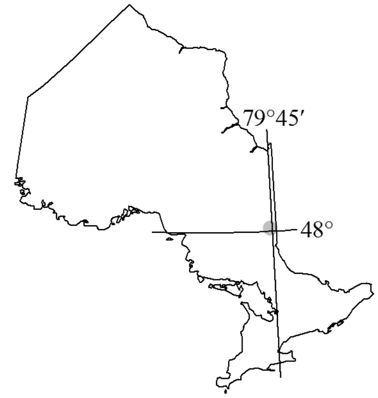
42. Preliminary Results from Mapping Alteration and Structure of a New Exposure South of Dobie, Ontario



L. Hunt[1] and K.E. Rubingh[1]

[1]Metal Earth, Mineral Exploration Research Centre, Harquail School of Earth Sciences, Laurentian University, Sudbury, Ontario P3E 2C6

INTRODUCTION

This summary presents the preliminary results of mapping a bedrock exposure located south of Dobie, Ontario, in Gauthier Township (Figure 42.1). The exposure is part of an Agnico Eagle Mines Ltd. exploration project. The principal author is conducting a structural and geochemical study of the area as part of a HBSc thesis, to define an overall sequence of geologic events. This work is part of the multi-year Metal Earth project being carried out by MERC (Mineral Exploration Research Centre, Laurentian University).

The exposure being studied is situated northeast of the McBean deposit and east of the Anoki deposit (*see* Figure 42.1). Both these deposits are spatially associated with the Larder–Cadillac deformation zone (Ispolatov et al. 2008) and are hosted in mafic to ultramafic volcanic rocks of the Larder Lake assemblage (Ispolatov et al. 2008). The study area is spatially associated with these deposits and is hosted within similar lithologies.

REGIONAL GEOLOGY

The mapped exposure is located within a deformation zone associated with the Larder–Cadillac deformation zone (Ispolatov et al. 2008), which is a major structure that extends through eastern Ontario and western Quebec (Poulsen 2017) and controls the distribution of gold deposits in the surrounding area. This structure is the contact between ultramafic and mafic rocks of the Larder Lake assemblage (2710–2704 Ma) and younger sedimentary rocks of the Timiskaming assemblage (2677.7±3.1 Ma; Ispolatov et al. 2005). The deformation zone that overprints and surrounds this contact shows a high degree of strain (Poulsen 2017). This high-strain zone is interpreted to be the result of the regional-scale faults of the Larder–Cadillac deformation zone and its splays (Poulsen 2017). The exposure being studied is located within this high-strain zone (*see* Figure 42.1), within rocks of the Larder Lake assemblage, a sequence of komatiitic, magnesium- and iron-rich tholeiitic basalts.

The bedrock north of the structure was mapped by Griffis in 1938 and by Thomson in 1940–1941 (Griffis and Thomson 1941) as fine-grained sedimentary rocks. In 2005, Ispolatov and Lafrance mapped a package of volcanic rocks, also located north of the structure, which they have assigned to the Larder Lake assemblage. As a result of geochemical similarities, they interpreted these rocks as a faulted segment of the main interval of Larder Lake assemblage rocks, which typically are found much closer to the Larder–Cadillac deformation zone (Ispolatov et al. 2005). The study area is located within this northern limb of magnesium- and iron-rich tholeiitic basalts that show a very high degree of strain typical of the Larder–Cadillac deformation zone.

Summary of Field Work and Other Activities, 2018,
Ontario Geological Survey, Open File Report 6350, p.42-1 to 42-6.

