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Geochemical Characterization and Simulation-Optimization of Ground-Water Resources in the Albuquerque Area, Middle Rio Grande Basin, New Mexico.

Abstract:

This is a two-part talk. Part 1 is about using geochemistry to characterize the current and paleogroundwater flow regimes of the Albuquerque Basin, motivated by the dependence of the metropolitan area on the aquifer for water. Part 2 talks about taking geochemical and other characterization information, including new geological maps and recent understanding of the roles of faults, to simulate the basin. Then using the simulation to make decisions about how the basin can best be exploited for a sustainable water supply.

Geochemical Characterization: Chemical and isotopic data from ground water and surface water throughout the Middle Rio Grande Basin (MRGB), New Mexico, were used to refine the conceptual model of ground-water flow in the basin. Ground-water data collected by the U.S. Geological Survey (USGS) as part of this study included major- and minor-element chemistry, oxygen-18 and deuterium content of water, carbon-13 content and carbon-14 activity of dissolved inorganic carbon, tritium, and chlorofluorocarbons from more than 250 wells in the Santa Fe Group aquifer system. The data were used to identify sources of recharge to the system; delineate ground-water flow paths; map water chemistry in relation to hydrogeologic, stratigraphic, and structural properties of the basin; determine radiocarbon ages of ground water; and reconstruct paleo-environmental conditions in the basin over the past 30,000 years. Spatial patterns in the data reflect the predominant north to south direction of ground-water flow. The patterns were used to delineate major sources of water to the basin, including recharge from mountains along the north, east and southwest margins; seepage from the Rio Grande, the Rio Puerco, and selected arroyos; and ground-water inflow along the northern and western basin margins. Radiocarbon ages of the ground water ranged from modern (post-1950) to more than 30,000 years before present. The radiocarbon ages were used in the calibration of a transient paleohydrologic model of ground-water flow, which indicated that recharge to the MRGB during the last glacial maximum was 7 to 15 times greater than that at present.

Simulation-Optimization: In the 1990s, the City of Albuquerque (COA) adopted a water-supply strategy that called for a transition in 2006 from complete reliance on ground water to primary reliance on surface water, supplemented by ground water. A U.S. Geological Survey ground-water-flow model for the Middle Rio Grande Basin (MRGB) was used to investigate the likely effects of this change on the regional river-aquifer system through 2040. Model simulations showed a substantial difference in the quantity of water retained in storage and the quantity of leakage from the river system into the aquifer. A simulation-optimization approach was then used to investigate how the COA

could distribute supplemental ground-water withdrawals among its municipal-supply wells between 2006 and 2040 to achieve certain management objectives for the river-aquifer system. One modeled management objective was to minimize overall depletion of water from aquifer storage while limiting water-level declines to no more than 2.5 feet per year in any simulation-model cell. The ground-water-flow model was used to generate response functions that indicated the response of aquifer storage, river leakage, and ground-water levels to unit stresses applied in each of the 25 COA well fields. The response functions were incorporated into an optimization model designed in a mathematical programming software package and solved with a linear approach. The optimization model indicated that optimization of ground-water withdrawals could result in about 242,000 acre-feet greater recovery of water in aquifer storage than the non-optimal distribution—equivalent to more than 2 times the quantity of water supplied to COA customers in 2000.

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