Stratigraphic relationships based on Dimroth et al., (1982), Mueller et al., (1996), Scott et al., (2002), and Tourigny et al., (1988). Adapted from Bedeaux et al., (2017).

The ~ 2709 Ma (Pilote et al., 2014) Piché Group, constituted largely of ultramafic to mafic intrusions and schist with minor felsic volcanic rocks and sediments, is equivalent to lower Tisdale assemblage. The 2704-2702 Ma (Pilote et al., 1998) Louvicourt Group, composed of mafic to intermediate volcanic rocks and minor intermediate to felsic volcaniclastic rocks, is equivalent to lower Blake River assemblage. Three metasedimentary packages are recognized in the Abitibi Subprovince in this area: < 2691-2685 Ma Kewagama Group (Feng and Kerrich, 1991; Davis, 2002), composed chiefly of mudstone and wacke typical of a turbidite sequence; <2690-2686 Ma Cadillac Group (Davis, 2002), constituted largely of turbiditic siltstone and wacke, with minor biotite-chlorite-actinolite schist and felsic volcaniclastic rocks; and < 2677-2672 Ma Timiskaming Group (Davis, 2002; Pilote et al., 2015), composed of cross-bedded siltstone and sandstone and polymictic conglomerate, which is typical of a fluvial-alluvial depositional environment. These metavolcanic-sedimentary rocks are intruded by several felsic plutonic suites: 2681-2660 Ma Preissac Batholith (Ducharme et al., 1997), 2680-2640 Ma La Corne Batholith (Machado et al., 1991), and 2647-2642 Ma La Motte Batholith (Ducharme et al, 1997; Machado et al., 1991). All these plutonic suites consist of various felsic intrusive phases and are crosscut by pegmatitic and aplite dikes (Mueller et al., 2008).

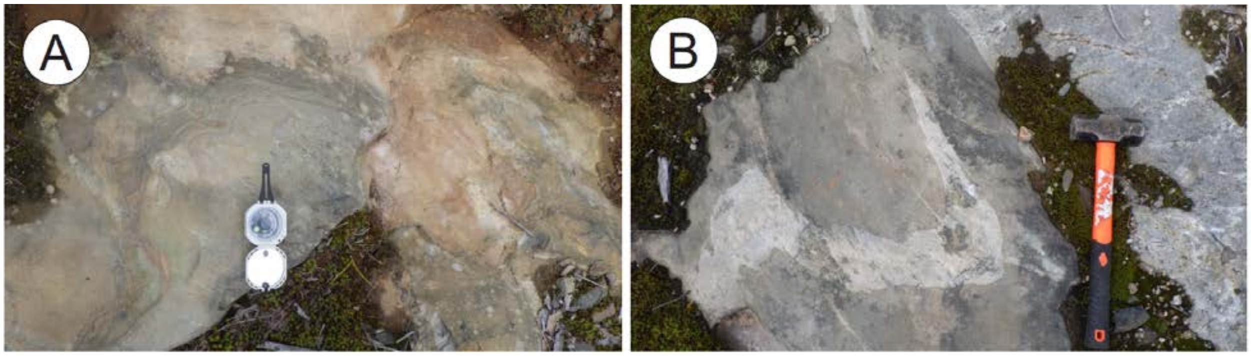
The < 2697-2685 Ma Pontiac Subprovince (Davis, 2002) to the south of the Abitibi Subprovince is predominantly turbuditic mudstone and wacke, rare conglomerate, with minor iron-rich amphibolite and garnetite, mafic and ultramafic flows (e.g., Perrouty et al., 2017). The supracrustal rocks are intruded by several felsic plutons: 2682 Ma Lac Fournière Pluton (Davis, 2002), 2679-2676 Ma Sladen intrusion (Helt et al., 2014; De Souza et al., 2015, 2016), and 2668-2663 Ma Décelles Batholith (Mortensen and Card, 1993).

Although supracrustal rocks in the Abitibi and Pontiac Subprovince are metamorphosed to greenschist or amphibolite facies, primary volcanic and sedimentary structures are still preserved (Mueller et al., 2008). Rocks in the area are variably deformed. Multiple phases of ductile deformation are commonly present in the east-to-southeast–striking crustal scale fault zones, namely the Destor-Porcupine-Manneville Fault Zone and Cadillac-Larder Lake Fault Zone (Figure 2). The Destor-Porcupine-Manneville Fault Zone has two splays in the La Motte area: the Northern and Southern Manneville Fault. The Northern Manneville Fault separates the volcanic rocks of the Kinojévis Group from the metasedimentary rocks of the Lac Caste Formation of the Kewagama Group, whereas the Southern Manneville Fault separates metasediments of the Lac Caste Formation from mafic and ultramafic flows of the La Motte-Vassan Formation (Malartic Group). The Cadillac-Larder Lake Fault Zone defines the boundary between Abitibi and Pontiac Subprovince.

Stop 1 Pontiac sediments and felsic intrusion, South of Cadillac-Larder Lake Fault (711772, 5334203; UTM Zone 17, NAD 83)

Follow Highway QC-117 in Malartic and turn west onto Rue Lasalle (270 m), turn left onto Chemin du Lac Mourier (1.3 km), turn right onto Chemin des Neiges (130 m), turn left onto Chemin Jolicoeur-et-Ste-Croix (55 m), turn right onto Chemin des Neiges (450 m), turn left at the first intersection onto a gravel road (1.3 km), park the vehicles and then walk south onto a trail (185 m). Stop 1 is on west side of the trail.

This stop includes two small roadside outcrops 1 km west of the Canadian Malartic gold deposit, which provides an exceptional opportunity to examine the setting of this world-class deposit. At this outcrop, interlayered turbuditic mudstone and wacke are intruded by a granitoid dike and a mafic dike. Both sediments and the felsic dike are tightly folded (Figure 4A, B). Primary sedimentary structures, like normal graded bedding and scours, are common way-up indicators (Figure 4A). The axial plane cleavage is defined by a preferred orientation of biotite in sediments, or elongate quartz, feldspar and xenoliths in the dike (Figure 4A). The bedding-cleavage angular relationship is extremely useful in interpreting the deformation of these Pontiac sediments. The principal cleavage is clockwise to bedding where the beds young to the north. In a few places, the principal cleavage is anticlockwise to bedding where the beds young to the south. These observations indicate that the metasedimentary rocks are tightly “S”-shaped folded in the area, with north-facing long limbs and south-facing short limbs. Disseminated pyrite is present in the plutonic rocks and sediments near the fold hinge zone, which is one of the main gold mineralization styles at the Canadian Malartic mine (De Souza et al, 2015, 2016; Perrouty, 2017). Boudinaged veins are also present in highly deformed



metasedimentary rocks.

Figure II-4A): Folded Pontiac sediments; B) Folded felsic dike in Pontiac sediments. Both plan view. Compass and hammer point to the north.

Stop 2 Cadillac sediments and vein-type gold mineralization, Cadillac-Larder Lake Fault (708239, 5341215; UTM Zone 17, NAD 83)

Drive back to Highway QC-117 and head north then west (11.3 km), turn left onto Chemin de la Gravière (1.8 km). Park the vehicles and follow a trail to the southeast for ~ 100 m then walk to the southwest for ~ 40 m.

This large, recently-stripped outcrop extraordinarily exhibits primary sedimentary features, multi-phase brittle and ductile deformation structures and complex auriferous vein systems in the Cadillac Group sediments north of the Cadillac-Larder Lake Fault. The bedrock consists of interlayered mudstone and normal graded sandstone, and coarse-grained, normal graded bedded and locally cross-bedded sandstone. Younging reversals and tight fold hinges are commonly observed at this outcrop. The east-striking, subvertical (~100°/87°, right hand rule, hereinafter) regional cleavage is axial planar to upright, east-plunging, isoclinal to tight folds (Figure 5A), which are interpreted as the earliest generation of deformation structure which formed during N-S shortening. Smoky-white sigmoidal tension gashes, locally in en echelon arrays, are commonly present in coarse-grained sandstone beds. The tips (~265°-270° striking) of these tension gashes are at around 45° to bedding (Figure 5B), which are interpreted to be parallel to the maximum principal strain axis of ductile progressive deformation, indicating these tension gashes formed during sinistral shearing. Some smoky-white veins are at a very low angle (< 30°) or subparallel to bedding (Figure 5C). These veins are typically tightly "S"-shaped folded. The orientation of these veins is inconsistent with their formation during principal cleavage development. Therefore, these bedding-subparallel veins were likely emplaced early during sinistral shearing. Gold mineralization hosted in these veins therefore must have occurred during sinistral shearing. These veins and the early principal cleavages are then tightly to openly "Z"-shaped folded, producing a new east-striking (~258°), subvertical cleavage that is axial planar to the "Z" shaped folds and anticlockwise to bedding (Figure 5D). These veins are asymmetrically boudinaged and displaced in a dextral manner (Figure 5C) along a "shear band cleavage" (Roper, 1972) or "extensional crenulation cleavage" (Platt and Vissers, 1980), or C'-type cleavage (Berthé et al., 1979) that is at a low angle (< 30°) clockwise to bedding. The "Z"-shaped folds and shear band cleavages are interpreted to have formed during later dextral shearing. The bedding-subparallel veins are observed to crosscut "S"-shaped veins. Tension gashes are typically crosscut by late, sheeted, planar, foliation-filling veins (Figure 5E), which were likely emplaced during sinistral shearing. Some tension gashes appear to have formed during dextral shearing (Figure 5F). Brittle deformation structures, such as conjugate sets of northwest-striking subvertical “S”-shaped and north-to-northeast–striking subvertical “Z”-shaped kind bands (Figure 5G), and northeast-striking (~030°) subvertical sinistral Riedel-shear fault (Figure 5H), postdate all precursor deformation structures.

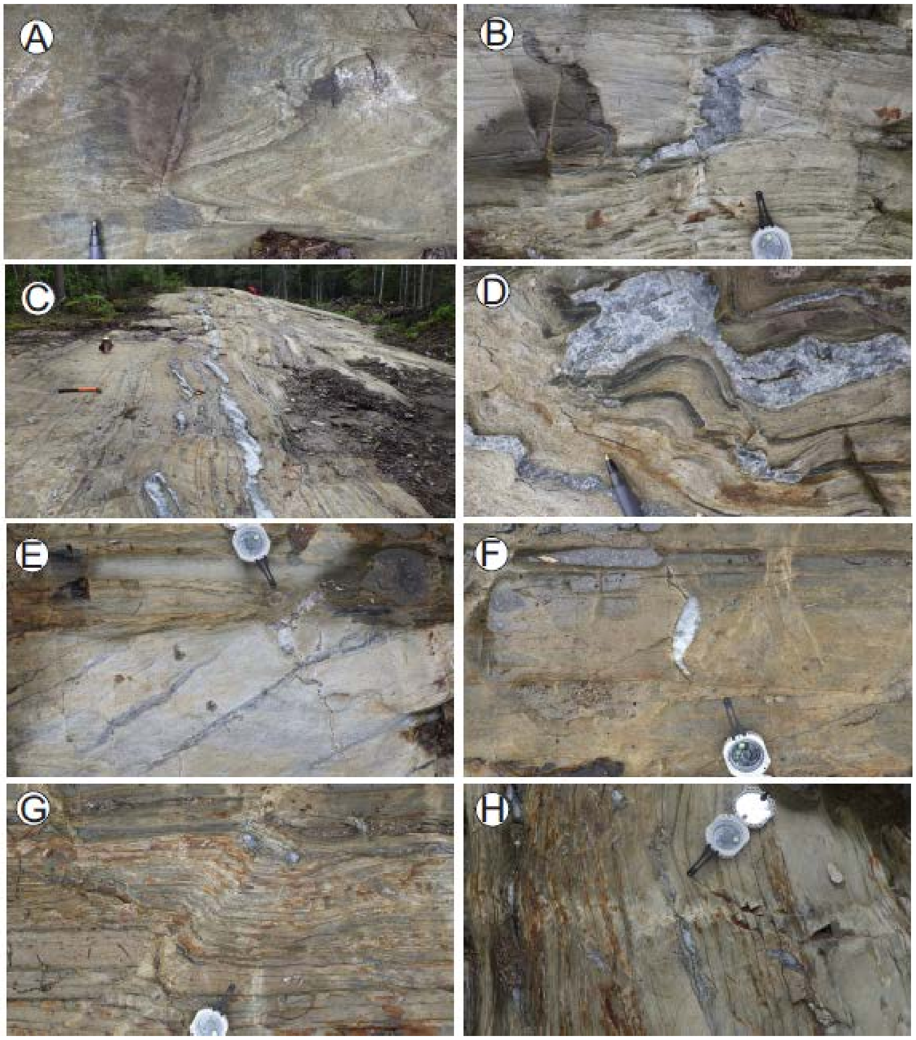


Figure II-5 Deformation structures in Cadillac metasedimentary rocks. All plan view; looking west in Figure 5C. Compass and pencil point to the north. See text of Stop 2 for details.

Stop 3 Timiskaming Conglomerate and Sandstone with vein-type gold mineralization, Cadillac-Larder Lake Fault (707001, 5341488; UTM Zone 17, NAD 83)

Drive southwest on Chemin de la Gravière (350 m), turn right at the first intersection onto a gravel road (~ 1.5 km). Park the vehicles and follow a trail to the south.

This extremely long, recently-stripped outcrop provides an excellent opportunity to examine the Timiskaming Group conglomerate and sandstone, deformation structures and vein-type gold mineralization north of the Cadillac-Larder Lake Fault. The polymictic clast-supported conglomerate contains various types of clasts, including rounded granodioritic-tonalitic clasts, flattened felsic and mafic metavolcanic clasts and minor chert clasts (Figure 6A). The shape of the clasts reflects their competency. Younging direction is generally to the north based on tabular and trough crossbedding and normal graded bedding (Figure 6B). Younging reversals are observed near the fold hinge zone (Figure 6C). The main cleavage (~110° striking, subvertical) in coarse-grained sandstone is clockwise to south-facing beds and anticlockwise to north-facing beds. The stretching lineation, defined by a preferred orientation of elongate granitoid clasts, plunges shallowly to the east (trend and plunge: 112°→35°). The slickenside striation, or slickenline, which is well developed on the vein margin, is mostly subparallel to the stretching lineation. The granitoid clasts are surrounded by asymmetrical strain shadows, which are locally filled with hydrothermal minerals, indicative of superposed dextral shearing (Figure 6A). The bedding-subparallel veins are asymmetrically boudinaged along a shear band cleavage, indicating these veins were emplaced before dextral shearing (Figure 6D). "S"-shaped kink bands (325°/86°) are also visible, which formed after dextral shearing.

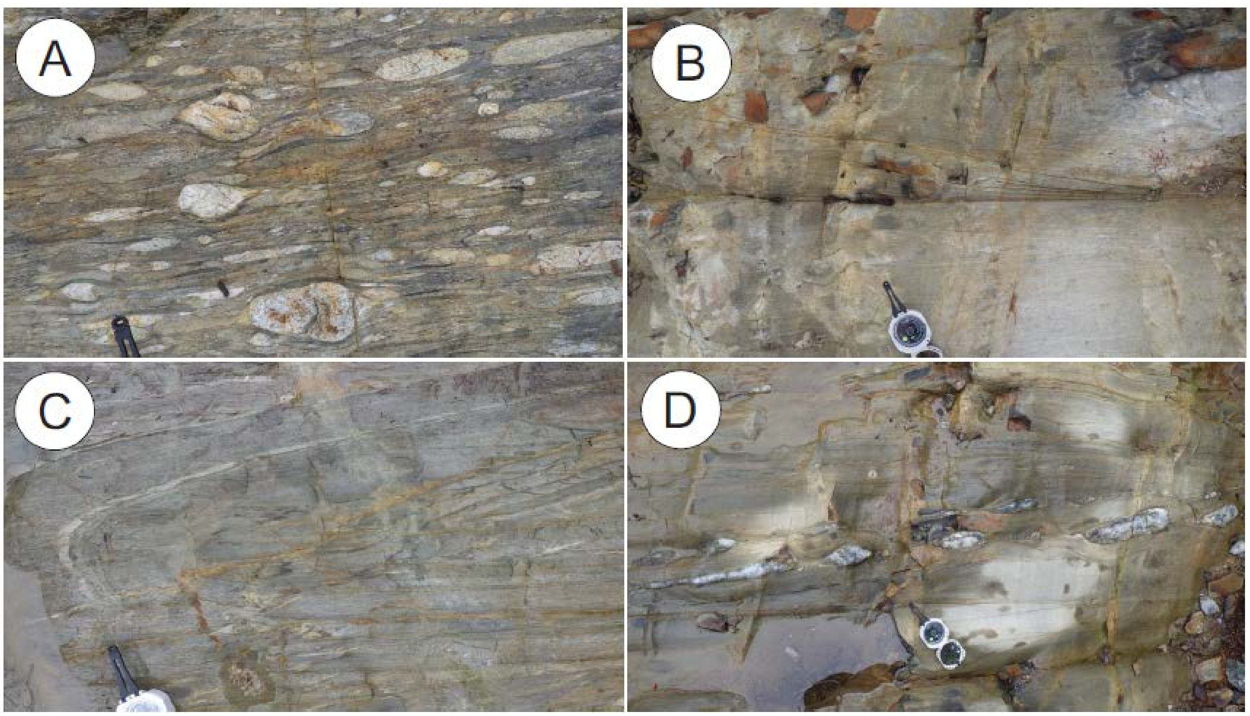


Figure II-6 Timiskaming conglomerate and sandstone. All plan view. Compass points to the north. See text of Stop 3 for details.

The vein system and deformation style in Timiskaming sediments are identical to that at Stop 2. The maximum age of gold mineralization is constrained by the detrital zircon age of the Timiskaming sediments, which is ~2672 Ma (Davis, 2002; Pilote et al., 2015).

Stop 4 Piché mafic intrusion and schist, bedded felsic tuff and quartz-tourmaline veins, Cadillac-Larder Lake Fault Zone (706079, 5340146; UTM Zone 17, NAD 83)

Drive southeast back to the intersection and turn left onto Chemin de la Gravière (~ 2 km) until the powerline. Park the vehicles, cross the railway and follow a trail to southwest (~ 200 m).

