Reconnaissance mapping of the geology and mineral deposits of the Powell block, Rouyn-Noranda area, Quebec

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INTRODUCTION

The Powell block, named by De Rosen-Spence in 1976, is located in the Rouyn-Noranda gold and base-metal district, where it extends from the Beauchastel fault to the north, to the Horne Creek fault to the south, forming a wedge-shaped fault block approximately 18 km long by 2–10 km wide. The most recent mapping of the Powell block was conducted by H.R. Morris in 1957, following earlier mapping work done by M.E Wilson in 1941. De Rosen-Spence (1976) and Lichtblau and Dimroth (1980) conducted further work in the 1970s and 1980s. Since then, there have been numerous conflicting interpretations regarding the nature of major geological features, specifically synvolcanic versus syntectonic faults. The Powell block is considered to be a key to understanding the nature of these faults and the structural-stratigraphic architecture of the Rouyn-Noranda district. It lies along the geophysical and geological transect of the Metal Earth project (transect line shown in green in Figure 1) and, as such, plays an essential role in promoting a better understanding of the geology of the transect. During the 2017 field season, a reconnaissance study of the Powell block was done and detailed mapping at a scale of 1:2000 was completed of the Mount Powell area and volcanic successions to the northeast of Mount Powell. Current map extent is shown in Figure 1, as well as the approximate boundaries of the entire area to be covered in subsequent field seasons.

REGIONAL GEOLOGY

The Noranda volcanic complex (NVC) comprises volcanic units of the Blake River group, a succession of transitional tholeiitic and calcalkaline submarine volcanic rocks, which are intruded by several generations of plutons, dykes and sills (Goldie, 1976). The Blake River group is bounded by two major subparallel faults, the Porcupine–Destor fault to the north and the Cadillac–Larder Lake fault to the south (Gunning, 1937; Gunning and Ambrose, 1939). These major structural features coincide with intense carbonate alteration and orogenic-style Au mineralization (Knight, 1924). The Flavrian and Powell plutons, which intruded into the Blake River group, have been interpreted as sill-like subvolcanic intrusions, genetically related to the overlying volcanic succession that hosts the volcanogenic massive sulphide (VMS) deposits (Goldie, 1976). The volcanic units range from basalt–andesite to rhyolite and form an ancient shield volcano. The NVC is subdivided into several structural blocks separated by major crosscutting regional faults (Hunter Creek, Beauchastel and Horne Creek), by major changes in strike of stratigraphy and by the age of the volcanic rocks within individual blocks.

The Rouyn–Noranda district hosts 22 base-metal massive sulphide deposits and 17 gold deposits within an area of approximately 962 km^2 (Gibson and Watkinson, 1990). The most significant deposits are the Quemont deposit, which produced 13.8 Mt of ore grading 1.32% Cu, 2.44% Zn, 5.5 g/t Au and 31 g/t Ag, and the Horne deposit, which produced 54.3 Mt of ore grading 2.2% Cu, 6.1 g/t Au and 13 g/t

Ag. Both deposits are separated from the northern part of the district by the Beauchastel fault and the Horne Creek fault, respectively (Kerr and Gibson, 1993; Setterfield et al., 1995). There have been several attempts to correlate VMS deposits from the central mine sequence across the Beauchastel fault and Horne Creek fault to the Horne mine, resulting in numerous different interpretations and, as such, considerable uncertainty remains as to the nature of these structural blocks and the way in which they tie into the mineralization history of the area.

DETAILED GEOLOGY

The Powell block contains the Powell pluton, which is interpreted as a faulted portion of the Flavrian pluton. Both plutons consist of trondhjemite, tonalite, granodiorite and diorite. Recent work by McNicoll et al. (2014) suggests an age of 2700.1 +/-1.0 Ma for the trondhjemite phase of the Powell pluton and an age of approximately 2700.8 +/-1.0 Ma for the trondhjemite phase of the Flavrian pluton. The Powell pluton, dips about 60° to the northeast and intrudes into the overlying older volcanic rocks of the Blake River group, which range in age from 2704 to 2695 Ma (McNicoll et al., 2014).

