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Evaluating and quantifying the potential for CO_2 leakage through the caprock during carbon sequestration using a Risk Matrix

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Geological sequestration of CO_2 in deep aquifers or depleted oil/gas reservoirs is considered a solution for reducing excess CO_2 currently being emitted to the atmosphere. Low permeability cap rocks trap the CO_2 that is then sequestered in the underlying porous reservoir or aquifer rock.

The long term dependability of CO_2 sequestration is directly linked to the integrity of the caprock seals effectively trapping the CO_2. Evaluation and quantification of all of the possible CO_2 leakage risks and their severity and probability throughout the life of the carbon sequestration timescale is essential.

This study aims to identify the CO_2 leakage risks, analyse them and then evaluate the impact of each risk - will it cause leakage, how will it leak and how much will it leak? The risks assessed covered all factors that may lead to CO_2 leakage including those associated with matrix permeability, CO_2 diffusion, aquifer flow, $scCO_2$ flow properties, capillary transport, effective and relative permeability of the $scCO_2$ / brine / pore system, migration through fracture and microfracture network both existing and induced, geological discontinuities and the wellbore and drilling environment.

The risks were assessed by assigning a severity and probability to each identified risk. Severity was ranked from 1 to 5; where 1 was mm scale intrusion and 5 was leakage above the top caprock. Probability was also ranked from 1 to 5; where 1 was likelihood of happening after 10,000 years and 5 was likelihood of it happening during injection.

A risk matrix was produced which highlights the risks that will have the most significant impact on CO_2 sequestration reliability.