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Trace metal mobility during CO_2-SO_2-NO-O_2 storage

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The environmental impacts of CO_2 storage are an important component of risk assessment of planned CCUS projects. Potential impacts include degradation of water quality from elevated concentrations of trace elements (eg. As, Cd, Co Cu, Mn, Ni, Pb, Zn), both in the deep storage system and in shallower groundwater systems being utilized for groundwater extraction. In this study, reactive transport modelling, in combination with geochemical characterisation of trace metal sources and mobilisation mechanisms is used to identify what the potential environment impacts may be. 2D radial and 3D multiphase reactive transport models were generated using the TOUGHREACT numerical simulation software. The models were populated using physical and chemical data derived from core sourced from near the targeted storage site. The sources of easily mobilised trace elements included carbonates and pyrite as well as adsorption sites and the sinks utilised in the modelling included carbonate minerals and adsorption. The numerical models show trace element behaviour consistent with the experiments. The elements As, Cd, Co Cu, Mn, Ni, Pb, Zn were mobilised as the carbonate minerals containing them were dissolved when in contact with the injected CO_2. Oxygen in the injection stream resulted in precipitation of iron oxyhydroxide producing additional adsorption sites. The mobility of the trace elements was enhanced in regions where lower pH water occurred, either through the migration of the CO_2 or through density driven convection currents moving towards the base and along the base of the model domain. The advective front was typically depleted in the trace elements mobilised relative to concentrations near where the migrating water initiated indicating that longer migration distances would result in diminishing trace element mobility.