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Lead-isotopic characteristics of the Silesian–Cracow Zn–Pb ores (southern Poland)

New lead-isotope analyses of a suite of samples of ore collected from a paragenetic sequence in the Silesian–Cracow Mississippi Valley-type (MVT) district show no lead-isotopic variation and are in agreement with lead-isotopic results from previous work by R. E. Zartman et al. (1979). Two well-studied MVT districts in the world show uniform lead-isotopic compositions, the Silesian–Cracow and the Pine Point districts. The lead-isotopic data require that the saline hydrothermal fluids which formed these deposits be prevented from circulation through crystalline basement rocks. This requirement is met in both the Silesian–Cracow and Pine Point districts because thick sequences of Devonian shale and carbonate rocks containing shale aquacludes separate the aquifers from basement rocks in both basins.

We postulate two sources of lead that might account for such uniform lead-isotopic signatures. Hypothesis one would require that the ore lead is bound in iron-oxide phases in multicycle molasse sedimentary rocks. In this case, leaching of ore lead must have occurred shortly after deposition to prevent measurable contributions of radiogenic lead that would form because of radiogenic decay of uranium and thorium in the silicate components of the sediments and that, upon leaching by the hydrothermal fluids, would result in a radiogenic lead-isotope array such as seen in most other MVT deposits. The time span between deposition and leaching would be limited by the mass balance between lead in the iron-oxide phases and the radiogenic lead in the silicate components. Hypothesis two calls for leaching of lead from evaporite sequences in the Upper Silesian Basin. Concentrations of lead from the evaporite sequence in the Western Canada sedimentary basin average almost 1 ppm in halite and 10 ppm in anhydrite (D. S. Thiede, E. N. Cameron, 1978). Dissolution of the evaporite

sequences in the Upper Silesian Basin by meteoric recharge in the Pre-Carpathian Mountains would produce the hydrodynamic fluid flow necessary to produce the highly saline brines currently in the Upper Silesian Basin. Mixing of these saline brines with sulfur-rich waters would cause precipitation of the ores. Lead in the evaporites would be uniform in composition because it was homogenized in solution and precipitated along with the evaporites. Furthermore, lead would be decoupled from uranium and thorium; thus, there would be no radiogenic growth of lead in the source rocks. Under these conditions, the 230 Ma model age of the lead in the Silesian–Cracow ores would reflect the age of the source rocks and provide no constraints on the time of formation of the ore deposits themselves but instead constrains the age of the source of lead. Further research is needed to test these two hypotheses.

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