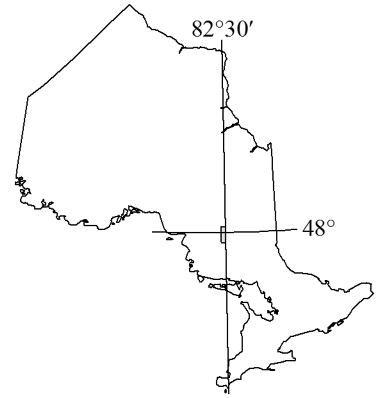
43. Lithological and Stratigraphic Relationships of the North Swayze and Matheson Areas, Abitibi Greenstone Belt



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INTRODUCTION

This work is part of the multi-year Metal Earth project carried out by MERC (Mineral Exploration Research Centre, Laurentian University, Sudbury) to refine the geological knowledge of the Abitibi greenstone belt (AGB). The project is designed to attempt to understand why some parts of the AGB have many mineral deposits, whereas other parts, such as the Swayze area, have fewer economic 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 performed along the transects, to provide an up-to-date base for interpretation of the geophysical surveys.

This article presents the preliminary results of Metal Earth 2018 transect research in the north Swayze area (Ayer et al. 2002; Figure 43.1). Despite the existing 1:50 000 scale mapping of the Swayze area (Ayer 1995; Heather 2001), there are still uncertainties concerning the geology of this area. Field observations during the 2017 mapping season show that the overall stratigraphy of the belt may be more complex than previously identified. A key question is whether the rocks in the Swayze greenstone belt represent a collage of unrelated metavolcanic fragments or are part of a continuous stratigraphy that can be correlated throughout not only the Swayze area but also the rest of the AGB, as proposed by Heather (2001). The Swayze area mapping and research project is partly designed to test this hypothesis, by carrying out more detailed mapping of important lithological contacts in the area and by collecting samples for geochronological analysis, to increase the number of U/Pb ages throughout the area.

From a geochronological point of view, not all spatially associated metavolcanic flows in the southern and northern Swayze areas seem to be genetically related, something that is crucial for exploration, because metal deposits formed during metavolcanic hiatuses (e.g., Thurston et al. 2008). The crystallization and depositional ages of important metavolcanic and metasedimentary units in the Swayze area are poorly constrained relative to other parts of the Abitibi greenstone belt. Refining the stratigraphy is crucial to revising the architecture of the Swayze area. For example, large uncertainties exist in the depositional ages and the nature of the 2 metasedimentary successor basins in the Swayze area—the Timiskaming-type conglomerate basin in the south and the presumably Porcupine-type greywacke-dominated basin in the north (Figure 43.1B). The field work this summer focussed on detailed work on the latter (Figure 43.1C) and complements the work done in the south Swayze area last year (Haugaard et al. 2017).

Summary of Field Work and Other Activities, 2018,
Ontario Geological Survey, Open File Report 6350, p.43-1 to 43-10.

