REGIONAL AQUIFER-SYSTEM ANALYSIS

GEOLOGY AND HYDROGEOLOGY OF THE CARIBBEAN ISLANDS AQUIFER SYSTEM OF THE COMMONWEALTH OF PUERTO RICO AND THE U.S. VIRGIN ISLANDS

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ABSTRACT

Poorly lithified to unconsolidated carbonate and clastic sedimentary rocks of Tertiary (Oligocene to Pliocene) and Quaternary (Pleistocene to Holocene) age compose the South Coast aquifer and the North Coast limestone aquifer system of Puerto Rico; poorly lithified to unlithified carbonate rocks of late Tertiary (early Miocene to Pliocene) age make up the Kingshill aquifer of St. Croix, U.S. Virgin Islands. The South Coast aquifer, North Coast limestone aquifer system, and Kingshill aquifer are the most areally extensive and function as the major sources of ground water in the U.S. Caribbean Islands Regional Aquifer-System Analysis (CI-RASA) study area.

In Puerto Rico's South Coast ground-water province, more than 1,000 meters of clastic and carbonate rocks of Oligocene to Pliocene age infill the South Coast Tertiary Basin. The pattern of lithofacies within this basin appears to have been controlled by changes in base level that were, at times, dominated by tectonic movement (uplift and subsidence), but were also influenced by eustasy. Deposition of the 70-kilometer long and 3- to 8-kilometer wide fan-delta plain that covers much of the South Coast ground-water province occurred largely in response to glacially-induced changes in sea level and climate during the Quaternary period. Tectonic movement played a much less important role during the Quaternary.

The North Coast ground-water province of Puerto Rico is underlain by a homoclinal coastal plain wedge of carbonate and siliciclastic rocks that infill the North Coast Tertiary Basin and thicken to more than 1,700 meters. A thin basal siliciclastic sequence of late Oligocene age is overlain by a thick section of mostly carbonate rocks of Oligocene to middle Miocene age. Globigerinid limestone of late Miocene to Pliocene age crops out and lies in the shallow subsurface areas of northwestern Puerto Rico. Oligocene to middle Miocene age rocks tentatively can be divided into five depositional sequences and associated systems tracts; these rocks record carbonate and minor siliciclastic deposition that occurred in response to changes in relative sea level. The Cibao Formation represents the most complex of these sequences and contains a varied facies of carbonate, mixed carbonate-siliciclastic, and siliciclastic rocks that reflect differential uplift, subsidence, and transgression of the sea.

Uplift, graben formation, and gradual shallowing of the sea are reflected within the bathyal-dominated sedimentary facies of the Kingshill Limestone in St. Croix, U.S. Virgin Islands. Reef-tract limestone beds of Pliocene age were subject to exposure, resubmergence, and meteoric leaching of aragonitic skeletal debris; these beds contain patchy lenses of dolomite that are restricted to a small, structurally-controlled embayment.

The South Coast aquifer, the principal water-bearing unit of Puerto Rico's South Coast ground-water province, consists of boulder- to silt-size detritus formed by large and small coalescing fan deltas of Pleistocene to Holocene age. Deep well data indicates that it is possible to vertically separate and group a highly complex and irregular-bedded detrital sequence that underlies distal parts of the fan-delta plain into discrete water-bearing units if correlated with 30- to 40-meter thick, eustatically-controlled depositional cycles. Lithofacies maps show that greatest hydraulic conductivity within the fan-delta plain is generally associated with proximal fan and midfan areas. Distal and interfan areas are least permeable. Alluvial valley aquifers located in the western part of the South Coast ground-water province are important local sources of water supply and appear to contain some of the same physical and hydraulic characteristics as the South Coast aquifer. Older sedimentary rocks within the basin are poor aquifers; conglomeratic beds are well-cemented, and carbonate beds do not contain well-developed solution features, except locally where the beds are overlain by alluvium. Ground-water occurs under unconfined conditions in proximal and midfan areas. Confined conditions within deeper parts of the system and in interfan and some midfan areas are created largely by the intercalated nature of discontinuous fine-grained beds that retard vertical ground-water movement.

The development of water resources in southern Puerto Rico has modified the hydrologic system of the South Coast aquifer considerably. Under predevelopment conditions, the South Coast aquifer was recharged in the unconfined, proximal fan and some midfan areas by infrequent rainfall and seepage from streams near the fan apex. Discharge occurred as seabed seepage, baseflow discharge along the lower coastal reach of streams, seepage to coastal wetlands, or evapotranspiration in areas underlain by a shallow water table. Under development conditions, seepage from irrigation canals and areal recharge from furrow irrigation represented a principal mechanism for recharge to the aquifer. Increased ground-water withdrawals in the 1960's and 1970's resulted in declines in the water table to below sea level in some places and intrusion of salt water into the aquifer. By the middle 1980's, a reduction in ground-water withdrawals and a shift from furrow irrigation to drip-irrigation techniques resulted in the recovery of water levels. Under present-day (1986) conditions, regional ground-water flow is coastward but with local movement to some well fields. In addition to the discharge mechanisms described above, ground-water discharges also to coastal canals.

The North Coast limestone aquifer system consists of limestone, lesser amounts of dolomite, and minor clastic detritus of Oligocene to Pliocene age

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