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A regional mineralising fluid in the Cornwallis Zn-Pb district, Arctic Canada

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Summary

The Cornwallis district in Canada's Arctic archipelago consists of Zn+Pb showings centred around the past-producing Polaris Zn-Pb deposit. Showings are predominantly in, although not limited to, the same organic-rich carbonate rock as Polaris (Thumb Mountain Formation). Most showings are near faults, but are not restricted to them. This study characterises the fluid(s) responsible for mineralisation throughout the Cornwallis district, to determine if the showings are part of the same mineralising event as the Polaris deposit, and to determine what controlled mineral precipitation, and location and size of the mineralised zones. To determine fluid characteristics, sphalerite and gangue (dolomite and calcite) from throughout the Cornwallis district were subjected to a suite of in-situ microanalytical approaches: optical, CL, and SEM-EDS petrography, fluid inclusion studies including evaporate mound SEM-EDS analysis, secondary ion mass spectrometry (SIMS), and laser ablation inductively coupled mass spectrometry (LA ICP-MS). The mineral paragenesis of ore and gangue phases is similar in all showings, as are fluid characteristics [80-100°C, 26-30 wt. % equiv. NaCl, Na-Ca-Cl-S chemistry, PAAS-normalised REEY carbonate patterns, and oxygen isotopic compositions ($\delta^{18}O_{V\text{-}SMOW}$ = ~24‰)]. There is, however, a large range in $\delta^{34}S_{VCDT}$ throughout the district (-5 to 32‰); each showing has a limited range in $\delta^{34}S$ values, within which the paragenetically earlier stages are generally ~5‰ lighter than later stages. Collectively, the data suggest that a single regional, metal- and sulphate-bearing fluid was responsible for the district's showings. This fluid was sourced from seawater and subsequently dissolved evaporites before interacting with other sedimentary rocks in the subsurface. The geographically variable sulphur isotopic signatures of sphalerite among the showings highlights the role of both local and regional sulphur sources. Although reduced sulphur was present at the showings, the regional fluid dominated the sulphur budget, and its delivery and subsequent thermochemical reduction produced an increase in $\delta^{34}S$ through the sulphide paragenesis. The location and sulphide volume in Cornwallis district showings is therefore a function of (1) the host rock's capacity to facilitate thermochemical sulphate reduction, and (2) the volume of fluid that a nearby fluid conduit (fault) could supply. With the exception of local variations in sulphur isotope values, the chemical characteristics of mineralisation throughout the district are approximately uniform, which is consistent with a regional, topographically driven fluid event.