Evaluating and quantifying the potential for CO2 leakage through the caprock during carbon sequestration using a Risk Matrix

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The long term dependability of CO2 sequestration is directly linked to the integrity of the caprock seals effectively trapping the CO2. A Risk Matrix provides an evaluation of the possible CO2 leakage risks through the caprock by quantifying the probability and severity of any CO2 leakage throughout the carbon sequestration timescale. This provides a methodology to assess storage site quality. The risks were quantified by assigning a severity and probability to each identified risk.

Severity was ranked from 1 to 5; where:
1 - Intrusion of CO2 into the first mm of the caprock.
2 - Intrusion of CO2 into the first 10 cm of the caprock.
3 - Intrusion of CO2 into the first meters of the caprock.
4 - Intrusion of CO2 into the first tens of meters of the caprock.
5 - Intrusion of CO2 above the top caprock.

Probability was also ranked from 1 to 5; where:
1 - Likelihood of CO2 leakage after 10000 years.
2 - Likelihood of CO2 leakage after 1000 years.
3 - Likelihood of CO2 leakage after 100 years.
4 - Likelihood of CO2 leakage after 10 years.
5 - Likelihood of CO2 leakage during injection.

Methodology
A questionnaire was sent out to the MUSTANG partners asking for:
• Best guess value of severity and probability for each leakage risk.
• Maximum value for each leakage risk severity and probability.
• Minimum value for each leakage risk severity and probability.
• Personal expert level on each leakage risk factor.
• The more expert input the more reliable the CO2 Leakage Risk Matrix.
• Currently there is only input from 3 experts and the Risk Matrix is still under development.
• The data will facilitate a study of expert level on risk perception.

This study aims to identify the CO2 leakage risks during carbon sequestration using a Risk Matrix. The leakage risks are identified and the impact of each risk evaluated and quantified. What factors will cause CO2 leakage? how will it leak? how much will it leak? and how far will it leak?

The risks were assessed for all factors that may lead to CO2 leakage through the caprock including those associated with the rock properties and well environment and those associated with the reservoir and CO2 fluid properties:
• Migration through fracture and microfracture network existing and induced, caprock matrix permeability, geological discontinuities and the wellbore / drilling environment.
• CO2 diffusion / aquifer flow, scCO2 flow properties, capillary transport, effective and relative permeability of the scCO2 / brine / pore system and mineral precipitation / dissolution.

If you wish to discuss further or receive a Risk Assessment questionnaire please contact: kedlmann@staffmail.ed.ac.uk.