This large outcrop provides a unique chance to observe the Piché Group, multi-phase deformation and auriferous quartz-tourmaline veins within the Cadillac-Larder Lake Fault Zone. The Piché Group consists of a coarse-grained mafic intrusion, mafic schist, minor bedded felsic tuff (~2709 Ma; Pilote et al., 2014) and a felsic dike at this stop. The dominant cleavage (S_p) is an east-southeast striking (~125°-140°), subvertical, closely-spaced foliation (Figure 7A), which is clockwise to bedding in the felsic tuff. The stretching lineation, defined by biotite and/or hornblende on the cleavage plane, plunges moderately (45°-55°) to the east-southeast. Unlike the mineralised veins in Cadillac or Timiskaming sediments, the veins within Piché mafic schist and intrusion are rich in tourmaline. They have sigmoidal shapes suggesting that they were likely emplaced during sinistral shearing (Figure 7B). Other veins are tightly "S"-shaped folded, suggesting that their emplacement occurred early during sinistral shearing (Figure 7C). This dominant cleavage is folded by an upright, tight to close, mostly moderately east-plunging, "Z"-shaped fold (Figure 7D). The "Z"-shaped fold have an axial plane cleavage (S_{p+1}) which is anticlockwise to the dominant cleavage (Figure 7D). The veins are typically boudinaged along the late cleavage (S_{p+1}) (Figure 7E). A dextral shear band cleavage is also present, which is at a low angle (~30°) anticlockwise to the late cleavage (S_{p+1}) (Figure 7E). Some thick subvertical veins are almost orthogonal to S_p and parallel to S_{p+1} but with no discernible boudin structure (Figure 7F).

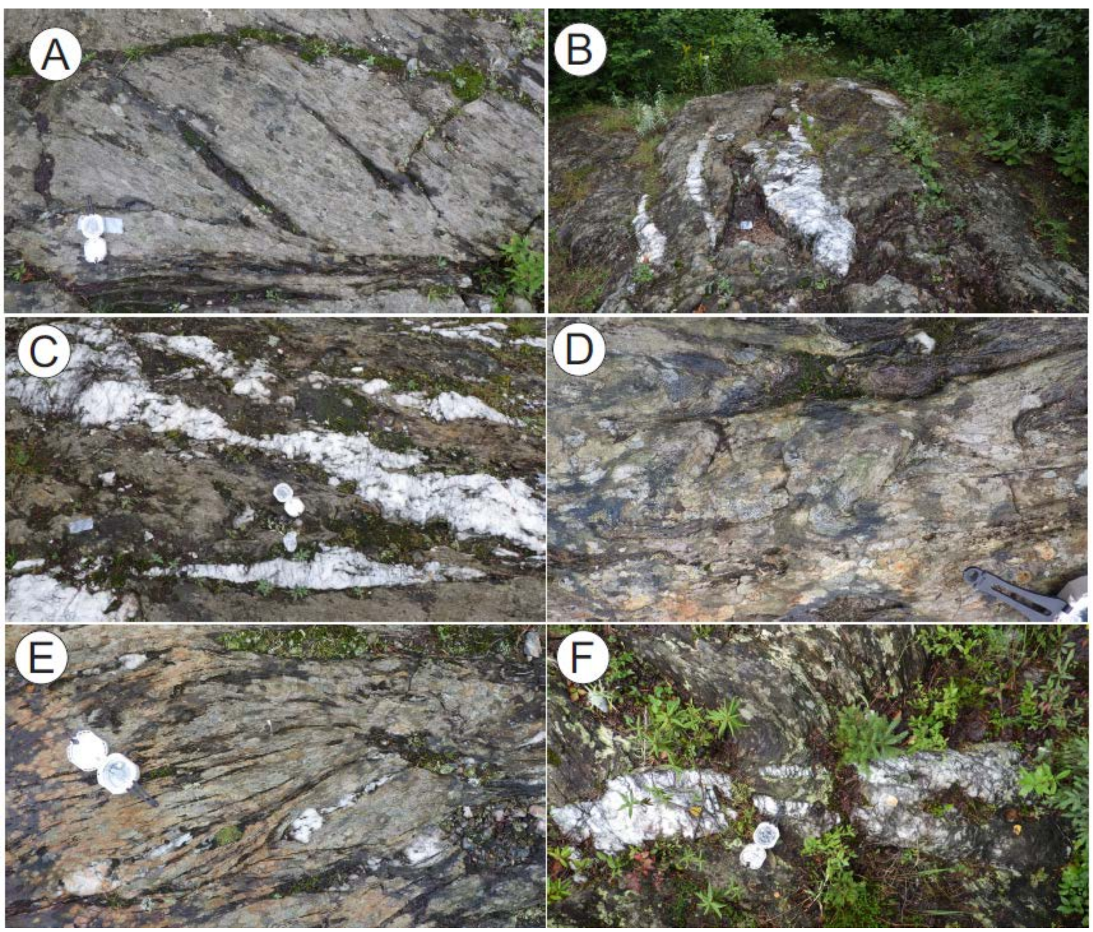


Figure II-7 Deformation structures and a vein system within the Piché Group. All plan view; looking west in Figure 7B. Compass points to the north. See text of Stop 4 for details.

Stop 5 Amphibolite north of the LaMotte Pluton, Northern Manneville Fault (712413, 5370319; UTM Zone 17, NAD 83)

Drive back to Chemin de la Gravière and turn left onto Highway QC-117 (4.4 km), slight right onto Rue Principale (4.1 km), Continue to Highway QC-109N (22.5 km). Stop 5 is on both sides of the highway. Be careful of the traffic.

This outcrop is located ~1 km north of the northern contact of the La Motte Pluton at the Northern Manneville Fault. The supracrustal rocks consist of west-striking, shallowly to moderately north-dipping coarse-grained amphibolite, chert and biotite-amphibole schist. The metamorphic grade is amphibolite facies. The principal cleavage is subparallel to bedding (Figure 8A) and it contains a down-dip stretching lineation defined by amphibole and biotite. Multiple shear sense indicators are present at this stop, including shear bands (Figure 8B), σ-type porphyroclast (Figure 8C), and tension gashes (Figure 8D), which consistently indicate north-side up south-side down, dip-slip reverse movement.

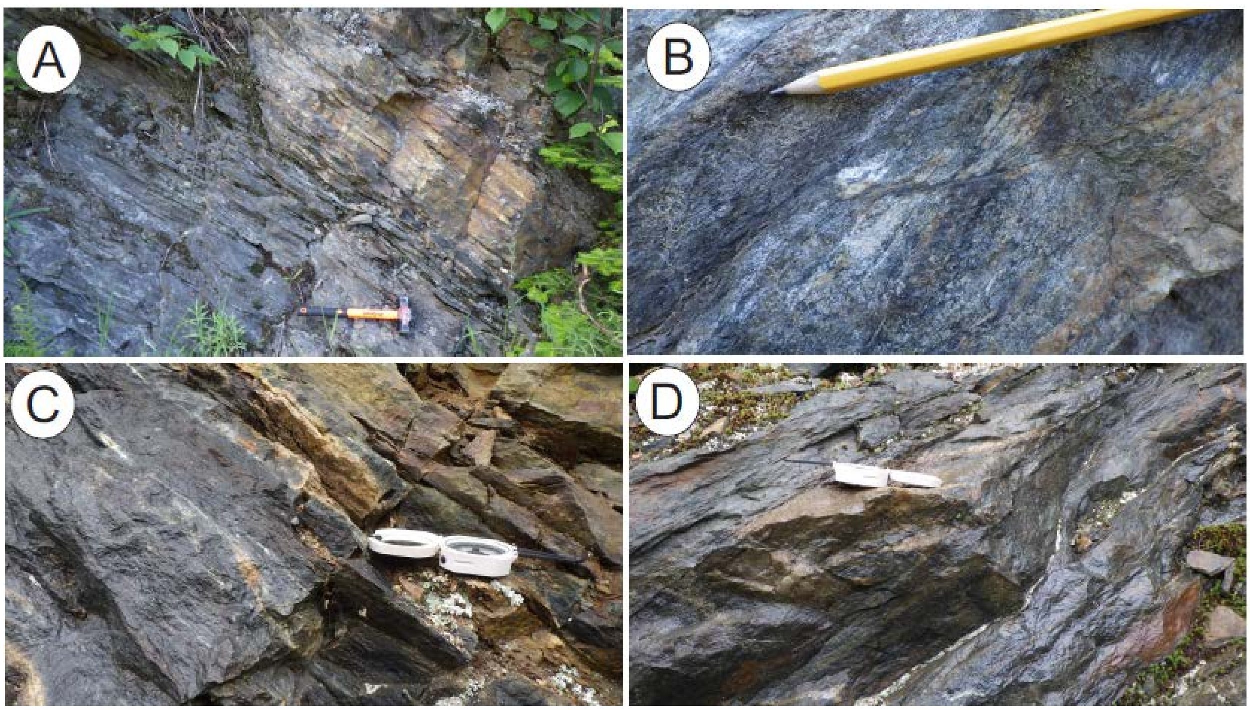


Figure II-8: Deformation structures of the Northern Manneville Fault. All section view. Hammer, compass and pencil point to the north. See text of Stop 5 for details.

Stop 6 Cubric Nickel Prospect, Southern Manneville Fault (711038, 5357050; UTM Zone 17; NAD 83)

Drive south on Highway QC-109 (13.6 km). Park the vehicles and follow a trail to the southeast. It's about 10 minutes' walk to Stop 6.

There are two Nickel-Copper surface showings (Marbridge and Cubric) within the Malartic Group in the Southern Manneville Fault. This stripped outcrop provides an excellent opportunity to examine the geological setting of the mineralization at Cubric. The bedrock includes amphibolite-facies metamorphosed mafic and ultramafic rocks, chert and iron formation (BIF?). They are intruded by various mafic or felsic intrusions: a coarse-grained mafic intrusion (Figure 9A), a monzogranite pluton (Figure 9B) and mafic dikes (Figure 9C). Pegmatitic pods occupy the centre of the dioritic intrusion (Figure 9D). The mineralized zones, composed chiefly of pyrite-chalcopyrite-pyrrhotite-pentlandite-magnetite lenses (Figure 9E), mostly occur near the contact between amphibolite and chert/iron formation. The earliest deformation feature is preserved in angular foliated (S_1) mafic volcanic clasts within the coarse-grained amphibolite (Figure 9A). All supracrustal rocks and felsic and mafic intrusions, including the ore zones, are isoclinally or tightly folded (F_2). The initial Nickel-Copper mineralization, therefore must have occurred before these tight (F_2) folds. The principal cleavage (S_2: 290°/85°) is axial planar to the isoclinal to tight (F_2) folds. This principal (S_2) cleavage is crenulated and folded by upright, open (F_3) folds (Figure 9F). A new crenulation cleavage (S_3) is axial planar to these open (F_3) folds. Dextral shearing, evidenced by S-C fabric in the talc-chlorite schist, is likely the latest deformation episode at this outcrop.

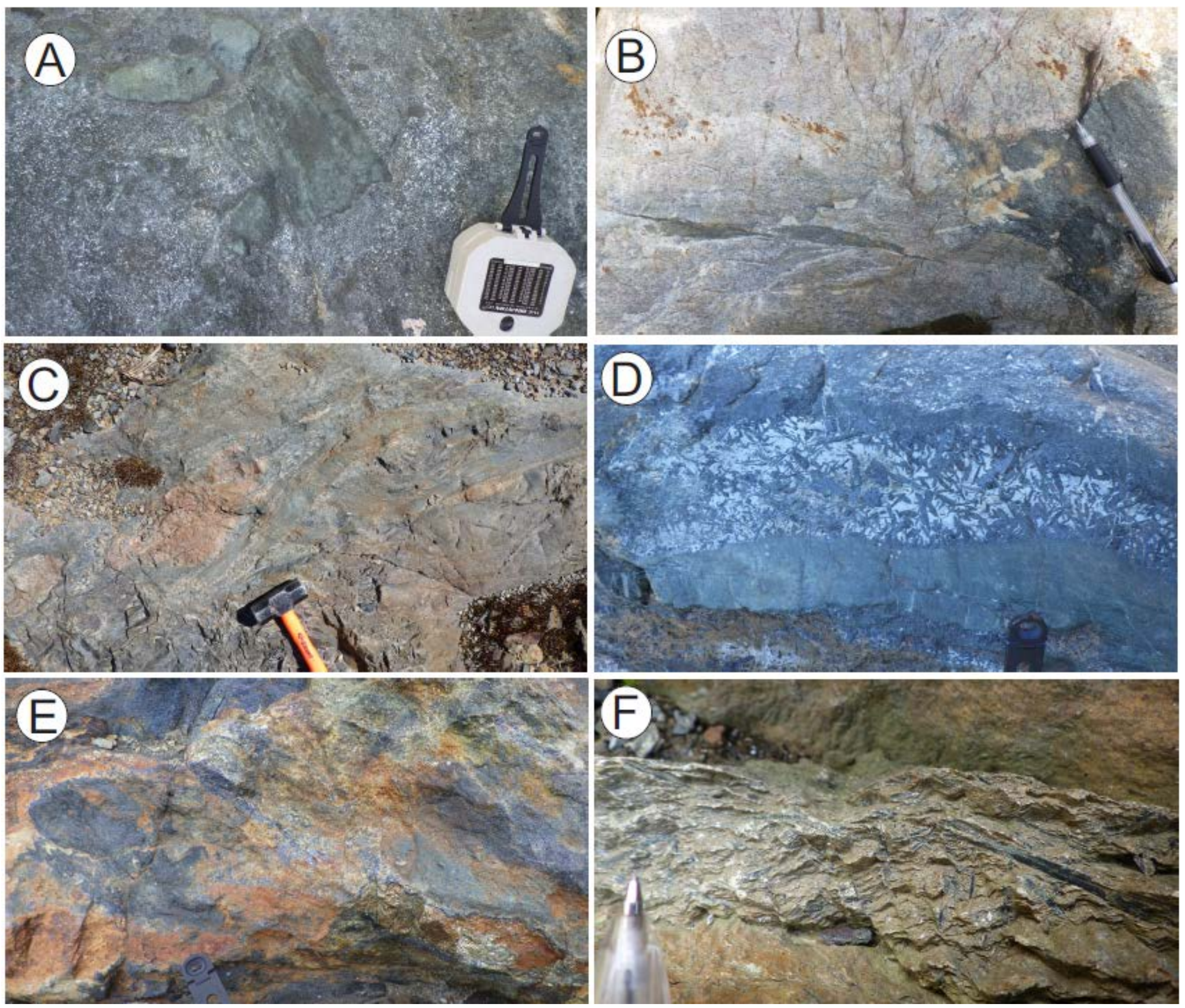


Figure II-9: Bedrock and deformation structures at the Cubric Nickel Prospect. All in plan view. Hammer, compass and pencil point to the north. See text of Stop 6 for details.

Stop 7 Roadcut Outcrop, Southern Manneville Fault (710882, 5357264; UTM Zone 17, NAD 83)

Walk back to the Highway QC-109 and follow the Highway QC-109 for 100 m. This stop is the east side of Highway QC-109. Be careful of the steep slope at this stop.

This outcrop is the western extension of the Cubric Prospect. Steeply north-dipping supracrustal rocks are observed along a vertical road cut (Figure 10A). On the top surface of this roadcut stop, the feldspar porphyry is isoclinally to tightly "M"-shaped and "S"-shaped folded (Figure 10B), forming a classical transposition foliation that is axial planar to these folds. The felsic dikes are both "S" and "Z" isoclinally folded (Figure 10C), which are likely parasitic folds on two limbs, suggest the fold hinge is located in between these parasitic folds but further to the northwest. A shallowly-to-moderately–plunging stretching lineation is well developed along the principal cleavage. The σ-type granitoid porphyroclasts on the horizontal surface (Figure 10D) suggest dextral strike-slip shearing, which is likely the latest deformation episode.

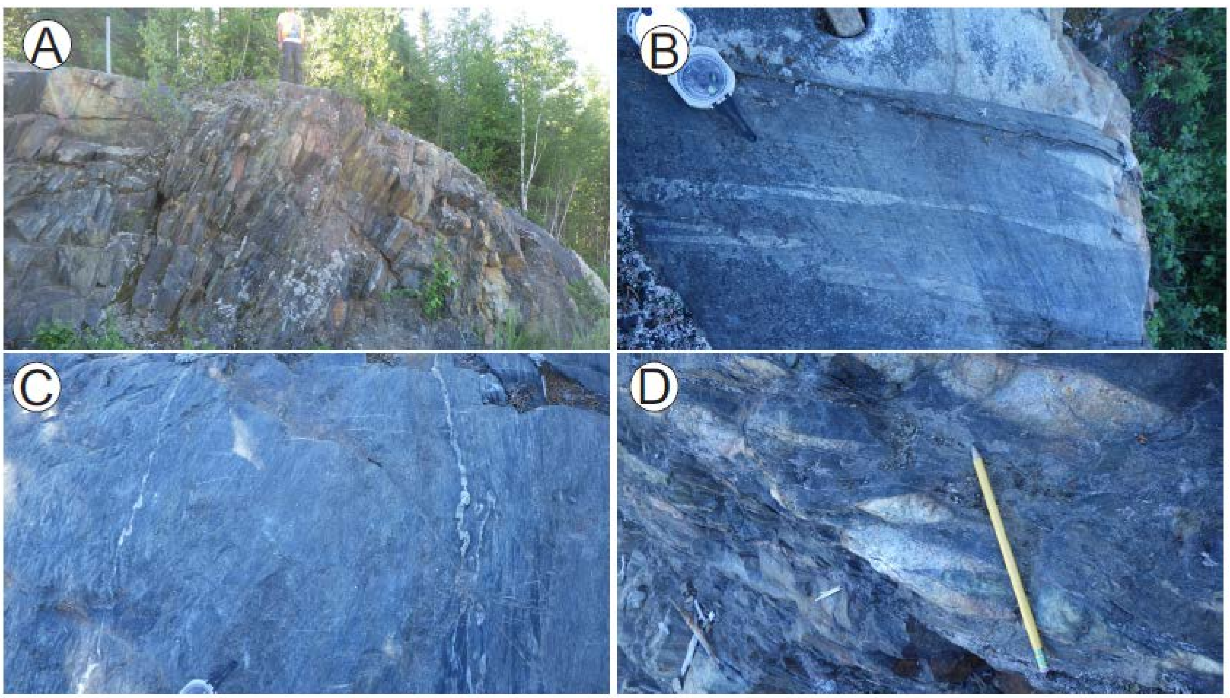


Figure II-10: Bedrock and deformation structures at the Road cut Stop 7. Figure 10A in section view, looking east; all others in plan view. Compass and pencil point to the north. See text for details.