Intrusions in the map area include the fine- to medium-grained Powell tonalite and quartz diorite, the glomeroporphyritic gabbro, and fine-grained, hypabyssal composite dykes and felsic 'rhyolite' feeder dykes (Figure 2a–e). The volcanic rocks, in which these intrusions are emplaced, comprise the Blake River group, which in the map area includes the lowermost Brownlee rhyolite formation (variably flow banded and lobed), overlain by the Powell formation, which consists of amygdaloidal andesite, pillowed flows, mafic tuffs and lapilli tuffs, and felsic quartz-phyric tuff breccia (Figure 2f–h). Various younging indicators, typically indicating top to the east or northeast, are present including well-defined cusps on pillows (Figure 2f), graded bedding, crossbedding, and ball-and-pillow structures (Figure 2g).

The hypabyssal felsic Héré Creek dykes, previously mapped as 'rhyolite dikes' (Morris, 1957), strike northeast and crosscut strata, which in the area predominantly strike northwest and dip approximately 60–70° to the northeast (Figure 3). They are feeder dykes to the overlying Héré Creek rhyolite (Figure 1). These early dykes now host Au-poor, Cu-vein mineralization localized along their margins (Figure 2d). In addition, an unusual type of spotted alteration, similar to the dalmationite alteration observed at the Amulet deposit, is visible in close proximity to these dykes (Figure 2c). These spots are locally elongate, defining a near-vertical stretching lineation, particularly in highly altered and less-competent rocks, for instance the highly chloritized mafic margins of the composite dykes (Figure 2c). Also interesting to note, is a change in the composition of volcanic strata from mafic to felsic south and north, respectively, of a felsic dyke at the Powell D-zone (Figure 3). This indicates that the volcanic stratigraphy was offset along the lineament represented by the felsic dyke, supporting the notion that the dyke represents a synvolcanic fault.

Along with its two bounding faults, the Beauchastel fault to the north and the Horne Creek fault to the south, the Powell block includes several internal faults and shear zones. All rocks within the Powell block experienced lower greenschist-facies metamorphism, and are variably altered and deformed. The most prominent structure is the Héré Creek syncline, which represents a late tectonic fold in the central part of the block that is likely post-Timiskaming in age. It has an east–west-striking (~080–090°) axial plane cleavage that becomes more intense along the Powell fault in the northern portion of the map area. Three styles of mineralization are present (Figure 1): Au-quartz veins (Powell, Sillidor, New Marlon, Anglo-Rouyn), VMS deposits (world–class, Au-rich Quemont lens) and Au-poor Cu-rich veins (Powell, B, D and F zones; Joliet(?) and Anglo A(?) deposits). Their relative timing is uncertain but will be determined in the course of this project.

The work during this past field season and that to be undertaken in subsequent field seasons, will attempt to resolve the detailed stratigraphy and deformation history of the Powell block, using basic principles of stratigraphic superposition and crosscutting relationships, supplemented by U-Pb geochronology of key units. Resolution of the age of the diorite phase of the Powell intrusive complex and that of the hypabyssal felsic dykes, which are ubiquitous in the mapping area and are presumed to be representative of early synvolcanic faults analogous to the McDougall–Despina fault set (Setterfield et al., 1995), should prove of particular interest. Additional units to be dated include the glomerophyric gabbro, the Brownlee rhyolite, which as the oldest volcanic unit in the Powell block could provide a lower age limit for the volcanic sequence, and a composite hypabyssal dyke, which crosscuts the diorite phase of the Powell pluton and is subsequently overprinted by its tonalitic phase.

FUTURE WORK

The overall goal of this project is to document the three main styles of mineral deposits in the area and determine how and when they formed during the structural and stratigraphic evolution of the Powell block. This will require documentation of the igneous history of the area, using a combination of mapping, geochemistry and geochronology along with a structural-chronological analysis. During the fall and winter (2017–2018), petrography and whole-rock geochemistry will be done on all units, as well as U-Pb geochronology on key units as described above. Morris's 1957 maps will be digitized and compiled into a spatially georeferenced map. This map will be used to target key outcrops for more detailed and focused mapping at the 1:500 scale in the summer of 2018. Samples will be collected for an alteration study and will be used as reference standards for a more comprehensive study using a portable X-ray fluorescence field instrument, which will help in rapidly identifying geochemical variation among key lithological units.

A structural-chronological study of folds, foliation, shear zones and faults (e.g., the Beauchastel, Powell and Horne Creek faults, and the Héré Creek, Powell and Quemont folds) will also be done, with an emphasis on the timing of these structures with respect to the volcanic and mineralization history of the Powell block.

