Paleoproterozoic Mississippi Valley-Type Pb-Zn mineralization in the Ramah Group, northern Labrador

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Mississippi Valley-type (MVT) Pb-Zn sulphide mineralization is common in Paleozoic rocks but relatively few MVT deposits have been reported from Paleoproterozoic rocks. This study investigates the genesis of numerous Pb-Zn showings in the ca. 2.0 Ga Ramah Group, northern Labrador. Pb-Zn sulphide mineralization is hosted within breccia zones in the Reddick Bight Dolomite Member, Ramah Group. The mineralogy consists of coeval dark-brown sphalerite, galena, and pyrite with gangue quartz, dolomite, calcite, and feldspar (which pre- and post-date main-stage mineralization). Solid pyrobitumen is common and is associated with early and main-stage mineralization.

Fluid inclusion analysis from coarse-grained sphalerite

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has identified H2O - NaCl - $CaCl_2$ + CO_2 ± CH_4 within the mineralizing fluids along with high salinities (up to 19 eq. wt.% NaCl + $CaCl_2$) and homogenization temperatures of 104 to 169°C. The presence of significant volatiles in the mineralizing fluids has been confirmed through quantitative fluid inclusion gas analysis of sphalerite, which has recorded 4.46 wt.% CO_2, 0.95 wt.% N_2, and 0.14 wt.% CH_4. Fluid inclusion data from gangue quartz suggests high temperature (200 to 227°C), high salinity (up to 15 eq. wt.% NaCl + $CaCl_2$) fluids with significant volatile contents (quantitative fluid inclusion gas analysis: 17.89 wt.% CO2). Carbon and oxygen isotope data indicate a progressive decrease in $\delta^{13}C$ from host dolomite (-1.3 ± 0.9‰) to pre-ore dolomite (-4.7 ± 1.5‰), and post-ore calcite (-5 ± 1.7‰). The $\delta^{18}O$ values remain relatively constant in all carbonate phases (-13.8 ± 2.3‰). Overall, the carbon and oxygen isotope data appear to define a mixing trend between the host dolomites and isotopically light $\delta^{13}C$ hydrocarbons (pyrobitumen), followed by re-equilibrium with the dolomite wall rocks. The $\delta^{34}S$ isotopic ratios range from 8.3 to 11.1‰ for early pyrite mineralization, 23.3 to 31.8‰ for late-stage pyrite, 16.7 to 32.9‰ for galena, and 23.2 to 33.8‰ for sphalerite. The high fluid temperatures (130 to 200°C) and relatively high $\delta^{34}S$ values associated with Pb-Zn mineralization indicate that ore deposition was associated with thermochemical sulphate reduction, controlled by an influx of hydrocarbon-bearing fluids that reacted with aqueous sulphate species (dissolved sea water sulphate and/or dissolution of solid calcium sulphate).

The Pb-Zn mineralization in the Reddick Bight Dolomite Member shares many features with Paleozoic MVT mineralization, including geological setting, mineralogy, fluid characteristics, and crustal sources for both metals and sulphur. However, the elevated fluid temperatures (>150°C) and high CO_2 (>>1 mole %) content of the mineralizing fluids are unusual when compared with Paleozoic MVT deposits. Similar characteristics have been described from other Paleoproterozoic MVT deposits (e.g., Pering Zn-Pb deposit, South Africa; Kamaraga Pb-Zn deposit, Australia). This may reflect common characteristics of MVT mineralization during the Paleoproterozoic, possibly related to lower sulphate in Paleoproterozoic seawater.