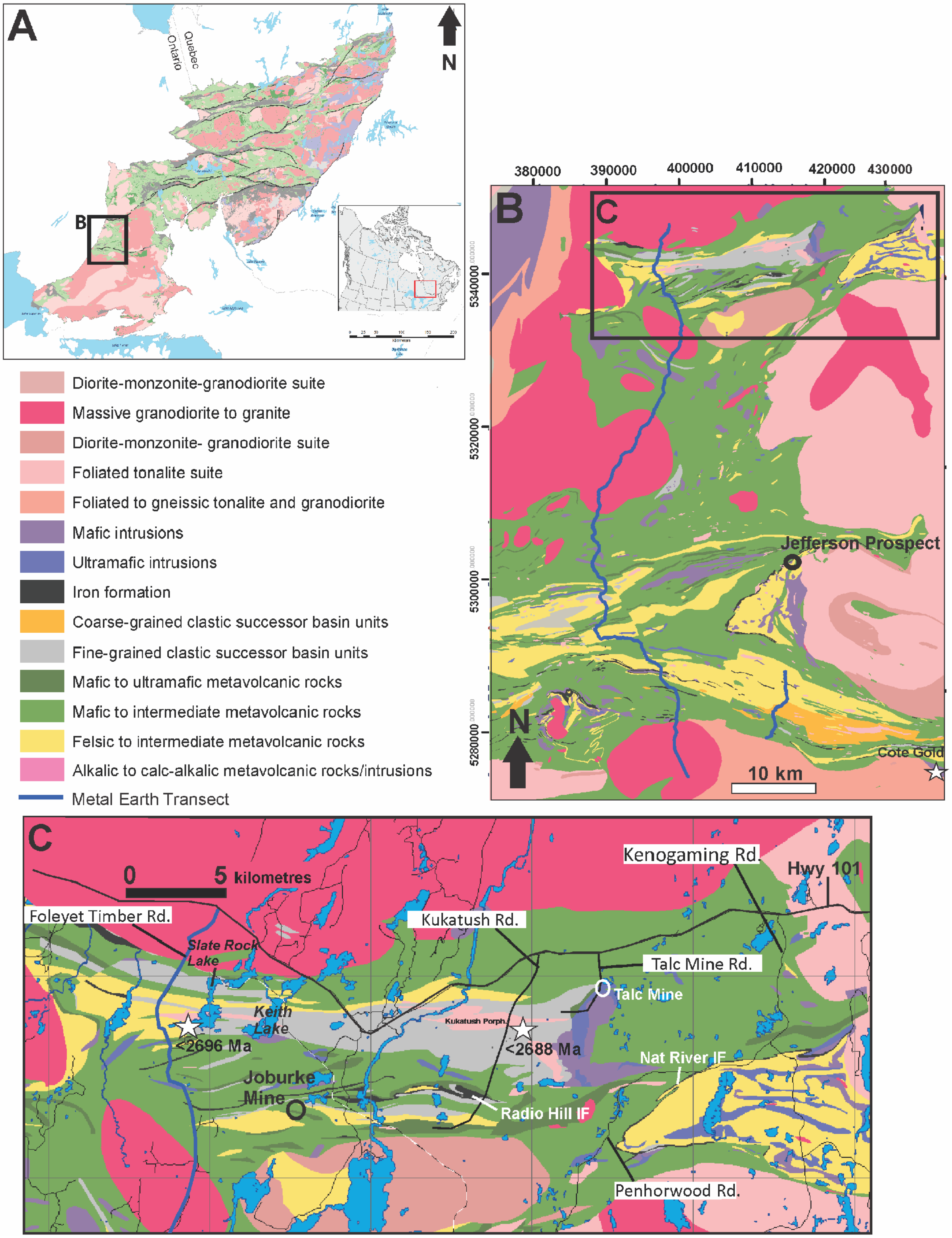

Figure 43.1. **A)** Location of the Swayze area within the Abitibi greenstone belt, and also showing the area in Figure 43.1B (thick black rectangle). **B)** General geology of the Swayze area, also showing the locations of the Metal Earth transect (thick blue line), the Côté Gold deposit (white star) and the Jefferson prospect (small black circle), and the location of the area shown in Figure 43.1C (thick black rectangle). **C)** General geology of the north Swayze area. Map *modified from* Montsion, Thurston and Ayer (2018). Abbreviation: IF, iron formation.

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, an MSc thesis project is part of this project; therefore, for the thesis, data were also collected on the Jefferson deposit (*see* Figure 43.1B) that is associated with the Woman River iron formation, which has an age of *circa* 2735 Ma. This summary describes some of the important rock units and their stratigraphic relationships observed during the Metal Earth 2018 mapping in the north Swayze area.

Preliminary field work was also carried out in the Matheson area, along the Metal Earth Matheson transect. A brief summary of this work is presented at the end of this report, along with a map showing locations of the important areas studied.