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Rouyn-Noranda Transect

Authors: Taus R. C. Jørgensen, Marina D. Schofield, Adrian Rehm, and Jonathan Sutton

Excursion Leaders: Taus R.C. Jørgensen, and Harold L. Gibson

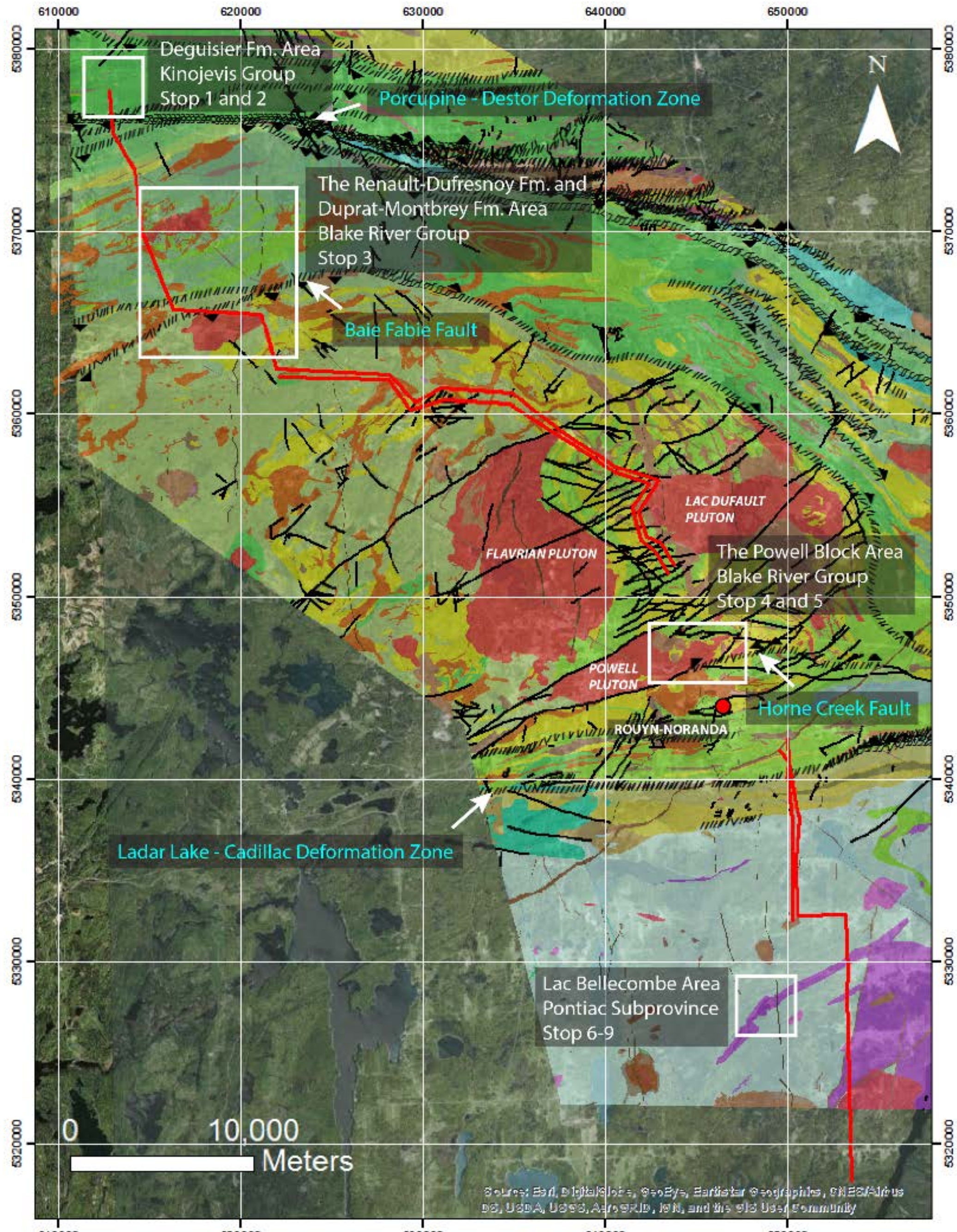

Fig. III-1: Regional geology of the Noranda camp showing the transect and field stops.

Rouyn-Noranda Transect

Metal Earth's Rouyn-Noranda transect (Fig. III-1) consists of two segments separated by the central part of the city. A northwestern segment, all within the Abitibi Subprovince, extends from the Deguisier Formation, Kinojévis Group, (~3 km east of Lac Dancës and ~1.5 km north of the Porcupine-Destor fault, PDF) in a southeast direction to near the southeastern margin of the Lac Dufault pluton. A southern segment extends from the Rouyn-Pelletier Formation, Blake River Group (at the intersection between Rue des Coteaux and Route des Pionniers), in a southward direction across the Cadillac-Larder Lake break, and to the end of Route des Pionniers ~1.5 km south of Saint Roch in the Pontiac Subprovince.

Integration of geological mapping, geophysical surveying, and compiling of historical data along the Rouyn-Noranda transect will allow for the construction of a crustal scale cross section traversing a base and precious metal endowed greenstone belt including two major, deep rooted crustal structures. Eventually, the Rouyn-Noranda transect will be compared to other transects through less endowed areas (e.g., Ben Nevis area of the Abitibi) in order to define key characteristics that distinguish endowed versus less endowed crust.

Field work during the inaugural Metal Earth 2017 field season included transect mapping, i.e., collection of geological observations and samples along the transect at a 1:10,000 scale. At the same time, 1 PhD project and 2 MSc projects were initiated locally along the transect to answer more specific outstanding questions within the Rouyn-Noranda camp and in the Pontiac Subprovince.

For the transect, more detailed work was carried out north of the PDF in the 2720–2718 Ma Deguisier Formation (DFm) that forms an east-west trending volcanic succession with a thickness of approximately 5 km. Along the transect, the DFm is dominated by sequences of southward younging pillowed and massive basalts and andesites with narrow intervals of hyaloclastites between flows. Lesser amounts of felsic tuffs and tuff breccias comprise the rest of the formation. The primary objective for this part of the transect, is to gain a better understanding of the DFm volcanic stratigraphy including the felsic lithologies through geological mapping and lithogeochemistry. Furthermore, the scarcity of zircon geochronological work on the DFm in the vicinity of the transect line makes the acquisition of such data a high priority. The results will be used in comparison studies between felsic lithologies in the DFm and the 2719-2711 Ma Kidd-Munro assemblage, and between basalts/andesites in the DFm and the younger 2706-2701 Ma Hébécourt Formation (Blake River Group) south of the PDF.

The PhD project is to characterize the stratigraphy and volcanology of the Powell Block, which is located between the Beauchastel Fault and the Horne Creek Fault (Fig III-1). Detailed mapping (1:2000 scale) will be done to characterize primary volcanic structures and textures and contact relationships between units. Emphasis will be on determining the relationships across fault blocks in order to unravel the structure, with the overall goal of fitting the Powell Block and neighbouring Horne Block into context with the well-studied Noranda Cauldron. Samples of representative units will also be collected for U-Pb geochronology. Key targets include cross-cutting bimodal dikes, in-addition to the tonalite, quartz-diorite and glomeroporphyritic "daisy gabbro" phases of the Powell pluton. In addition, this project will map mineralization and alteration variation, in order to better understand the hydrothermal system. Geochemistry and petrology will be used to determine the nature of the metamorphic/hydrothermal overprint on the various intrusive phases and their volcanic equivalents. Through the use of the aforementioned techniques, this project will attempt to provide insights into the origin of the Au-mineralization, and whether: 1) synvolcanic fault reactivation during deformation along the Cadillac-Larder Lake break allowed for secondary enrichment of pre-existing Volcanogenic massive sulphide (VMS) deposits; or 2) if some favourable feature resulted in producing the originally Au-rich VMS deposits.

One MSc project revolves around the 2702 Ma Renault-Dufresnoy (RDF) and the 2701 Ma Duprat-Montbrey Formations (2701 Ma) that are both part of the lower Blake River Group but separated by the Baie Fabie fault (Fig III-1). In the RDF, the Monsabrais pluton (2696 Ma) is much younger than the surrounding volcanic stratigraphy and no VMS deposit has been found within the area. In the DMF, the Fabie pluton (2701 Ma) is closer in age and two VMS deposits are hosted within the volcanic stratigraphy, the Fabie and Magusi deposits. Furthermore, the volcanic stratigraphy appears to include a higher proportion of rhyolites within the DMF compared to the RDF. The primary objective of this project is to gain a better understanding of the volcanic stratigraphy in the DMF and RDF and the spatio-temporal relationship with the plutons. The hydrothermal footprint of the two deposits and various sulphide occurrences will also be studied in order to further understand the extent of mineralisation. The project will involve: 1) detailed mapping (1:10,000) and sampling of the RDF, DMF and associated intrusions, 2) geochemical analysis of the volcanic stratigraphy and intrusions, and 3) geochronology of relevant rhyolites and intrusions. The results of the project would also enable a comparison of the DMF and RDF and a discussion of the apparent lower metal endowment in the RDF.

Another MSc project is in the Lac Bellecombe area, located ~15km south of Rouyn-Noranda (Fig. III-1). The local geology is characterized by a mafic-ultramafic volcanic complex that is hosted within metagreywackes of the Pontiac Group. Regionally, the relationship between the metasedimentary rocks of the Pontiac Group and the volcanic rocks is not fully understood mainly due to the lack of mapping of the volcanic rocks and their contact relationships with the metasedimentary rocks. The focus of this project will be to on these volcanic rocks in order to explain the nature and timing of the emplacement of the volcanic rocks in the sedimentary rocks of the Pontiac Group. The main question is whether the volcanic rocks formed contemporaneously with the sedimentary rocks or were emplaced during a later thrusting event. Rocks in this region have been strongly deformed, so a good understanding of the structures in both the volcanic rocks and surrounding sedimentary rocks will be crucial for describing the tectonic history of the region. Identifying and tracing the different volcanic units and establishing whether they are genetically related to the small mafic dikes and sills that intrude the metasediments will also be important for this project. Potential research avenues include analyzing and comparing the major and trace elements of the volcanic rocks and intrusive rocks, and using zircon geochronology on tonalitic dikes that intrude both the metasediments and metavolcanics to constrain the age and timing of deformation.

The field trip will include stops in these four project areas.

STOP 1 PILLOWED FLOWS IN THE DEGUISIER FORMATION (FIG. III-2 & 3)

Pillowed volcanic flows in the 2720-2718 Ma Deguisier Formation (Kinojévis Group) showing good younging directions, local hyaloclastite, concentric cooling fractures, and finely laminated interpillow material. Locally, massive flows or sills. The stop illustrates a typical example of aphyric pillowed and massive basaltic flows that dominate this part of the transect. The Deguisier Formation has received little attention in this area and geological mapping and sampling is required in order to better understand this part of the transect and make comparisons to the contemporaneous Kidd-Munro Group in Ontario and the younger Blake River Group south of the PDF.

Fig. III-2: (left) Pillowed flows with well-developed cusps indicating younging toward the south. (right) Finely bedded interpillow material locally suggest an east-west striking stratigraphy.

STOP 2 FELSIC TUFFS AND BANDED IRON FORMATION IN THE DEGUISIER FORMATION (FIG. 5 & 6)

The 2720-2718 Ma Deguisier Formation (Kinojévis Group) is dominated by sequences of pillowed and massive basaltic flows (see STOP 1). Locally, rhyolite tuffs and tuff-breccias display significant strike lengths of several kilometers despite relatively narrow thicknesses between ~50 – 100 m. Occasionally, the rhyolite tuffs are intercalated with cm- to dm-wide discontinuous beds of banded iron formation composed of interbedded magnetite-rich layers and hematitic red metachert ("jasper") layers. At this stop, rhyolite tuff and a narrow interval of banded iron formation will be examined where they have been intruded by gabbroic and microgabbroic sills. The rhyolite tuffs will be important to better constrain the timing of volcanism in this area that severely lacks geochronological work.

Fig. III-3: (left) Narrow unit of felsic tuff in a stratigraphy dominated by mafic to intermediate pillowed and massive flows. (right) A narrow interval of banded iron formation intercalated with felsic tuff.

STOP 3A NORTHWEST YOUNGING STRATIGRAPHY NEAR THE FABIE BAY COPPER DEPOSIT

Courtesy of Globex Mining Enterprises Inc. the geology near the Fabie Bay copper deposit (former New Insco) will be examined. The Fabie Bay deposit is hosted in a sequence of mafic pillowed flows, breccias and tuffs of the 2701 Ma Duprat-Montbrey Formation (DMF, Blake River Group). The deposit was discovered in the early 1970' when the first drill hole to test a weakly magnetic conductive zone intersected a 61.9 ft interval of 2.96% Cu. Subsequently, a 1.0 M ton conformable massive sulfide lens averaging 2.5% Cu and 0.25 OPT Ag (Zn less than 0.07%) was delineated with an ~100 m east-northeast strike length and ~180 m down-dip (70°) extension. From 1976 to 1977 Noranda Mines Limited mined a total of 103,574 tons of ore grading 2.64% Cu from a small open pit and sank a production ramp almost to the bottom of the known orebody. The ore is composed of fine grained pyrrhotite (30%), disseminated and finely banded chalcopyrite (5%) and pyrite (25%). Sphalerite and galena are associated with oxidized zone and account for less than 1% of the sulfide content. Production at the Fabie Bay mine ceased in 1977 due to a depressed copper market. Intermittent exploration and mining has been done on the property since the 1977 mine closure.

The stop represents the first evidence in the area for an opposing younging direction in the DMF compared to north of the Baie Fabie Shear Zone (BFSZ) where the 2702 Ma Renault-Dufresnoy Formation (Blake River Group) is younging to the southeast. Younging is indicated by pillowed mafic flows and is located ~200 m SE of the BFSZ

See also http://www.globexmining.com/ for more information on the history of the Fabie Bay mine

Fig. III-4: Pillowed flow showing younging direction toward 345°.

STOP 3B SURFACE EXPRESSION OF THE BAIE FABIE SHEAR ZONE

The BFSZ is an east-west trending structure with a south over north sense of movement. The BFSZ separates the RDF to the north and DMF to the south, both younging in the direction of the fault. This is a short stop to see the surface expression of the fault zone.

Fig. III-5: Lakeshore exposure of the Baie Fabie fault near the Fabie deposit. In this area, the fault is striking ~025° with a near vertical dip.

STOP 4A PANORAMIC VIEW OF THE NORANDA VOLCANIC COMPLEX FROM MT. POWELL

The Noranda volcanic complex (NVC) is one of a number of distinct volcanic centres in the Blake River Group. Major faults and their extrapolation has been used to subdivide the NVC into several structural blocks and lithological correlation between blocks has been a challenge. The area limited to the south by the Horne Creek Fault and to the north by the Beauchastel Fault is referred to as the Powell block, so-named by A.F. De Rosen-Spence in 1976. It can be considered to be a key-stone in understanding the structural-stratigraphic architecture of the Rouyn-Noranda gold and precious metal district in the central part of the Metal Earth transect. The block includes several internal faults and shear zones and, according to M.E. Wilson, (1941; 1942) the central part of the block is occupied by the Héré Creek syncline which logically is a late-tectonic fold (i.e., likely post-Timiskaming ductile deformation).

Since the original attempt by C.D. Spence and A.F. De Rosen-Spence in 1975 to make correlations of the massive sulfide deposits north of the Beauchastel fault southward to the Horne Mine on the south side of the Horne Creek Fault, there has been a proliferation of conflicting interpretations put forward regarding the correlation of the corresponding geological elements. The seemingly reasonable arguments of the early workers for syn-tectonic folds and faults have given way to interpretations involving syn-volcanic faults and syn-volcanic cauldron subsidence for which there is also local compelling evidence (i.e., McDougall-Despina Fault). Considerable uncertainty remains, however, about which features are syn-volcanic versus those that are entirely syn-tectonic. Perhaps the most extreme interpretation has been that of E. Dimroth and A. Lichtblau who concluded that the Powell Block includes the site of a caldera margin and complex stratigraphic correlations can be made with volcanic units beyond it. Also critical to the discussion is the timing of magmatic events in the Powell intrusive complex composed mainly of tonalite, diorite and numerous hypabyssal dikes below the volcanic rocks. Along with its sister Flavian Intrusion to the north of the Beauchastel fault, the Powell "granite" has been interpreted to be a subvolcanic intrusion genetically related to overlying massive sulfide deposits but new interpretation by the GSC has cast doubt on this on geochronological grounds.

Together, the Powell block and the Flavrian block to the north contain most of the known VMS deposits in the NVC. The VMS deposits in the Powell block are the Au-rich Quemont deposit that produced 13.9 Mt of ore with an average grade of 1.31 wt.% Cu, 2.43 wt.% Zn, 5.38 g/t Au, and 30.9 g/t Ag, and the smaller Joliet deposit that produced 2.1 Mt at 1 wt.% Cu (also considered a gold-poor vein-Cu style deposit). The Horne block on the south side of the Powell block is host to the Horne deposit, one of the largest VMS deposits in the world. The Horne mine produced 260 t of Au and 1.13 Mt of Cu from 1927 to 1976, making it the largest gold producer of its class. The 53.7 Mt of ore had an average grade of 2.22 wt.% Cu, 6.1 g/t Au and 13 g/t Ag.

Outside of VMS and related Cu-vein style deposits, the Powell block also hosts orogenic style gold-quartz veins (Powell, Silidor, New Marlon, and Anglo-Rouyn). Although the Powell main vein, Joliet and Quemont are no longer accessible, there are many lesser, reasonably exposed occurrences which require documentation and relative structural timing among the mineralization types is uncertain. There is also compelling evidence of hydrothermal modification of the rocks in many of the outcrops, particularly in the form of a unique type of spotted alteration, disseminated sulfides and veinlets, as well as local zones containing carbonate minerals: none of these appear to have been documented in a systematic way.

