Assessment of Pressure Interference from Carbon Capture Hubs: Approaches, Problem Scale, and Sensitive Parameters.

Nelson Molina Giraldo
Fluid Domains Inc.

Gordon J. MacMillan
Fluid Domains Inc.

Jens Schumacher
Fluid Domains Inc.

Rob Pockar
Canadian Discovery Ltd.

Summary

Carbon capture and storage (CCS) has the potential to make a meaningful contribution in the global effort to reduce greenhouse gas emissions. To date, the Government of Alberta has accepted 24 pore space evaluation permits and project proponents have entered into evaluation agreements with the province to further explore the project areas' suitability for CCS.

This presentation argues that CCS projects in Alberta need to do a better job of considering the pressure related effects of CCS and spend less effort refining estimates of the available pore space in the receiving formation. This presentation considers the workflow, problem scale, and sensitive parameters required to address pressure propagation from CCS projects in Alberta.

Theory

The evaluation of feasibility of CO_2 injection requires consideration of the short-term and long-term pressure response to injection. Pressure in the receiving formation is a function of the rate of CO_2 injection, the formation geometry, storage parameters, and the formation permeability. Of these, the spatially averaged hydraulic property of permeability is usually the most uncertain variable when evaluating long-term feasibility as this parameter ranges over several orders of magnitude even within similar lithologies.

Because pressure propagation is not limited by the fluid type, there is pressure continuity between supercritical CO_2 and brine. Increased pressure near the injection well can propagate through groundwater, which is nearly incompressible, and result in an aerial and vertical extent of pressure increase that is much larger than the CO_2 plume. The resulting pressure interference creates uncertainty on injectivity and storage capacity for each CCS project because there are a number of Hubs utilizing the same regional aquifer.

We believe predictions about CCS outcomes are most valuable when the simulation tool is tailored to the specific prediction of interest i.e., lateral fluid migration, vertical fluid migration, or pressure propagation. We contend that predictions need to recognize important differences in the resolution and scale of a characterization required to predict CO_2 migration versus pressure propagation. These differences typically make it impractical to address all of the potential CCS predictions in a single workflow or model.

In this presentation, it is shown that for spatial scales important to regional cumulative pressure effects, numerical simulation of CCS injection can be greatly simplified by reducing the problem to a single fluid phase (brine). The workflow and simplifying methods are demonstrated using a multiphase numerical model (TOUGH3) and a single-phase numerical model (FEFLOW).

The workflow is then validated by simulating the historical injection of CO_2 at the Shell Quest Project and the insensitivity of the porosity characterization is demonstrated.

The value of applying a prediction specific workflow is further proven by comparing model simulation times of the multi-phase and single-phase models. Future quantification of heterogeneity and cumulative effects depend on simplifications such as those demonstrated here to make future predictions of pressure propagation tractable.