POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER IN SOUTH CAROLINA, JULY 1986

By Michael S. Crouch, W. Brian Hughes, W. Robert Logan, and J. Kevin Meadows

INTRODUCTION

The Floridan aquifer is the collective name for a series of Tertiary carbonate aquifers underlying parts of Alabama, Georgia, and South Carolina and all of Florida. The aquifer is composed of Paleocene to early Miocene rocks that are hydraulically connected in varying degree (Johnston and others, 1981).

The map shows the configuration of the potentiometric surface of the Floridan aquifer in South Carolina, as of July 1986. The contours indicate the elevation to which water would rise in wells tapping the Floridan aquifer, and they are presented as an aid for evaluation of regional ground water occurrence. A potentiometric map indicates the direction of ground water flow and, in conjunction with other information, the rate of flow.

Previous investigators have published maps of the potentiometric surface of the Floridan aquifer on local and regional scales. Hayes (1979) presented a map of Beaufort, Jasper, Colleton, and Hampton Counties representing 1976 water levels for the Ocala and Santee aquifers. Park (1985) published a potentiometric map of the Trident area (Berkeley, Dorchester, and Charleston Counties) for 1982 that represents water levels in the Santee Limestone and the upper 50 feet of the Black Mingo Formation. Aucott and Speiran (1985) constructed a more general potentiometric map of the Floridan aquifer and its hydraulically connected updip clastic equivalent in South Carolina for 1982. A regional map showing the entire Floridan aquifer's potentiometric surface in 1980 was presented by Johnston and others (1981). Other maps have been published by Mundorff (1944), Siple (1960), and Counts and Donsky (1963).

The map herein is limited to the Floridan aquifer where it occurs in South Carolina. The counties underlain are Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton, Jasper, and Orangeburg, an area of 7,900 square miles.

GEOHYDROLOGY

The Floridan aquifer in South Carolina, as used in this report, comprises all middle to upper Eocene carbonate rocks. This aquifer, which dips toward the south, is underlain by lower Eocene sand, clay, and limestone and overlain by either low-permeability limestone or sandy clay in areas where it is confined and by sand where it is unconfined. The landward limit of the Santee Limestone defines the extent of the Floridan aquifer in South Carolina. Regionally, the aquifer is heterogeneous, but local permeable zones are essentially homogeneous.

Two sections are presented to illustrate the geohydrologic framework. The sections are based largely on electric, gamma-ray, and lithologic logs. Section A-A′ runs northeast and extends from Parris Island to Moncks Corner. In southern Beaufort County the Floridan aquifer consists of the highly permeable upper unit of the Ocala Limestone, the moderately permeable lower unit of the Ocala, and the relatively impermeable Santee Limestone. The aquifer is overlain by sand and clay of the Hawthorn Formation. Most water wells in the area are between 100 and 200 feet deep and obtain water solely from the upper permeable unit of the Ocala.

Northeastward, the upper unit thins and pinches out. The lower Ocala remains hydraulically unchanged, but the Santee gradually increases in permeability. In areas where the upper Ocala is absent, wells are generally constructed to obtain water from several hundred feet of Ocala and/or Santee Limestone. Farther to the northeast, the lower unit of the Ocala Limestone thins and the overlying confining beds of the Cooper Formation (Oligocene age) are present. At the northeast edge of the mapped area, the Cooper thins and eventually pinches out.

Section B-B′ runs down the dip from near Ulmer to Fripp Island. Northwest of the section, the aquifer is similar to the northeastern part of the study area in that the Santee Limestone subcrops below Tertiary sand beds.

Near Ulmer the Floridan aquifer consists solely of Santee Limestone, which occurs as layers of varying permeability. The Ocala is absent and the Santee is overlain by Tertiary sand and clay that are, in turn, overlain by clay. Downdip, the Santee thickens and goes through a facies change to relatively impermeable limestone, and the Tertiary sand grades into the moderately permeable Ocala Limestone. Wells in this area are generally in the Ocala. Farther downdip, the upper permeable unit is present and is the principal source of well water.