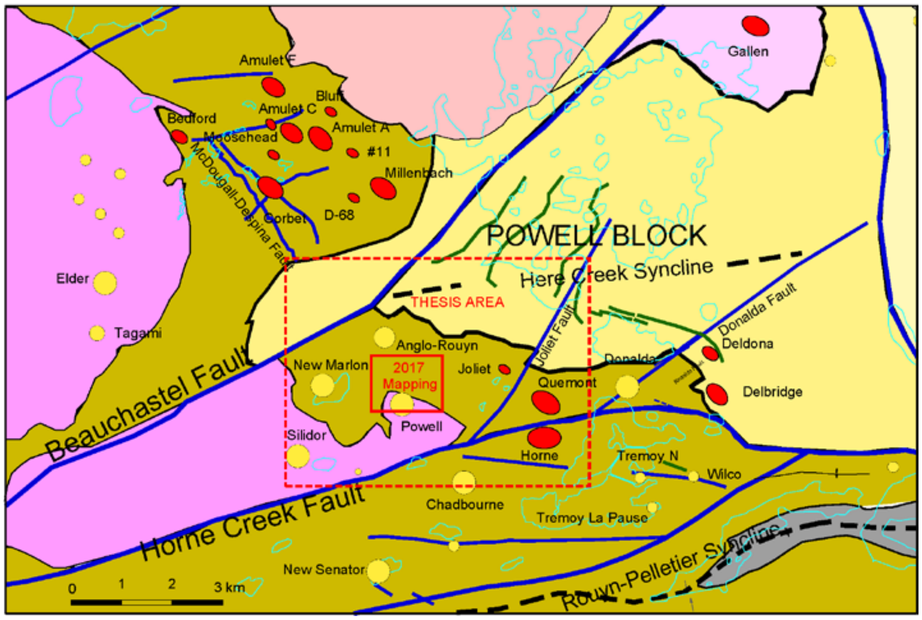

Fig. III-6: Map showing the Powell block project area and the 2017 map area. VMS/Cu-vein deposits shown in red oval shapes and quartz-gold veins in yellow circles (K.H. Poulsen)

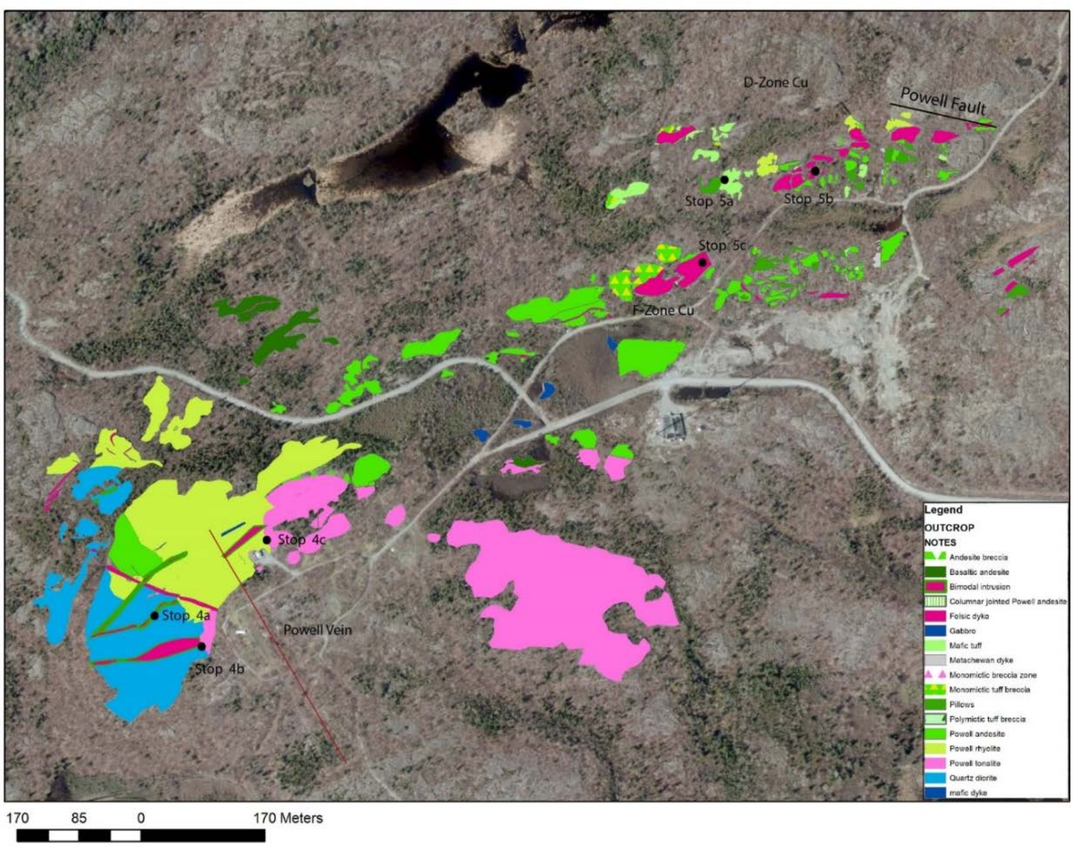

Fig. III-7: The extent of the 2017 map area, indicating the field trip stops in this area and the location of mineral occurrences.

Fig. III-8: Alteration spotting in a felsic dike.

Fig III-9: Composite felsic and mafic dike with sulfides along the contact margin. Alteration spotting is also locally present in the mafic dike.

STOP 4B CONTACT RELATIONSHIPS BETWEEN AN APHYRIC FELSIC DIKE, THE POWELL GRANITOID AND HÉRÉ DIORITE

The timing relationship between the felsic dike, the Héré diorite and the Powell granitoid is poorly constrained with no age date for the felsic dike and the Héré diorite. This outcrop shows the felsic dike crosscutting the diorite and the Powell granitoid crosscutting both the felsic dike and the diorite. This has implications for whether or not the granitoid represents a fractionation product of the diorite. Also, hydrothermal alteration observed as subrounded spots is present in all other units but the Powell granitoid, suggesting that the Powell granitoid was either younger or could have been the heat source for the alteration system.

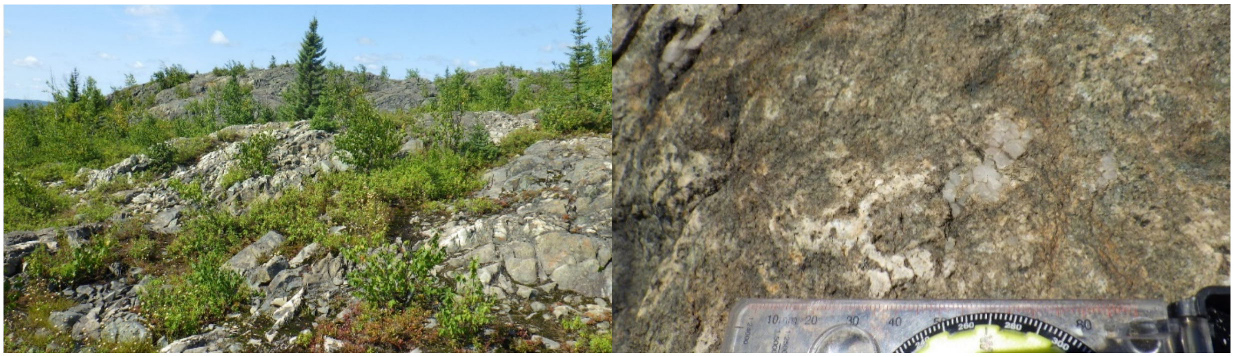

Fig. III-10: (left) Standing on the Powell granitoid looking along strike of a felsic dike (white weathering).(right) Miarolitic cavities in the Powell granitoid.

Fig. III-11: Looking south at the contact between the Powell granitoid (left) and a felsic dike/diorite (right)

STOP 4C OROGENIC STYLE QUARTZ VEINING IN THE POWELL GRANITOID

The Powell vein is an Au-bearing quartz vein cutting the intrusive and volcanic rocks in the area. This outcrop shows similar style quartz veining as the Powell vein but without gold. These veins are orogenic in nature and emphasizes the presence of two significantly different styles of mineralization in the area.

Fig. III-12: Photo looks northward; the E-W brittle ductile shear filled with white ribbon quartz is visible at the top of the photo; it cuts and deforms a NW-striking and NE dipping breccia vein which is composed of quartz-ankerite-pyrite and likely is representative of the type of mineralization mined at Powell Gold Mine.

STOP 5A DISCORDANT CU-SULFIDE STRINGER MINERALIZATION IN VOLCANIC ROCKS OF THE POWELL BLOCK

This stop in the Powell block shows Blake River Group pillowed flows and bedded tuffs. The outcrop shows excellent younging direction which has importance to the overall structural understanding of the Powell block volcanic rocks that are folded, which has not been fully appreciated previously.

Fig. III-13: (left) Amoeboid pillows with well-defined cusps and concentric cooling cracks (right) E-NE to W-SW striking faults offsetting bedding

Fig. III-14: (left) Thin tuff layer. (right) Stringer sulfides follow the cleavage (approximately 080). In addition, there are rusty zones of disseminated sulphides parallel to bedding.

Fig. III-15: (left) Thick bedded mafic tuff and lapilli tuff. (right) Several faults with minor offsets of the bedding.

STOP 5B SULFIDE BRECCIA

This stop shows a felsic dike with sulfides along the contact margin, cross-cut locally by breccia composed of angular felsic clasts in a rusty sulfide-rich matrix. The sulfides along the margins of the felsic dike combined with the crosscutting sulfide breccias is indicative of how previous magmatic conduits are incorporated into the plumbing system responsible for driving the VMS forming hydrothermal system.

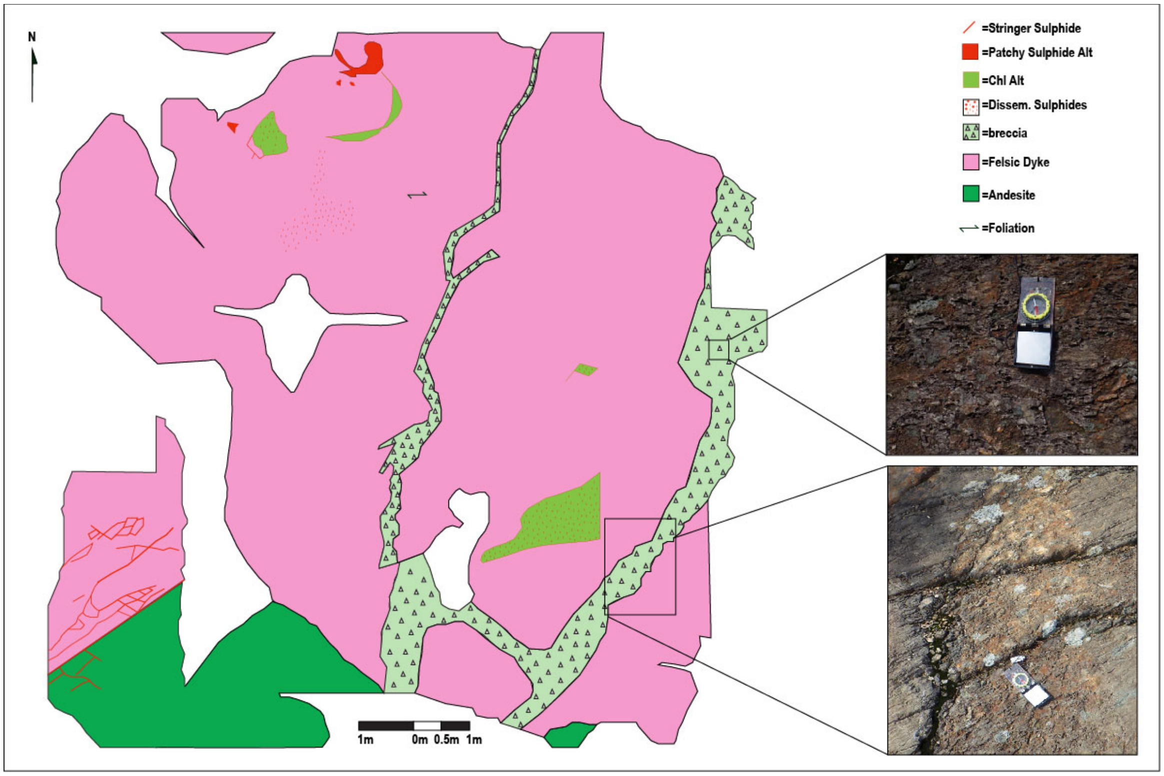

Fig. III-16: Grid map of breccia zone

Fig. III-17: (left) Breccia dike cross-cutting felsic dike, with rusty fine grained sulfide-rich matrix.(right) Close up of breccia, showing angular clasts and matrix.

STOP 5C THE F-ZONE COPPER OCCURRENCE

Blake River Group pillowed flows and bedded tuffs with discordant sulfide stringer zones utilizing earlier magmatic pathways most likely representing syn-volcanic faults. This is another example of the hydrothermal system taking advantage of pre-existing structure.

Fig. III-18: Sulfides along margin of felsic dike. F Zone Cu occurrence.

STOP 6 to 9 - LAC BELLECOMBE PROJECT (PONTIAC SUBPROVINCE)

Pontiac Subprovince

The Pontiac Subprovince is a granite-metasedimentary domain situated at the southern margin of the Superior Province (Fig. I-1). The Pontiac sedimentary rocks Fig. I-3) were deposited after the similar Porcupine assemblage, but before the Timiskaming assemblage of the Abitibi subprovince (Mortensen and Card, 1993; Davis, 2002). Depending on the preferred tectonic model, the sedimentary rocks of the Pontiac Subprovince likely formed as a foreland basin or accretionary prism in response to subduction or subduction-like processes (e.g., White et al., 2003; Percival et al., 2012; Frieman et al., 2017), or in basins formed as a result of transient uplift and erosion during subcretion, followed by postorogenic collapse (e.g., Calvert et al., 2004, Bedard and Harris, 2017).

The Pontiac Subprovince also includes discontinuous bodies of mafic to ultramafic volcanic rocks that are interpreted to represent a structurally emplaced assemblage with similar chemical characteristics to those of early volcanics in the southern Abitibi Subprovince (Camiré et al., 1993). The supracrustal rocks are intruded by several felsic plutons: the aforementioned Lac Fournière pluton, the 2679-2676 Ma Sladen intrusion (Helt et al., 2014; De Souza et al., 2015, 2016), and the 2668-2663 Ma Décelles Batholith (Mortensen and Card, 1993).

The deformation history of the northern part of the Pontiac Subprovince includes three main deformation events. The D_1 event produced isoclinal folding and an S_1 pressure-solution cleavage, mainly subparallel to bedding (Derry, 1939; Camiré and Burg, 1993; Perrouty et al., 2017). D_2 resulted in open to tight F_2 folds, locally accompanied by a penetrative S_2 biotite foliation on average trending E-W to NW-SE (Camiré and Burg, 1993; Benn et al., 1993; Perrouty et al., 2017). D_3 is characterized by a non-penetrative S_3 crenulation cleavage and conjugate kinks (Benn et al., 1993; Perrouty et al., 2017).

The 18.6 Moz Canadian Malartic gold deposit (measured, indicated, inferred and past production), located 30 km west of Val d'Or is the only known world-class gold deposit in the Pontiac Subprovince (Gervais et al., 2014). The gold mineralizing events consist of an early magmatic-hydrothermal episode and a main hydrothermal synkinematic episode during D_2 with a molybdenite Re-Os age of 2664 ± 11 (De Souza et al., 2016). The rheological contrast between Pontiac metasedimentary rocks and structurally controlled felsic-intermediate intrusive bodies facilitated the propagation of the local Sladen Fault Zone and allowed for connectivity with the regional Cadillac Larder Lake Deformation Zone, resulting in an increased gold endowment of the Canadian Malartic deposit (Perrouty et al., 2017).

The Pontiac Subprovince is also host to a number of other types of economic mineral occurrences, including greywacke hosted Qtz-Py-Gn-Ag veins, Qtz-Ccp-Bn veins southwest of the Lac Fournière, and beryl associated with Qtz-Bi-Tur-Mo veins in a pegmatite dike at the margin of the Dècelles Batholith (Perrouty et al., 2017 and references therein).

Lac Bellecombe area

Lac Bellecombe is located ~15km south of Rouyn-Noranda. The local geology is characterized by a mafic-ultramafic volcanic complex that is hosted within metagreywackes of the Pontiac Group (Fig. 11). Regionally, the relationship between the metasedimentary rocks from the Pontiac group and the volcanic rocks is not fully understood mainly due to the lack of mapping of the volcanic rocks and their contact relationships with the metasedimentary rocks. The focus of this project will be to on these rocks in Bellecombe, and other similar volcanic rocks in surrounding areas, to explain the nature and timing of the emplacement of the volcanic rocks in the sedimentary rocks of the Pontiac Group.

The main question is whether the volcanic rocks formed contemporaneously with the sedimentary rocks or were emplaced during a later thrusting event. Rocks in this region have been strongly deformed, so a good understanding of the structures in both the volcanic rocks and surrounding sedimentary rocks will be crucial for describing the tectonic history of the region. Identifying and tracing the different volcanic units (Fig. 12) and establishing whether they are genetically related to the small mafic dikes and sills that intrude the metasediments will also be important for this project. Potential research avenues include analyzing and comparing the major and trace elements of the volcanic rocks and intrusive rocks, and using zircon geochronology on tonalitic dikes that intrude both the metasediments and metavolcanics to constrain the age and timing of deformation.