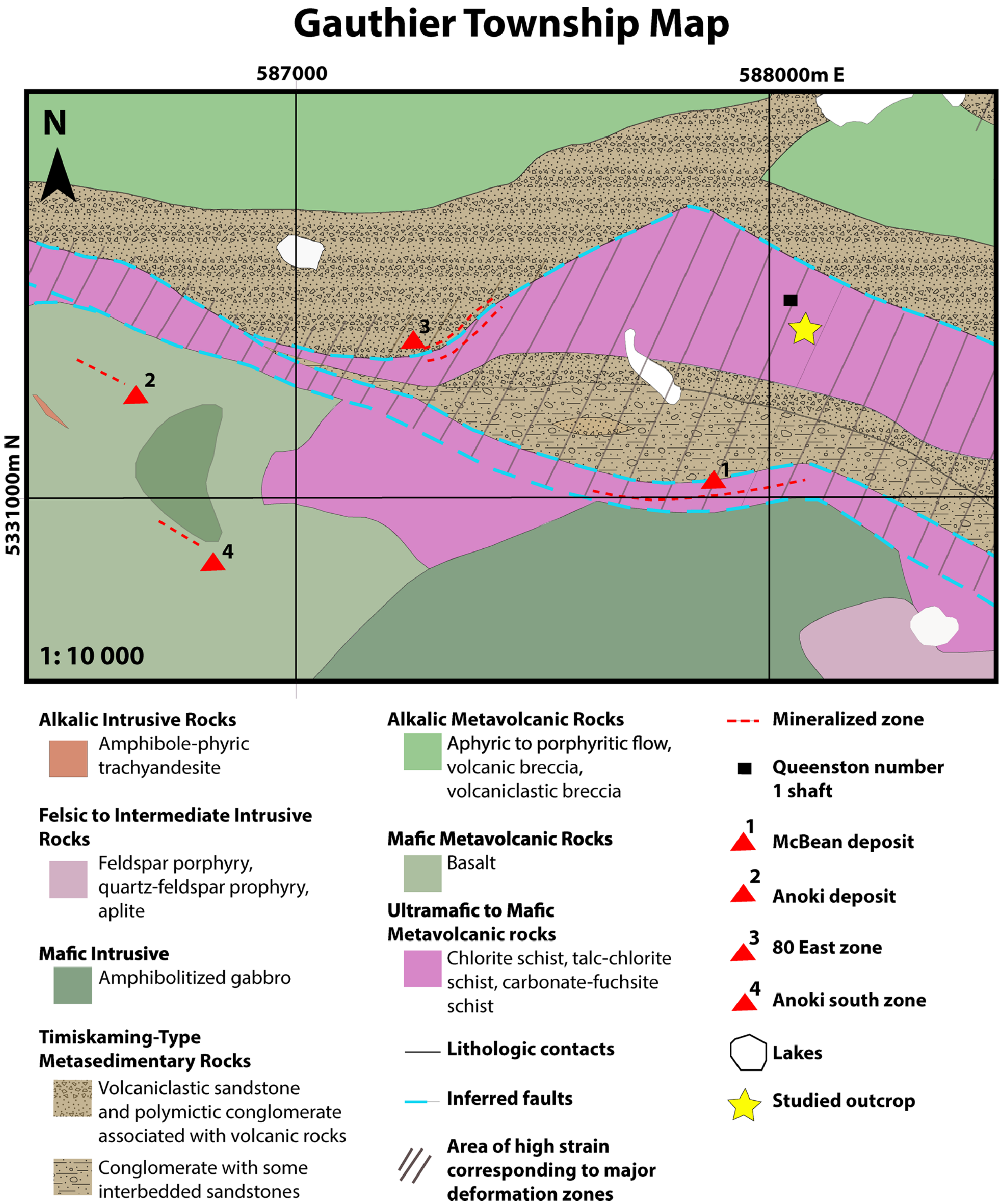


Figure 42.1. Regional geology of the study area, with the mapped exposure indicated by the yellow star (*modified from* Ispolatov and Lafrance 2005). Universal Transverse Mercator (UTM) co-ordinates are in North American Datum 1983 (NAD83), Zone 17N.