REGIONAL GEOLOGY

The Swayze area is bounded to the north, east and south by granitoid complexes and to the west by the Kapuskasing Structural Zone (*see* Figure 43.1B). The Swayze greenstone belt consists of overall east-trending ultramafic to felsic metavolcanic and metasedimentary assemblages that have been intruded by volumetrically significant mafic to felsic intrusive rocks (*see* Figure 43.1B). The area has undergone regional greenschist-grade metamorphism (Ayer et al. 2002). The stratigraphy of the supracrustal rocks in the Swayze area broadly correlates with that in the rest of the AGB. The following nomenclature was defined by Thurston et al. (2008) (the equivalent AGB nomenclature is included in brackets): 2750–2735 Ma Chester group (Pacaud assemblage); 2735–2724 Ma Marion Group (Deloro assemblage); 2710–2704 Ma Trailbreaker Group (Tisdale assemblage); 2704–2695 Ma Swayze Group (Blake River assemblage); and the *circa* 2680–2670 Ma Ridout Group (Timiskaming assemblage). The steeply dipping, east-trending metasedimentary basin in the northern Swayze area is bounded to the south and north by rocks that are likely part of the Kidd–Munro assemblage, with mafic metavolcanic rocks to the south, and mafic and felsic metavolcanic rocks to the north (*see* Figure 43.1B). The metasedimentary rocks are cut by various ultramafic, mafic and felsic intrusive units (*see* Figure 43.1B).

The Swayze area has been seen historically as an area with less mineral endowment relative to other parts of the Abitibi greenstone belt. However, recent development by IAMGOLD Corporation at the Côté Gold deposit (*see* Figure 43.1B), which has an indicated resource of 8.65 million ounces of gold (Katz et al. 2017), is proof that the Swayze area has the potential for discovery of still more exploration targets. The Côté Gold deposit is associated with the Chester tonalite–diorite (~2740 Ma; *see* Figure 43.1B), and the nature of the mineralization suggests a porphyry-style origin (Katz et al. 2017). Other gold and silver mineral occurrences are evident within the large northwest-trending Timiskaming-type conglomerate unit in the southern Swayze area. These smaller deposits are associated with younger (*circa* 2680 Ma) porphyry intrusions. In the north Swayze area, gold mineralization is related to deformation zones in the Horwood Lake area (e.g., the Joburke Mine; Harding 1938), and to quartz veins associated with the Kukatush porphyry (Pope 2014; *see* Figure 43.1C). Gold production at the Joburke Mine totalled 180 000 tons grading 0.105 ounces of gold per ton from 1973–1975, and further exploration by Noranda Exploration Company Limited resulted in the production of 292 000 tons grading 0.106 ounces of gold per ton from 1979–1981 (*see* Ayer 1994, and references therein). The gold was recovered from the main ductile deformation zone, in areas that showed pervasive iron carbonate alteration and quartz veining. The deposit is mainly located in a sequence of mafic metavolcanic rocks, minor felsic metavolcanic rocks and intercalated argillaceous sedimentary rocks (Ayer 1994; *see* Figure 43.1C).

GEOLOGY OF THE 2018 STUDY AREA

Porcupine- and Timiskaming-type Clastic Metasedimentary Rocks

The metasedimentary basin in the north Swayze area extends from west of the Foleyet Timber Road to the Talc Mine in the east—a strike length of almost 25 km (*see* Figure 43.1C). To date, only 2 samples from within this basin have had detrital zircon analyses: a sample from the Slate Rock assemblage in the southwest part of the basin, collected by van Breemen, Heather and Ayer (2006; *see* Figure 43.1C) gave a maximum depositional age of 2696 Ma; and a sample from the metasedimentary rocks in the eastern part of the basin, south of the Kukatush porphyry, collected by Bleeker et al. (2015), was analyzed for detrital zircon and provided a maximum depositional age of 2688±2 Ma (U/Pb age of youngest zircon among 13 zircons analyzed by thermal ionization mass spectrometry (TIMS)). The metasedimentary rocks had been initially investigated by Bleeker and co-authors in 2014, and their early investigation led them to conclude that the conglomerate in this area was polymictic in nature and showed similarities in lithofacies to the Timiskaming conglomerate around Timmins. The authors suggested that the metasedimentary units south of the Kukatush porphyry were synorogenic in origin, and were deposited in an active tectonic environment (Bleeker, Atkinson and Stalker 2014). However, despite the low statistical number of zircons, the detrital zircon study on these metasedimentary rocks, by Bleeker et al. (2015), suggest that the conglomerate belongs to the Porcupine assemblage.