The zone tapped by water wells differs with location. Where the upper permeable zone of the Ocala is present, it is utilized. Elsewhere a combination of the moderately permeable Ocala Limestone and Santee Limestone is tapped. The zones are hydraulically connected to some degree, and water levels throughout the Floridan aquifer are related.

METHODOLOGY

Water level data were collected from July 28 to August 5, 1986, by South Carolina Water Resources Commission personnel. Measurements were taken in 640 wells known to be open exclusively to the Floridan aquifer as defined in this report. Elevations were obtained from U. S. Geological Survey topographic quadrangles, except for 191 wells in Beaufort County that were leveled in accordance with South Carolina Geodetic Survey specifications (± 1¼ inches per 3 miles). The distribution of the data points is indicated on the map.

Potentiometric contours are based on measured water levels and knowledge of the geohydrologic framework. The contours are at 10-foot intervals where data permit and at 25-foot intervals elsewhere. More detailed potentiometric contours can be drawn in a part of Beaufort County, owing to the density of data points. The inset shows detailed contours for the sea island area.

GROUND WATER FLOW

Ground water flows toward the southeast except where locally influenced by recharge, natural discharge, and pumping from wells. Water levels range from 200 feet above sea level in the northwest to 90 feet below sea level near Savannah, Ga.

Regional recharge occurs in the updip areas of the north and northeast where the Floridan aquifer is unconfined or poorly confined. Local recharge mounds are present near Allendale, Jamestown, and Beaufort, and south of Lake Moultrie.

Natural discharge from the aquifer occurs to streams and lakes in the updip areas. Discharge from the upper permeable unit of the Ocala Formation occurs in some low-lying areas near the coast.

Major potentiometric depressions are caused by discharge from wells in the Charleston and Savannah areas. A small pumping depression is also centered at Walterboro. In the Charleston area, an elongated trough caused by pumping approximately 5.4 mgd (million gallons per day) is present between Charleston and Moncks Corner. This relatively small pumpage causes a large feature because of the low transmissivity of the aquifer in that area. In the Savannah area, a steep, circular cone of depression extending to Port Royal Sound is caused by pumping approximately 80 mgd in the area. The transmissivity in this area is high, ranging from 20,000 to over 70,000 ft^2/day (feet squared per day). This tends to dampen the effects of pumping on the potentiometric surface. The small cone of depression near Walterboro is caused by pumping between 2 and 3 mgd.

WATER LEVEL TRENDS

A study of water-level changes with time and with rainfall showed no consistent relation on a regional basis. In general, the observation wells respond uniquely, depending on pumping and variation in the hydraulic character of the aquifer system in the area, and no single trend was evident. Precipitation in 1986 was below normal, but this probably did not cause significant regional declines in water levels. Locally, pumping increased because of the drought, and water levels were affected slightly.

BEAUFORT AREA

A potentiometric map of the upper unit of the Floridan aquifer in the Beaufort area (Ocala Limestone) during July 1986 is shown above. The upper permeable zone of the Ocala Limestone is underlain by poorly permeable clayey limestone and overlain by sand and clay of areally varying permeability. The finer detail of the potentiometric contouring in this area was made possible by the intensive water-level monitoring network that was established because of increasing demand for ground water and the threat of saltwater contamination. More than 240 wells are measured in this network.

Locally significant recharge occurs on the northern part of Port Royal Island and on the barrier islands. Ground-water flow on these islands radiates away from the land masses toward the areas of discharge; the ocean, estuaries, and marshes. The large mounding on the northern part of Port Royal Island is present because of significant recharge in an area of relatively low transmissivity (800-1,000 ft^2/day). Transmissivity increases to 70,000 ft^2/day in the southwest, and potentiometric features caused by recharge and discharge are dampened. The northern part of Hilton Head Island is possibly an area of recharge (Back and others, 1971; Hayes, 1979; Siple, 1960), but the potentiometric contours are dominated by the edge of a cone of depression centered in Savannah.

