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LIMITS ON THE METAL CONTENT OF FLUID INCLUSIONS IN GANGUE MINERALS FROM THE VIBURNUM TREND, SOUTHEAST MISSOURI, DETERMINED BY LASER ABLATION ICP-MS

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Abstract

The hydrothermal fluids that deposited the ores of the Viburnum Trend of the Southeast Missouri district have long been recognized to be sedimentary basinal brines. The major element composition of these brines has been well characterized; however, there have been no attempts to measure their metal content, which is only loosely constrained by theoretical solubility relations. The present study is an effort to assess the metal content of these mineralizing brines by analyzing fluid inclusions from gangue minerals in the Viburnum Trend using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) and microthermometry. By focusing on gangue minerals instead of metal sulfide minerals, interferences from the mineral matrix are avoided. A high priority was to determine whether brines of anomalously high metal content were circulating through southeast Missouri during the time of Mississippi Valley-type mineralization.

Fluid inclusions in dolomite, quartz, and calcite gangue from throughout the Viburnum Trend and representative of the entire paragenesis were analyzed. None of the inclusions contained measurable quantities of Pb, Zn, or Cu and only a few contained measurable quantities of Ba, which ranged from about 100 to 500 ppm. Where detection limits were not exceeded, they indicated maximum possible concentrations of the element in the fluid inclusion. Maximum possible concentrations varied from inclusion to inclusion and were controlled by the mass of analyte within the fluid volume—the larger or more saline the inclusion, the lower the detection limit. These results showed that the fluid that deposited quartz, calcite, and most of the dolomite gangue in the Viburnum Trend is unlikely to have had order-of-magnitude concentrations of Pb and Zn higher than 10^2 ppm or order-of-magnitude concentrations of Cu higher than 10^1 ppm. Concentrations of Pb and Zn during deposition of stage 3 dolomite could not have been higher than 10^3 ppm, and concentrations of Cu could not have been higher than 10^2 ppm. These upper limits on possible metal concentrations, with the principal exception of those in stage 3 dolomite fluid inclusions, are of magnitude similar to the highest measured concentrations of Pb, Zn, Cu, and Ba found in typical sedimentary brines. Thus, the brines responsible for depositing gangue minerals in the Viburnum Trend are unlikely to have had higher ore metal concentrations than typical basinal brines. The lack of temporal overlap between gangue and metal sulfide deposition, and the higher K/Na and lower Ca/Mg ratios in fluid inclusions in the gangue minerals compared with fluid inclusions in the metal sulfides, leaves open the possibility that the metal content of the fluid that deposited the sulfides was different from that responsible for depositing gangue. However, the data show that fluid entering the Southeast Missouri district was not pervasively metal rich throughout time, and that if metal-enriched fluid ever entered the district it did so at discrete intervals.

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