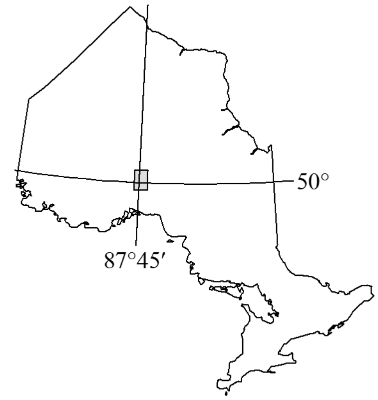
# 33. Preliminary Results from Geological Mapping of the Volcanic Stratigraphy of the Elmhirst–Rickaby and Humboldt Assemblages, Onaman–Tashota Greenstone Belt

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## INTRODUCTION

The work presented in this summary is part of the larger Metal Earth project carried out by the Mineral Exploration Research Centre (MERC), Laurentian University, Sudbury. This research forms the basis of a PhD study conducted by the senior author as part of a Metal Earth transect across the Onaman–Tashota greenstone belt, in the Beardmore–Geraldton area. The goals of this research are to determine and describe the base- and precious-metal metallogeny of the Onaman–Tashota greenstone belt by reconstructing the volcanic stratigraphy and architecture of the assemblages that comprise the belt, and by describing, and placing into time-stratigraphic and deformational context, the key mineralized showings within the belt.

This is the first year of a four-year project, and work to date has focussed primarily on the Elmhirst–Rickaby and Humboldt assemblages, as well as the Vent, Kenty, Golden Mile and Ishkoday exploration properties (Figure 33.1). Field work conducted during the summer of 2018 included the following:

1. mapping and targeted sampling of volcanic strata along transects through the Elmhirst–Rickaby and Humboldt assemblages at 1:20 000 scale;
2. detailed mapping and sampling of the Kenty zinc-silver-lead-copper-tungsten prospect at 1:1000 scale, with a focus on the host volcanic rocks and alteration;
3. mapping and sampling of the mineralization and alteration at the Golden Mile gold-silver prospect;
4. detailed mapping and sampling of the Vent silver-gold showing at 1:400 scale, with a focus on reconstructing the facies architecture and the stratigraphy, and establishing the spatial and temporal relationship of alteration and mineralization; and
5. description, detailed mapping and sampling of the mineralized zones on the Ishkoday zinc-lead-copper-silver-gold-cadmium-tungsten property, with a focus on describing vein textures, mineralogy, alteration and the host stratigraphy.

This report will concentrate on areas of study 1, 2 and 3 in the above list.

*Summary of Field Work and Other Activities, 2018,*
*Ontario Geological Survey, Open File Report 6350, p.33-1 to 33-7.*

# GEOLOGY OF THE ONAMAN–TASHOTA GREENSTONE BELT

The Onaman–Tashota greenstone belt is a Meso- to Neoarchean (2968–2692 Ma) segment of the eastern Wabigoon Subprovince that spans approximately 80 km between the metasedimentary English River and Quetico subprovinces to the north and south, respectively (*see* Figure 33.1; Stott et al. 2002; Stott 2011). Volcanic strata of the belt can be grouped into 4 episodes: 1) Mesoarchean (*circa* 2975–2968 Ma) mafic flows interlayered with dacitic tuffs of the Tashota assemblage; 2) Mesoarchean (*circa* 2922 Ma) mafic flows interbedded with intermediate tuffs and minor felsic flows of the Toronto assemblage; 3) Neoarchean (*circa* 2780–2768 Ma) mafic flows overlain by tuffaceous volcaniclastic rocks and felsic flows of the Onaman assemblage; and 4) Neoarchean (*circa* 2740–2713 Ma) mafic and intermediate flows, volcaniclastic rocks and minor felsic flows of the Willet, Elmhirst–Rickaby, Marshall, O'Sullivan, Metcalfe–Venus and Humboldt assemblages (Stott et al. 2002).