The lithofacies of the metasedimentary rocks in the north Swayze basin comprise clast-supported polymictic conglomerate interbedded with sandstone and pebbly sandstone (Photos 43.1A to 43.1D). Mudstone and siltstone to finer grained sandstone beds are seen mostly in the western part of this basin (Photos 43.1E and 43.1F). Clast types in the conglomerate range from granite, gabbro, quartz vein and black chert to talc-altered ultramafic clasts (*see* Photo 43.1C) and fuchsite (*see* Photo 43.1D). Unlike the metasedimentary basin in the south Swayze area, no clasts of banded iron formation (BIF) were observed, despite the presence of extensive BIF units within older metavolcanic units south of the basin (*see* Figure 43.1C). The decimetre-scale beds of sandstone appear massive, with no metasedimentary structures preserved (*see* Photo 43.1A). When comparing these lithofacies with the Timiskaming assemblage in the southern part of the Swayze area (*see* Haugaard et al. 2017), the metasedimentary rocks in the north Swayze basin contain a higher proportion of the mudstone-siltstone-greywacke facies (*see* Photos 43.1E and 43.1F) and they lack the larger size boulders (>30 cm) that are a feature of the basin in the south. This could indicate a slightly different environment of deposition for the north basin than a typical continental fluvial environment, perhaps one with more of a marine influence, such as a distal part of a prograding river delta into the marine environment. An important point to note is that the appearance of the conglomerate in the north basin remains relatively similar from west to east (*see* Photos 43.1A and 43.1B); however, the proportion of finer grained mudstone and siltstone facies is higher in the western part of the basin, particularly on Slate Rock Lake and Keith Lake (*see* Figure 43.1C).

Other Metasedimentary Rocks

A 3 m thick sequence of metasedimentary rocks within deformed pillowed mafic metavolcanic rocks is exposed north of the northern contact between mafic metavolcanic rocks and the north Swayze metasedimentary basin (*see* Figure 43.1C; Photo 43.2A). The sedimentary rocks display thin oxide-facies BIF horizons, with sulphidic exhalative beds grading into mudstone, siltstone and fine-grained greywacke beds. This metasedimentary unit likely represents interflow sediment, because pillowed mafic metavolcanic rocks are found on both sides of it. The mafic metavolcanic rocks north of the basin are likely of Kidd–Munro age (2719–2710 Ma), hence are likely older than the rocks of the north Swayze basin. Distinctive alteration features are seen in the pillows that reflect a change from typical metabasalt to bleached and intensely silicified pillows north and south of the metasedimentary unit (*see* Photo 43.2A). The strain and deformation are moderate to high. Interflow sediments such as these could be an important marker horizon for syngenetic base metal mineralization in the area, because they may represent a long gap between periods of volcanic activity (Thurston et al. 2008), which is when this type of mineralization is most commonly deposited.