West of Port Royal Sound the flow is toward Savannah. The zero (sea level) contour occurs somewhere in Port Royal Sound, and the gradient is toward the southwest. Water levels are 20 feet below mean sea level on the southern part of Hilton Head Island.

SUMMARY

Three distinct potentiometric features are evident from a July 1986 water-level map of the Floridan aquifer in South Carolina:

1) areally extensive recharge zones in the north and northwest;
2) potentiometric lows in the Charleston area;
3) cone of depression centered at Savannah, Ga.

The occurrence of water-bearing zones in the Floridan aquifer varies with location. The permeable upper zone of the Ocala Limestone is utilized where present. Where this unit is absent, a combination of the Ocala and Santee Limestones is used. These areas are delineated on the regional-scale map. Water levels in the various zones are related because the formations are hydraulically connected in varying degree.

Hydrographs show no regional trend in water-level change; however, only limited data are presently available. The drought of 1986 did not significantly affect the potentiometric level of the aquifer.

Recharge occurs locally and regionally where the aquifer is unconfined or is poorly confined. Natural discharge occurs to streams and lakes in the outcrop area of the aquifer, and to the estuaries and the Atlantic Ocean.

SELECTED REFERENCES

Aucott, W. R., and Speiran, G. K., 1985, Potentiometric surfaces of November 1982 and declines in the potentiometric surfaces between the period prior to development and November 1982 for the Coastal Plain aquifers of South Carolina: U. S. Geological Survey Water-Resources Investigations Report 84-4215, 7 plates.

Back, William, Hanshaw, B. B., and Rubin, Meyer, 1970, Carbon-14 ages related to occurrence of saltwater: Journal of the Hydraulics Division, American Society Civil Engineers Proceedings, November, 1970, 12 p.

Cooke, C. W., 1936, Geology of the Coastal Plain of South Carolina: U. S. Geological Survey Bulletin 867, 196 p.

Counts, H. B., and Donsky, Ellis, 1963, Saltwater encrochment, geology, and ground-water resources of Savannah Area Georgia and South Carolina: U. S. Geological Survey Water-Supply Paper 1611, 100 p.

Hayes, L. R., 1979, The ground-water resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina: South Carolina Water Resources Commission Report No. 9, 91 p.

Heron, S. D., Jr., 1962, Limestone resources of the Coastal Plain of South Carolina: South Carolina State Development Board, Division of Geology, Bulletin No. 28, 128 p.

Johnston, R. H., Healy, H. G., and Hayes, L. R., 1981, Potentiometric surface of the Tertiary limestone aquifer system, Southeastern United States, May 1980: U. S. Geological Survey Open-File Report 81-486, 1 plate.

Logan, W. R., and Euler, G. M., 1987, (in press), Geology and ground-water of Allendale, Bamberg, and Barnwell Counties and part of Aiken County, South Carolina: South Carolina Water Resources Commission Report No. 155.

Meadows, J. K., 1987, Ground-water conditions in the Santee Limestone and Black Mingo Formation near Moncks Corner, South Carolina: South Carolina Water Resources Commission Report No. 156.