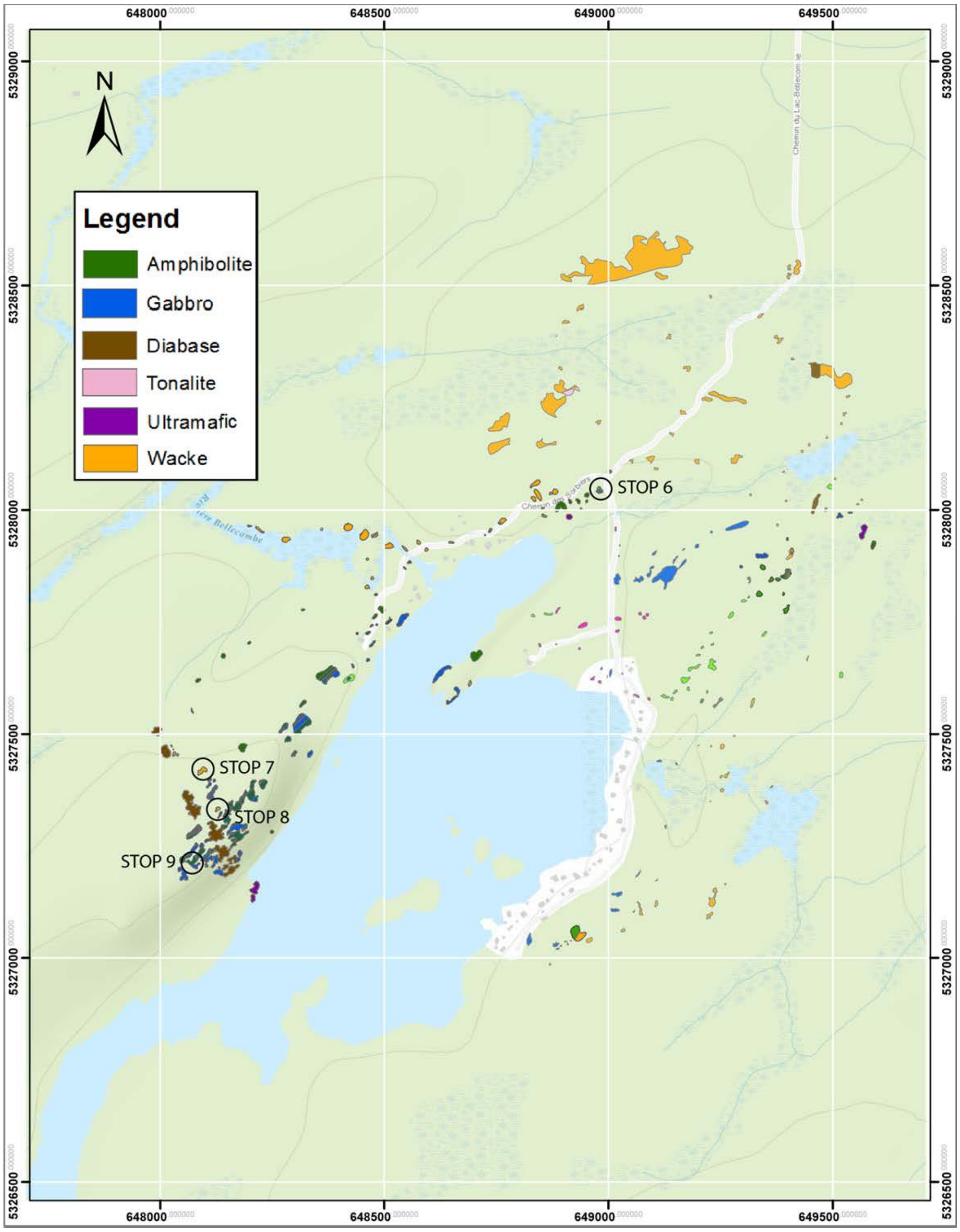

Figure III-19. Outcrop map of the Lac Bellecombe project area showing a central core of ultramafic and mafic volcanic rocks, and Pontiac metasedimentary rocks to the NW and SE of the volcanic package. Stratigraphy is generally striking SW – NE.

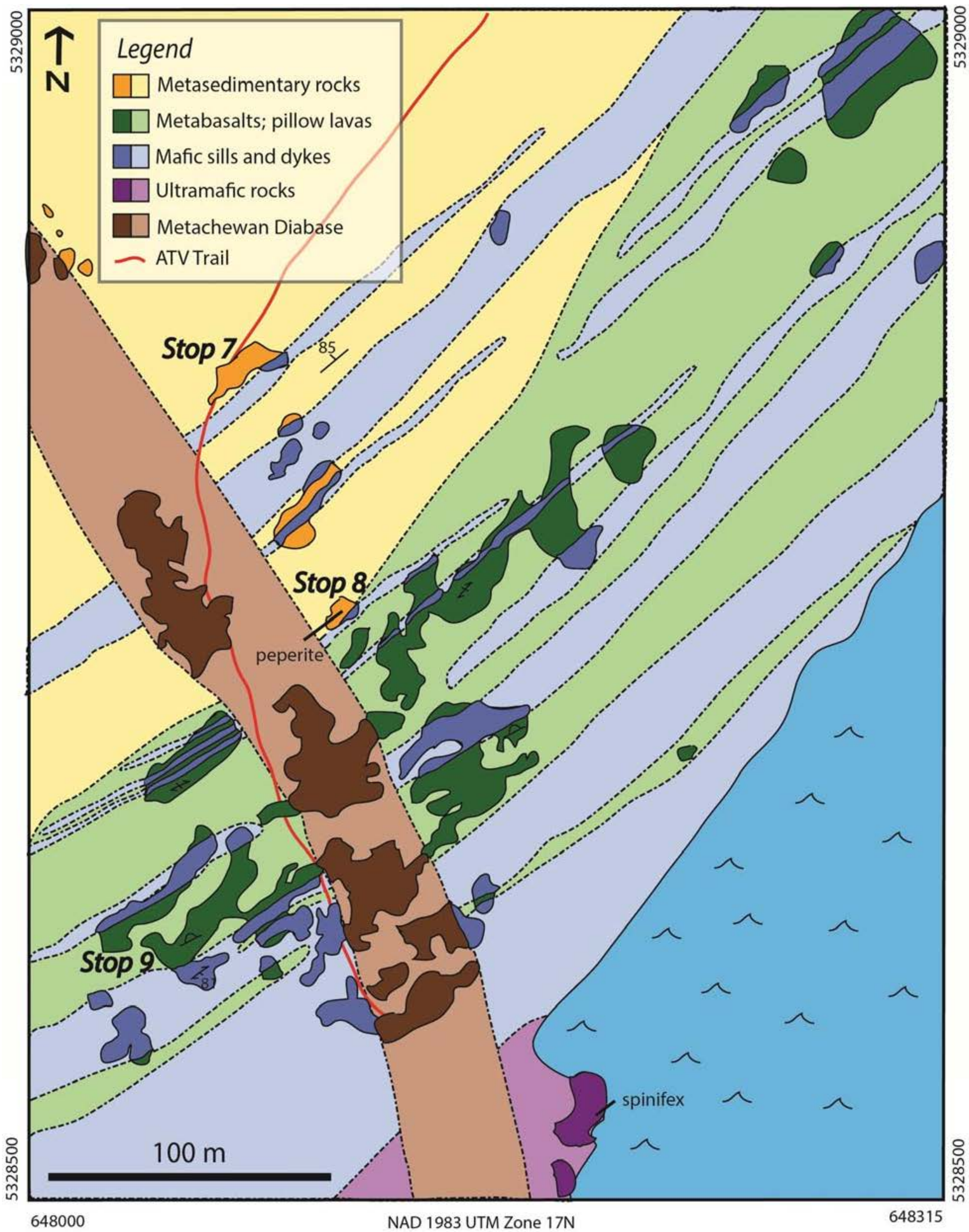

Figure III-20. Detailed map showing the contact area between the volcanic stratigraphy and the Pontiac metasedimentary rocks.

STOP 6 - PEPERITE TEXTURES IN PONTIAC METASEDIMENTARY ROCKS AT THE CONTACT WITH MAFIC SILLS

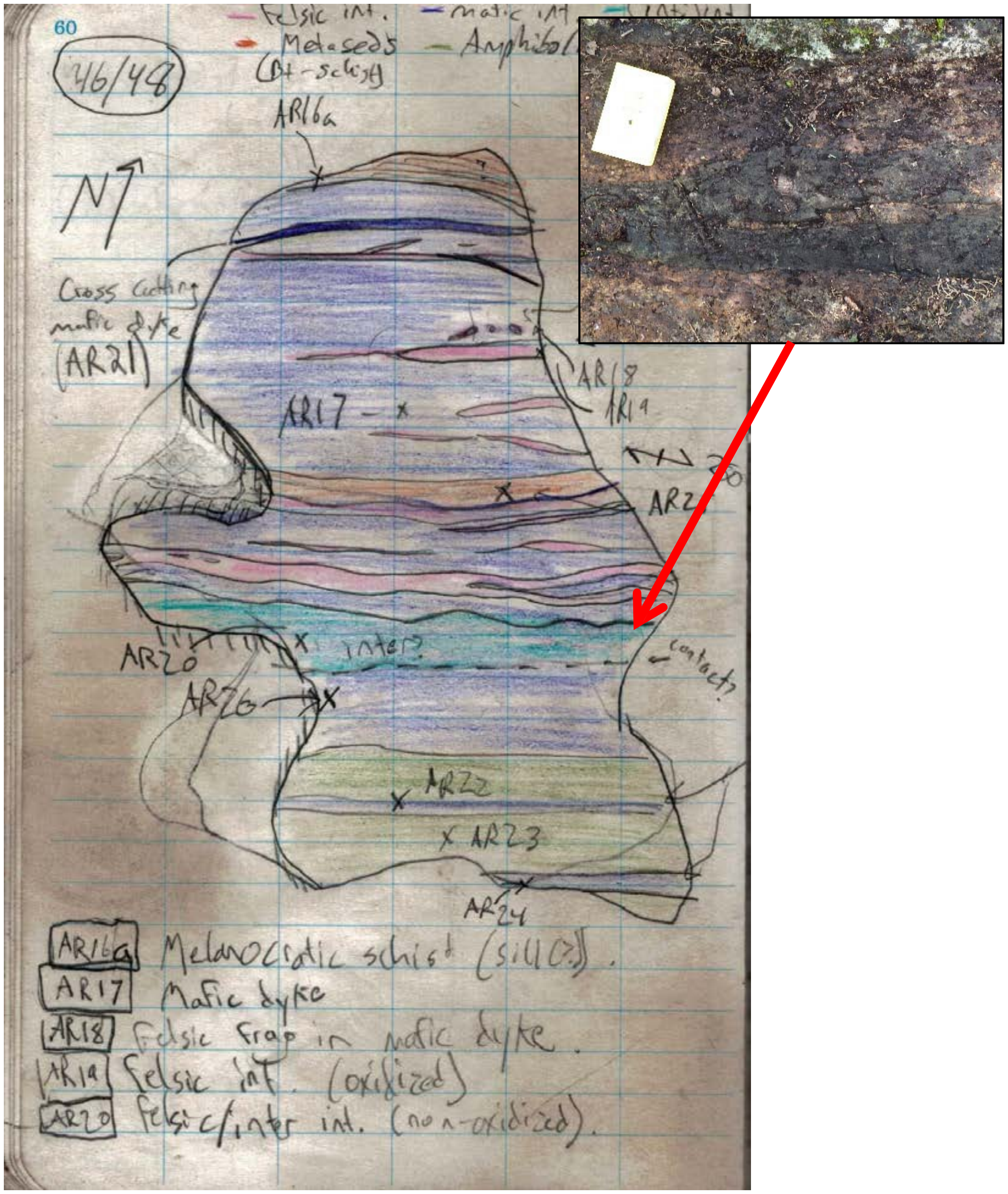

Figure III-21:. Sketch map of an outcrop exposing multiple mafic sills intruding the Pontiac metasedimentary rocks . Locally, the metasedimentary cks are characterized by peperite textures along the sill contacts (inset).

STOP 7 - FOLDED PONTIAC METASEDIMENTS INTRUDED BY SEVERAL GENERATIONS OF MAFIC DIKES AND SILLS.

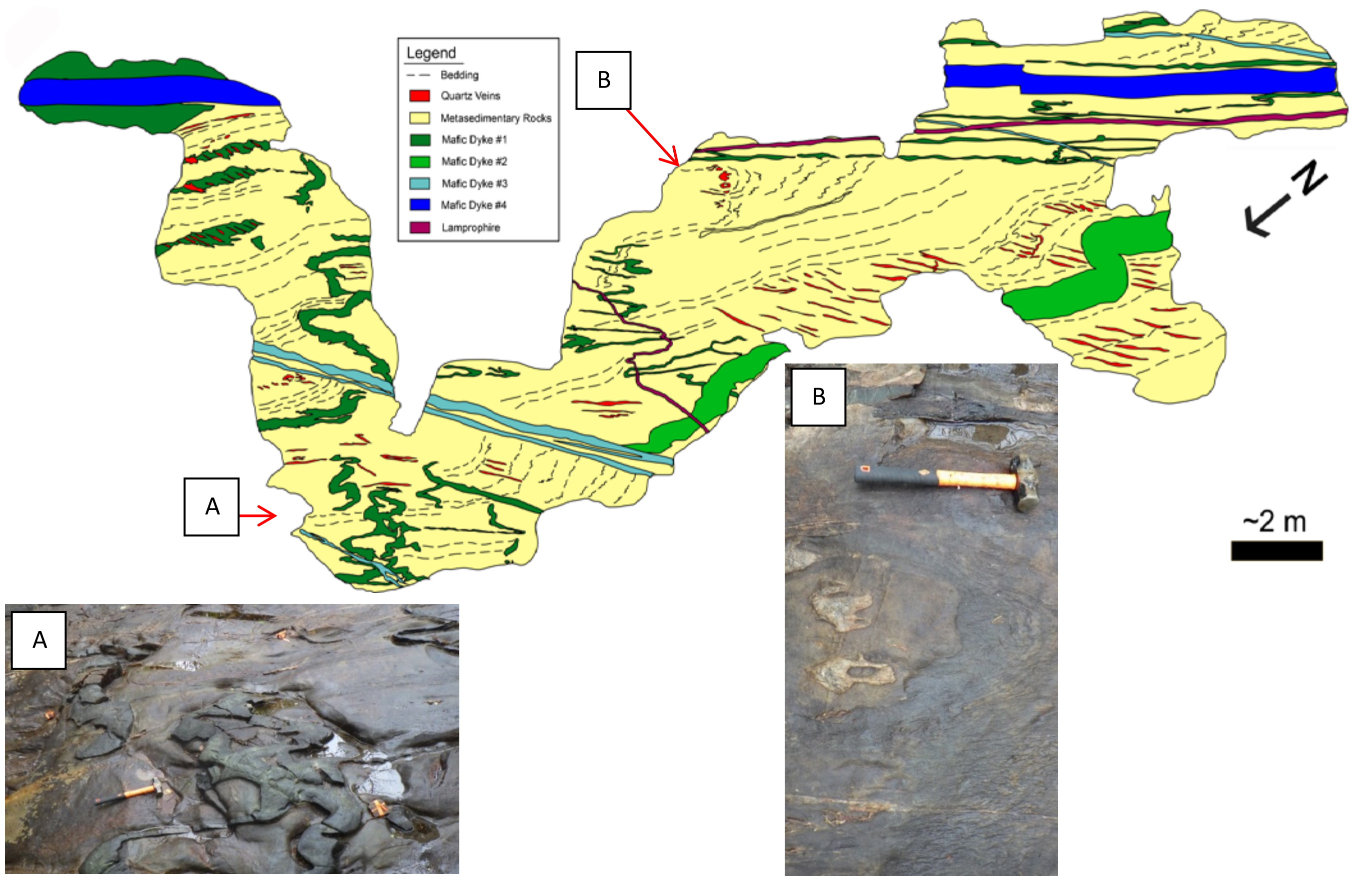

Figure III-22: Grid map showing folded Pontiac metasedimentary rocks and mafic dikes. Several generations of dikes are present and many are strongly folded or boundinaged. Inset A) showing strongly deformed mafic dikes and inset B) shows m-folds in the metasedimentary rocks.

STOP 8 – OUTCROP EXPOSING STRONGLY DEVELOPED PEPERITE TEXTURES IN THE NEAR CONTACT ENVIRONMENT BETWEEN THE VOLCANIC PACKAGE AND PONTIAC METASEDIMENTARY ROCKS.

Figure III-23 Extreme peperite textures in metasedimentary rocks at the contact between the volcanic package and the Pontiac sediment (see also Fig. III-20).

STOP 9 - STRONGLY DEFORMED PILLOWS IN THE VOLCANIC PACKAGE NEAR THE CONTACT WITH THE PONTIAC METASEDIMENTARY ROCKS.

Figure III-24. Strongly deformed pillowed flows near the contact with the Pontiac metasedimentary rocks.

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STOP	UTM E	UTM N	BRIEF DESCRIPTION
STOP 1	0613114	5378709	Pillowed volcanic flows in the Deguisier Formation (Kinojevis Group). Locally, massive flows or sills.
STOP 2	0613069	5378070	Felsic tuff overturned and intercalated with a minor interval of banded iron formation. A narrow mafic sill at the contact might be an apophysis of a gabbroic sill subparallel to the felsic tuff unit.
STOP 3A	0621953	5366665	Pillow basalts showing the change in younging direction on the south side of the Baie Fabie Shear Zone.
STOP 3B	0621807	5366876	Exposures of the Baie Fabie fault & outcrops near the Fabie deposit in the Blake River Group.
STOP 4A	0644454	5347291	Panoramic view of the Noranda camp from Mt. Powell.
STOP 4B	0644514	5347252	Contacts between aphyric felsic dike, Powell granitoid, and a diorite.
STOP 4 C	0644611	5347388	Orogenic style quartz veining in the Powell granitoid.
STOP 5A	0645231	5347879	Well-defined younging indicators in a sequence of the Blake River Group including pillowed flows, felsic tuff breccia, mafic tuff and lapilli tuff. Bedding is folded and offset by faults.
STOP 5B	0645358	5347894	Felsic dike with sulfides along the contact margin, cross-cut locally by breccia composed of angular felsic clasts in a rusty sulfide-rich matrix.
STOP 5C	0645208	5347762	Blake River Group pillowed flows and bedded tuffs with discordant sulfide stringers utilizing earlier magmatic pathways - possible syn-volcanic faults?
STOP 6	0648987	5328042	Peperite textures in Pontiac metasedimentary rocks at the contact with mafic sills.

STOP 7	0648094	5327413	Deformed Pontiac metasedimentary rocks intruded by several generations of mafic dikes and sills.
STOP 8	0648142	5327324	Outcrop exposing strongly developed peperite textures in the near contact environment between the volcanic package and Pontiac metasedimentary rocks.
STOP 9	0648086	5327228	Strongly deformed pillows in the volcanic package near the contact with the Pontiac metasedimentary rocks.

