Multi-scale Models for CO_2 Injection into Deep Saline Aquifers

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Abstract. Geological storage of carbon dioxide, as part of a Carbon Capture and Storage (CCS) strategy, is a promising technology for large-scale carbon mitigation. One of the many interesting challenges associated with this technology involves quantitative modeling of the injection, migration, long-term fate, and possible leakage of the CO_2 as well as fluids displaced by the injected CO_2. While several different kinds of formations may be targets for injection, deep saline aquifers have the largest storage capacity and are globally ubiquitous. As such, they are likely to be used for large-scale injection operations. Injection into deep saline aquifers involves two-phase flow with interphase mass transfer, strong gravity override, and unfavorable viscosity ratios. While the resulting problem can become quite complex mathematically, it may also be possible to simplify the system by taking advantage of characteristic length and time scales associated with the problem. These simplifications can be incorporated into a multi-scale modeling framework suitable for the CO_2 injection problem.
In this presentation, multi-scale approaches that are specific to the CO_2 problem will be discussed, with a focus on models that take advantage of the strong buoyancy in the system. Example calculations will include injection studies for an aquifer underlying the North Sea, and injection and leakage studies for a specific set of formations in the Alberta Basin.