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Mine-Scale Structural Controls on the Mount Isa Zn-Pb-Ag and Cu Orebodies

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Abstract

The Mount Isa Zn-Pb-Cu-Ag deposit contained almost 30 million tons (Mt) of base metals, prior to mining, in spatially separate Cu and Zn-Pb-Ag orebodies. The origin of the Zn-Pb-Ag ores is debated due to apparently conflicting features at intermediate to microscales. Ambiguity is associated with small-scale features, which can be interpreted either in terms of syndeformation mineralization or in terms of remobilization of a predeformation orebody when considered in isolation of larger scale characteristics of the orebody. Understanding the relationship between metal distribution and the structural framework at the mine scale helps to determine whether the orebody is deformed and leads to a better understanding of its formation.

The deposit contains 10 strata-bound Zn-Pb-Ag orebodies in an en echelon array. The extremities of the orebodies correlate with F_4 folds, and high-grade shoots are centred on F_4 hinges and short limbs that contain older F_2 folds. Contours of Pb/Zn ratios throughout the orebodies are parallel to F_4 hinges and silica-dolomite alteration fronts. Restoring the large-scale effects of folding by rotating bedding and the orebodies to horizontal indicates that a sedimentary exhalative style of mineralization cannot account for the present geometries of the Zn-Pb-Ag orebodies. This reconstruction places the depositional basin in a compressional setting or places the ores on topographic highs. These scenarios are considered to be incompatible with synsedimentary processes.

There are a number of important similarities between the geometries of the Zn-Pb-Ag bodies and the copper orebodies, which are interpreted to have a syntectonic origin. The Zn-Pb-Ag orebodies display the same structural controls as the syntectonic copper ores and appear to have been emplaced at the same time during D_4. Older F_2 folds are preserved on the hinges and short limb areas of F_4 folds and are interpreted to have behaved as structural heterogeneities during D_4, which caused the dilation that led to metal deposition. F_4 folds closest to the copper orebodies contain the highest grade Zn-Pb-Ag ore shoots, possibly indicating decreasing metal deposition away from the copper ores as fluids became progressively depleted in metals and/or concentration of fluid flow near the copper orebodies. In some areas, Zn-Pb-Ag ores wrap around silica-dolomite alteration associated with syntectonic copper mineralization, suggesting a similarly late timing. The continuity of metal grades and Pb/Zn ratios throughout the Zn-Pb-Ag orebodies indicates that the ores are not the result of local remobilization. Instead, large-scale processes that introduced metals from an external source during D_4 must have been involved in the formation of these orebodies.

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