Three main sedimentary episodes are recognized: 1) Mesoarchean (*circa* 2975–2968 Ma) volcaniclastic sedimentary rocks within the Tashota assemblage; 2) Neoarchean (*circa* 2784–2740 Ma) conglomerate of the Lower Willet assemblage; and 3) Neoarchean (*circa* 2710–2698 Ma) conglomerates, siltstones and mudstones with minor arenitic sandstones of the Albert–Gledhill, Conglomerate, English River and Quetico assemblages (Stott et al. 2002). Deformation within the belt has been attributed to the "Wabigoonian" phase of the Kenoran orogeny from 2706 to 2695 Ma (Stott and Corfu 1991; Stott et al. 2002; Percival et al. 2006; Percival et al. 2012).

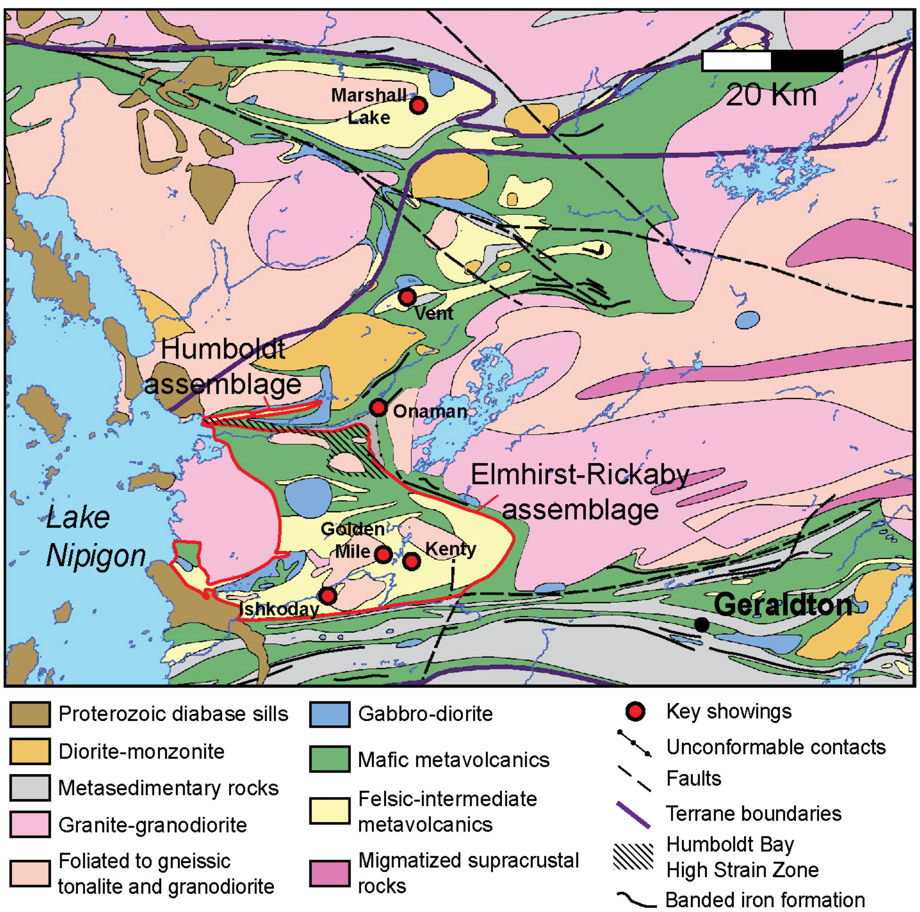


**Figure 33.1.** Regional geology of the Onaman–Tashota greenstone belt, with the location of key showings that will be investigated over the course of this four-year study. The Elmhirst–Rickaby and Humboldt assemblages are outlined in red. *Modified from* Ontario Geological Survey (2011), Stott et al. (1996) and Stott et al. (2002).

Plutonic rocks are subdivided by Stott et al. (2002) into 3 groups, based on U/Pb zircon geochronology, crosscutting fabric relationships and composition: 1) synvolcanic plutons and dikes of predominantly gabbroic and tonalitic compositions; 2) synkinematic plutons and dikes (generally with ages between 2706 and 2700 Ma) typically comprising tonalite-trondhjemite-granodiorite (TTG) suite intrusions; and 3) syn- to post-kinematic sanukitoid suite plutons ranging in age from 2698 to 2692 Ma and comprising granodiorite, granite, monzodiorite, syenite and monzogranites.

