MODELING SUBSURFACE TRANSPORT OF OIL-FIELD BRINE AT USGS OSPER "A", OKLAHOMA

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The USGS has been investigating environmental impacts of oil production activities at the Osage-Skiatook Petroleum Environmental Research (OSPER) "A" Site, Oklahoma. Saline water from nearby oil wells was released into pits and a stream bed at this site for 61 years (1912-1973). Some of the brine infiltrated into underlying interbedded sandstone, mudstone, and shale bedrock. A salt scar now ~60 m wide by 100 m long at land surface formed prior to 1936 has persisted for 33 years after the end of significant oil production. We installed 41 wells up to 23 m deep for ground-water sampling and hydraulic testing. Water samples show a plume of high salinity (up to 30,000 mg/L) Na-Cl-type ground water that extends far beyond the area of the salt scar. Slug tests indicate the hydraulic conductivity of the underlying bedrock is low (~1 cm/day). Continuous monitoring of water levels in wells indicates that the ground-water recharge rate is low. A simple two-dimensional ground-water flow and solute transport model of the site does a reasonable job of simulating the observed plume. In the model, we assumed that 60,000 mg/L TDS brine infiltrated through the pit bottom into the underlying bedrock at a low rate (~1 mm/day) for 61 years. Model results indicate that the natural dilution of the plume subsequent to abandonment has been very slow because the rock permeability is low and the natural ground-water flow rate is slow. Also, the down-slope migration of the plume likely slowed when Skiatook Lake reservoir was filled in 1987, raising the water table elevation at the toe of the plume. Results indicate that the brine plume will exist for many years to come with continued deleterious environmental impact at ground-water discharge points.