

Public Abstract

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

Mississippi-Valley-type (MVT) deposits have some of the greatest enrichments of Pb, Zn, Ba, and F in the Earth's crust. Fundamental to understanding how these elements were transported and precipitated to form MVT deposits is knowledge of their concentrations in the ore fluids. Previous research aimed at determining the concentrations of Pb, Zn, and Ba in the ore fluids that formed the MVT deposits has focused on analysis of fluids trapped during mineral precipitation, fluid inclusions. However, the results for Pb and Zn concentrations are equivocal due to interferences from Zn and Pb in the host mineral matrix and uncertainties about whether the measured Pb and Zn signals arise from Pb or Zn in aqueous solution or from "accidentals", i.e. solid particles of Pb or Zn bearing minerals trapped within the fluid inclusions. In light of these limitations, this study sought to determine metal concentrations in MVT ore fluids instead by calculating them theoretically based on their solid solution concentrations measured in the ore-stage minerals calcite and galena.

Using experimental partition coefficients from Rimstidt et al. (1998) at ore stage temperatures and measured compositions of ore-stage calcite from the Illinois-Kentucky and Central Tennessee MVT districts, concentrations of Mg, Mn, Fe, Zn, Sr, Ba, and Pb in the ore fluid were predicted. The predicted ore fluid concentrations of Mg and Mn, which form carbonate minerals (magnesite and rhodochrosite) with the calcite structure, 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 carbonate minerals (smithsonite and siderite) with the calcite structure, 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. These Zn concentrations are typical of modern sedimentary brines and high enough to allow efficient Zn ore formation. In contrast, the predicted ore fluid concentrations of Sr and Ba, which form carbonate minerals (strontianite and witherite) with the aragonite structure, 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 a carbonate mineral (cerussite) with the aragonite structure, 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. This distribution coefficient was used in combination with Zn concentrations measured in solid solution in galena from the Central Missouri, Central Tennessee, Illinois-Kentucky, Northern Arkansas, Tri-State, and Southeast Missouri MVT districts to predict Zn/Pb ratios for the ore fluids. 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. Therefore the predicted ore fluid Zn/Pb ratios are unlikely to be correct.