## ELMHIRST–RICKABY ASSEMBLAGE

The Elmhirst–Rickaby assemblage (*circa* 2740 Ma) is located along the southern margin of the Onaman–Tashota greenstone belt (Stott et al. 2002). It is an approximately 28 km thick sequence of mafic and intermediate volcanic rocks and lesser felsic flows, with calc-alkalic affinity (Mackasey and Wallace 1978). The northern portion of the assemblage comprises pillowed and massive mafic flows with thick hyaloclastite-bearing pillow and flow-top breccias (Photo 33.1A) that consistently face southwards. Flows range from 5 to 30 m in thickness and contain large, elongate pillows with concentric fractures (*see* Photo 33.1A). Hyaloclastite-rich flow-top breccias are roughly equal in abundance to flows by volume, and are intruded by mafic and intermediate dikes and sills, some of which have peperitic margins. The southern portion of the assemblage is dominated by intermediate volcaniclastic units comprising heterolithic and monolithic tuff breccia, lapilli tuff, and feldspar-crystal tuff with minor feldspar-phyric flows and feldspar porphyritic bodies (Photos 33.1B, 33.1C, 33.1D and 33.1F). Lesser spherulitic felsic flows and domes with blocky flow-top breccias are interlayered within this package (Photo 33.1E). The Kenty showing occurs within, and is associated with, one of the felsic flows. The Elmhirst–Rickaby assemblage contains 2 large synvolcanic plutons: 1) the quartz-dioritic to tonalitic Kaby pluton (2734 Ma); and 2) the composite Elmhirst–Rickaby pluton (2736 Ma: Tomlinson 2000; Tomlinson, Stott and Davis 2000; Tomlinson et al. 2001). Both of these intrusions occur within the southern portion of the assemblage and numerous gold occurrences are associated with them. The most significant occurrence is the quartz vein–hosted orogenic gold mineralization at the Golden Mile and Orphan Mine properties (Mackasey and Wallace 1978; Parker 1996).

## HUMBOLDT ASSEMBLAGE

The 1.3 km thick Humboldt assemblage (*circa* 2713 Ma) is located east of Humboldt Bay, Lake Nipigon, and bridges the gap in time between the extrusive volcanic activity of the Metcalfe–Venus assemblage (*circa* 2734–2722 Ma) and the unconformably overlying “Timiskaming-like” sedimentary Albert–Gledhill and Conglomerate assemblages (<2710 and <2707 Ma, respectively; Stott et al. 2002). The Humboldt assemblage consists of 2 main lithofacies. The lower unit is a polylithic, matrix-supported, tuffaceous conglomerate containing approximately 35% medium-grained, rounded tonalitic fragments (3–35 cm in size), along with various other fragment types, including fine-grained, subangular fragments (2–40 cm in size) of volcanic rock and banded iron formation (Photos 33.2A and 33.2B). This tuffaceous conglomerate contains a fine-grained, well-sorted, quartz-crystal tuff matrix that lacks abundant ash-sized material.

The conglomerate grades normally upwards over several metres into the second lithofacies, a package of quartz ± feldspar crystal tuffs and lapilli tuffs that are similarly fines depleted (Photo 33.2C). The latter tuffs form approximately 30 to 50 cm thick beds with abundant flaser beds, and contain up to 25% broken and angular quartz crystals. Finely bedded to laminated siltstone and crystal tuff layers within the sequence display normal grading and scours that indicate stratigraphic facing is to the south (Photo 33.2D). Mapping has revealed that at least 3 sections of tuffaceous conglomerate, each overlain by crystal tuff beds, are present over the thickness of the Humboldt assemblage. It is unclear if this repetition of the tuffaceous conglomerate is primary and reflects repeated events of conglomerate deposition, or is a structural phenomenon.

