Application of geological laboratory techniques for insight into the geomechanical behaviour of skarn-related veined rocks

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The role of healed intrablock structures, such as hydrothermal veins, on rockmass behaviour has recently become a critical consideration in geotechnical engineering development of deep mines and other excavations, both in designing ground support and predicting rockmass failure behaviours. Observations of rockmass instability at these depths have shown that intrablock structures can have a significantly greater influence than conventional rockmass structures (interblock structures) such as joints, bedding, and other fractures. Conventional approaches of geotechnical engineering design, developed for homogeneous rockmasses, do not adequately represent heterogeneous complex rockmasses such as those that contain hydrothermal vein networks. Diamond drill core samples were selected from two historical exploration boreholes in the Legacy skarn deposit in northern New Brunswick and sorted into homogeneous (matrix) and heterogeneous (veined) categories for mineralogical and geotechnical laboratory testing. Hand sample observations, thin section petrography, micro-X-ray Fluorescence (micro-XRF) and powdered X-ray Diffraction were used for detailed mineralogical characterization. Three matrix (vein host rock) lithotypes were identified, and one lithotype was subdivided into three categories to account for alteration: (1) The matrix of the garnet-pyroxene skarn unit contains garnet, diopside, and albite. Stockwork veining was abundant in this unit, containing quartz with minor sulphide mineralization (2–10 mm thick). (2) The granodiorite unit matrix contains sodium-rich plagioclase and quartz with minor amounts of biotite. Hydrothermal alteration processes including saussuritization and sericitization, are considered to be responsible for the varying amounts of chlorite and amphibole in the granodiorite samples, resulting in three subdivisions. The veins within the granodiorite unit display little geometric variability (often single veins, 1–2 mm thick) and are composed primarily of calcite. (3) The calcareous mudstone unit matrix contains an abundance of muscovite with minor amounts of calcite. The veins in this unit display the greatest geometric variability, ranging from single to multiple calcite veins (5–25 mm thick). The compositions of these lithological units (both matrix and vein materials) identified during this study are consistent with results from laboratory analysis techniques as well as previously published studies on the Legacy deposit. Micro-XRF relative imaging, and its ability to map 2D locations (matrix and vein) of mineral abundance at that scale, has provided key insight to explain geomechanical failure behaviours. Accurate and detailed mineralogy characterization of hydrothermally altered rockmasses like this study, with correlation to geotechnical properties and rockmass behaviour, is becoming critical for the success of modern, numerical geotechnical design of particularly large and deep excavations.

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