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Experimental investigation of the effect of coupled processes (Thermo-Hydro-Mechanical-Chemical) on CO_2 flow through fractured caprock

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In order for geological storage of CO_2 to be effective in mitigation of anthropogenically induced climate change, the occurrence of CO_2 leakage from the storage reservoir to the surface must be negligible. One of the key potential pathways for CO_2 leakage is escape through macroscopic fractures or faults in caprock overlying the storage reservoir. The laboratory investigation of fracture permeability to CO_2 under a range of in-situ temperature and pressure conditions, using typical caprock samples, will improve understanding of the flow and transport properties of CO_2 under typical geological storage conditions. Knowledge gained from such laboratory investigations will be critical for development of accurate models of CO_2 flow and transport in the subsurface, which in turn will inform on leakage risk and site suitability.

Experimental equipment has been designed and built at the University of Edinburgh that allows investigation of CO_2 flow through 38mm diameter rock samples under realistic reservoir/overburden conditions of temperature (up to 80°C) and pressure (up to 60MPa). The fractured rock sample is contained within a Hassler-type uniaxial pressure cell and CO_2 flow through the sample is controlled via high precision, high pressure syringe pumps. Fluid pressures upstream and downstream of the sample, and the confining pressure, are continuously monitored.

Single phase CO_2 flow experiments have been conducted on artificial planar fractures within a variety of representative caprock samples. The effect on fracture permeability of varying: (i) effective stress (confining pressure); (ii) temperature; and (iii) fluid pressure has been investigated. The impact of mineralogy has also been considered through comparison of results obtained from samples of differing rock type.

Initial results and findings from the experiments are presented. A discussion of the use of the experimental results for development of coupled process (thermo-hydro-mechanical and chemical) single fracture benchmark models is also included. Proposed future experimental work, which includes investigation of natural fractures, is outlined.