

Assessing Seal Capacity of Exploited Oil and Gas Reservoirs, Aquifers and Coal Beds for Potential Use in CO₂ Sequestration

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Objective: This study investigates the seal capacity of deep aquifers, exploited oil and gas reservoirs in order to assess their potential utilization for CO₂ sequestration. In addition, the study will examine the CO₂ injection in coal beds for both sequestration and enhancement of coal bed methane (CBM) production.

Background and Approach: Excess pressures at the top of the formation used for sequestration arise from the buoyancy of the CO₂ column with respect to the water or oil originally in the reservoir. The excess pressure has the potential to fracture hydraulically the cap rock (allowing leakage to occur), or to activate reservoir-bounding faults that results in leakage of natural gas from reservoirs at depth. This concept, referred to as dynamic seal capacity, has been applied in a number of oil and gas fields around the world. An important outstanding question is how such processes may influence CO₂ sequestration.

The approach for this study includes:

- Evaluation of seal integrity of potential repositories in terms of conventional and advanced concepts governing seal capacity (such as dynamic constraints on column height, potential for production-related loss of seal integrity, etc.).
- Investigation of the viscoelastic properties of coal in the presence of CO₂ through a laboratory study.

Activities: The activities to be performed under this effort include:

- Development of a comprehensive geomechanical model of the Mountaineer Project, which is considering a site in West Virginia for sequestration in a deep aquifer. The geomechanical model and fracture characterization will be used to determine the distribution and orientation of hydraulically conductive fractures within the aquifers as well as the effectiveness of adjacent layers to act as seals against the vertical migration of the injected CO₂. Other goals of the study are to determine the safe pressures for CO₂ injection to prevent hydraulic fracturing of the surrounding formations and to determine the maximum fluid pressures that can be maintained in the formations (*i.e.*, their dynamic capacity) without resulting in frictional failure and leakage through hydraulically active fractures.
- Review of the Weyburn project in Saskatchewan, Canada and Burlington project in San Juan Basin, New Mexico. The former project is an enhanced oil recovery (EOR) project and the latter is one in which CO₂ injection is being used for enhanced coal-bed methane (ECBM) activities and possibly CO₂ sequestration.
- Comprehensive review of trap and seal evaluation workflow as a possible analog for development of a related workflow for CO₂ sequestration in depleted oil and gas reservoirs.

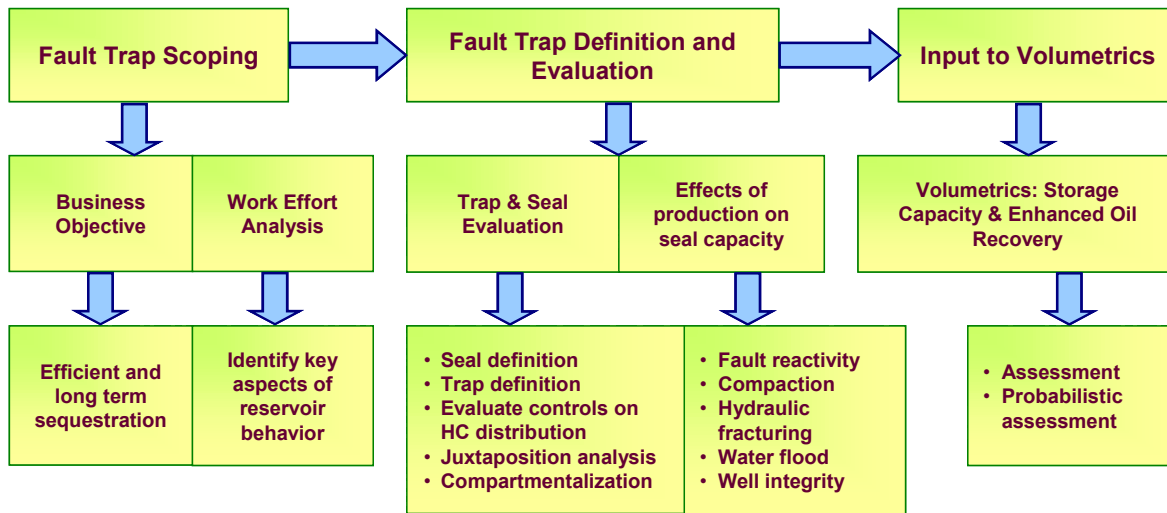
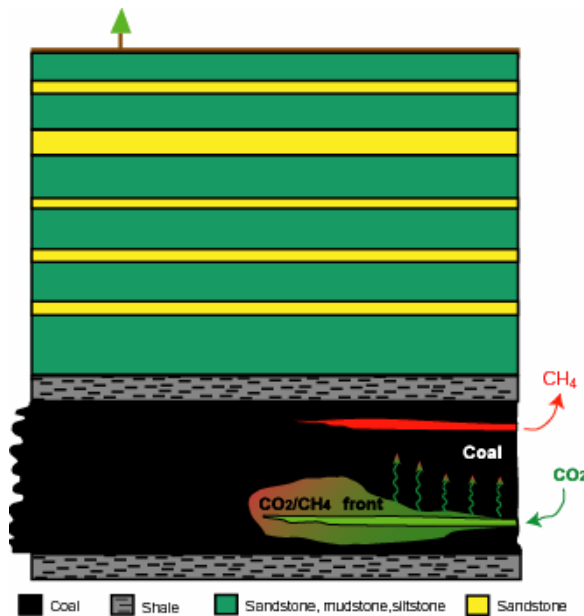


Figure 1: Trap and Seal Evaluation Workflow

- Investigation of the dual role of CO₂ injection in coal beds, that is, sequestration of CO₂ and enhanced CBM production, and exploration of the idea of using hydraulic fractures, which have been produced in coal, as a more effective path for CO₂ injection. The model that is developed will include a hydrofrac towards the bottom of the coal seam where CO₂ would be injected and a hydrofrac towards the upper part of the coal seam from which CH₄ and water would be produced (see Figure 2). The purpose of the simulation is to answer the question of how the CO₂/CH₄ adsorption front moves away from one hydrofrac toward the other. Additionally an alternative way of sequestering CO₂ in a specific setting like the Powder River Basin, Wyoming may be found.



Advantages of CO₂ Injection:

- Stimulate CH₄ production without dewatering
- Sequestration of CO₂ as an adsorbed phase

Key questions:

- Geomechanics
 - Hydraulic fracturing
 - Natural Fractures and flow

Figure 2: CO₂ Sequestration and ECBM in the Powder River Basin

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