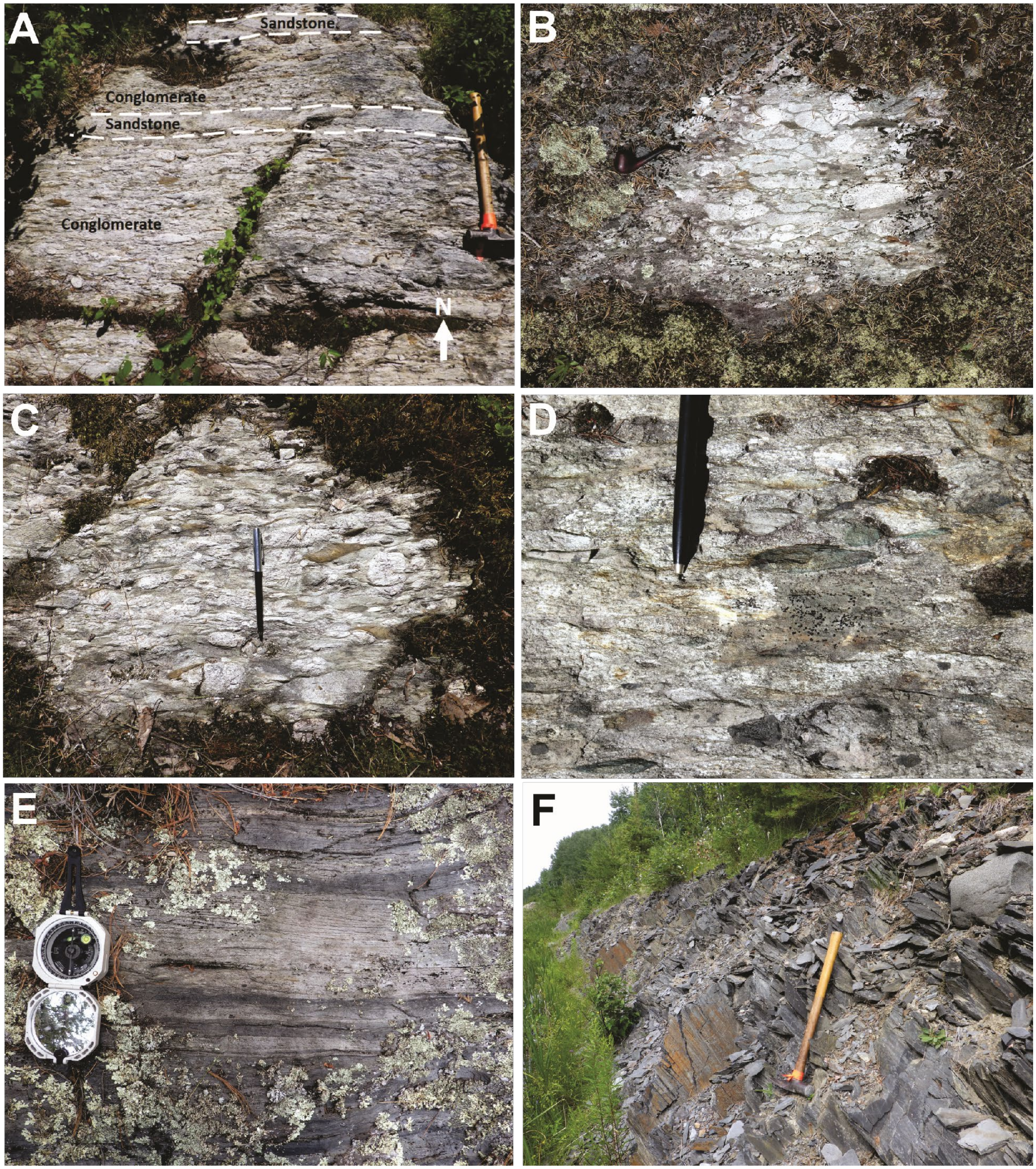

Photo 43.1. **A**) The Penhorwood sedimentary sequence exposed in Penhorwood Township, south of the Kukatush porphyry, showing conglomerate beds interbedded with decimetre-scale sandstone beds. **B**) An exposure of the conglomerate common in the western part of the basin. **C**) Exposure of conglomerate with talc-altered ultramafic clasts, in Penhorwood Township. **D**) A closer view of the conglomerate in Photo 43.1C, showing the fuchsitic quartz clasts. **E**) Mudstone interbedded with fine-grained sandstone from the western part of the basin, at Slate Rock Lake. The sedimentary features in this rock indicate a likely marine environment of deposition. **F**) Siltstone interbedded with fine-grained greywacke from along Highway 101, looking toward the west.

