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Field Analysis of Contrasting Epigenetic Gold and Copper Vein Mineralization, Rouyn-Noranda Mining District, Québec

Marina D. Schofield[1], Bruno Lafrance[1], Harold L. Gibson[1], K. H. Poulsen[2]
1. Laurentian University, Sudbury, ON, Canada, 2. Consultant, Ottawa, ON, Canada

The Rouyn-Noranda mining district of Québec is best known globally for its 20 Cu-Zn (±Au ±Ag) volcanogenic massive sulfide (VMS) deposits including the giant Horne Cu-Au system. The district also hosts 19 gold-quartz-carbonate vein deposits and several subeconomic Cu-Ag occurrences comprised of vein to disseminated quartz, chalcopyrite, pyrite, pyrrhotite ±sphalerite ±galena ±Ag-Bi tellurides. Historically, there was no genetic distinction among the deposit types and all were inferred to be epigenetic, hypozonal, and magmatic-hydrothermal in origin. In the mid 1960s, a syngenetic origin became widely accepted for VMS mineralization worldwide and the gold-quartz-carbonate veins were described as epigenetic. The origins of the vein and disseminated Cu-Ag deposits were much more uncertain and were interpreted to be related to VMS or porphyry-copper deposits. They are similar to the epigenetic Au veins in that involve infilling of brittle fractures, locally contain vuggy quartz and petrogenetically late sulphides, and are overprinted by regional deformation. However, the two vein styles have very different metal tenors and alteration signatures and occur in different structural orientations. The Au veins contain ~3–6 g/t Au and are associated with hematite ± ankerite ± sericite ± chlorite alteration. They uniformly strike NNW, dip moderately towards the E, and are typically spatially associated with lamprophyre dikes that crosscut the Flavrian-Powell Intrusive Complex. In contrast, the Cu-Ag veins contain ~7 wt % Cu, ~98 g/t Ag, and <0.3 g/t Au and are associated with spotted to massive, sericite, chlorite alteration. They are dominantly hosted in the volcanic strata along NE-striking structures that are infilled by felsic dikes and are interpreted as synvolcanic structures that formed during extension. The Au veins locally crosscut the Cu-Ag veins and are folded and overprinted by an E-W regional cleavage that formed during the main NNE-directed deformation event, which affected the ca. 2704–2695 Ma volcanic rocks and younger ca. 2679–2669 Ma Timiskaming Group sedimentary rocks of the Rouyn-Noranda mining district. They are interpreted to have been emplaced early during this deformation event. The association of these Au veins along the margins of narrow lamprophyre dikes suggests the presence of preexisting structures, which were likely reactivated during later deformation and acted as structural traps for later Au-quartz vein mineralization. Similarly, the presence of the Cu-Ag veins along the margins of the NE oriented felsic dikes suggests continued reactivation of synvolcanic structures during progressive extension. The superposition of multiple mineralization events, each a product of different genetic processes that utilize preexisting structures and indicate a fertile geodynamic environment, is of importance to our understanding of the broader metallogeny of the district. With more deposits being discovered undercover, a better understanding of how ore systems evolve and are superimposed in metal-endowed districts is essential to help guide exploration, especially in complex Archean terranes.