Potential Pb mobilization, transport, and sequestration in shallow sandstone aquifers impacted by CO_2 leakage: A natural analogue study from the Virgin River Basin, Southwestern Utah

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Geologic carbon sequestration (GCS) can help reduce greenhouse gas emissions, but it poses contamination risks if CO_2 and brine were to leak out of deep storage formations into underground sources of drinking water. For this study, a natural analogue in the Virgin River Basin of Southwestern Utah where salty, moderately CO_2-rich water is leaking upward into shallow aquifers was investigated. The aquifers include the Navajo Sandstone, which is pervasive across southern Utah and has been considered as a potential GCS target where it is sufficiently deep. Multi-scale numerical models of the site were constructed based on measured water chemistry and head distributions from previous studies. Simulations performed with TOUGHREACT were used to improve understanding of the rate and distribution of the upwelling flow into the aquifers, and to assess the reactive transport processes that may occur if the upwelling fluids were to interact with a zone of iron oxide and other heavy metals, representing concretions that are common in the Navajo Formation. Various concretion zone compositions were tested, including one in which Pb was adsorbed to ferrihydrite (a hydrated FeOH compound), and another in which it was bound within a solid solution of litharge (PbO) and hematite (Fe_2O_3). Results indicate that metal mobilization depends strongly on the source zone composition and that Pb transport can be attenuated by gas phase formation, downward migration due to increased water density when metals dissolve, and carbonate mineral precipitation.