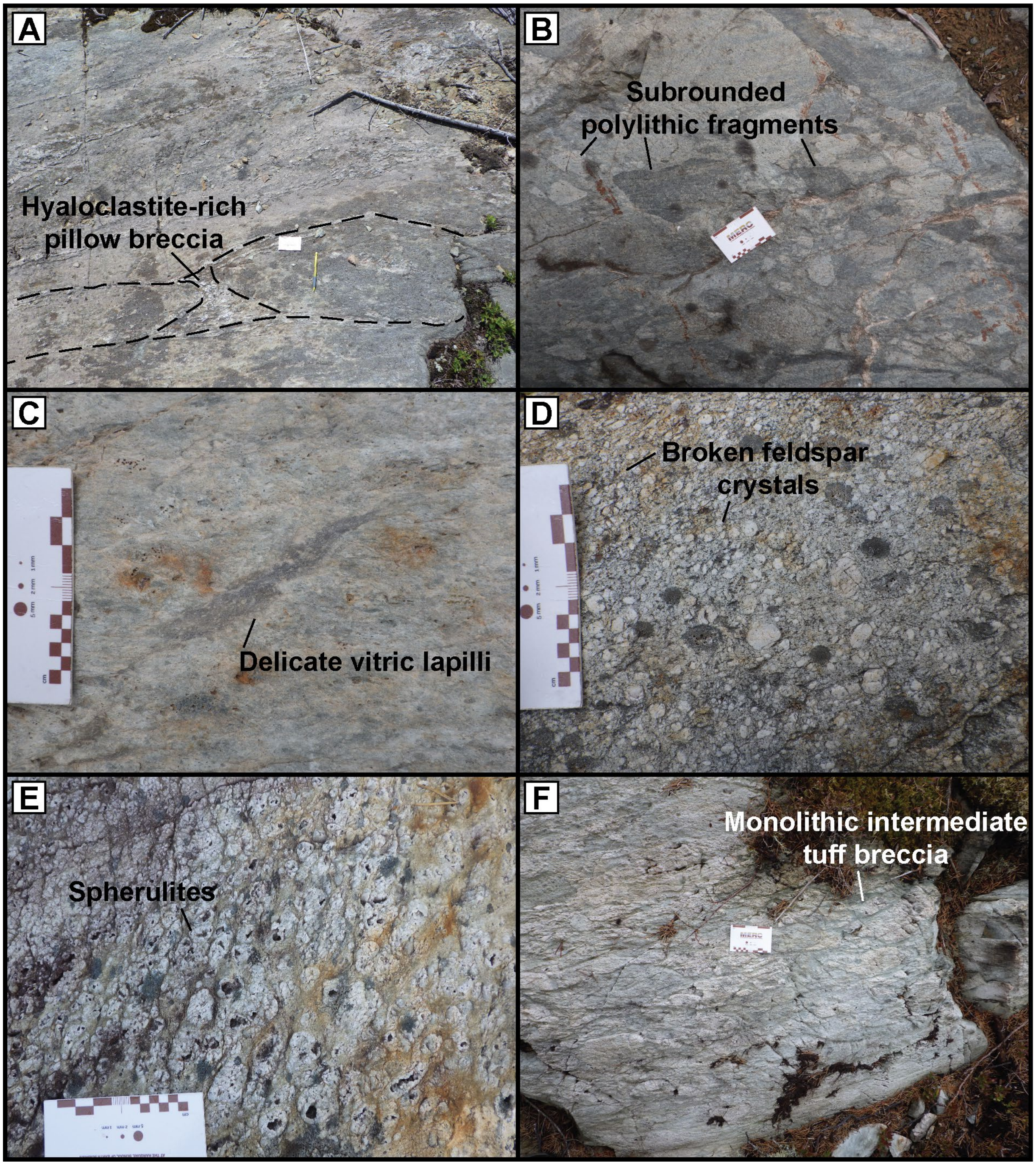


**Photo 33.1.** Lithofacies of the Elmhirst–Rickaby assemblage. **A**) Pillowed mafic flow with hyaloclastite-rich pillow breccia developed along the pillow margins. **B**) Heterolithic, clast-supported, intermediate tuff breccia displaying a variety of subangular to subrounded volcanic clast types. **C**) Intermediate lapilli tuff containing dark, chloritized, delicate, wispy, altered vitric lapilli. **D**) Intermediate feldspar-crystal tuff. The feldspar crystals exhibit a wide range of sizes and shapes, including broken, angular and rounded crystals, the latter indicating transport. **E**) Spherulitic, flow-banded, highly vesiculated rhyolite displaying coalescence of spherulites into linear bands that define flow banding. **F**) Monolithic, intermediate, clast-supported tuff breccia without bedding or grading apparent at the outcrop scale.

