

Pb Isotope Ratios of Lower Mississippian Boone Formation Chert and Its Potential Relationship to Mississippi Valley-Type Ore Deposits, Southern Midcontinent

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Abstract

The Lower Mississippian Boone Formation chert-bearing carbonates serve as a host for Mississippi Valley-Type (MVT) Pb/Zn ore deposits in the Southern Ozarks Region in both the Tri-State Mining District and the Northern Arkansas District. MVT ore deposits are typically hosted by carbonate intervals on the flanks of sedimentary basins and are emplaced by hydrothermal fluids (ranging between 75°C-200°C). Other authors have linked MVT deposits with hydrocarbons, which often occur in close proximity, and have even proposed organic rich, black shales as a source of metals. The MVT deposits in the midcontinent region contain highly radiogenic Pb, and Pb isotope results indicate a potential genetic relationship between the Boone Formation tripolitic chert interval and the MVT ore deposits. Tripolitic chert in the Boone Formation is a porous, microcrystalline chert formed by replacement of carbonate by silica and subsequent leaching. Boone Formation chert samples were strategically collected to represent a stratigraphic and geographic distribution in northern Arkansas and adjacent areas. Whole rock samples were powdered, digested, and analyzed for Pb isotope ratios using a high-resolution Nu Plasma MC-ICP-MS and trace element concentrations using a Thermo Scientific iCAP Q ICP-MS. The Pb isotope ratios were age corrected to 250 million years, corresponding to the precipitation of the ores for comparison. The Boone Formation cherts exhibit a range of Pb isotope ratios (age corrected Pb isotope ratios range 18.5551 to 21.8540 for $^{206}\text{Pb}/^{204}\text{Pb}$, 15.6456 to 15.8886 for $^{207}\text{Pb}/^{204}\text{Pb}$, and

38.4385 to 40.6122 for $^{208}\text{Pb}/^{204}\text{Pb}$), but specifically the tripolitic chert and adjacent intervals contain highly radiogenic Pb ($^{206}\text{Pb}/^{204}\text{Pb} \sim 21.5473$, $^{207}\text{Pb}/^{204}\text{Pb} \sim 15.8547$, $^{208}\text{Pb}/^{204}\text{Pb} \sim 40.2698$; median values for tripolitic interval) similar to the MVT ore deposits in the Northern Arkansas and Tri-State districts. It is hypothesized that the tripolitic chert interval acted as a fluid migration pathway for the hydrothermal fluids responsible for the MVT ore deposition and the silicification of this interval. The Boone Formation likely assimilated radiogenic Pb during the replacement of carbonate by silica via hydrothermal fluid alteration. Porosity within the tripolitic chert is the result of post-silicification leaching of disseminated carbonate within the rock, and contains terminated euhedral quartz crystals, suggesting multiple phases of silica-bearing hydrothermal fluid movement through this interval.