Field Geology of Gold Occurrences in the Larder Lake – Skead Area

Authors: Sean Brace, Nadia St-Jean, Taus R.C. Jørgensen and Ross Sherlock

Excursion leader: Ross Sherlock

The Kerr Addison Mine in the 1950's

STOP	UTM E	UTM N	BRIEF DESCRIPTION
Meeting Point	605,100E	5,332,170N	Introduction at the Virginia Town Curling Club's "Green Carbonate" rock
STOP 1	605,500E	5,332,400N	Kerr Addison Mine to examine new drill core and trenches on the property.
STOP 2	605,372E	5,332,450N	Strongly deformed "green carbonate" and "flow" ore at the Cheminis deposit
STOP 3	598,340E	5,329,830N	The Fernland area showing conglomerates and cross bedded sandstones of the Hearst assemblage
STOP 4A	599,125E	5,316,560N	Composite syenitic stock with associated auriferous quartz veins emplaced within the Lincoln-Nipissing shear zone
STOP 4B	598,725E	5,316,963N	Basal unconformity of Hearst assemblage and ultramafic flows (Larder Lake assemblage)

Introduction

Metal Earth's Larder Lake Transect, Figures IV-1A & 1B, extends from the Ben Nevis volcanic complex in the north to the Skead pyroclastic rocks in the south, crossing the Cadillac-Larder Lake break. The transect is designed to address a number of long-standing geologic issues related to metal endowment, such as the nature of the Ben Nevis complex which is the stratigraphic equivalent to the Noranda complex, but lacking much of the base and precious metal endowment; the nature of the Cadillac-Larder Lake break and stratigraphic framework of the Larder Lake Grp. and relationship to gold mineralization; the stratigraphic and structural framework of Skead township, north of the Lincoln Nipissing shear zone and the relationship to gold mineralization.

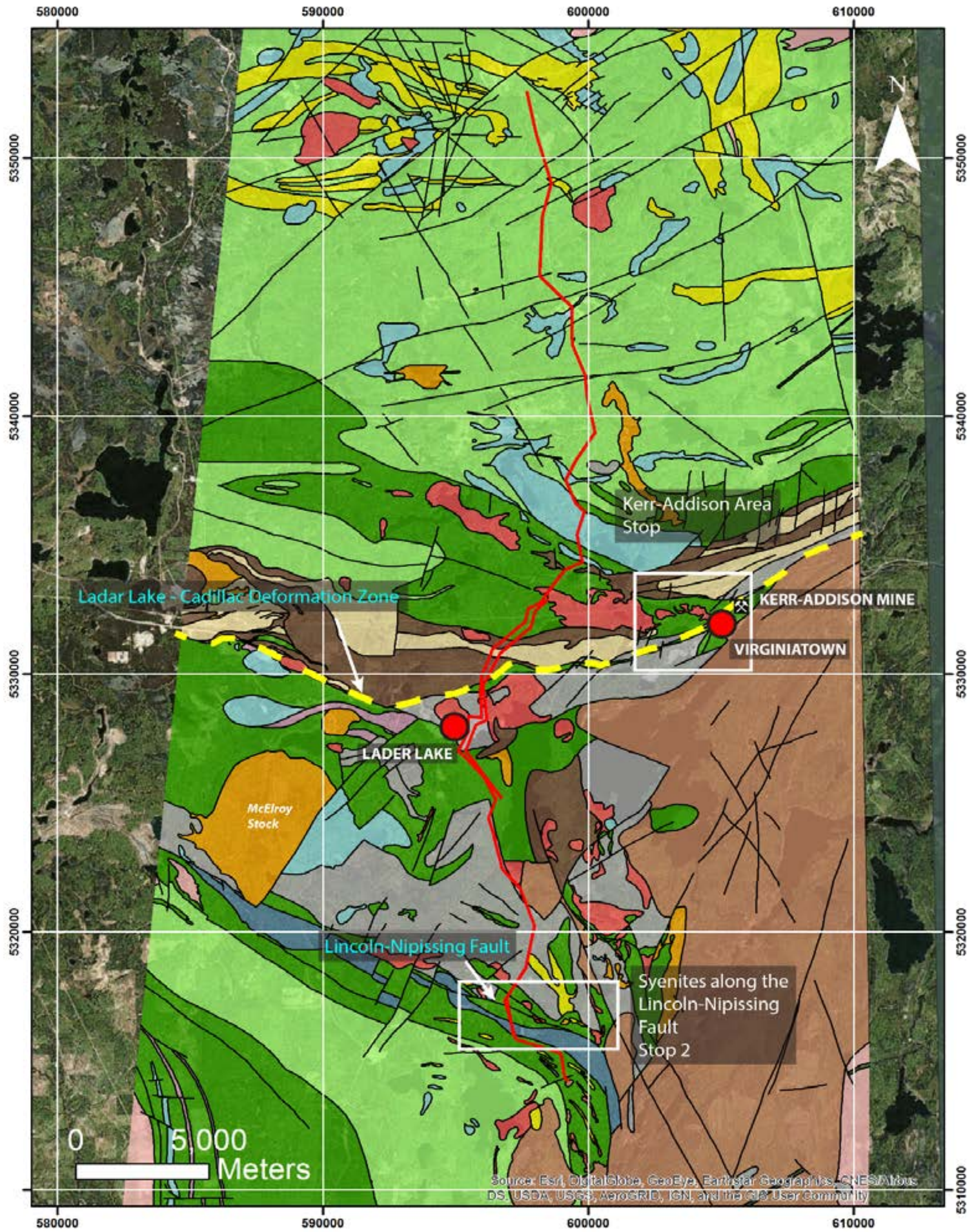

Fig. IV-1A: Regional geology along the Metal Earth Ben Nevis – Larder Lake transect. White boxes outline project areas along the transect, where more detailed mapping was conducted during the 2017 field season. Field trip stops are located in or near these areas.

Figure IV-1B. Field stops 1-3 with turnoff to Skead twp. In the town of Larder Lake

Field work in 2017 accomplished less than was originally anticipated. Much of the work completed was targeted mapping / core logging at Kerr-Addison to resolve stratigraphic and structural framework of the Larder Lake Grp. and the relationship to gold mineralization. Also field work focused on targeted mapping in Skead Township (stops 4A & B) around the Lincoln Nipissing fault zone and its relationship to gold mineralization.

Work in 2018 will continue to focus on the Kerr-Addison area and Skead township and will expand to include the northern part of the transect to Ben Nevis. Transect seismic and MT work will be conducted in fall of 2017 and will be available to help guide targeted mapping in 2018 and onwards.

The nomenclature used has been adopted from Ontario Geologic Survey including the use of assemblages, which are informal litho-tectonic terms used to describe a regionally mappable collection of units defined by lithic, structural, geochemical, geochronological and geophysical parameters. Assemblages are commonly fault bounded and they may, if sufficient data, permit be redefined to formal lithostratigraphic nomenclature such as Group."

Of note, this field trip guide also adopts the Ontario stratigraphic nomenclature, as such the Larder Lake Grp. is the equivalent of the Piché Grp. in Quebec.

Stop 1 Kerr-Addison (Figures IV-2 & 3)

Figure IV-2. Meeting place and location of Kerr –Addison, stop 1.

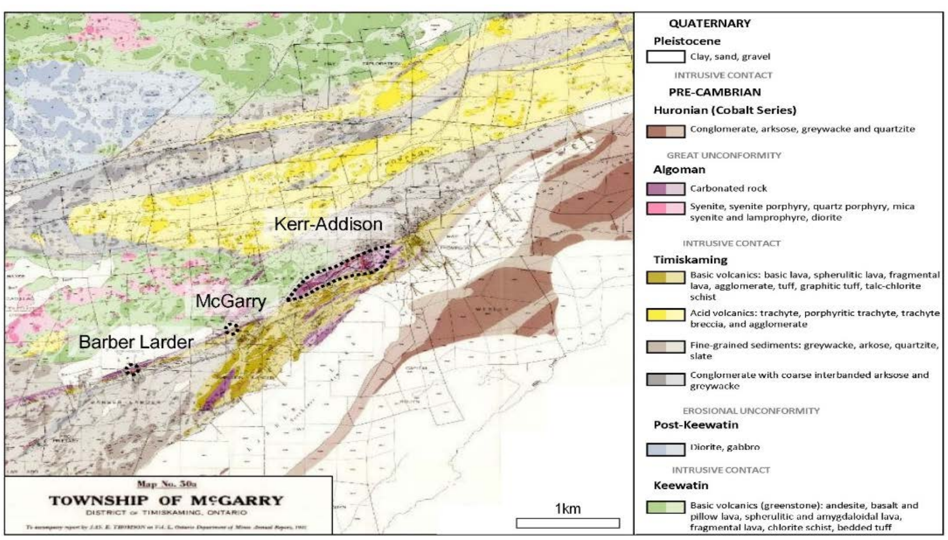

Figure IV-3. Geology of the McGarry Township (Thompson, 1941) showing the location of Kerr Addison

The Kerr-Addison mine was one of the largest gold producers in Canada, having produced 11 Moz of gold at an average grade of 9 g/t, between 1938 and 1996 (Figure 4). Gold was produced from “Green Carbonate Ore” which is an assemblage of fuchsite, magnesite, ankerite and quartz that resulted from the alteration of komatiitic volcanic rocks. Gold was also produced from “Flow Ore’ which is an assemblage of albite, quartz, and ankerite that resulted from the alteration of mafic volcanic rocks, particularly a flow breccia facies which has a fine black sediment matrix (Figure IV-6).

Figure IV-4. Aerial view of the Kerr-Addison mine site circa 1957 (looking east)

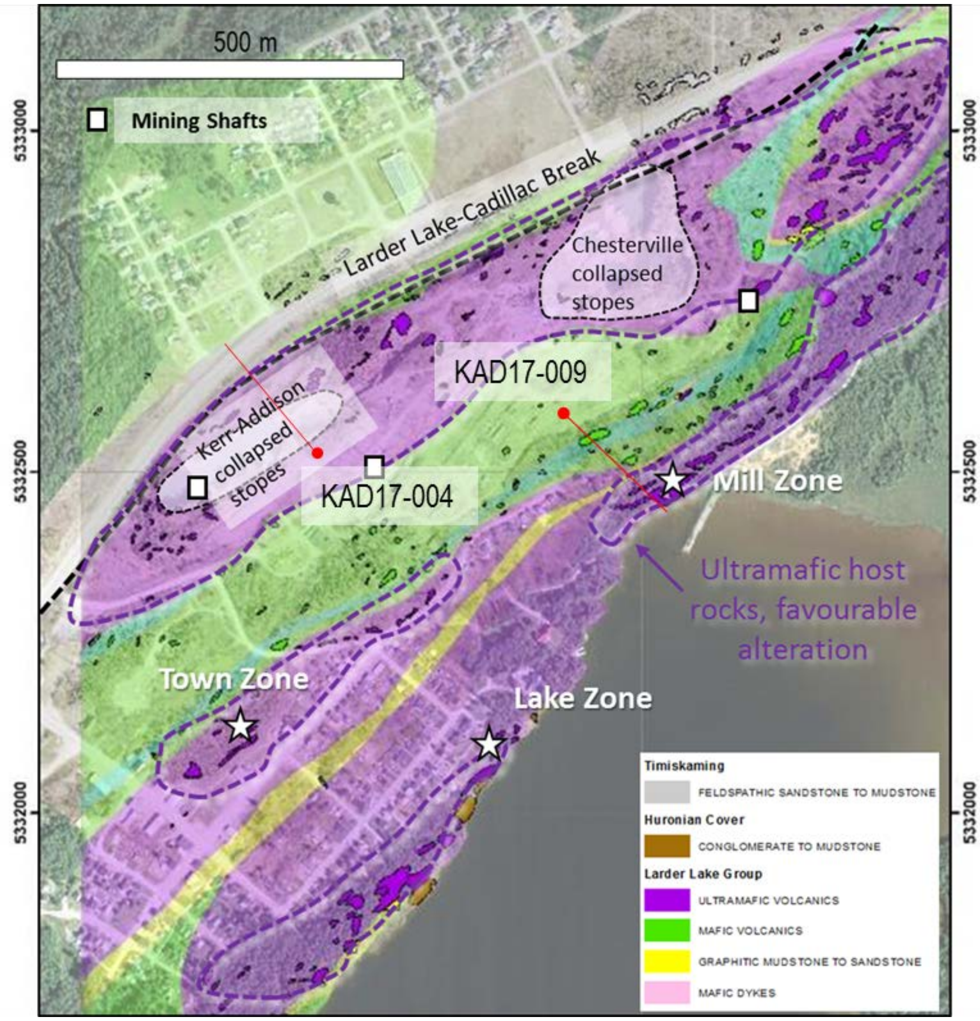

Figure IV-5. Surface geology of the Kerr-Addison deposit (Blackwell, 2015).

The Kerr-Addison deposit is hosted within the Larder Lake Grp. ca. 2705 Ma, a fault bounded panel of ultramafic and mafic volcanic rocks with minor sedimentary rocks. Immediately north of the Larder Lake Grp., are the Timiskaming, ca. 2685-2675 Ma sedimentary rocks, mainly marine facies (Figure IV-5). This contact defines the Cadillac-Larder Lake break. The Timiskaming sedimentary rocks are typically strongly deformed but often show a transitional contact between the ultramafic and sedimentary end-members which may reflect structural interleaving or potentially relict sedimentary intercalations (deformed unconformity). The Larder Lake Grp. at Kerr-Addison is unusually thick, at least 750m, the southern contact has not been recognized.

Work on the Kerr-Addison deposit has been conducted by Nadia St Jean, a MSc student within Metal Earth. Nadia will look to establish the structural / stratigraphic framework of the Larder Lake Grp. at Kerr-Addison and will place the mineralizing event within this context. Although the work will have a structural / stratigraphic focus, geochronology on dykes and interflow sedimentary rocks will help constrain the timing of the mineralization to help place the Larder Lake Grp., into a regional context.

The field trip will have the opportunity to examine new drill core and trenches courtesy of Gold Candle Ltd., a private exploration company exploring the Kerr-Addison deposit (Figures IV-6-8). Due to confidentiality, strip logs of the drill holes will be provided without any corresponding assays. One hole (KAD17-004) is from the central portion of Kerr-Addison and shows a wide interval of fuchsite altered komatiite with intercalations of mafic volcanic rocks. These rocks are representative of the Green Carbonate Ore; this hole terminates in the Timiskaming sedimentary rocks. A second drill hole KAD17-009 will be examined which was drilled south from the main Kerr-Addison deposit. This hole intersected intervals of mafic volcanic rocks, dominantly flow brecciated with sedimentary matrix and albitic alteration. This interval is representative of the “Flow Ore” at Kerr Addison. This hole also intersected ultramafic rocks with weaker fuchsite dominantly Mg-chlorite-ankerite-silica alteration, locally referred to as brown carbonate alteration and represents a more distal alteration assemblage of the ultramafic rocks, but is commonly auriferous.

Figure IV-6. Drill core from the Kerr-Addison deposit showing coarse visible gold in green carbonate ore.

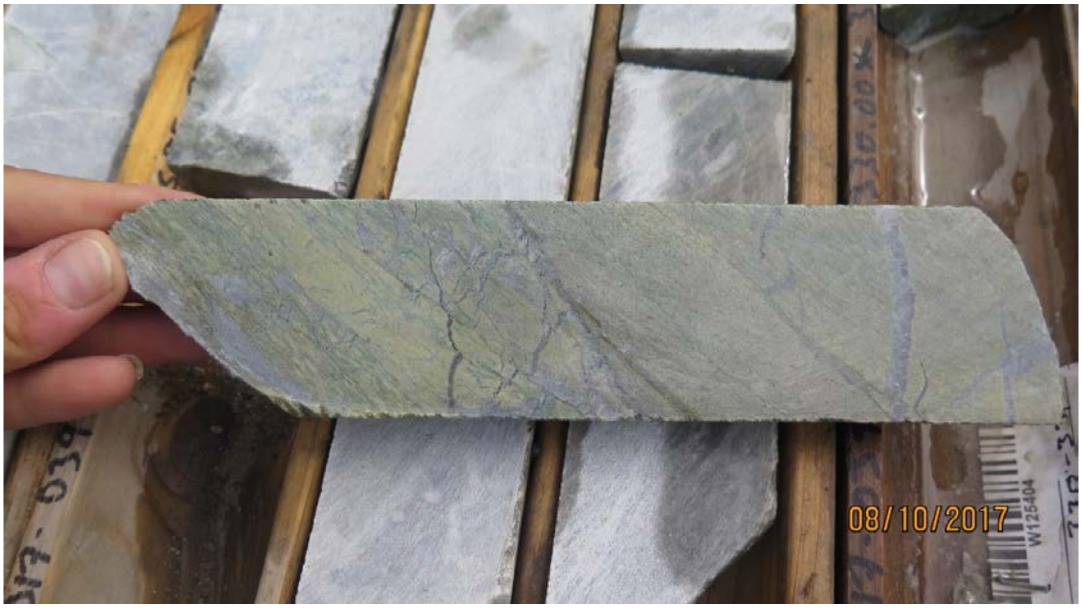

Figure IV-7. Drill core from the Kerr-Addison deposit showing albite altered mafic volcanic rock, representative of flow ore style mineralization.