# GEOLOGY AND MINERALIZATION AT THE KENTY SHOWING

The Kenty showing exposes 3 stratigraphic units within the southern segment of the Elmhirst–Rickaby assemblage: 1) a lower intermediate volcaniclastic unit ("LIVU"), 2) a rhyolitic flow unit ("RFU") and 3) an upper intermediate volcaniclastic unit ("UIVU"). The lower intermediate volcaniclastic unit consists of massive, thick (>1 m) beds of heterolithic tuff breccia, lapilli tuff, feldspar-crystal tuff and intermediate tuff. Wispy, delicate, chloritized, vitric lapilli are observed within the lapilli tuff (*see* Photo 33.1C). Conformably overlying the lower intermediate volcaniclastic unit is an aphanitic, aphyric rhyolitic flow unit that displays a well-developed spherulitic texture, flow banding and a blocky flow-top breccia, indicating that the strata face to the south. The rhyolitic flow unit is overlain by the upper intermediate volcaniclastic unit, comprising heterolithic intermediate tuff breccias with subangular to subrounded fragments and thin beds of laminated tuff. The volcaniclastic units are intruded by 4 separate dikes: 1) an intermediate feldspar porphyry dike that crosscuts the mineralized zone; 2) a series of thin, fine-grained mafic dikes that predominantly intrude the top of the felsic flow where it is overlain by tuff breccia; 3) a single, highly sericite-altered, fine-grained felsic dike; and 4) a late lamprophyre dike. Two mineralization styles are recognized: 1) a sulphide stringer mineralization (zinc-lead-copper±gold-silver-tungsten) dominated by centimetre- to millimetre-scale, anastomosing veinlets of pyrite-sphalerite-galena with minor chalcopyrite (Parker 1996); and 2) a newly recognized folded and boudinaged iron carbonate–quartz vein that is localized along the contact between the sericitized felsic dike and the intermediate tuff breccia.

