Geochemical CO_2-SO_2-O_2-fluid-rock interactions

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The reactivity of the impurity gases SO_2 and O_2 which may be present in industrial CO_2 capture streams from coal post combustion capture, oxyfuel firing, gas processing, cement or steel production etc. have been investigated through the CO2CRC and ANLEC R&D.

Six reservoir and seal cores from the West Wandoan-1 well, drilled at the CTSCo Surat Basin CCS project site in Queensland, Australia, were selected for visualisation and quantification of porosity and mineralogy by micro-CT and QEMSCAN. SEM, XRD, and selected porosity-permeability measurements were also undertaken before and after high PT batch experiments with a supercritical CO_2-SO_2-O_2 gas mixture and low salinity brine at reservoir temperature and pressure.

The reservoir rock, Precipice Sandstone, showed minimal change, except minor movement of kaolin. Potential initial changes to water quality (low pH and high sulphate from SO_2) were identified through geochemical analysis of reaction fluids. The overlying Evergreen Formation cores showed a variable response controlled mainly by mineralogy. Reshaping of pore networks by dissolution of calcite cements was characterised by micro-CT in core from the reservoir-seal interface. In carbonate-poor low permeability seal core, corrosion of Fe-rich chlorite, plagioclase, and minor carbonates contributed to initial increases in dissolved cations. In an overlying section of Hutton Sandstone core, calcite cement convertion to higher volume Ca-sulphate indicated potential self-sealing capacity over longer time-scales. Reductions in dissolved trace metals were most apparent where mineral precipitation occurred. Enhanced dissolution of silicates with impurity gases present indicated potential for accelerated mineral trapping which is currently being investigated. Data from these and previous studies are contributing to geochemical model validation and improvement [1][2][3].

The findings of this study are applicable to understanding potential impacts of impurities in other carbon storage sites expecting to inject impure CO_2.

[1] Pearce et al. (2014) *ChemGeo*, 10.1016/j.chemgeo.2014.10.028. [2] Farquhar et al. (2014) *ChemGeo*, 10.1016/j.chemgeo.2014.10.006. [3] Kirste et al. (2013) *MinMag*, 77, 1470.