SIMULATION OF SUPERCRITICAL CARBON DIOXIDE LEAKAGES IN FRACTURED POROUS RESERVOIR

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Leakage to the atmosphere or t he overlaying groundwater aquifers of a significant fraction of injected CO2 would constitute a failure of a geological CO2 storage project from greenhouse gas mitigation and safety perspectives. We present a numerical model that simulates flow and transport of CO2 into a multi-layered subsurface system. The model uses state-of-the-art multi-threaded finite element methods and unstructured adaptive mesh refinement scheme. Several scenarios spanning from a homogeneous single layered reservoir to heterogeneous multi-layered systems, which including cap-rock with embedded fractures, have been simulated under different operations of CO2 injection and CO2 leaking conditions. Results show the impact of the injection and leakage rates on the time-evolution of the spread of the CO2 plume, its interception of the fractured cap-rock, and the risk associated with the contamination of the overlying aquifer. Spatial and temporal moments have been calculated for different, deterministic or stochastic, subsurface physical and chemical properties. Spatial moments enable assessing the extent of the region of investigation under conditions of uncertainty. Furthermore, several leakage scenarios show the intermittent behavior and development of the CO2 plume in the subsurface. Both, leakages and cap-rock breaches reduce the safety and effectiveness of geologic sequestration. Discussion on a ir, surface and subsurface monitoring needs for CO2 seepage detection and monitoring with minimal economic and near surface environmental impact is presented. (Prepared by LLNL under Contract DE-AC52-07NA27344).