DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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Introduction

The Tertiary limestone aquifer system of the southeastern United States has been subject to steadily increasing pumpage during the past 100 years resulting in significant declines of artesian head. This map is intended to show the potentiometric surface of the upper part of the aquifer system as it existed prior to development. The map has been prepared primarily for use in making a regional hydrogeologic analysis including digital simulation of the entire aquifer system.

Terminology of the Tertiary limestone aquifer system varies from state to state. Generally, the aquifer system is referred to as the principal artesian aquifer in Alabama, Georgia, and South Carolina (Stringfield, 1953) and as the Floridan aquifer in Florida (Parker and others, 1955). The upper water-bearing units occur in limestones and dolomites within several formations—principally the Tampa, Suwannee, Ocala, and Avon Park limestones. Wells tapping those units have provided the water-level data upon which this map and many early maps are based. Locally, confining beds exist below these upper units and wells tapping lower water-bearing units in the aquifer system may have different heads than those above.

No area-wide predevelopment potentiometric map exists. The pioneer work by Stringfield in the early 1930s provided the first potentiometric map of peninsular Florida (Stringfield, 1936). Although the map contains local inaccuracies due to lack of altitude control, and measurements were made over a 2-year period, the map is a milestone because it presented, for the first time, the essential features of the flow system in the aquifer. During the early 1940s, Warren (1944) prepared similar maps for the Coastal Plain of Georgia. However, these maps show the effects of heavy pumping in the coastal areas, and for comparison Warren constructed a generalized map showing the approximate configuration of the potentiometric surface prior to about 1880 along the coast.

In recent years, new maps have documented extensive changes in the potentiometric surface caused by increased pumpage. Noteworthy is a Florida map by Healy (1962), which utilized more than 600 water-level measurements made during 12 days in July 1961 to present a "snapshot" of the surface. Many potentiometric maps are currently prepared on an annual or semiannual basis by the U.S. Geological Survey in cooperation with various State agencies and Florida's Water Management Districts.

Thus this map is a composite of many other maps: recent potentiometric surface maps where pumping has been light; older maps or modifications of them where ground-water development has been intensive. The map is intended to show the best estimate that can be made with available data of the configuration of the "average" potentiometric surface as it existed prior to development; it is not intended to show precise water-level data at specific sites.

Although the limestone aquifer system extends offshore, potentiometric surface contours are shown only in the offshore area adjacent to coastal Georgia and northeast Florida because the only offshore pressure-head measurements to date are in this area.

Areal Descriptions

In coastal Georgia and adjacent South Carolina the configuration of the potentiometric surface is essentially unchanged from Warren's generalized 1880 map. In northeast Florida, contours from Warren's map were modified because recent head measurements in undeveloped areas indicate that heads were never as high as Warren postulated. Warren's map is based largely on water level measurements made in the late 1800s as reported by McCallie (1898 and 1908) and Stephenson and Veatch (1915). Additional control in the offshore area was provided by pressure-head measurements in JOIDES core hole J-1 (Wait and Leve, 1967) and a Tenneco offshore exploratory well (Atlantic OCS, lease block 427) (unpublished data, 1979).

The general configuration of the potentiometric surface in the area upgradient of the 80-ft. contour in Georgia is from Warren's (1944) surface, and should be a close approximation of the original surface, as this area is largely unstressed. In southwest Georgia, pumpage was very light until the recent advent of large-scale self-propelled irrigation systems. Contours in this area are primarily from maps prepared in the early 1960s by Sever (1965) and Wait (1963).

Generally in northwest Florida and the panhandle, heads have been affected little by development. A deep cone of depression exists in the Fort Walton Beach area; formerly a cone existed in Panama City but has largely dissipated because ground-water withdrawals have sharply declined. Moderately large withdrawals in the Tallahassee area have had little effect on heads. Healy's 1974 potentiometric surface map (Healy, 1975), and more detailed maps prepared in 1976 by Fisk and Rosenau (1977) and Rosenau and Meadows (1977), have been used with minor modification for northwest Florida. However, a potentiometric high centered around Gadsden and Liberty counties, a prominent feature on Healy's map, has been deleted. This was necessary because wells from which the high head measurements were obtained are not open exclusively to the limestone aquifer system.

