Hydrogeologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, Alabama, and South Carolina

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REGIONAL AQUIFER-SYSTEM ANALYSIS

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effect can be seen on potentiometric surface maps of the aquifer system. Other small-displacement faults in peninsular Florida do not appear to affect the regional flow system because there is no apparent change in the permeability of the rocks that have been juxtaposed by fault movement.

Variations in permeability within the Floridan aquifer system result from a combination of original depositional conditions, diagenesis, large- and small-scale structural features, and dissolution of carbonate rocks or evaporite deposits. Local permeability variations are accordingly more complex than the generalized regional portrayal presented in this report.

INTRODUCTION

PURPOSE AND SCOPE

In 1977 the U.S. Geological Survey began a nationwide program to study a number of the regional aquifers that provide a significant part of the country's water supply. This program, termed the Regional Aquifer-System Analysis (RASA), is discussed in detail by Johnston and Bush (1985). In brief, the general objectives of each RASA study are (1) to describe the ground-water system as it exists today and as it existed before development, (2) to analyze changes between present and predevelopment systems (3) to integrate the results of previous studies dealing with local areas or discrete aspects of the system, and (4) to provide some capability for evaluating the effects (particularly the hydraulic effects) that future ground-water development will have on the system. These objectives can best be met by a regional-scale digital computer simulation of the aquifer system, supplemented where necessary by more detailed subregional simulations and by interpretations of the distribution of observed water-quality variations. Because of its importance as a source of ground-water supply and because of various problems that have arisen from intensive use, the Floridan aquifer system of the Southeastern United States was among the first regional aquifer systems chosen for study.

The Floridan aquifer system is comprised of carbonate rocks of Tertiary age and includes but is not limited to the sequence of rocks generally called the "Floridan aquifer" in Florida and the "principal artesian aquifer" in Georgia. Tertiary limestones also yield water, locally in appreciable quantities, in parts of southwestern South Carolina and southeastern Alabama. These limestones are included in the Floridan aquifer system in this report. The approximate areal extent of the aquifer system is shown in figure 1. The system includes rocks of Paleocene to early Miocene age that combine to form a vertically continuous carbonate sequence that is hydraulically connected in varying degrees. Very locally, in the Brunswick, Ga., area, beds assignable to the uppermost part of the Upper Cretaceous System are included in the Floridan aquifer system. Over much of the area where the aquifer system crops out, it consists of one vertically continuous permeable unit. Downdip, the aquifer system generally consists of two major permeable zones, herein called the Upper Floridan aquifer and the Lower Floridan aquifer, that are separated by less-permeable rock of highly variable hydraulic properties (very leaky to virtually nonleaky). Hydraulic conditions for the aquifer system vary from confined to unconfined, depending upon whether the argillaceous middle Miocene and younger rocks that form the upper confining unit of the system have been breached or removed by erosion.

As one of several chapters of a Professional Paper describing different aspects of the Floridan aquifer system and discussing the results of computer simulations, this report presents the hydrogeologic framework of the aquifer system as determined from subsurface geologic and hydrologic data. The objectives of this part of the study were:

1. To identify the aquifer system regionally in terms of the geologic and hydrologic units that comprise it and to define its extent.

2. To delineate regional permeability variations within the aquifer system, primarily on the basis of rock composition and texture and, to a lesser extent, on the development of secondary (solution) porosity.

3. To establish the influence of geologic structure and of variation in rock type on the ground-water flow pattern of the aquifer system.

4. To identify and map regional stratigraphic units and to establish a correlation framework between surface and subsurface geologic units.

5. To determine variations in the geometry and physical makeup of the aquifer system that affect either hydraulic parameters or the water quality of the system.

PREVIOUS WORK

Numerous reports have been published, chiefly by the U.S. Geological Survey and State geological surveys, that discuss various aspects of the geology and ground-water resources of the study area. For the most part, the scope of these reports is local or subregional. Extensive lists of publications on the geology and hydrology of the Floridan aquifer system are contained in reports by Murray (1961), Stringfield

