

Thermodynamic modeling of Ag-Pb-Zn deposition from typical magmatic-hydrothermal ore system

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Introduction

Silver-lead-zinc mineralized veins are commonly discovered worldwide and have contributed significantly to world production of these commodities. However, their genesis remains controversial. A number of new discoveries of base and precious metal (Ag-Pb-Zn) vein type deposits in the Great Hinggan Range ore district have made this region the most important Ag-Pb-Zn metallogenic belt in China. Numerous well-preserved hydrothermal Ag-Pb-Zn vein system in this region provides an excellent opportunity to determine the physicochemical conditions of ore formation and the crucial controls on silver deposition.

Results and Discussions

In this contribution, we present the results of a comprehensive investigation of the typical Ag-Pb-Zn deposits utilizing ore mineralogy, texture, and thermodynamic modelling. Physicochemical calculations suggest that the silver bisulfide species (AgHS^\ominus) was the dominant species responsible for Ag transport in an intermediate-low temperature (170° to 220 °C), relatively reducing and weakly acidic aqueous fluid. The phase equilibrium calculations and mineral deposition modeling explain satisfactorily the commonly observed precipitation sequences of base and precious metals from the fluid, and reveal that the fluid-rock interactions leading to reduction (decreasing $\log f\text{O}_2$) and cooling of the fluid are the key factors to decrease silver solubility and successively promoted silver precipitation. This study emphasizes the importance of fluid-rock interactions between hot and metal-rich aqueous fluids mostly with a magmatic origin and relatively reduced host rocks in producing large Ag-Pb-Zn vein type deposits. The thermodynamic modeling further suggests that an externally derived fluid is not a prerequisite for the formation of large base metal vein type deposits. The mechanism of Ag-Pb-Zn ore formation highlighted in this study can be used to understand the genesis of other base metal vein type deposits in comparable geological settings elsewhere.