FIELD WORK AND OBSERVATIONS

Field work carried out this summer consisted of mapping the alteration zones visible in the exposed bedrock, defining the sequence of deformational events evidenced by the structures in the rocks, and collecting samples for geochemical and petrographic analysis, to further characterize the alteration assemblages and gold mineralization.

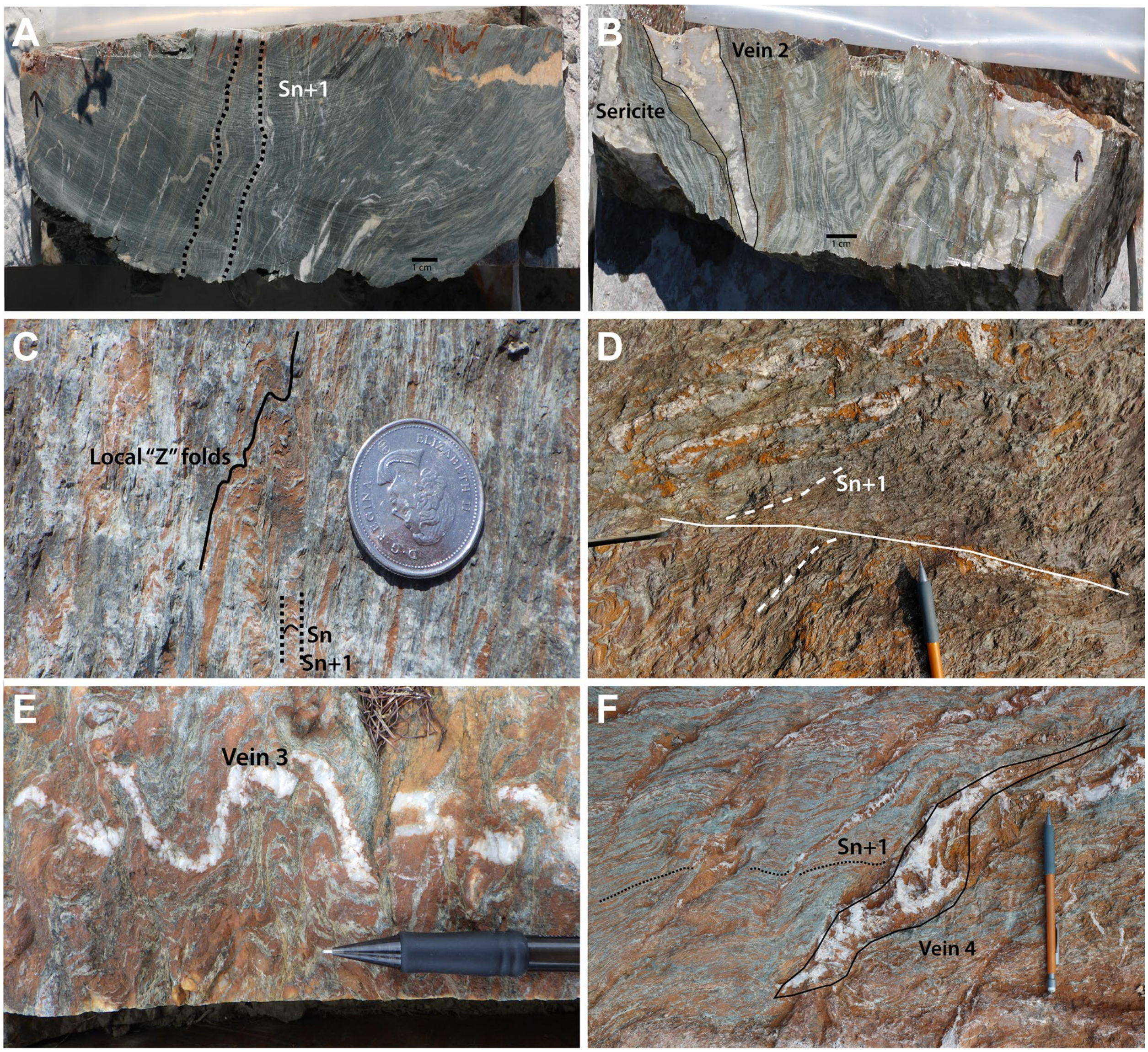


Photo 42.1. **A**) Pervasive chlorite alteration, with S_{n+1} fabric defined by carbonate veinlets. **B**) Carbonate alteration zone defined by intense carbonate veining with second generation (Vein 2) quartz-carbonate veins that have a sericite rim. **C**) Carbonate veinlets defining the 2 earliest fabrics (S_n and S_{n+1}, in the lower part of the photo) and local Z-folding (in the centre of the photo). **D**) Late dextral movement offsetting and rotating S_{n+1}. **E**) Third generation veins (Vein 3) being crenulated and attenuated by north-south shortening. **F**) Late tension veins (Vein 4) cutting the second fabric (S_{n+1}). (Coin in Photo 42.1C is approximately 2 cm in diameter; pen in Photos 42.1D, 42.1E and 42.1F is 15 cm long.)

Alteration

The mapped area is within a mafic volcanic unit, which is very fine grained and contains no visible primary textures. Distinct alteration zones recognized are carbonate, chlorite and sericite. The chlorite alteration is pervasive throughout the map area and is defined by a very fine-grained mineral assemblage and is a distinctive green (Photo 42.1A). This alteration could be the result of either regional metamorphism or hydrothermal overprinting from the proximal orogenic gold deposits. At hand sample scale, it is difficult to discern any other mineralogy of the rock; however, samples have been collected and thin sections will be prepared for later petrographic study.

Carbonate alteration zones appear to have overprinted the chlorite alteration and are defined by an abundance (60%) of carbonate (most likely ankerite) veins. These veins are variably deformed, with complex fold patterns and multiple fabrics (Photo 42.1B). They are 1 to 50 mm in width, very fine grained and, on surface, have oxidized to orange-brown.

