Origin of Mississippi Valley-type deposits in the U.S. mid-continent: Insights from trace occurrences of mineralization

MARTIN S. APPOLD[1*], JOSHUA D. FIELD[1] AND RAYMOND M. COVENEY, JR.[2]

[1]Department of Geological Sciences, University of Missouri—Columbia, Columbia, MO 65211 USA (*correspondence: appoldm@missouri.edu)

[2]Department of Geosciences, University of Missouri—Kansas City, Kansas City, MO 64012 USA (coveneyr@umkc.edu)

Widespread occurrences of sphalerite±calcite±dolomite± galena mineral assemblages in Paleozoic carbonate rocks in the U.S. mid-continent record the passage of saline hydrothermal fluids with temperatures typically between 80-150° C. Most of these occurrences consist of no more than traces of mineralization. However, in a few occurrences, mineralization has accumulated into great ore bodies that have defined the Mississippi Valley-type (MVT) deposit class. What factors govern the growth of large MVT ore deposits? Recent research has sought to answer this question by studying the composition of ore fluids trapped as fluid inclusions in major MVT ore districts like the Southeast Missouri, Tri-State, Northern Arkansas, Central Missouri, and Illinois-Kentucky districts. This research has shown that the ore fluids most likely were sedimentary basinal brines that were highly dolomitizing, chemically reducing, and rich in methane, but compared to typical sedimentary brines were enriched in potassium and possibly lead. Current research on trace occurrences of MVT mineralization shows systematic differences in the compositions of fluids that formed trace mineralization and those that formed ore-grade mineralization. Compared to fluid inclusions in MVT ore deposits, fluid inclusions in trace MVT mineralization tend to have slightly lower homogenization temperatures, salinities, and potassium concentrations, but higher magnesium concentrations. Fluid inclusions in trace MVT mineralization do not contain detectable methane whereas fluid inclusions in MVT ore deposits contain hundreds of parts per million (ppm) methane. As for MVT ore deposits, some fluid inclusions in trace MVT mineralization contain high apparent lead concentrations on the order of hundreds to thousands of ppm. Lead isotope compositions of trace MVT occurrences are significantly less radiogenic than those of MVT ore deposits. The results of the present study suggest that the fluids that formed trace MVT mineralization in the U.S. mid-continent were compositionally distinct from the fluids that formed MVT ore deposits and acquired less of their lead from the Precambrian basement.