Carbon Storage Prospect Assessment – Integrating Uncertainty on Pore Space, PVT, Seal and CO_2 Plume Shape

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Abstract

In the early exploration phase, when areas are screened for their potential for carbon storage, leads and prospects need to be evaluated in a time-efficient, transparent and auditable way. In most cases available data is incomplete and of various types and quality. Decisions to proceed or not with the investigation of a prospect need to consider a balance between storage capacity, injectivity, containment risk and monitorability. Currently, there is no common agreement on any of these terms in the industry, and even within the same company, assessment workflows differ dependent on the evaluation teams, areas and prospects.

We propose a probabilistic assessment workflow which addresses some of these issues and allows for a consistent and quantitative prediction of containment risk and storage capacity for different types of prospects, including open saline aquifers. Our approach fully integrates subsurface uncertainty of pore volume, 3D plume shape, CO2 in-situ phase and density as well as seal properties. Probabilistic ranges of effectively stored CO2 and associated containment risk are calculated based on the likelihood of failure due to fracturing, leakage through the top or fault seal, plume extent or structural spill based on CO2 pressure and phase properties.

For a given prospect, a probabilistic evaluation is made with various injection cases. With increasing injection amount, the storage efficiency and the effective capacity increases. However, seal pressures, risk of spill and containment also increase. Therefore, the containment risk and the storage efficiency are closely linked to the injection mass and the effective storage capacity. Also, both containment risk and storage efficiency are not a single number or an uncertain range, but a decision which is more or less informed. Generally, lower risk goes with lower storage capacity.

Multiple prospects can be compared based on risk versus capacity diagrams. Thresholds on capacity (minimum economic resource), containment (maximum tolerated amount of loss and its likelihood) and monitorability (how predictable is the outflow of CO2 if it was to happen) help the explorationist to focus on the best places where the balance between risk and capacity is optimal.