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Relationships Between the Tectonic Evolution and the Formation of Polymetallic Vein Deposits Along the Caledonian-Appalachian Belt

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The Caledonian-Appalachian Belt (CAB) hosts several economic and sub-economic polymetallic (Au-Ag-Pb-Zn-Cu) vein systems and is, therefore, an excellent natural laboratory to study the variations in the characteristics of ore deposit and the timing of their formation, within an orogenic belt. We present some of the preliminary outcomes of a large-scale study on the variability of the vein-hosted mineralisation within the CAB, covering c. 20 different polymetallic vein systems within the Grampian Terrane and its equivalents of CAB in Scotland, Northern Ireland, Ireland and Newfoundland.

The multi-disciplinary study combines structural data, age determinations, vein textural mapping and paragenetic interpretation, gold geochemical characterisation, and stable isotope data. We show that although the occurrences show many superficial structural and mineralogical similarities, there are differences between the structural styles, mineralogy and timing of the mineralisation in different areas. At least three, possibly four, distinct mineralisation stages are identified between Ordovician and Early Devonian; however, the main mineralisation pulse is identified at around 420-410 Ma. 'Magmatic' (possibly porphyry/epithermal) and 'orogenic' mineralisation styles are found associated with specific areas which in turn are characterized by distinct structural styles that can be linked to the overall tectonic evolution of the Grampian Terrane around this time.

The study shows what are the critical windows in time and space for mineralisation, whilst demonstrating that the local structural style and ore deposit type can vary significantly even with coeval deposits, depending on the wider tectonic controls on the mineral system. The coeval nature and mineralogical similarities of the 420-410 Ma vein systems across the area suggest that the entire terrane was fertile and that the sources for the main metals were likely similar for all vein systems.