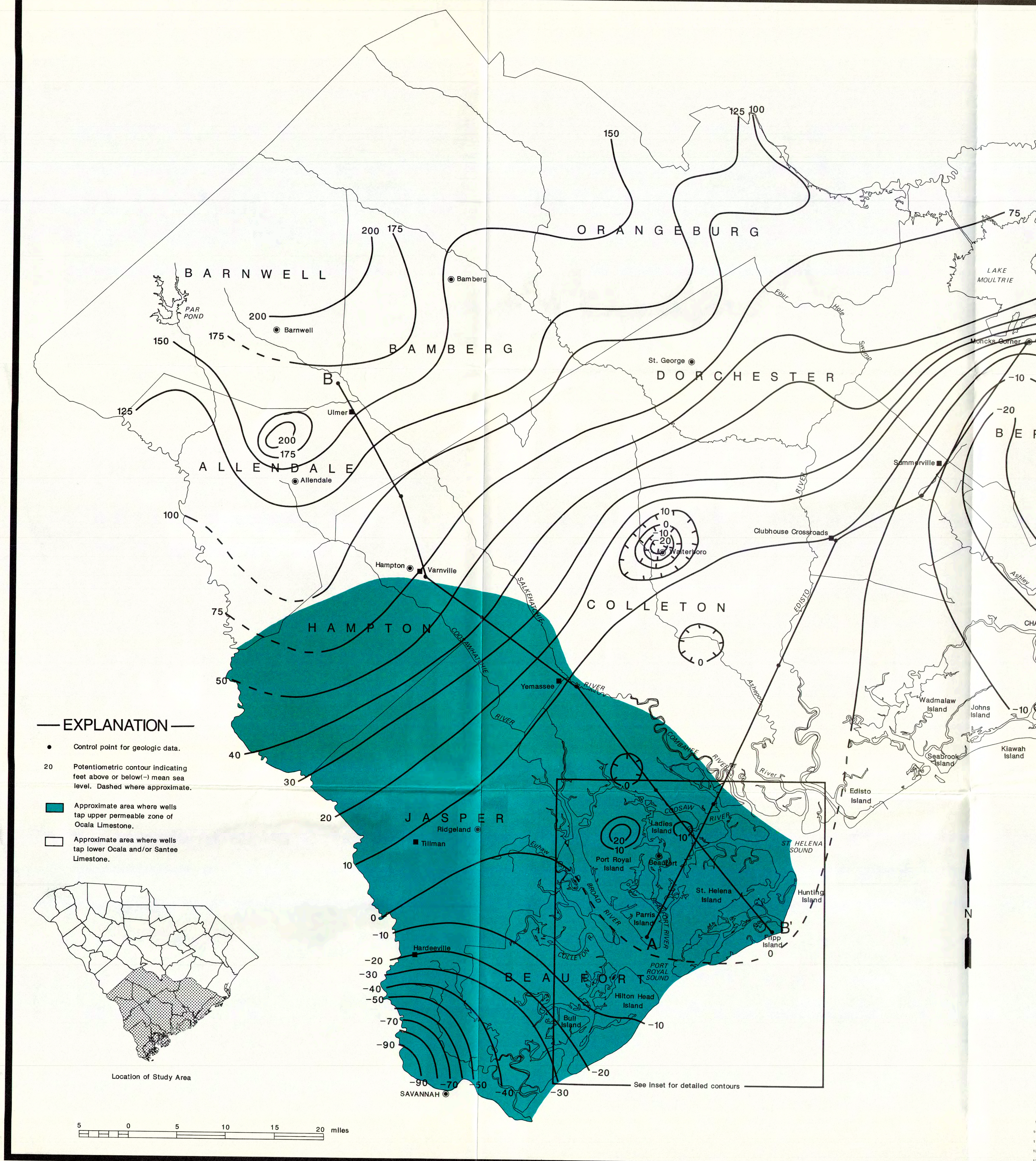
Mundorff, M. J., 1944, Ground water in the Beaufort area, South Carolina: U. S. Geological Survey, Administrative Report to the Bureau of Yards and Docks, Department of the Navy, 21 p.