The sericite alteration assemblage is visible as beige along the selvages of carbonate veinlets, or as a halo around the quartz carbonate veins.

Narrow (maximum 10 cm thick) felsic dikes, which generally trend east, are very fine grained and are pink. The dikes have been overprinted by multiple fabrics. The colouring could be the result of either a more felsic composition, or hydrothermal alteration of the mafic rocks. Geochemical analysis will be done on collected samples to help further define this rock type.

Structure

The earliest fabric visible in the outcrop, S_n, is oriented north-south and is defined by carbonate veining (Photo 42.1C). The S_n fabric was likely originally a penetrative alignment of chlorite and parallel carbonate veins resulting from regional compression; however, the north-south fabric has been crenulated, forming a discontinuous crenulation cleavage, S_{n+1} (*see* Photo 42.1C). As S_n fabric is still recognizable, S_{n+1} cleavage is interpreted as an incomplete transposition fabric, seen as a spaced cleavage. There are only remnants of this early fabric within the outcrop.

The S_{n+1} cleavage is an east-trending discontinuous crenulation cleavage that forms the dominant fabric in the outcrop. Associated with this fabric is a mineral lineation (L_{n+1}) defined by chlorite and sericite. The plunge of L_{n+1} lineation ranges from 25 to 50° in an easterly direction. Accompanying this fabric are local Z- and S-folds (*see* Photo 42.1C). These folds may be parasitic to larger scale folds formed during north-south shortening, or may be a result of later folding associated with an overprinting deformation event.

Overprinting all of the above-mentioned fabrics is a shear that is defined by discrete fractures, some with infilling vein material that has rotated the fabric in a dextral fashion (Photo 42.1D). The sequence of formation of the fabrics identified during this study is listed in Table 42.1.