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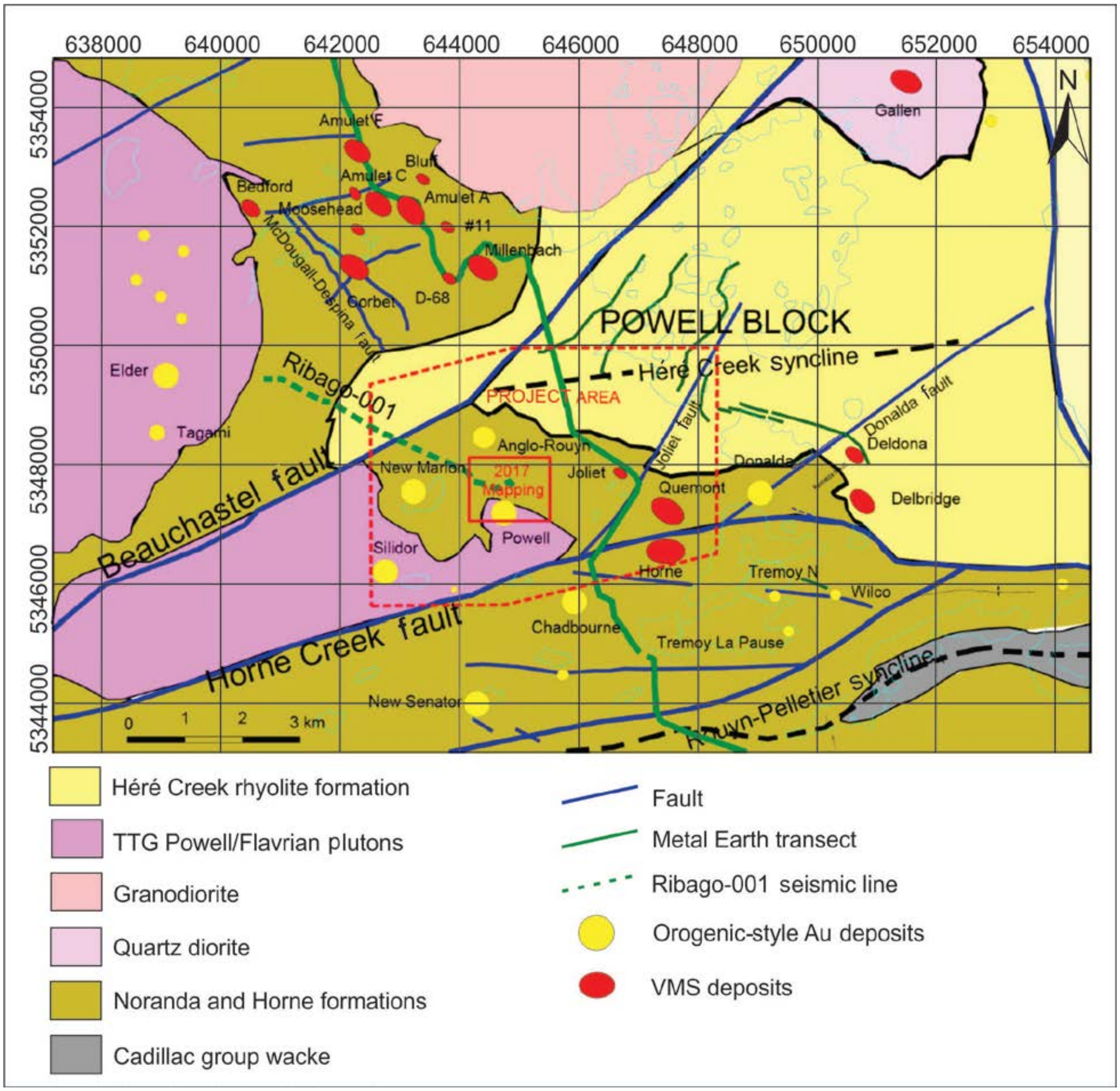

Figure 1. Geology of the Noranda volcanic complex (modified from De Rosen-Spence, 1976), showing the Powell block with the map area of the 2017 field season (box outlined in red), as well as the maximum extent of the map area to be covered over subsequent field seasons (box outlined by red dashed line). Flavrian and Powell plutons (pink), major faults (blue lines), VMS deposits (red ovals) and gold deposits (yellow circles) are also highlighted. Volcanic rocks are shown in shades of yellow: older volcanic rocks of the Noranda and Horne formations (dark yellow), Héré Creek formation and younger rocks (light yellow). The Metal Earth Rouyn–Noranda transect is shown in green and the private sector Ribago-001 seismic transect, by a green dashed line. Abbreviations: TTG, tonalite, trondhjemite, granodiorite; VMS, volcanogenic massive sulphide.