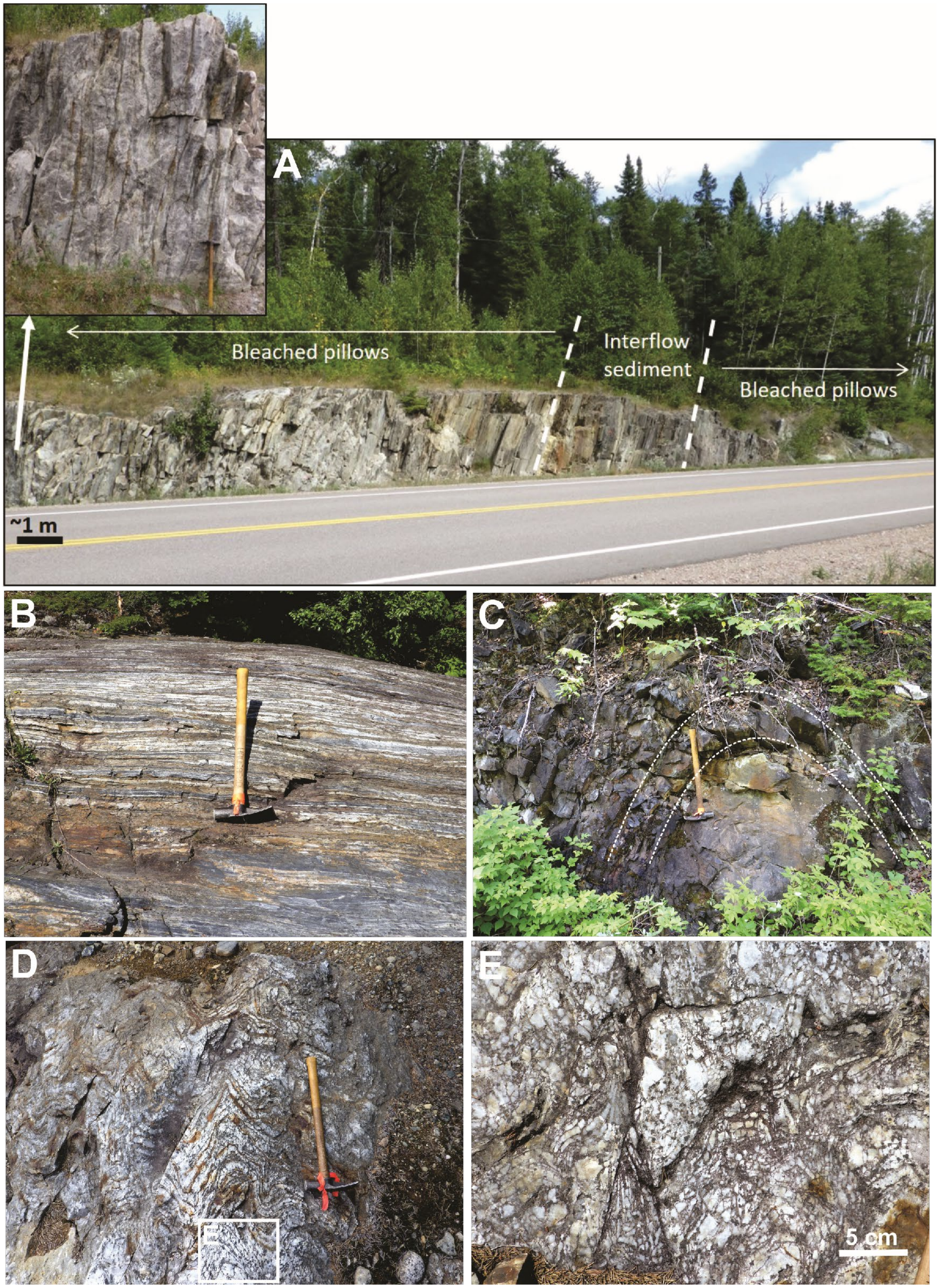

Photo 43.2. **A**) A 3 m wide sequence of metasedimentary rocks that likely represent interflow sediment between 2 pillowed mafic volcanic flows, from a roadcut along Highway 101, looking eastward. (Inset in upper left shows a closer view of the interflow sediments.) **B**) Exposure of the Nat River iron formation showing the well-developed banding typical of this unit. **C**) Isoclinal folding in the Radio Hill iron formation, looking westward. **D**) Tight folding in the chert unit within the Nat River iron formation (area shown in Photo 43.2E is outlined in white). **E**) Close-up view of the chert brecciation within the Nat River iron formation.

Porphyritic Intrusions

Situated in the central part of the north metasedimentary basin, the Kukatush porphyry represents one of the largest felsic porphyry intrusions in the area, with an east–west strike of almost 5 km and a north-to-south width of up to 1 km. The quartz-feldspar porphyry sits within the metasedimentary basin (*see* Figure 43.1C) and likely intrudes the sedimentary rocks, although no contacts were observed. The porphyry is in large part homogeneous and unaltered, but locally it is bleached and sheared, with sericite-ankerite alteration and quartz (±tourmaline) veins. The age of the porphyry is currently unknown, but geochronology analyses will be carried out on samples collected this summer. This work is important, as it will provide a minimum age of deposition for the metasedimentary basin. In addition, the age of a large east-trending porphyry intruding the metasedimentary rocks farther west, in the area of Keith Lake and Slate Rock Lake, will also be determined, to help constrain the timing of formation of the basin.