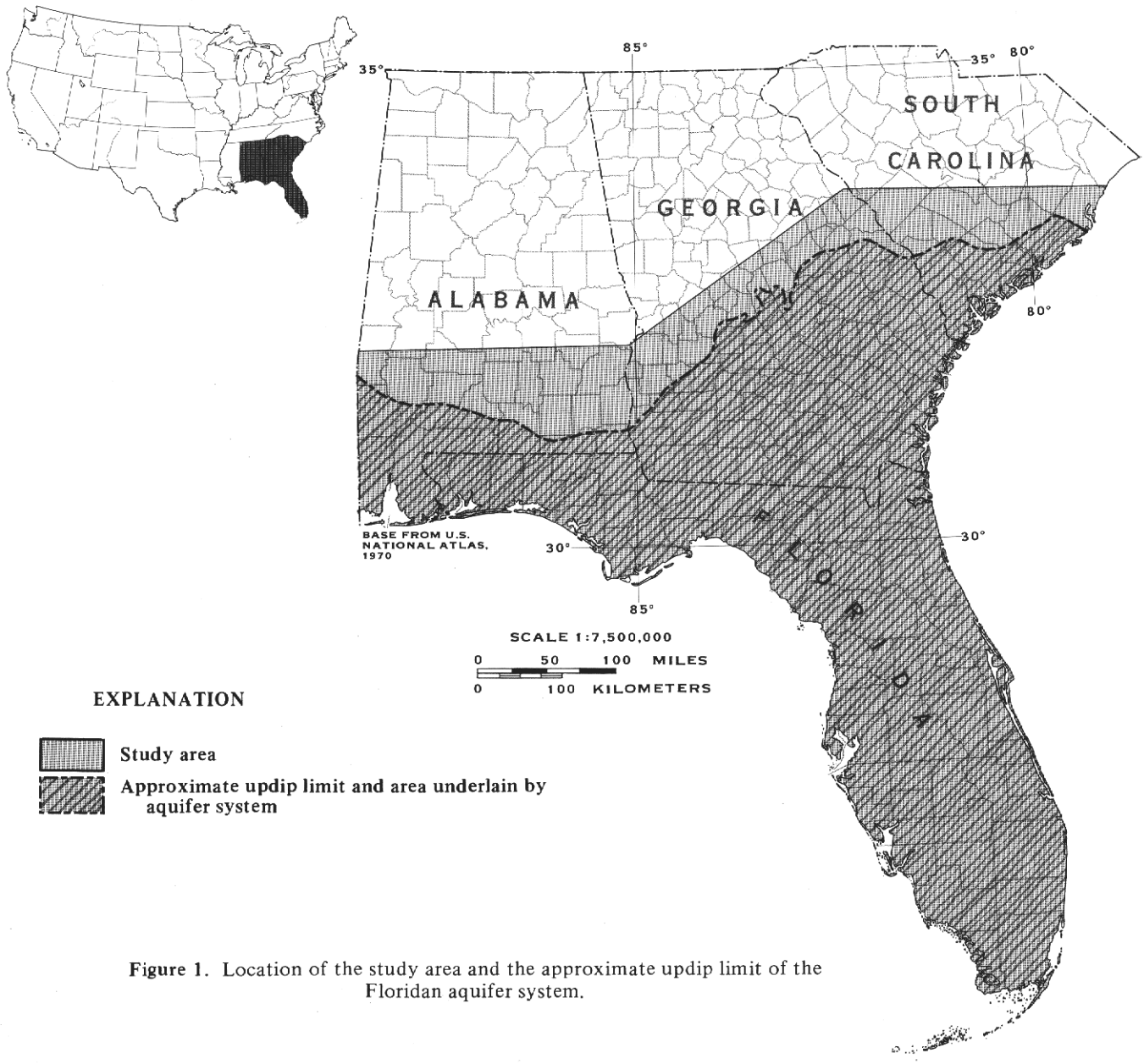

Figure 1. Location of the study area and the approximate updip limit of the Floridan aquifer system.

(1966), Braunstein (1970, 1976), Heath and Conover (1981), and Krause (1982). Reports dealing with the regional surface and subsurface geology of the Tertiary rocks in the report area include those of Applin and Applin (1944, 1964), Chen (1965), Cooke (1943, 1945), Copeland (1968), Herrick (1961), Herrick and Vorhis (1963), LaMoreaux (1946), Maher (1965, 1971), Maher and Applin (1968), Murray (1961), Puri (1953b, 1957), Puri and Vernon (1964), Randazzo and others (1977), and Randazzo and Hickey (1978). Reports that discuss regional aspects of ground water in the Floridan aquifer system have been written by Callahan (1964), Cederstrom and others (1979), Hanshaw and others (1971), Hayes (1979), Parker and others (1955), Stephenson and Veatch (1915), Stringfield (1936, 1966), and Warren (1944).