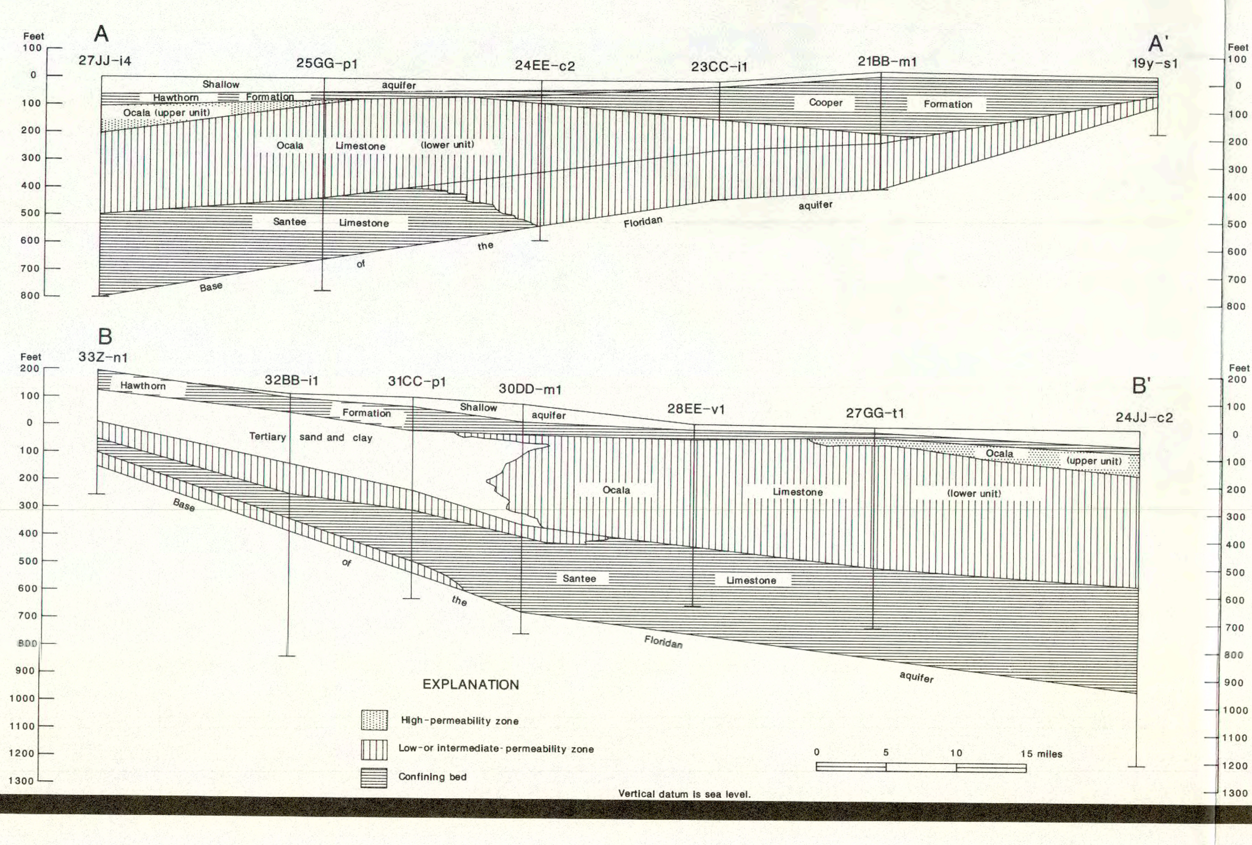
Park, A. D., 1985, The ground-water resources of Charleston, Berkeley, and Dorchester Counties, South Carolina: South Carolina Water Resources Commission Report No. 139, 146 p.

