Geochemical and geomechanical testing of samples from a potential Surat Basin CO_2 sequestration site

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Lab experiments were conducted on fresh core from the target formations of the Wandoan geosequestration project in the Surat Basin, Queensland, Australia. The Surat core samples were taken from a stacked reservoir-seal sequence. The Upper Triassic to Lower Jurassic Precipice Sandstone is the potential CO_2 storage reservoir, with the overlying Lower to Middle Jurassic Evergreen Formation acting as the primary seal.

Geochemical reaction investigations of the CO_2-H_2O-rock system of target formations were carried out using both batch and continuous flow reactors. For most samples, the conditions of 60°C and 12 MPa were used to simulate in situ conditions of the site. The fluids of the batch reactors were sampled over a period of some 28 days, as this project is focused upon the short-term behaviour of the near wellbore environment during injection. Geochemical modelling using GWB was used to explore possible mineral reactions during the experiments. Both mineral dissolution and precipitation took place, with dissolution being predominant.

Sample characterisation before and after reaction included X-ray micro-CT scanning, QEMSCAN, SEM-EDS, stressed and unstressed permeability, rock strain response, and Hg-porosimetry. Carbonates and some silicates such as iron-rich chlorite reacted during the experiments, with overall sample porosity and permeability increasing in most cases, although less so for the low-reactivity Precipice Sandstone than for samples with more varied mineralogy.

The pre and post reaction CT-scans of samples were used to build pore-scale models using an in-house extended Lattice Boltzmann Model (XLBM) for understanding fluid flow and local changes to the flow architecture at the mesoscalse, including porosity change with calcite dissolution. Large scale near wellbore modelling using GEM and very conservative simplifying assumptions showed a substantial improvement in injectivity in more reactive lithologies