Banded Iron Formation

Numerous occurrences of banded iron formation (BIF) are found south and southeast of the northern metasedimentary basin (*see* Figure 43.1C). As the deposition of BIF represents a long period without volcanic activity, these units represent important gaps and marker horizons in the volcanic stratigraphy (Thurston et al. 2008). These BIF units may be correlated with similar BIF units elsewhere in the Abitibi greenstone belt (e.g., the Woman River iron formation farther south), thus providing marker horizons to help constrain the overall stratigraphy in the Swayze area. The most extensive horizon of BIF is the Nat River iron formation(Photo 43.2B). The outcrops of this unit show isoclinally folded magnetite-oxide, sulphide-facies BIF in contact with intermediate to felsic metavolcanic rocks of the Deloro assemblage to the south, and sheared ultramafic to mafic rocks to the north. The BIF has been cut by several porphyry and lamprophyre dikes. The ultramafic and mafic metavolcanic rocks just north of the Nat River iron formation lie within the Deerfoot deformation zone, and are locally intensely sheared and altered. Quartz veins and gold mineralization are also locally present. Multiple and complex structural patterns, with tightly isoclinal folding (Photos 43.2C and 43.2D) and chert brecciation (Photo 43.2E), are observed within this iron formation. The sulphide mineralization ranges from massive pyrite and pyrrhotite to millimetre-scale pyrrhotite veins that crosscut the banding in the iron formation. This mineralization also occurs in the underlying Deloro assemblage metavolcanic rocks.

PRELIMINARY WORK IN THE MATHESON AREA

As part of the 2018 Metal Earth transect mapping and research, important outcrops and diamond-drill core were examined from the Matheson area of the AGB during the month of August (Figure 43.2). The purpose was to gather more information on the timing of formation and mineralization of the extensive metasedimentary and intrusive rocks in the area (*see* Figure 43.2). More specifically, the work was carried out to strengthen the geological knowledge of the stratigraphy in the area, to better interpret the seismic and magnetotelluric surveys being conducted along the Metal Earth transect in the Matheson area (*see* Figure 43.2). Importantly, the seismic transect in the Matheson area is located 14 km east of the Shillington high-resolution seismic reflection line obtained during the Discover Abitibi Initiative (Snyder et al. 2008; *see* Figure 43.2). The surveys along the Metal Earth transect will be imaging key crustal structures, such as the Porcupine–Destor deformation zone, extending the geological architecture of the area farther east (*see* Figure 43.2). This will contribute to establishing new targets for exploration for gold and base metals.

The supracrustal rocks along the Matheson transect are composed of at least 5 rock assemblages (Berger 2002; Ayer et al. 2005): Kidd–Munro (2719–2710 Ma), Tisdale (2710–2704 Ma), Lower Blake River (2704–2701 Ma), Porcupine (2690–2685 Ma) and Timiskaming (2676–2670 Ma). The former 3 are dominantly metavolcanic and the latter 2 are dominantly metasedimentary. Broadly coeval with the Timiskaming assemblage are various alkalic intrusive and extrusive rocks (Berger 2002).

Large portions of the Matheson transect area are covered by overburden; therefore, the Metal Earth research work focussed on supplementing limited outcrop mapping and sampling with logging and sampling of diamond-drill core from the various exploration companies working in the area. Figure 43.2 shows the areas that were focussed on during this study. The majority of the work in the Matheson transect area will be concentrated on determining the geochemical and geochronological characteristics of the rocks in the area. The timing of deposition and the provenance of the metasedimentary rocks will be

