

Fingerprinting Multi-Stage Gold Mineralization at the Dome Mine, Timmins, Ontario

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The Dome mine in Timmins, Ontario has produced over 16 Moz of gold over the last 100 years. The gold endowment at the Dome Mine is the result of a multi-stage, ~10-25 Ma mineralization history, in which a massive set of ankerite veins represents the earliest economic mineralization event and constitutes ~20% of production to date. The characterization of the gold and trace metal content of different mineralization events is integral to understanding the complex mineralization history which led to the world-class gold endowment at the Dome Mine. It also has implications for further exploration in the region and requires a mine- to micron-scale approach, combining conventional geochemical techniques with *in-situ* high resolution trace element analysis of ore minerals. The bulk mineralogy and major element geochemistry of the ankerite veins is uniform across their ~2300 m strike, as well as between different vein sets. The exception is the variability in SiO₂ content, which ranges from 2-50% and is the result of later cross-cutting gold-bearing quartz extension veins. Gold grades range from 0.5-85.5 g/t in ankerite vein samples with an average grade of 6.6 g/t. Trace metal (Ti, V, Ni, Co, Cu, Zn, As) and REE contents also vary considerably, and there are no correlations between trace metals and gold content, making the discrimination of distinct mineralization events inherently difficult. Gold across the deposit is intimately associated with pyrite mineralization, and occurs as inclusions and fracture fill, as well as nanoparticles and/or in the pyrite crystal lattice. Synchrotron X-ray fluorescence (sXRF) provides quick and effective quantitative, micron-scale trace element analysis and mapping of ore minerals with ppm detection limits. Using sXRF, we have identified at least 4 stages of pyrite growth at the Dome mine, each with a distinct trace element fingerprint. Three distinct fluid events are identifiable in the ankerite veins based on pyrite growth history, trace element and gold content. The early, syn-ankerite gold event is enriched in metals and metalloids (Cu, As, Zn, Ni) with respect to the main stage mineralization which contributed the bulk of the gold to the system. This enrichment may be related to a pre-ankerite stage of mineralization observed in auriferous sulphide-rich clasts in the Timiskaming conglomerate and previously undescribed local lenses of massive sulphide in the Tisdale Assemblage volcanics characterized by sXRF. The first stage of ankerite mineralization was followed by a Ni-rich Au remobilization event before the main stage quartz vein-hosted gold mineralization.