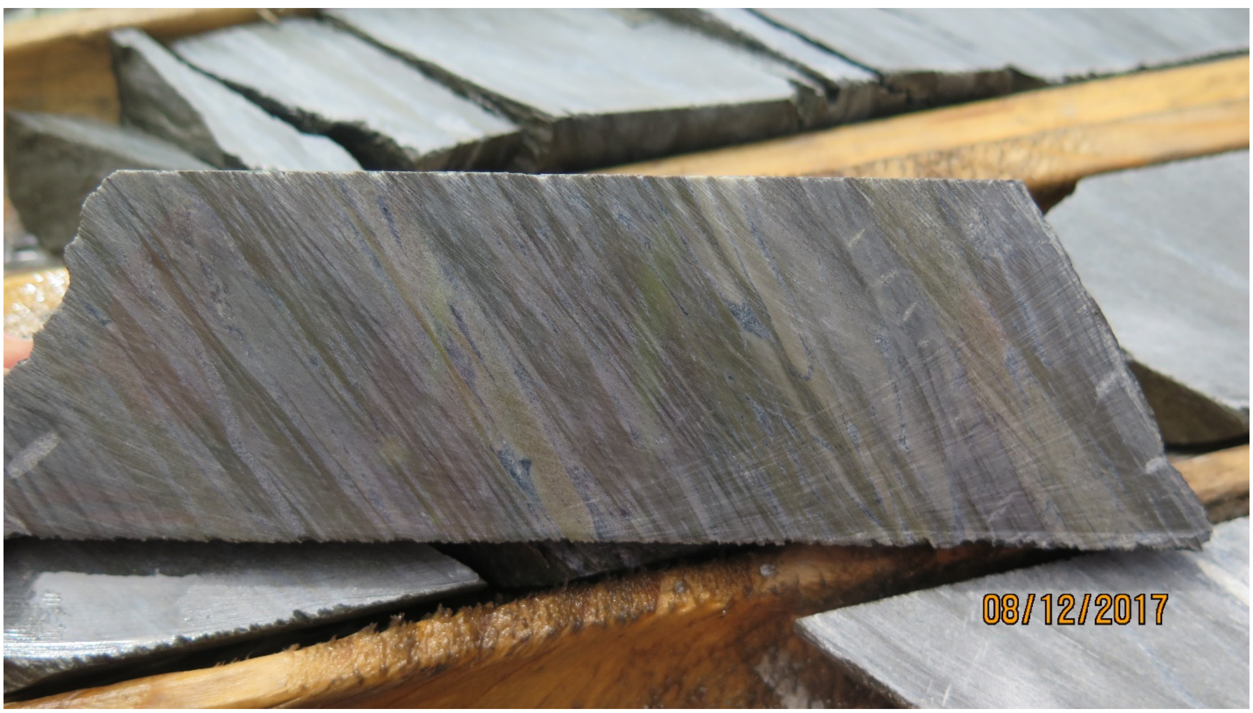

Figure IV-8. Drill core from the Kerr-Addison deposit showing the transition zone between Larder Lake Grp. and the Timiskaming sedimentary rocks

STOP 2 CHEMINIS MINE (FIGURES IV-9, 10 & 11)

The Cheminis deposit is located west of Kerr-Addison along the Cadillac-Larder Lake break. The geology is very similar to Kerr-Addison with the same overall structural and stratigraphic characteristics.

Cheminis was discovered in 1937 and had limited underground development in 1938 to 1940. The deposit has had a long history of surface and underground exploration through the 1970's to present day, although production has been minor with a total of 236,000 tonnes at an average grade of 3.57 g/t.

As with Kerr-Addison, the Cheminis deposit is hosted within the Larder Lake Grp. (Figures 10 & 11). The Larder Lake Grp. Is relatively narrow with a thickness of about 225m. To the north is a thin interval of Timiskaming sedimentary rocks followed by trachyte of Timiskaming age. To the south is a thick interval of Hearst assemblage (Timiskaming?) clastic sedimentary rocks, which are well exposed in the Fernland area (Stop 3).

Although no direct work is planned in the Cheminis area for Metal Earth, drill core through the southern contact with the Larder Lake Grp. and Timiskaming sedimentary rocks will be examined to compare with the relationships seen on the northern contact with Kerr-Addison.

This field trip stop will examine the surface expression of the C zone (Figure 12) which are deformed mafic volcanic rocks altered to an assemblage of albite, silica and ankerite representative of "flow ore" style of mineralization. To the south, in the structural footwall of the flow ore, is a panel of ultramafic volcanic rocks altered to an assemblage of fuchsite, magnesite, ankerite and quartz which is representative of "green carbonate ore".

Figure IV-9. Stops 2 and 3 at Cheminis and Fernland respectively

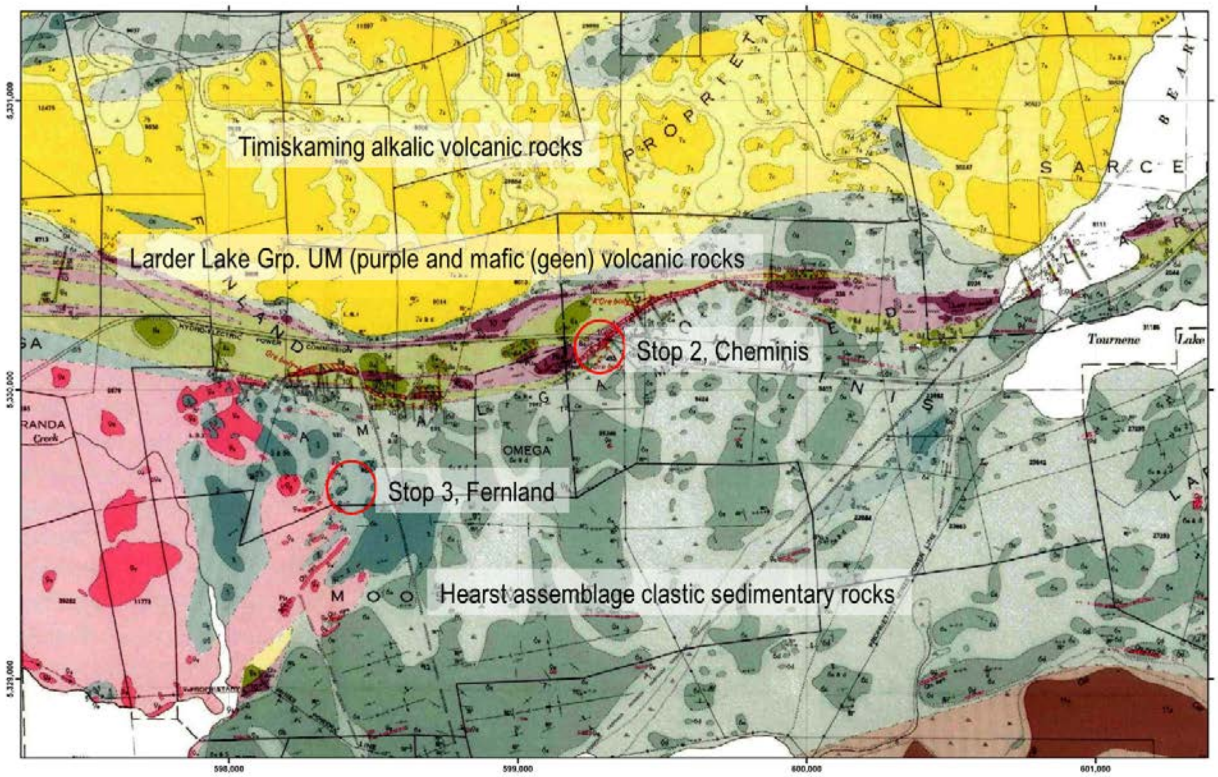

Figure IV-10. Geology of the Cadillac-Larder Lake break, showing the geologic setting of Cheminis and Fernland. Geology from Thompson, (1941).

Figure IV-11. Outcrop of "flow ore" at Cheminis

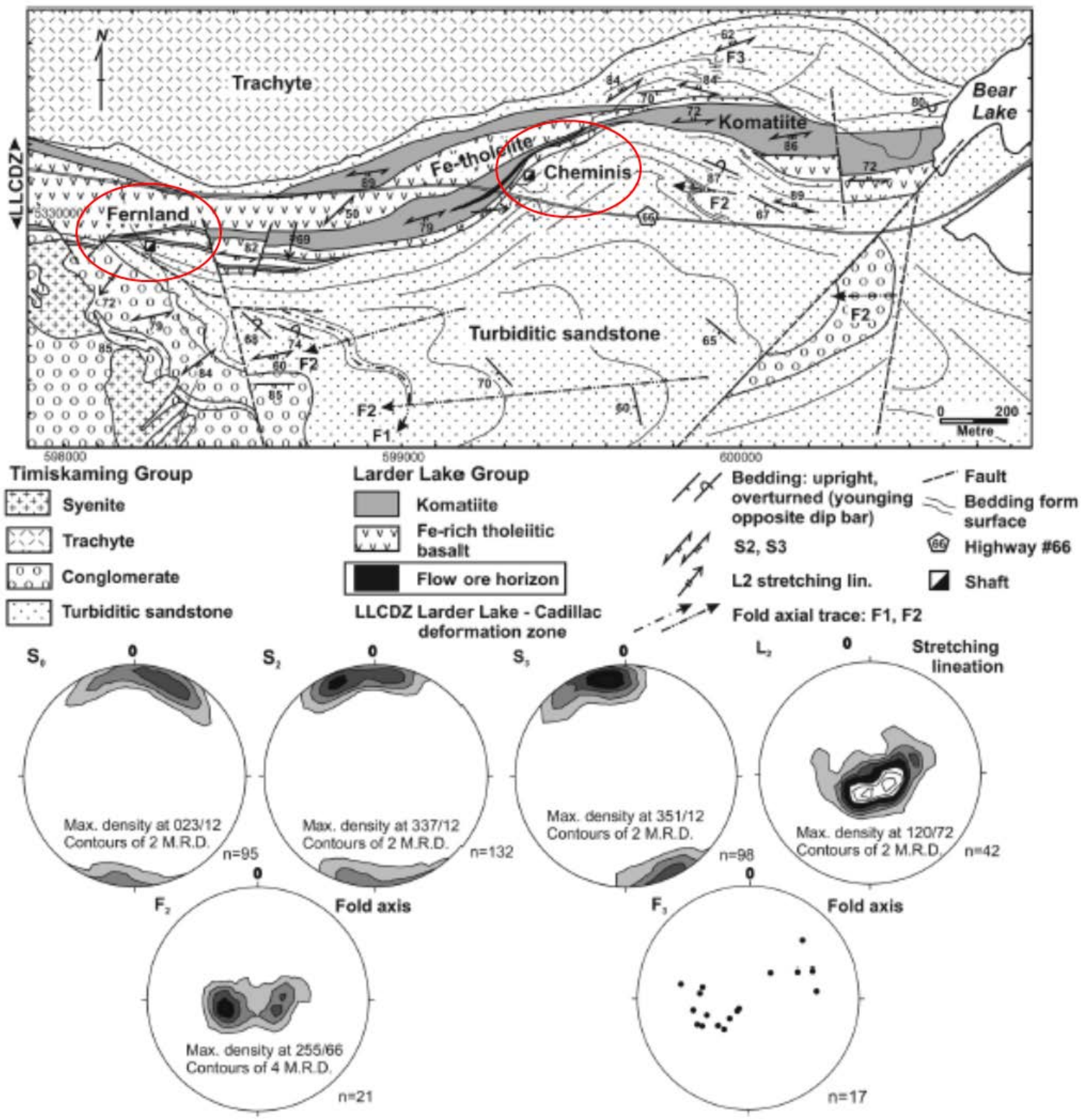

Figure IV-12. Geologic map of Cheminis – Fernland (Lafrance, 2015)

Stop 3 Fernland (Figures IV-10, 11 & 12)

Fernland was a small gold producer about 1 km west of Cheminis. The deposit is hosted in the Larder Lake Grp., with similar geologic features as Cheminis (Figures 10 & 11).

The field stop will examine the footwall sedimentary rocks, south of the Larder Lake Grp. Here these sedimentary rocks are considered to be the Hearst assemblage but are likely correlated with the Timiskaming formation. The field stop will examine flattened, clast supported conglomerates and cross bedded sandstone. In addition, this panel of sedimentary rocks south of the Larder Lake Grp., has intercalations of chert-magnetite iron formation.

As part of the Kerr-Addison project, Metal Earth will examine the southern contact of the Larder Lake Grp., with the Hearst assemblage to determine the original stratigraphic / structural relationship. Detrital geochronology from this package will also be attempted to correlate this part of the Hearst assemblage with Timiskaming sedimentary rocks or otherwise.

Stop 4A & B Skead Township

Work on Skead Township has been conducted by Sean Brace and Nadia St Jean, both MSc students within Metal Earth. Sean will conduct MSc research on the small volume syenitic intrusions which are emplaced into the Lincoln Nipissing shear zones. This work will include the petrochemistry of the intrusions and how the composite stocks form as well as their relationship to gold mineralization.

The geology of the Skead Township has been mapped by Hewitt (1949) and Jackson, (1994 & 1995; Figure IV-13). To the west and south in Catherine Township, the geology is well behaved and fairly straightforward. In Catherine Township, the southern-most assemblage is the Pacaud assemblage which consists of strained ultramafic to felsic rocks mainly metabasalts and gabbro. An intercalated intermediate volcanic unit has an age of ca. 2750Ma

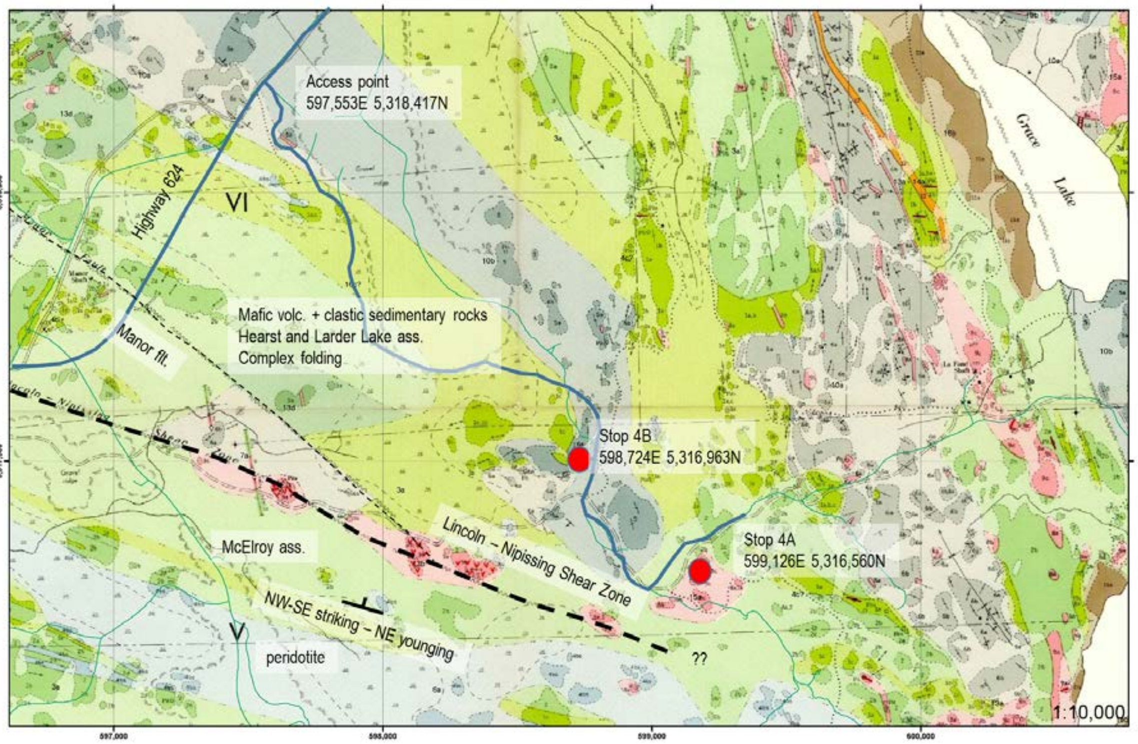

Figure IV-13. Geology of the Skead Township from Hewitt (1948) showing the route and locations of stopes 4A and 4B

To the northeast of the Paucaud is the Catherine assemblage a continuous northeast younging succession of mafic pillowed basalts and komatiitic volcanic rocks. These form the stratigraphic basement to the overlying Skead assemblage and have an age of ca. 2720Ma on a gabbro. The Skead assemblage is dominated by the Skead pyroclastic rocks, which consist of a felsic – intermediate massive to fragmental rocks. The age of the unit is ca. 2700Ma. Overlying the Skead is the McElroy assemblage a mafic to felsic succession of volcanic and intrusive rocks. This is undated but appears to be conformable with the underlying Skead assemblage and young to the northeast and contains a thick peridotite/komatiitic unit. The Lincoln Nipissing shear zone is cuts the peridotite and the overlying mafic volcanic strata.

North of the Lincoln Nipissing shear zone the geology changes in complexity with folded clastic sediments and mafic volcanic rocks. Intruded into these units are syenitic bodies of unknown association, possibly Timiskaming in age. Commonly these small volume intrusions are intruded into the Lincoln Nipissing shear. Locally the intrusions are cut by swarms of auriferous quartz carbonate veins and veinlets. The clastic sedimentary rocks are considered by Johnson (1993) to be Hearst assemblage and the mafic volcanic rocks to be Larder Lake assemblage.

Metal Earth has focused work on the succession of rocks north of the Lincoln Nipissing shear due to its complex geometries and uncertain correlations.

Stop 4A (Figures IV-14 & 15)

A composite intrusive body on the southeast portion of the Lincoln Nipissing shear. The intrusions range in composition from ultramafic to a fine grained leucocratic syenite. Previous exploration in the area has identified gold mineralization associated with the quartz veining, but potentially also associated with the fine grained pyrite within the intrusive rocks (Figures 15 &16)

Figure IV-14. Sketch geology map of the composite intrusion at stop 4A

Figure IV-15. Contact / transition zone between hornblendite and syenite

Figure IV-16. Leucosyenite with quartz veining.

Further work will examine the relationship of the intrusive bodies to gold mineralization and to the structural development of the Lincoln Nipissing shear zone. In addition, the intrusive stocks are composite varying in composition, and further work will examine the nature of this variation and collect geochronology samples to determine timing of the intrusions.

Stop 4B (Figures IV-13, 17 - 20)

Focused mapping in the sedimentary rocks has discovered a basal conglomerate between the Hearst and the Larder Lake assemblage. This is a low strain outcrop with lower komatiitic volcanic unit that contains polyhedral jointing and well developed spinifex. This progresses upward into a coarse conglomerate with cobbles of spinifex textured ultramafic volcanic rocks and boulders of granitoids of variable composition. This grades upwards over several meters into a polymict conglomerate (Figures 19 & 20).