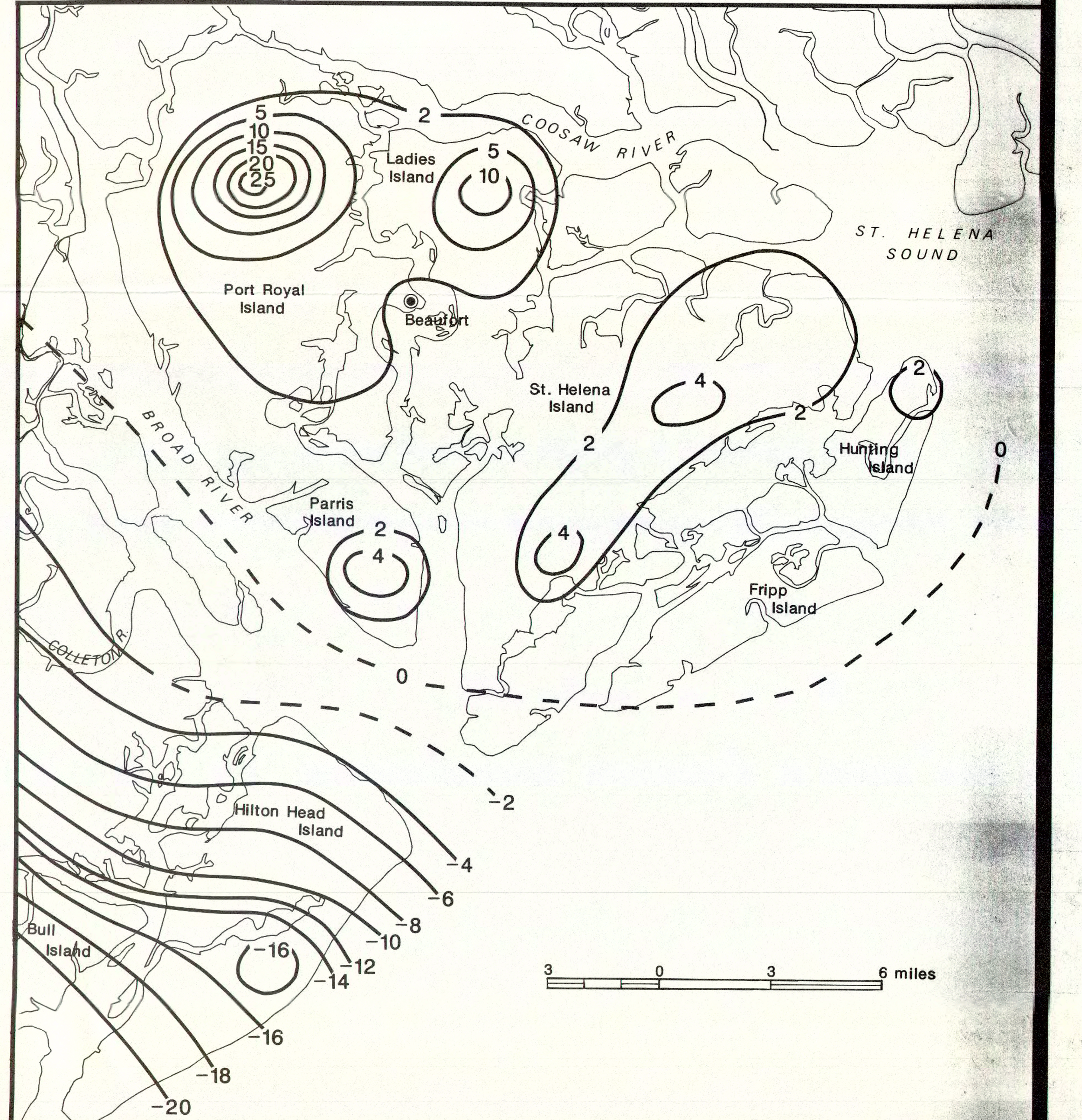
Siple, G. E., 1960, Geology and ground-water conditions in the Beaufort area, South Carolina: U. S. Geological Survey, Open-File Report, 124 p.

Siple, G. E., 1975, Ground-water resources of Orangeburg County, South Carolina: South Carolina State Department Board Bulletin No. 36, 59 p., 8 plates.

South Carolina Water Resources Commission, 1985, Annual report of the South Carolina Water Resources Commission for fiscal year 1984-1985: State Budget and Control Board, Columbia, South Carolina, 60 p.







STATE OF SOUTH CAROLINA