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Experimentally Determined Partitioning of Cu and Pb between Brine and Dolomite: Toward a Tool for Determining Cu and Pb Concentrations of Ancient Sedimentary Ore-Forming Brines

MRIDULA MAMUN BRISTY[1], MARTIN S. APPOLD[1] AND HECTOR LAMADRID[2]

[1]University of Missouri-Columbia
[2]University of Oklahoma

A comprehensive understanding of ore fluid compositions is essential for understanding the origin of sediment-hosted base metal deposits, particularly ore fluid base metal concentrations, as they directly affect possible precipitation mechanisms and the time needed for deposit formation. Despite the attention given in the literature, base metal concentrations of ancient sedimentary ore-forming fluids and methods for measuring them effectively remain uncertain. One possible method is based on element partitioning between a fluid and a mineral. For example, dolomite, a common ore-stage gangue mineral in sediment-hosted base metal deposits, may incorporate copper and lead into its crystal structure in proportion to their concentrations in the parent fluid. Thus, if the Cu and Pb concentrations in dolomite can be measured, then the Cu and Pb concentrations in the brine that precipitated that dolomite can be calculated, provided that a suitable partition coefficient is available. This study aims to determine such partition coefficients from laboratory experiments performed at conditions typical of sediment-hosted base metal ore deposit formation. The experiments employed a synthetic sedimentary brine containing ~21 weight % total dissolved solids, and Cu and Pb concentrations of either 100 or 1000 ppm. Thus far, copper experiments have been performed at a pressure of 100 bars and temperatures between 125 and 200°C for durations between 10 and 90 days. For lead, experiments have been performed at the saturation pressure of water at 200°C for 10 and 20 days. All of the experiments were confirmed by powdered X-ray diffraction analysis to have produced ordered dolomite. The elemental composition of the dolomite was determined by LA-ICP-MS. Based on 17 precipitates, the average partition coefficient values calculated for Cu are 325, 570, and 115, with standard deviations of 300, 460, and 90, at temperatures of 200°, 175°, and 150° C, respectively. However, the partition coefficient values determined thus far have not yet stabilized as a function of experimental duration, suggesting that longer experiments, which are currently ongoing, are required to reach equilibrium. Nonetheless, these partition coefficient values are an advancement toward generating a convenient tool for determining base metal concentration in brines under typical sedimentary basinal conditions.