PREDICTION OF MISSISSIPPI-VALLEY TYPE ORE FLUID METAL CONCENTRATIONS FROM SOLID SOLUTION METAL CONCENTRATIONS IN ORE-STAGE MINERALS

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Abstract

Mississippi-Valley type (MVT) deposits represent extreme enrichment of Pb, Zn, Ba, and F in the Earth's crust. Key to understanding the formation of these deposits is knowledge of the ore fluid Pb. Zn, Ba, and F concentrations. Recent research aimed at determination of ore fluid Pb, Zn, and Ba concentrations has focused on LA-ICP-MS analyses of fluid inclusions. However, LA-ICP-MS results for Pb and Zn concentrations are equivocal due to interferences from Zn and Pb in the host mineral matrix and uncertainties about the source of Pb and Zn signals. In light of these limitations, this study sought to determine metal concentrations in MVT ore fluids by calculating them theoretically from their solid solution concentrations in the ore-stage minerals calcite and galena.

Concentrations of Mg, Mn, Fe, Zn, Sr, Ba, and Pb in the ore fluid were predicted using experimental partition coefficients from Rimstidt et al. (1998) and measured compositions of ore-stage calcite from the Illinois-Kentucky and Central Tennessee MVT districts. The predicted ore fluid concentrations of Mg and Mn, which form calcite structure carbonates, were in good agreement with available fluid inclusion data for these elements. Thus, the predicted ore fluid concentrations of Zn and Fe, which also form calcite structure carbonates, 10's of ppm Zn and 1's to 10's of ppm Fe in Illinois-Kentucky and a maximum of 10's of ppm Zn and 1's to 10's of ppm Fe in Central Tennessee, are likely to be accurate. In contrast, the predicted ore fluid concentrations of Sr and Ba, which form aragonite structure carbonates, were in poor agreement with available fluid inclusion data for these elements. Thus, the predicted 1's of ppm ore fluid concentration of Pb, which also forms an aragonite structure carbonate, is unlikely to be accurate.

Using predicted thermodynamic data (Sverjensky, 1985) for ZnS with the galena structure, a thermodynamic distribution coefficient for Zn between aqueous solution and solid solution in galena was calculated and used in combination with solid solution Zn concentrations in galena from the Central Missouri, Central Tennessee, Illinois-Kentucky, Northern Arkansas, Tri-State, and Southeast Missouri MVT districts to predict ore fluid Zn/Pb ratios. The Zn/Pb ratios do not agree with the ore Zn/Pb ratios of the districts and appear to be an artifact of the temperature used in the calculations. Thus the predicted ore fluid Zn/Pb ratios are unlikely to be correct