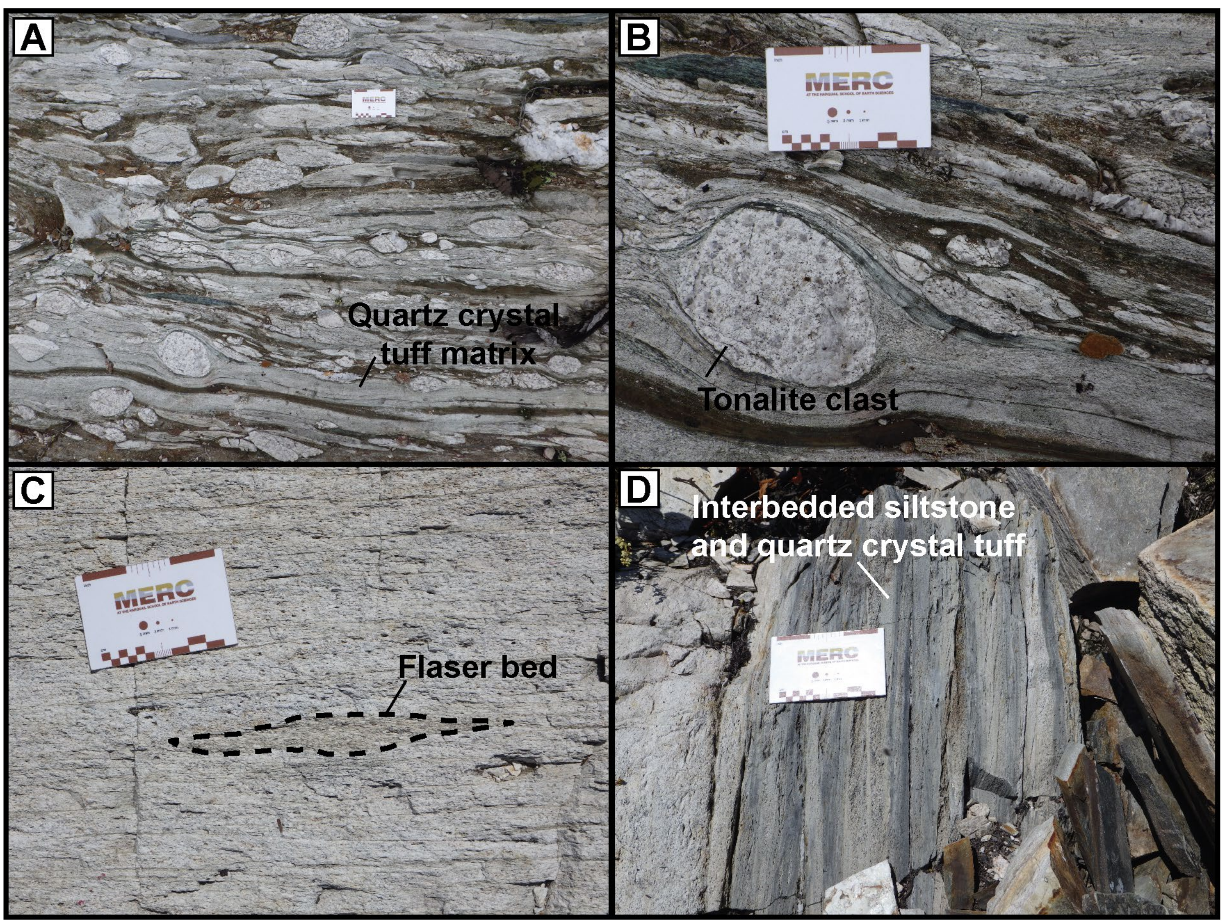


**Photo 33.2.** Photos of key lithofacies within the Humboldt assemblage. **A**) Conglomerate with a quartz-crystal tuff matrix and fine silty interbeds hosting large tonalite clasts. **B**) A rounded tonalite clast in a quartz-crystal tuff bed of the conglomerate. **C**) Finely bedded, fines-depleted, quartz-crystal tuff with possible lensoidal flaser bedding. **D**) Interbedded siltstone and crystal tuff beds within a crystal tuff package; scoured crystal tuff beds indicate facing to the south (left). A felsic, monolithic lapilli tuff overlies the siltstone (far left).

## GEOLOGY AND MINERALIZATION AT THE GOLDEN MILE EXTENSION

The Golden Mile extension is hosted by the tonalitic phase of the composite, synvolcanic Elmhirst pluton (2737 Ma) (*see* Figure 33.1; Mackasey and Wallace 1978; Stott et al. 2002). Three dominant vein types are recognized, and crosscutting relationships between these sets reveal the following sequence of events (from oldest to youngest): 1) crack-and-seal–textured quartz veins with minor sulphides; 2) quartz-chlorite veins; and 3) massive white quartz veins with minor sulphides. All vein types are localized near the contacts with a narrow, fine-grained mafic dike. It is unclear which vein types host the gold mineralization; however, the crack-and-seal–textured quartz veins are the most continuous and voluminous, and these are the only veins directly associated with hematite alteration. Assays from diamond-drill holes intersecting the veins at depth yielded gold values exceeding 5 g/t Au (Vanstone 2009; Haroldson 2011). Hydrothermal alteration at the Golden Mile extension is dominated by a pervasive, weak to moderate hematite alteration of feldspars that occurs as metres-wide envelopes surrounding crack-and-seal–textured quartz veins. Pervasive, moderate to strong iron carbonate alteration, which replaces mafic minerals and feldspars within the host tonalite, extends for up to 3 m away from crack-and-seal–textured veins, and overprints hematite alteration.

## ACKNOWLEDGMENTS

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