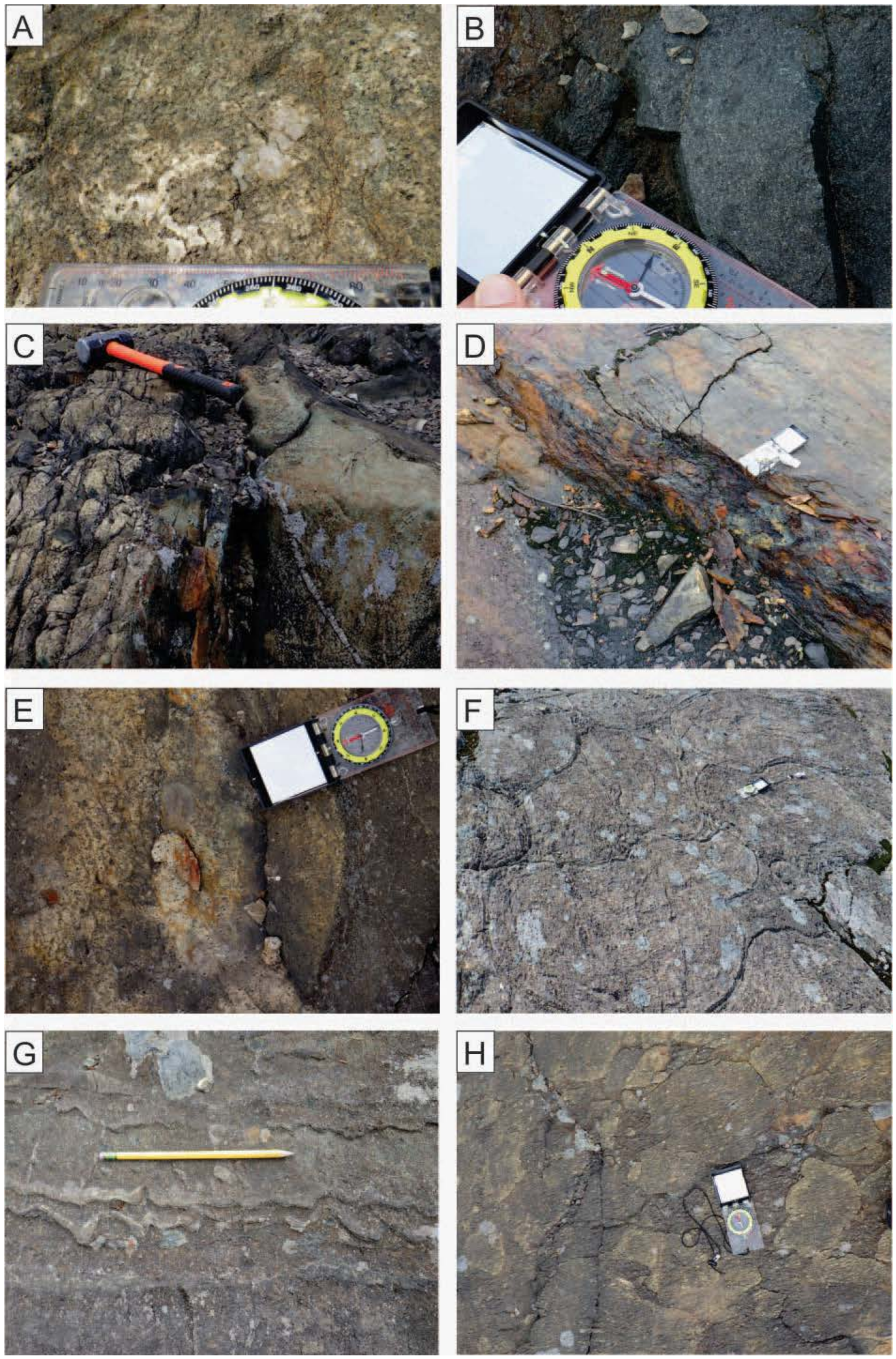

Figure 2. Field photographs from the Rouyn-Noranda study area, showing **a)** Powell block tonalite, with miarolitic cavities; **b)** quartz diorite with euhedral plagioclase laths; **c)** composite dyke, with felsic core and mafic margin (sulphide minerals are present along the mafic margin and alteration spots are elongate parallel to a stretching lineation); **d)** felsic feeder dyke, with Cu-veining along contact margin between dyke and andesite; **e)** Brownlee rhyolite with vesicles and glass shards concentrated near the top of flow bands; **f)** pillows with well-defined cusps, defining an eastward younging direction; **g)** ball-and-pillow sedimentary structures in mafic tuff, defining an eastward younging direction; **h)** proximal quartz-phyric tuff breccia, showing angular, closely packed, jigsaw-fit clasts. Compass (10 cm) for scale.

