**Source of Elevated Concentrations of Chloride, Sulfate, Sodium, and Calcium in the Eastern Snake River Plain Aquifer, Mud Lake Area, Eastern Idaho**

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Groundwater with elevated dissolved-solids concentrations—containing large concentrations of chloride, sodium, sulfate, and calcium—is present in the eastern Snake River Plain aquifer in the Mud Lake area of eastern Idaho. The source of these solutes is unknown; however, an understanding of the geochemical sources and processes controlling their presence in groundwater in the Mud Lake area is needed to better understand the geochemical sources and processes controlling the water quality of groundwater at the Idaho National Laboratory.

The geochemical sources and processes controlling the water quality of groundwater in the Mud Lake area were determined by investigating the geology, hydrology, land use, and groundwater geochemistry in the Mud Lake area, proposing sources for solutes, and testing the proposed sources through geochemical modeling with PHREEQC. Modeling indicated that sources of water to the eastern Snake River Plain aquifer were groundwater from the Beaverhead Mountains and the Camas Creek drainage basin; surface water from Medicine Lodge and Camas Creeks, Mud Lake, and irrigation water; and upward flow of geothermal water from beneath the aquifer. Mixing of groundwater with surface water or other groundwater occurred throughout the aquifer. Carbonate reactions, silicate weathering, and dissolution of evaporite minerals and fertilizer explain most of the changes in chemistry in the aquifer. Redox reactions, cation exchange, and evaporation were locally important.

The source of large concentrations of chloride, sodium, sulfate, and calcium was evaporite deposits in the unsaturated zone associated with Pleistocene Lake Terreton. Large amounts of chloride, sodium, sulfate, and calcium are added to groundwater from irrigation water infiltrating through lake bed sediments containing evaporite deposits and the resultant dissolution of gypsum, halite, sylvite, and bischofite.