AAPG Annual Convention
Salt Lake City, Utah
May 11-14, 2003

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Carbon Dioxide Sequestration in Depleted Oil/Gas Fields: Evaluation of Gas Microseepage and Carbon Dioxide Fate at Rangely, Colorado U.S.A

Large-scale carbon dioxide injection for purposes of enhanced oil recovery (EOR) has been operational at Rangely, Colorado since 1986. The Rangely field serves as an onshore prototype for carbon dioxide sequestration in depleted fields by production of a valuable commodity which partially offsets infrastructure costs. The injection is at pressures considerably above hydrostatic pressure, thereby enhancing the possibility for migration of buoyant gases toward the surface.

Methane and carbon dioxide were measured in soil gas, and as fluxes into the atmosphere in both winter and summer seasons at Rangely. There were large seasonal variations in surface biological noise that were evaluated in order to estimate deep-sourced fluxes to the atmosphere. Methane flux to the atmosphere was estimated at 400 metric tonnes per year over the 78 km2 area of the field, and cabon dioxide between 170 and 3800 metric tonnes per year. These direct measurements of flux were aided by the use of both stable isotopes and carbon-14. The measurements and computer modeling of the gases in the unsaturated zone suggest that methane makes a greater environmental contribution to the atmosphere than does carbon dioxide. Bacterial oxidation of methane in the unsaturated zone significantly attenuates the potential methane flux to the atmosphere.

The 23+ million tonnes of carbon dioxide that have been injected at Rangely are largely stored as dissolved carbon dioxide and to a lesser extent as bicarbonate in the saline water of the reservior. Scaling problems, as a result of acid gas dissolution of carbonate cement, and subsequent precipitation of calcium sulfate will be an increasing problem as EOR/ sequestration systems mature. Ultimate injector and field capacities will be determined by the balance between mineral dissolution and precipitation in the formation as it affects porosity and permeability.