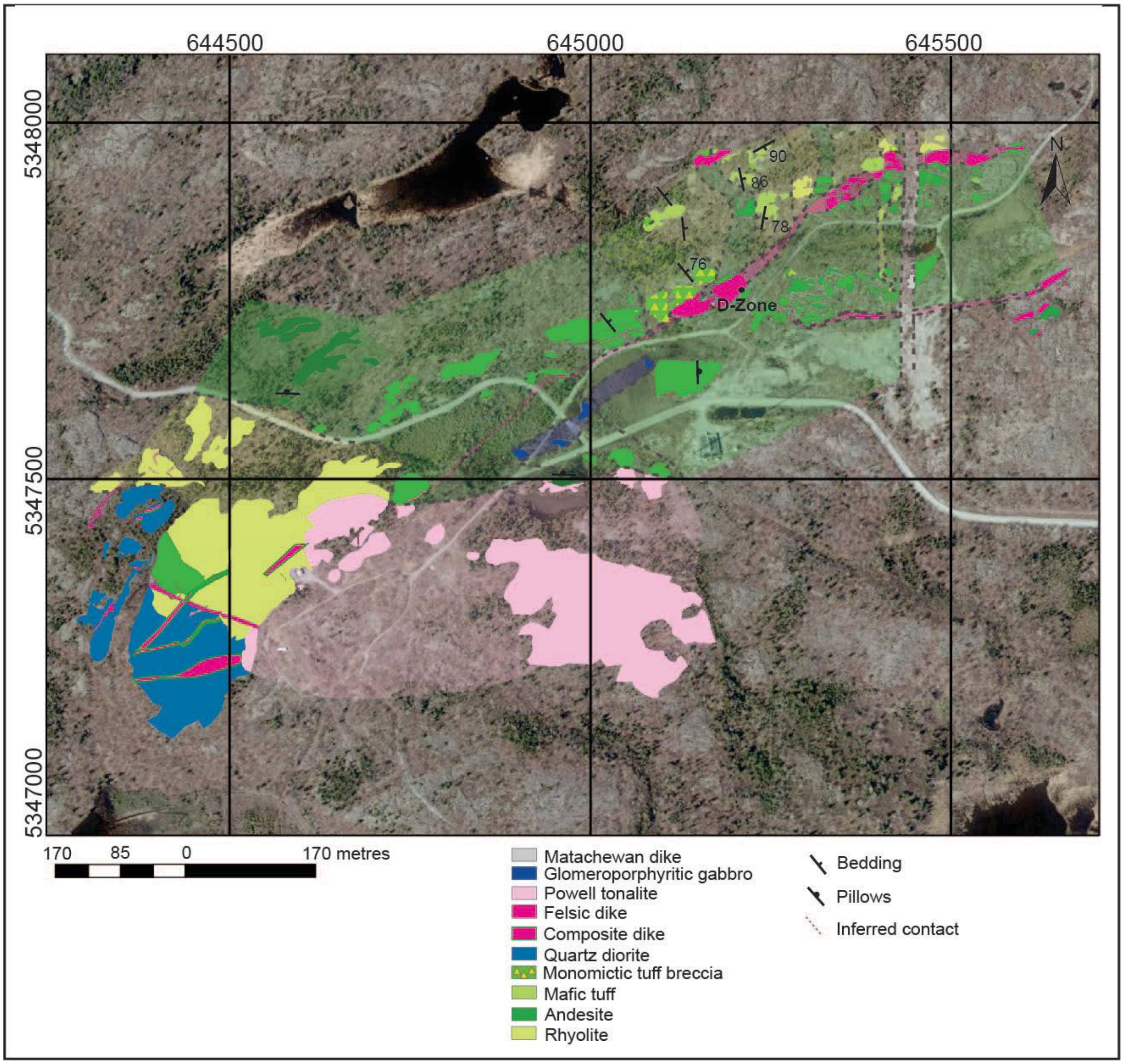

Figure 3. Preliminary geology from 2017 field season in the Rouyn-Noranda area. Felsic dykes shown in dark pink are the rhyolite feeder dykes.