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CO_2 storage site CO_2 SO_2 NO_X O_2 reactions and metal mobilisation

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A demonstration site in the Surat Basin, Australia previously underwent an environmental impact assessment. The reservoir is in a deep, brackish, part of the lower Precipice Sandstone. However, the broader formation is an aquifer of the Great Artesian Basin, therefore stakeholders are sensitive to potential environmental impacts. Drill cores from the reservoir, the overlying and underlying formations were characterised for minerals, total and extracted metals, and porosity. Elements including Li, Ba, Sr, K, Mg, V, Zn, REE, Fe, Pb, P, and S were relatively elevated in the Moolayember Formation seal underlying the reservoir. Synchrotron XFM showed the main host of Mn was siderite, with Rb in K-feldspar, Zn and Cu in sphalerite and chalcopyrite, and As mainly hosted in pyrite in coal pores associated with coal laminations. Drill cores were reacted at reservoir conditions with synthetic formation water and an impure CO_2 stream of CO_2-SOx-NOx-O_2 expected to be injected at the site. Elements released were dependant on mineral content where quartz rich reservoir, Precipice Sandstone, reactions resulted in dissolution of trace carbonates, sulphides and monazite, and variable elevated dissolved Pb, and U. Dissolved Co, Ni, Ca, Zn, Li, Rb, and U were released at relatively elevated concentrations from the mudstone. With carbonate cemented upper Precipice Sandstone or Moolayember Formation core, dissolution of calcite, ankerite, siderite, Fe-rich chlorite, sulphides or monazite were observed after reaction. Dissolved elements including Ca, Mg, Mn, Sr, and Ba increased from reaction of calcite, siderite and ankerite. Generally dissolved Fe, Pb, Cr, Cu, Co etc. increased from mineral dissolution, then subsequently decreased in concentration with adsorption and precipitation. In the reactive transport model, fast mobilisation of elements including Fe and Pb are consistent with metal release from carbonate dissolution and desorption. The presence of O_2 and NO_X results in Fe-(oxyhydr)oxide precipitation especially where Fe was rapidly mobilised from dissolution of siderite and Fe-chlorite. This provides new adsorption sites for sequestering a proportion of the trace metals. These processes are applicable to other CO_2 storage sites and potential leakage indicators in overlying drinking water aquifers. The findings are also more broadly applicable to other subsurface energy storage.