Mineral chemistry and zoning of sulfarsenide minerals at Nictaux Falls Co-Ni-Au-Ag-Bi occurrence in the Annapolis Valley, Nova Scotia, Canada

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The mineralogy of understudied polymetallic (Co-Ni-Au-Ag-Bi) quartz veins exposed in the Nictaux Falls Spillway, Annapolis Valley, Nova Scotia, has been investigated. Two styles of mineralization crosscut the Kentville Formation metasedimentary rocks in the spillway: (i) laminated sulfarsenide-quartz veins, and (ii) quartz breccia veins containing sulfarsenide-mineralized wallrock clasts. Laminated veins are heterogeneous with euhedral sulfarsenides and coxcomb quartz occurring on opposite sides of the vein. Wallrock clasts contain late net-texture sulfarsenides and quartz. Petrographic work identified a spatial relationship between sulfarsenides and wallrock material (e.g., chlorite, rutile) in both styles of mineralization, suggesting that the wallrock may have acted as a reaction site, or provided chemical components (e.g., S, As, Fe), for mineralization.

Compositional maps of mineralization were produced at a variety of scales, from an entire thin section (micro-XRF) to a single crystal (50 µm) (EPMA). Sulfarsenides in both styles of mineralization exhibit unidirectional zoning characterized by euhedral arsenopyrite cores (50 to 100 µm) mantled by a succession of overgrowths from arsenopyrite to cobaltite to gersdorffite. In laminated veins, gersdorffite is constrained to the middle of the vein at the sulfarsenidequartz boundary. The direction of zoning and textures of laminated veins reflect a process whereby dense arsenopyrite precipitated from the hydrothermal fluid and accumulated at the base of the vein; the surface of the arsenopyrite accumulation reacted with the fluid to produce cobaltite and then gersdorffite overgrowths, followed by quartz. The early arsenopyrite cores are disseminated throughout both styles of mineralization and may have been inherited from the wallrock, serving as nucleation sites for sulfarsenide overgrowths. Future S-isotope work aims to confirm this relationship and the source of S for both generations of sulfarsenides. The compositional zoning may reflect either: (i) a decrease in pH over time, or (ii) Rayleigh fractionation of the fluid through the progressive removal of Fe and Co during mineralization. Future trace element work will quantify and map the distribution of trace elements including Au and Ag. Interestingly, the sulfarsenide zoning patterns are opposite of that for classic "five-metals" deposits, such as Cobalt, Ontario, and Eldorado, Northwest Territories, which have similar elemental assemblages but grade from Ni- to Fe-rich.

The elemental assemblage of the polymetallic veins suggests a mafic source. Petrographic work on gabbro, diabase, and surrounding contact-metamorphosed metasedimentary rocks in the area identified primary cobaltite and Co-Ni-rich secondary minerals such as actinolite, chlorite, and sulfides, confirming these rocks as a potential source of metals.

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