



Caprock effects of geological sequestration of Carbon Dioxide

P. Armitage (1), D. Faulkner (1), R. Worden (2), J. Illife (3)

(1) Rock Deformation Laboratory, Department of Earth & Ocean Sciences, University of Liverpool, UK, (2) Department of Earth Sciences & Ocean Sciences, University of Liverpool, UK, (3) BP Exploration, Sunbury on Thames, Middlesex, UK (peter.armitage@liv.ac.uk / Phone: 0044 0151 794 5149)

Elevated concentrations of anthropogenically sourced greenhouse gases in the atmosphere since the industrial revolution, particularly CO₂, have been strongly implicated as a cause of global warming. Options to reduce emissions include injection of industrially produced CO₂ into geological reservoirs for long term storage. The subsurface storage of CO₂ can only work if there is closure to structure intended to trap it, part of which requires a sealing caprock, commonly a low permeability mudstone.

Subsurface storage of CO₂ is a recent and novel proposal. As such there is a lack of data pertaining to geochemical reactions and their effects caused by storage. Our geochemical modelling has shown that dissolution of CO₂ in reservoir formation water will lead to pH as low as 3. Acidic conditions could cause various geochemical reactions with the caprock, our experiments have shown up to 25% weight loss, predominantly of carbonates, in bulk dissolution experiments. These reactions could potentially change a caprock's physical properties, such as permeability and porosity and promote the leakage of CO₂ from the structure. There is a particular paucity of information relating these reactions. Evidence from enhanced oil recovery, experimental studies, and field trials indicate possible reactions including carbonate mineral dissolution, and feldspar and clay alteration reactions. Although the majority of these studies concentrate on the host formation rather than the caprock, the reactions could be indicative of caprock reactions.

We address this problem experimentally. Caprock samples recovered from a CO₂ injection pilot scheme are placed under confining pressures of up to 100 MPa, simulating

pressure conditions at depth. Initially the permeability of the samples have been determined with an inert pore fluid (argon). We plan to monitor the permeability of the samples using a constant flow rate with acidic solutions, simulating the pH of aqueous CO₂ fluids. Finally we will use acidic CO₂ / water mixes over prolonged time periods (days to weeks) using servo-controlled pumps at either end of the sample. Continuous measurement of flow rate and pressure difference across the sample during the experiment will be used to monitor any temporal porosity and permeability changes with progression of the experiment and hence geochemical reaction. Analysis of samples, using techniques such as XRD, CL and SEM at various points in their dissolution history will quantify the types and rates of geochemical reactions and their effects on the physical properties of the rock.

This contribution describes the scope of the problem to be tackled, defines the key issues that motivate the current investigation and outlines our experimental approach, initial mudstone characterisation and properties results. Preliminary permeability experiment results are presented, initially using argon as the permeant, then a low pH fluid.