The positions of the potentiometric contours in the east-central Florida area are estimated to be those that prevailed at about the time that Stringfield (1936) collected the data for this 1934 map. Stringfield's interpretation in the unstressed areas has been modified by using subsequent data from more recent and more detailed potentiometric maps. For example, the several depression contours are caused by natural discharge from large artesian springs and are not the result of pumping stresses.

In west-central Florida, contours from Stringfield's map (1936) were used, unmodified, for Polk and Pinellas counties and most of Hillsborough and Hardee counties. Ground water in these counties was rapidly developed after Stringfield's investigation in 1930–34, and the later, more detailed investigations of the 1960s and 1970s could not be used to improve the accuracy of Stringfield's contours.

In west Florida from about latitude 28° to 29°30′ N., the confining bed overlying the aquifer system becomes thin or is absent, and recharge to the limestone aquifer is rapid. Changes to the potentiometric surface are localized around a few pumping centers, and a simple smoothing of present-day contours restores the potentiometric surface to predevelopment conditions. Potentiometric-surface maps for this area made from the mid '70s through 1979 are considered more accurate than previous maps because of better vertical control on measuring points and the fact that more wells were measured. Water-level measurements from these maps were averaged at each well site and new contours were drawn.

The pre-stress potentiometric surface was made substantially higher than that of Stringfield (1936) in nearly all of Manatee, Sarasota, DeSoto, and Charlotte counties. Two important factors would account for the lower potentiometric surface of Stringfield in these counties: (1) A significant amount of development had already occurred by the early 1930s, particularly in the form of flowing irrigation wells in low-lying areas; (2) In all of the above-mentioned counties, with the exception of northeast Manatee County, the head in the limestone aquifer is substantially higher than that in the overlying aquifer (Hawthorn Formation). Wells are usually constructed open hole to both aquifers, resulting in interaquifer flow and a composite head that is lower than that which would exist in the Floridan aquifer. Stringfield undoubtedly had to use measurements from these; indeed, the vast majority of present-day observation wells in these southern counties are wells of this type.

In south Florida the artesian limestone aquifer system is highly stratified and several water-bearing zones comprise the overall system (Meyer, 1974). Variations in head and in ground-water salinity occur both laterally and vertically. Generally, salinity and head increase with depth of penetration. Most wells used for mapping in south Florida tap several zones; therefore, static heads and water salinities are composites. Water-level contours south of Lake Okeechobee are based chiefly on wells that are several hundred feet deep and that yield brackish ground water. Corrections for southward density increases are necessary for quantitative comparisons. East of Miami and south of Key Largo the aquifer system contains seawater.

Major Features of the Flow System

In general, depressions in the potentiometric surface indicate localized areas of natural discharge along stream channels or near springs. In the offshore extension of the aquifer system, variable discharge conditions exist. Heads of less than 10 feet along the shoreline generally indicate discharge from near-shore springs or seepage from submarine outcrops (example: the north-central Gulf Coast of Florida). In contrast, heads of 50 to 60 feet at the coast occur where a thick confining bed extends far offshore (southeast Georgia-northeast Florida coast). Sluggish but widespread upward leakage probably extends up to 50 miles offshore in that area.

Potentiometric highs, or domes on the surface, are areas of potential recharge; however, natural recharge rates vary greatly. For example, the Valdosta, Ga., "high" is a major recharge area with substantial losses of streamflow directly into the aquifer. In contrast, recharge rates are significant only in a small part of the prominent potentiometric high of central Florida (centered near Polk City). In much of the area, which is swampy, little recharge occurs due to the lack of downward hydraulic gradients, and rejected recharge leaves the area as runoff or evapotranspiration (Grubb, 1977).

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EXPLANATION

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CONTOUR SHOWS APPROXIMATE ALTITUDE OF THE POTENTIOMETRIC SURFACE FOR THE UPPER PART OF THE TERTIARY LIMESTONE AQUIFER SYSTEM. CONTOUR INTERVALS 10, 20, 30, and 50 FEET. HACHURES INDICATE DEPRESSIONS. DATUM IS NATIONAL GEODETIC VERTICAL DATUM OF 1929.

0 10 20 30 40 50 MILES

ESTIMATED POTENTIOMETRIC SURFACE FOR THE TERTIARY LIMESTONE AQUIFER SYSTEM, SOUTHEASTERN UNITED STATES, PRIOR TO DEVELOPMENT

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