In places, the lithologic differences between strata that form the Floridan aquifer system are subtle. Accordingly, the microfauna contained in these strata have been used by some workers to establish stratigraphic subdivisions within the system. Reports on the microfauna of the Tertiary limestones include those of Applin and Jordan (1945), Cole (1938, 1941, 1942, 1944, 1945), Cushman (1935, 1951), Cushman and Ponton (1932), Levin (1957), and Loeblich and Tappan (1957).

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Carol Gelbaum, formerly of the Georgia Geologic Survey, provided extensive information on the lithology, paleontology, and water-bearing characteristics of the rocks in the Gulf Trough area of the central Georgia coastal plain and did the initial drafting of the cross sections and fence diagram used in this report.

U.S. Geological Survey colleagues who contributed to the investigation include M. E. Davis, J. G. Newton, and C. A. Pascale (Alabama); D. P. Brown, J. D. Fretwell, H. G. Healy, G. H. Hughes, G. W. Leve, A. S. Navoy, Horace Sutcliffe, Jr., D. F. Tucker, John Vecchioli, and F. A. Watkins (Florida); H. E. Gill, R. W. Hicks, and S. E. Matthews (Georgia); and R. N. Cherry and P. W. Johnson (South Carolina).

P. A. Thayer, formerly of the University of North Carolina at Wilmington, studied the carbonate mineralogy and petrography of cores collected during test-hole drilling conducted for this study. Valerie McCollister did the preliminary drafting of the cross sections and other related illustrations.

METHOD OF STUDY

APPROACH

The study area (fig. 1) extends from the southern part of the Atlantic Coastal Plain, a geologic province that has been affected primarily by compressional tectonics (Brown and others, 1972) westward into the eastern part of the Gulf Coastal Plain, which has been affected predominantly by gravity tectonics (Murray, 1961), and southward to encompass the Florida platform, which is underlain by a thick sequence of shallow-water platform-type carbonate rocks. Rapid and complex facies changes occur in the area, especially in places where carbonate rock grades laterally into clastic rock. Correlation between clastic and carbonate units or between surface and subsurface units is at present imprecise in the study area. Accordingly, the stratigraphic units used herein have been delineated in the subsurface and mapped as chronostratigraphic units that may include several formations. Structure contour and isopach maps have been prepared for six such Cenozoic chronostratigraphic units. These maps, along with eight cross sections and a fence diagram, show the geometry of and relations between the mapped units. Altitudes on the maps and cross sections and on the fence diagram are related to the National Geodetic Vertical Datum (NGVD) of 1929, a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada. The NGVD of 1929 was formerly called mean sea level. For convenience of usage, however, the NGVD of 1929 is referred to as sea level in the text and on the figures and plates in this report.

The top and base of the Floridan aquifer system, as well as the top and base of major permeability variations within the system, commonly coincide with the top of a chronostratigraphic unit or a particular rock type. Such coincidence is not the case everywhere, however. The vertical limits of the aquifer system as mapped for this study represent the top and base of carbonate rocks that are generally highly permeable and that are overlain and underlain by low-permeability material. The low-permeability rock that delineates the system may be either a clastic rock or a carbonate. In places, the permeability contrast between the aquifer system and its upper and lower confining units may exist within a rock unit or a chronostratigraphic unit. For example, in places, the upper part of the Suwannee Limestone of Oligocene age consists of low-permeability micritic limestone underlain by highly permeable limestone comprised largely of pelecypod and gastropod casts and molds that is also part of the Suwannee. In this case, the top of the Floridan aquifer system would be placed at the top of the highly permeable cast-and-mold limestone rather than at the top of the Suwannee. The aquifer system is thus defined on the basis of its permeability characteristics rather than on the basis of lithology. Accordingly, the structure contour map of the top of the Floridan aquifer system presented in this report differs considerably from previously published maps that represent either the top of vertically continuous limestone or the top of a particular geologic horizon, regardless of its permeability. Structure contour maps representing the base of the aquifer system and the base of the upper major permeable zone within it (the Upper Floridan aquifer) were presented for the first time by Miller (1982a, b) in preliminary open-file publications and are reproduced in this report with minor modifications. Isopach maps of the total aquifer system and of the Upper Floridan aquifer are also presented.