Veins

There are 4 different generations of veins visible in the mapped outcrop. The earliest vein type (V_1) is carbonate veinlets that are parallel to the north-south penetrative fabric (S_n). There is very little quartz in the veinlets (<10%) and, on surface, these have been oxidized to red-orange. The second generation of veins (V_2) generally follow the dominant east-west fabric (S_{n+1}). These are coarse-grained quartz-carbonate veins, with a strong iron carbonate alteration on the margins of, and within, the vein. Most of these veins are milky white, but some veins in this orientation are dark grey. The veins range from 1 to 30 cm in thickness. There are silicified clasts of wall rock incorporated within the vein matrix, as well as strongly

Table 42.1. Sequence of fabric development (S_n, S_{n+1}, L_{n+1}) and vein emplacement (V_1 to V_4).

Generation		Orientation	Description	Defined by
1	S_n	N–S	Penetrative chlorite mineral alignment	Parallel carbonate veinlets
2	S_{n+1}	E–W	Discontinuous crenulation cleavage	Parallel carbonate veinlets dipping steeply north, as well as parasitic S-folds forming a spaced cleavage
2	L_{n+1}	E	Chlorite-sericite mineral lineation	Chlorite and sericite mineral aggregates plunging 25–50°
3		NW	Dextral shear	Discrete fractures that cut and rotate all other fabrics in a dextral sense, as well as local Z-folding of the S_{n+1} fabric
1	V_1	N–S reoriented E–W	Carbonate veinlets	Parallel to S_n and S_{n+1} fabrics
2	V_2	E–W	Milky white quartz-carbonate veins	Roughly parallel to S_{n+1} fabric
3	V_3	N–S	Crenulated quartz-carbonate veins	Cuts the S_{n+1} fabric as well as being crenulated
4	V_4		Tension quartz-carbonate veins	Cuts S_{n+1} fabric and all other vein types and is only weakly deformed

iron carbonate–altered clasts that could be inclusions of altered wall rock. There is a narrow sericite selvage (<1 cm) around some of these veins (*see* Photo 42.1B). They commonly display a pinch-and-swell texture interpreted as boundinaged. These veins locally cut the S_{n+1} fabric and, in some locations, dip in the opposite direction, although they generally follow the same east-west trend.

The third generation of veining (V_3) is defined by medium-grained quartz-carbonate veins (<10% iron carbonate). These veins are 0.5 to 3 cm thick and oriented north-south, cutting the dominant east-west fabric. These veins have been crenulated about an east-west fold axis, interpreted to have formed during continual north-south shortening (Photo 42.1E). The youngest vein generation (V_4) is also defined by medium-grained quartz-carbonate veins, but these have an iron carbonate selvage. They are interpreted as late tension veins, which crosscut the S_{n+1} fabrics and all other vein types, and have undergone the least deformation (Photo 42.1F).

In addition to the carbonate and quartz-carbonate veins, there are also narrow (<1 cm) sulphide stringers that are composed of probable fine-grained pyrite. Petrographic analysis will be performed to further characterize the sulphide composition. The sulphide stringers occur along vein boundaries, but also form stringers within the host rock.

The sequence of emplacement of the veins is presented in Table 42.1.

FUTURE WORK

Future work on this project will involve correlating the defined sequence of deformational events with the overall structural evolution for the area. Detailed optical microscopy—transmitted and reflected light—as well as scanning electron microscope (SEM) work will be conducted to define the alteration assemblage for each fabric and the relationship to the mineralization. Whole rock geochemical analyses will be performed on samples of select rock types that were chosen specifically to help characterize the alteration. These results will be compared to the assay results from samples of the veins, to better define the mineralization.

RELEVANCE

The outcrop mapped in this study is part of the Larder Lake assemblage and lies within the Larder–Cadillac deformation zone, a major structure that controls gold mineralization in the area. Two gold-mineralized deposits located south of the mapped outcrop—the McBean and Anoki deposits—are also found along this deformation zone. By placing the mineralization events determined for the outcrop in this study within the stratigraphic and structural evolution of the area, and comparing this to the known deposits, we hope to help constrain further exploration targets.

ACKNOWLEDGMENTS

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