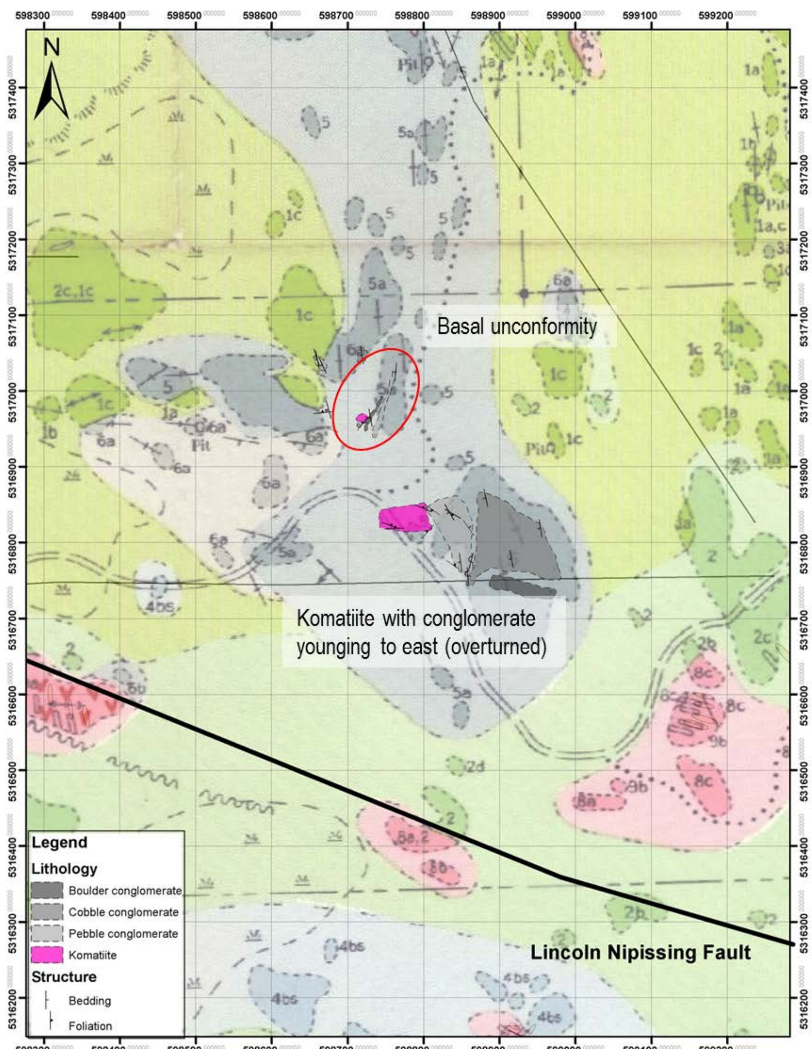

Figure IV-17. Geology after Hewitt 1948 with location of stop 4B

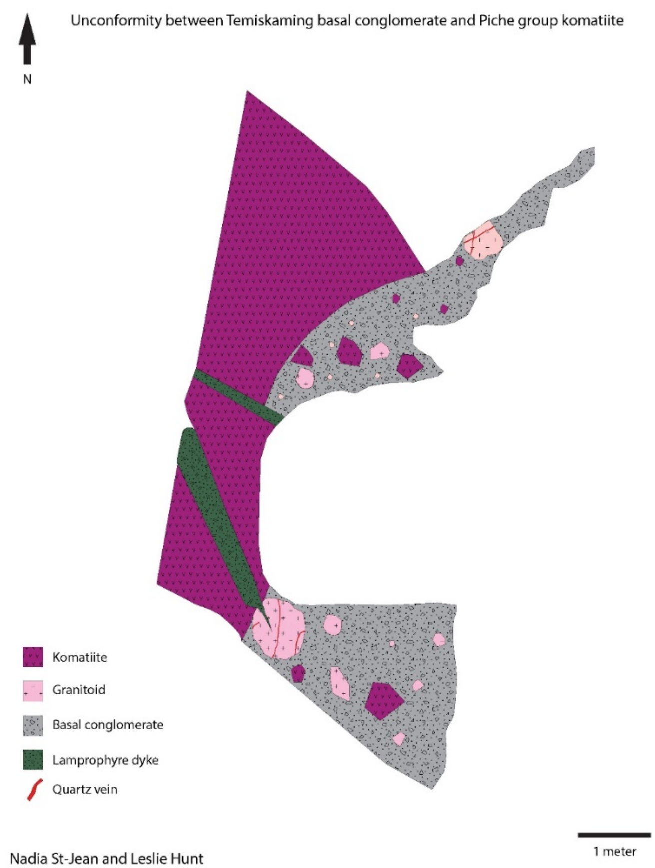

Figure IV-18. Sketch geology map of basal unconformity.

Figure IV-19. Photograph of unconformity.

Figure III-20. Spinifex bearing clast within the basal conglomerate.

This is a new occurrence and further work is planned to determine the regional context of this unconformity and to sample the sediments for detrital zircons to determine the maximum age of the unit and its regional correlation.

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The Swayze Greenstone Belt: Lithologies and stratigraphic relationships

Author: Rasmus Haugaard;

Excursion Leaders: Rasmus Haugaard, Tom Gemmell,

The pickup spot for the start of the Swayze trip is the front parking lot of Camp Gilla. The camp is situated about 1 km west of Highway 144 on the Sultan Industrial Road located approx. ½ way between Timmins and Sudbury. Turn west from the Watershed gas station, then turn left at the Camp Gilla/Surprise Chef sign and continue ½ km south.

Introduction

The Swayze greenstone belt (SGB) is located within the western Abitibi subprovince and its likely the westward extension of the Abitibi greenstone belt. Despite the geological map of SGB compiled by Heather (2002), there are still geological units that have compiled or interpreted with geophysical data. Establishing an overall stratigraphy in the SGB is important in a regional perspective when relating and comparing formations in the SGB with the rest of the Abitibi greenstone belt. In light of this, finding important sedimentary interface zones and depositional gaps between and within volcanic units, can help constrain the stratigraphy and the autochthonous evolution of the SGB. These zones and gaps are also crucial time markers for syngenetic mineralization and related hydrothermal activity. The geochronology of important volcanic and sedimentary units is poorly constrained relative to other parts of the Abitibi greenstone belt. There are, for example, large uncertainties in the depositional ages of the two successor basins - the Timiskaming-style conglomerate basin and the Porcupine greywacke basin. Is the Timiskaming basin in the SGB, which locally contains Au and Ag mineralization in relation to various porphyritic intrusions, coeval with the 2677-2670 Ma Timiskaming basins in Timmins, Kirkland Lake and Larder Lake area? O,r does the SGB Timiskaming assemblage only reflect the local source area and as such be dependent on lateral variations in the basin?

This field trip (see Fig. 1 for locations) will take us to the large NW-SE trending Timiskaming-style conglomerate in the Opeepeesway Lake area that is associated with Au and Ag mineralised porphyry intrusions; a newly discovered conglomerate further westward, that is possible an extension of the conglomerate in the Opeepeesway Lake area; a BIF that is an important marker horizon in the SGB, a volcanic breccia of Timiskaming age; a large flow of komatiite with well-developed pillows and hyaloclastites the stratigraphic position of which is unclear. As for the BIF, the komatiite is a very useful stratigraphic marker horizon in the SGB.

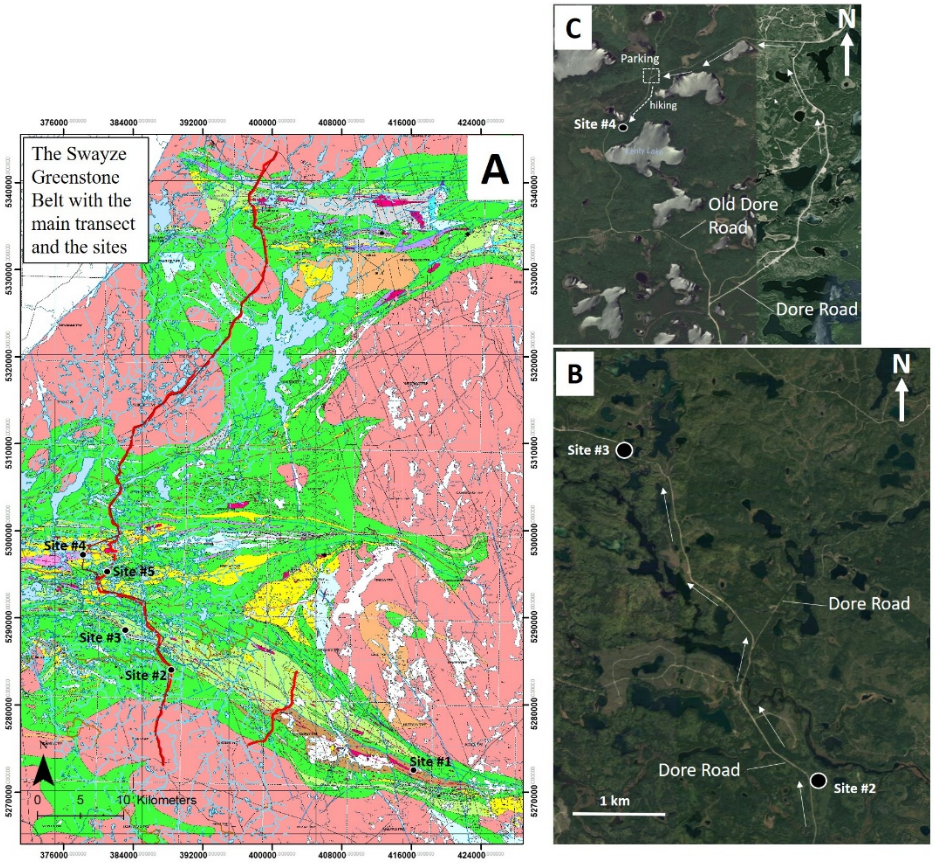

Fig.V- 1. A) The Swayze greenstone belt with the five sites shown. B) The logging roads showing the access to sites #2 and #3. C) The logging roads showing the access to sites #4 and #5.

SITE #1: NAMEX DEPOSIT – CONGLOMERATE AND PORPHYRY (UTM 416325 5272326)

The Namex deposit is located just off Yeo Road southeast of Huffman Township (Fig. 1A). Along the road towards the deposit the polymictic conglomerate is well-exposed on both sides of the road. The Namex outcrop is a 340 m x 140 m large stripping where a feldspar porphyry intruded the conglomerate (Fig. 2). The conglomerate varies in clast-to-matrix ratio and clast composition. In the western part of the stripping, the conglomerate contains strained clasts of tonalite, ultramafic, mafic and felsic volcanics, iron formation, gabbro and breccia. A new discovery this summer in the area has revealed cobbles of quartz breccia in the conglomerate. The conglomerate changes from clast supported to matrix supported towards North. Sedimentary truncation in an interbedded sandy bed indicates north-younging at this location. However, new field observations this summer reveal that only 5-800 m east of the Namex deposit, cross-bedded sandstone on top of the conglomerate shows a likely south-younging direction. The youngest zircon from the conglomerate from the Namex site yields a U-Pb age of 2680 ± 3 Ma (LA-ICP-MS) which is the maximum deposition age of the sediment at this location (Davies, 2016).

The mineralized zone is primarily found in the eastern part of the stripping in the contact zone of conglomerate-porphyry. Gold is hosted both in disseminated pyrite in the porphyry (≤1 ppm) and in multiple generations of quartz-ankerite-tetrahedrite veins (≤11 ppm). Silver is also present in these veins with values between 40-200 ppm (Hastie, 2017).

Fig. V-2: A ~2680 Ma porphyry cutting the foliation in the Timiskaming conglomerate close to the Namex deposit.

SITE #2: A MAFIC VOLCANIC – CONGLOMERATE UNCONFORMITY -UTM 388326 5284377

This summer has revealed a new conglomerate that is tentatively constrained to about 400 m x 600 m with very limited exposures. About 13 km up the Dore road (Figs. IV-1A, IV-1B), a presumable mafic volcanic rock is found in direct contact with the conglomerate (Fig IV-3). This is likely an erosional unconformity striking SE-NW. The conglomerate has a matrix of the same appearance as the mafic volcanic. If this is an erosional contact, the younging direction here is SW. The conglomerate contains granules, pebbles, cobbles and boulder sized clasts of jasper BIF, BIF breccia, tonalite, quartz veins, lapilli tuff, and mafic and felsic volcanic rocks. A sandy, clast-free bed was found within the conglomerate and the youngest zircon from this bed will be an important maximum depositional age determination to carry out.

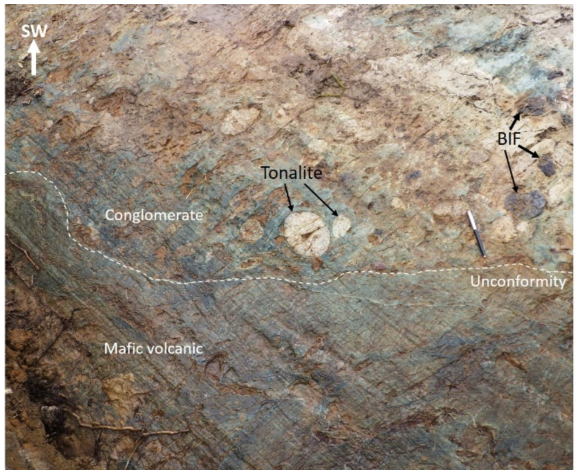

Fig. V-3. The Timiskaming-type conglomerate with various clasts in contact with a more coherent mafic rock. The contact may represent an erosional unconformity.

Questions to be answered here are: what unit does the mafic volcanic belong to? It could be the Trailbreaker Group, October Lake Fm (2705 Ma, equivalent to the Tisdale assemblage) or an even older volcanic unit; is the conglomerate the same in composition and depositional age as the Opeepeesway Fm conglomerate?

SITE #3: THE JASPER MOUNTAIN BIF -UTM 382255 5289496

The BIF is well-exposed on the Mortimer jasper property about 2 km up Dore Road from site #2 and 4-5 km west off the Dore road. It is ~20 m in thickness and can be traced ~80-100 m along strike (Fig. IV-4). It is composed of alternating micro- and meso-bands of jasper, chert and magnetite. Many small brittle thrust-faults are evident throughout. This BIF is an important marker horizon on the transect. It has been mapped by Heather (2002) as the Woman River Fm sitting on top of the Marion Group (2735-2725 Ma, equivalent to the Deloro assemblage) but no age date supports that. The Jasper BIF sits in direct contact with a lapilli-tuff unit and a sample of that unit on each side of the BIF has been collected for further geochronology work. As the deposition of BIF represents a period of non-volcanic activity, this represents an important gap in the volcanic stratigraphy increasing the potential for syngenetic mineralization as a consequence of the higher activity of hydrothermal fluids. This BIF can possible be correlated with other similar BIFs in Swayze and in the Abitibi greenstone belt helping constraining the overall stratigraphy in the Abitibi. Beside the lapilli-tuff, the adjacent volcanic rocks also contain tuff and tuff-breccia. The Jasper mountain BIF is furthermore interesting as it is the only preserved BIF in the area that could have delivered the BIF clasts to the conglomerate further south on the transect. The younging direction for the sequence is still uncertain pending thin section work.

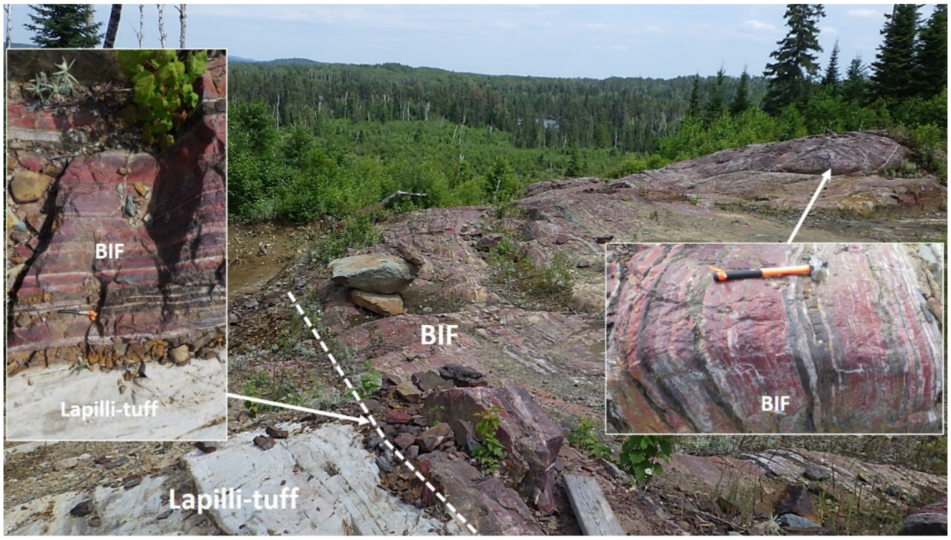

Fig. V-4: The Jasper BIF in sharp contact with volcanic tuff. Looking towards east.

SITE #4: MEGA-BRECCIA AT KENTY LAKE (378199 5297357)

The outcrop is along a side road to the old Dore road but we will enter the outcrop by going up Dore Road and turn left at UTM 381521 5298721. After 1.3 km we will park the trucks at a large area where the road splits into two roads (Fig. IV-1C). We will then walk approx. 1 km to the outcrop that appears on our left hand side. The outcrop represents an extraordinary breccia containing chaotically distributed fragments of up to 1 m in size (Fig. IV-5)! Some of these fragments have fabric developed that indicates deformation prior to rip-up and deposition. Whether this breccia is sedimentary or volcanic in origin is currently unknown. An age date of an adjacent volcaniclastic unit yield a Timiskaming age of 2670 ± 2 Ma (Ayer et., 2005). The breccia only consists of few types of fragments that could indicate a very local source. The unit is partly traceable for at least 1.5 km towards east-southeast.

Fig. V-5. The Timiskaming age breccia at Kenty Lake showing multiple sized fragments.

SITE #5: KOMATIITES (UTM 380951 5294995)

On the Dore road, black komatiites stand out as a 2-3 m high and 10 m wide exposure on each side of the road. They exhibit well-developed spinifex texture throughout with only minor alteration such as serpentinization (Fig. V-6). On the northern side, pillowed komatiitic basalts are recognized with a north-younging direction. Furthermore, hyaloclastites can be seen in the south end and indicate a submarine emplacement for these ultramafic volcanic flows. This is important because in other parts of the Metal Earth transect, it is still uncertain whether the komatiites are sills or part of the original stratigraphy (e.g., the komatiites within the Pontiac turbidite sediments in Noranda area). The komatiites here belong to the Swayze Group, Newton Fm (equivalent to the ca. 2700 Ma Blake River assemblage) and are here interpreted as being part of the stratigraphy. As for BIF, komatiites are very important stratigraphic markers and their emplacement history and depositional environment are crucial in understanding the stratigraphy in the Swayze belt and furthermore in the regional correlation in the Abitibi greenstone belt.

Fig. V-6 Komatiite with spinifex texture

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