Displaced Fluid Management: An Operational Imperative in Commercial-Scale Co2 Sequestration Projects

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The Wyoming State Geological Survey (WSGS) has completed an extensive inventory of geological CO2 sequestration sites in Wyoming. In terms of “deep” saline aquifers, the Paleozoic sandstones and carbonates have the highest sequestration potential. The Rock Springs Uplift (RSU) and the Moxa Arch (MA) in southwestern Wyoming are the two highest priority CO2 sequestration sites. These two sites are characterized by thick saline aquifer sequences associated with multiple sealing lithologies, huge structures with substantial closure, and reservoir units that have properties required for CO2 sequestration.

Regional 3-D models have been constructed for both the Rock Springs Uplift and the Moxa Arch (i.e., EarthVision software). Both the FutureGen and the USGS protocols suggest that the Paleozoic sandstones and carbonates at these sites have huge CO2 sequestration capacities. In cooperation with the Los Alamos National Laboratory, the WSGS geologic databases have been combined with LANL numerical simulation techniques (i.e., FEHM) to significantly improve CO2 sequestration estimates.

A variety of numerical simulations demonstrate that at the RSU, over the course of 50 years, utilizing 9 injection wells with a cumulative injection rate of 15 Mt of CO2 / year and a storage domain of 16 X 16 km, the Weber sandstone can accommodate the injected CO2 (total of 750 Mt CO2). The MA simulations demonstrate, over the course of 50 years, utilizing 9 injection wells and a storage domain of 10 X 10 km and a cumulative injection rate of 7.5 Mt of CO2 / year, can be accommodated by the Bighorn dolomite (total of 345 Mt CO2). However, as pressures in the reservoirs return to background over the 50 years following injection, the sequestered CO2 at the RSU site will displace 1 cubic kilometer of formation fluid. At the MA site, 0.4 cubic kilometers of fluid will be displaced. For successful CO2 sequestration, this displaced fluid must leave the storage domain and find fluid accommodation space elsewhere. At both sites, the displaced fluids will cause pressure effects 48 km (30 miles) beyond the boundaries of the storage domains. To reduce the risk of large-scale hydrofracture, especially at introformational fluid-flow barriers and “sealed” faults, or larger ranged fluid migration along high-permeability pathways, displaced fluids must be managed in commercial-level (5-15 Mt CO2 / year) geological CO2 sequestration projects.