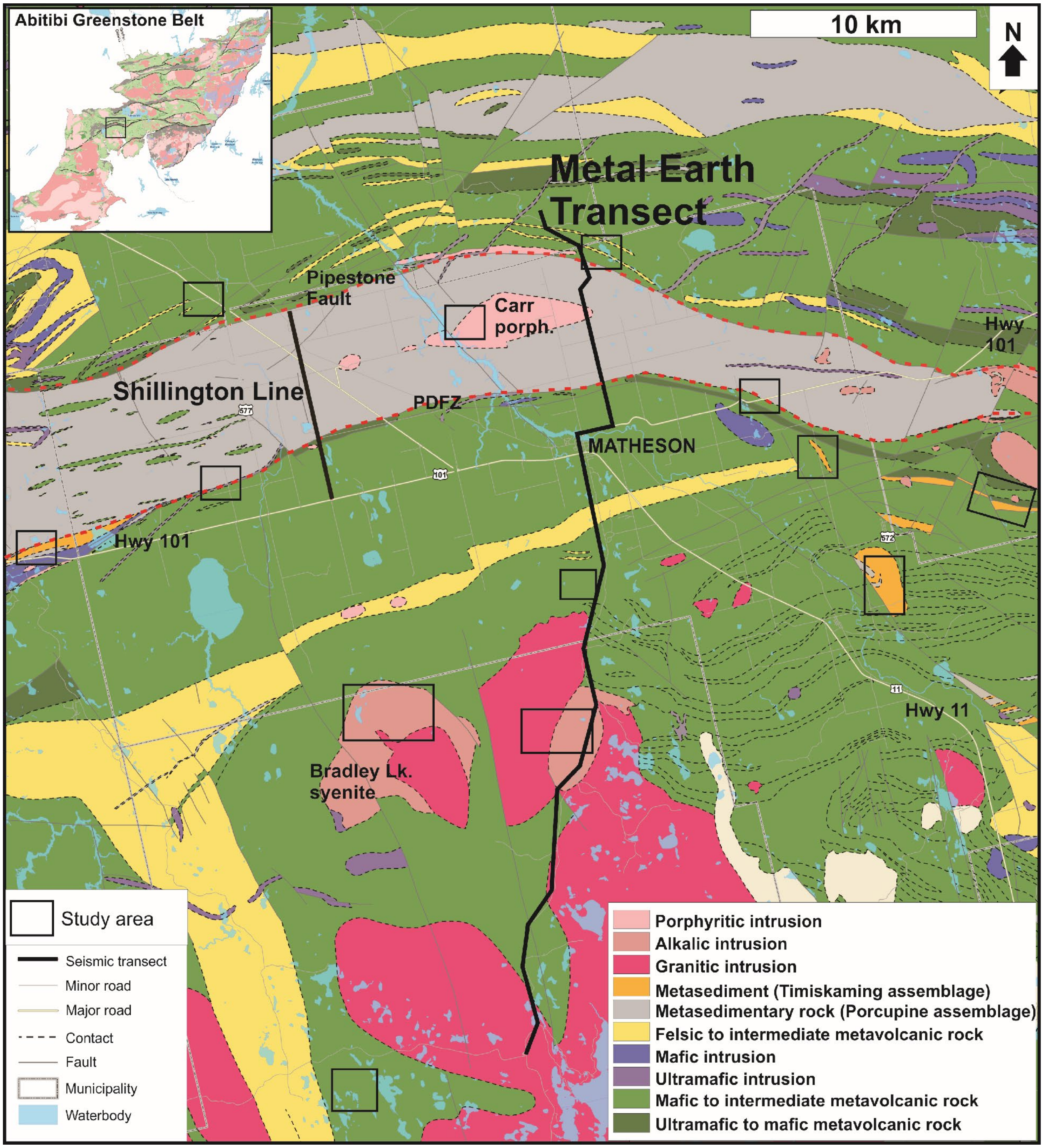

Figure 43.2. General geology of the Matheson area, and the location of the Metal Earth Matheson transect (thick black line). The key areas of study during the 2018 summer field work are also shown. Abbreviation: Lk, Lake; PDFZ, Porcupine–Destor fault zone; porph, porphyry. Map *modified from* Montsion, Thurston and Ayer (2018).

determined by U/Pb isotope analysis on detrital zircons using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). The age of emplacement of intrusive bodies, including the Bradley Lake syenite and the Carr porphyry, will be determined by U/Pb analysis on magmatic zircons using isotope dilution thermal ionization mass spectrometry (ID-TIMS). Establishing the timing of intrusions will also help establish a minimum age of deposition for the Porcupine metasedimentary basin, and a maximum age of deposition for orogenic gold mineralization.

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