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Controls on the chemistry of minerals in late-stage veins and implications for exploration vectoring tools for mineral deposits: an example from the Marathon Cu-Pd deposit, Ontario, Canada

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Abstract

Exploration for mineral deposits is becoming increasingly difficult, requiring the use of novel approaches that are reliable and cost-effective. One such approach is the use of vein-hosted mineral chemistry. A number of studies have described the use of vein-hosted mineral chemistry as an exploration tool, but few have assessed a variety of factors that may have controlled the composition of these minerals. An understanding of why and how the composition of minerals varies, however, is critical to the development of robust exploration tools. This contribution combines detailed mineralogy using energy- and wavelength-dispersive spectroscopy, Raman spectroscopy, and μXRD with high-resolution laser ablation ICP-MS trace element analysis to characterize the controls on the chemistry of vein-hosted minerals, and the implications of these controls for the applicability of these minerals for mineral exploration.

In and around the Marathon Cu-Pd deposit, veins consist of a complex mixture of phyllo and chain silicates, including chlorite, serpentine, saponite, and Ca-rich amphibole, whereas disseminated alteration consists predominantly of Ca-rich amphibole with lesser chlorite. The abundance of these veins is inversely correlated with the presence of mineralization. Minerals hosted in veins and patchy alteration crystallized from different fluids during temporally distinct events; the veins formed later than the disseminated alteration and from multiple stages of lower-temperature fluids. There is no correlation between the rock types that the veins are hosted by and the composition of the vein minerals, but on a very local scale, the mineral that a vein is hosted by does exhibit a compositional control. Vein minerals that are hosted by magnetite, and to a lesser extent, pyroxene, are enriched in Ti, V, and Cr compared to those hosted by plagioclase. In vein minerals that are hosted by plagioclase, the concentration of Co, Ni, and Zn increase systematically with distance from mineralization. The concentrations of Co, Ni, and Zn in vein minerals hosted by plagioclase also, however, increase systematically with distance from