Early diagenetic controls on the size of Palaeozoic sediment hosted massive sulphide Zn deposits

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The North American Cordillera contains a number of large Zn deposits hosted in Palaeozoic biosiliceous, carbonaceous, radiolarian-rich mudstones. Stratabound barite units are associated with the ore deposits, but are also found regionally in barren, correlative sequences. Recent studies have shown that stratabound barite, pyrite and authigenic carbonate formed in the sediment at the sulphate methane transition zone (SMTZ), and are therefore a product of pre-ore diagenesis. In situ $\delta^{34}S$ values from pre-ore pyrite preserve evidence of the anaerobic oxidation of methane coupled with sulphate reduction (AOM-SR), which was an important source of reduced sulphur during diagenesis. The hydrothermal systems are superimposed on this diagenetic environment, do not exhale onto the seafloor and developed in non-euxinic conditions. The $\delta^{34}S$ values in ore-stage pyrites suggest reduced S is derived from a number of sources, including recycling of sulphate from diagenetic barite.

The radiolarian-rich host rocks, likely dominated by Opal A in the top 100s of metres of the sediment, had high porosities and permabilities that allowed the ore deposits to form in the sub-surface and precluded significant exhalation of the hydrothermal system into the water column. Therefore, the biosiliceous nature of host rock, together with the ability of the hydrothermal fluids to dissolve authigenic barite and carbonate, are major controls on the genesis and size of these important deposits.