

Controls on Precious and Critical Metal Enrichment in Sulphide Occurrences of the Caledonian-Appalachian Orogen

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Volcanogenic massive sulfide (VMS) deposits not only host significant quantities of base metals (Zn, Cu, Pb) of which there is growing global demand but can also be enriched in precious metals (Ag, Au) and a number of critical metals (e.g., Co, Ga, Bi, In, Sb) crucial for renewable technologies.

The Caledonian-Appalachian orogenic belt hosts a large number of VMS deposits in arc and ophiolite sequences of varying age, host stratigraphy, magmatic affinity, and tectonic setting. World-class deposits occur on both sides of the Iapetus Suture upon Laurentian and Gondwanan affinity crust. Within these arc systems, regional-scale to intra-deposit controls on precious and critical metal enrichments are poorly understood. Controls on the latter may reflect footwall leaching, a magmatic volatile contribution, and/or fluid conditions.

The Tyrone Igneous Complex (TIC) of Northern Ireland represents a late arc-ophiolite system that accreted to the margin of Laurentia during the Middle Ordovician. It is now recognized to be a direct correlative to the VMS-rich Annisquamish Accretionary Tract of Newfoundland, host to the world-class Buchan's deposits. The precious metal enrichment varies significantly within and between deposits, and their critical metal potential is largely unknown. This study aims to improve the understanding of controls on mineralization within the Caledonian-Appalachian orogeny, to provide a detailed assessment of their precious and critical metal potential and to contribute to their global exploration and development efforts.

We present new deposit paragenetic characterisation and sulfide trace element data (SEM, EPMA, LA-ICP-MS) combined with multiple sulfur isotope data (SF6+ IRMS), highlighting the differences in geochemical signatures of the various mineralized occurrences found within the TIC. This data, integrated with existing and new geochronological data will enable to place these sulfide occurrences within a robust geodynamical framework, improving the targeting of prospective lithologies.