Deposit Scale Zonation in Sphalerite Colour and Chemistry in the Macmillan Pass SHMS Deposits, Yukon – Implications for Deposit Genesis and Geometallurgy

By

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ABSTRACT

The sediment hosted massive sulfide (SHMS) deposits of the Macmillan Pass district, Yukon, are hosted within Mid-Devonian strata of the Neoproterozoic to Permian Selwyn Basin, which formed along the continental margin of Laurentia. These SHMS deposits are associated with synsedimentary faults, which acted as feeder structures for the hydrothermal fluids that formed the deposits via the replacement of sediments in the shallow subsurface. The deposit scale ore mineralogy and ore texture zonation at Macmillan Pass is correlatable between deposits and occurs with respect to distance from a deposit's feeder structure. Across a deposit it is possible to link this zonation to a series of distinct ore facies defined by mineral assemblage, relative Pb/Zn ratio, ore textures, and sphalerite colour. In this study sphalerite representing various deposits and ore facies was analysed using Electron Probe Micro-Analysis (EPMA) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) in order to determine major, minor, and trace element concentrations. Concentration data was successfully obtained for S, Fe, Zn, As, Cd, Ti, V, Cr, Mn, Co, Ni, Se, Nb, Mo, Ag, Sn, Sb, Ta, Pb, Bi, Th, and U. Correlations between elements, sphalerite colour, and/or deposit scale zonation were observed for Fe, Zn, Mn, Co, Ag, Sb, and Pb. The Fe and Zn content of sphalerite was inversely correlated and proved to be a good proxy for deposit zonation as well as sphalerite colour, for which increasing Fe content is likely the primary control. A positive correlation between Fe and Co and a negative correlation between Mn and Fe is also present. In very low Fe sphalerite, high Mn concentrations may be responsible for pink colours. Correlations between Ag and Sb, Ag and Sb, and Sb and Pb hint at possible small inclusions of tetrahedrite or other Ag-Sb minerals, Ag bearing galena, and Pb-Sb sulfosalts within sphalerite, though they do not entirely preclude the possibility these elements residing in the sphalerite lattice. An analysis of the Fe–Zn–S system at the Tom deposit, assuming a fluid temperature of approximately 225 to 275 °C in the feeder zone, predicts a low αS_2 value of 10^{-14} to 10^{-12}, which supports a local sulfur source for precipitated metal sulfides (e.g. reduction and replacement of barite). The utility of ore blending based on sphalerite colour and ore facies to control certain element concentrations in an ore concentrate is promising for Fe, Co, and Mn and is not promising, or at best unknown for all other elements. For future studies, improvements on the LA-ICP-MS method are recommended with respect to sample preparation and spot selection, external and internal standard choices, and ICP-MS equipment used.