

CHEMICAL CHARACTER OF WATER IN THE FLORIDAN AQUIFER
IN SOUTHERN PEACE RIVER BASIN, FLORIDABy
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INTRODUCTION

The chemical character of water from the artesian Floridan aquifer underlying the southern Peace River basin varies considerably both areally and vertically. Water from this aquifer is used extensively throughout the southern Peace River basin with the primary use being for irrigation. In addition, most municipal and some industrial and domestic water is obtained from the Floridan aquifer.

One factor that governs the use of water for various purposes is its chemical quality. Knowledge of variations in the chemical character of water areally, vertically, and with time is needed to properly develop water commensurate with its intended use. Such knowledge is also needed to obtain a better understanding of the geologic framework and the hydrologic system in general and the ground-water flow pattern in particular.

This report (1) portrays and discusses the areal and vertical variations in chemical quality, (2) analyzes the variations in chemical character, and (3) presents a possible interpretation of the observed patterns of distribution in terms of the hydrologic system. The hydrologic parameters discussed include the piezometric surface and directions of ground-water flow, the temperature and chemical character of water in the Floridan aquifer, and the related stratigraphy.

The Peace River is in west-central Florida and drains an area of approximately 2,000 square miles extending southward from the Green Swamp area in northern Polk County to Charlotte Harbor on the Gulf of Mexico. The southern Peace River basin as covered herein, see figure 1, includes all of Hardee and De Soto counties and most of Charlotte County.

The principal source of ground water in the southern Peace River basin is the Floridan aquifer which is composed of marine limestones and dolomites, Eocene to Miocene in age. Formations that comprise the aquifer are, from oldest to youngest, the Lake City Limestone, the Avon Park Limestone, the Ocala Group, the Suwannee Limestone, the Tampa Formation, and the lower permeable zones of the Hawthorn Formation (see figure 2). These formations dip gently and thicken to the south and west. It should be noted that the nomenclature used in this report is that of the Florida Geological Survey and not necessarily that of the U.S. Geological Survey.

Variations in vertical and horizontal permeability occur within the Floridan aquifer throughout the area covered by this report. These variations along with variations in artesian pressure in the different zones of the aquifer control to some degree the ground-water flow pattern and the hydrologic interconnection among the several formations comprising the aquifer, and therefore, in part, control the water chemistry and temperature distribution.

MOVEMENT OF WATER

Figure 3 shows the piezometric surface of the upper part of the Floridan aquifer in May 1965 and the generalized area of artesian flow. The principal recharge area is the southern Peace River basin to the northeast and east along the Lake Wales and Highlands ridges in Polk and Highlands counties. The regional direction of ground-water movement is to the south and west, normal to the piezometric contours. The irregular shape of the contours indicates deviations from the regional direction of movement. In addition, strong directional permeability resulting from solution cavities and channels in the carbonate rock aquifer can cause large departures from a directly downgradient direction of flow.

The pattern of artesian flow is also controlled to some degree by variations in artesian pressure with depth within the Floridan aquifer. Woodard (1964) noted a decrease in artesian pressure with depth of penetration into the aquifer in northwest Hardee and northeast Manatee counties. This decrease in artesian pressure with depth creates a potential for downward movement of artesian water and possible local recharge. Similar conditions are believed to occur in parts of northeast Hardee County.

An opposite relation of artesian pressure with depth occurs in the vicinity of the Peace River and within the area of artesian flow portrayed in figure 3. In this area observations indicate that water under higher pressures with increased depth. This increase in artesian pressure with depth creates a potential for upward movement of artesian water and local discharge. For example, during the drilling of an irrigation well in southwestern DeSoto County, pressure heads were observed to increase from 8.4 feet above land surface at a well depth of 510 feet in the upper part of the Floridan aquifer to 14.5 feet at a well depth of 1,000 feet. Also, the yields by natural flow increased between the above depths from 500 to 1,130 gallons per minute.

Troughs in the piezometric surface in the vicinity of the Peace River (figure 3) are caused in part by the upward leakage of ground water to the Peace River and in part by heavy ground-water pumping from the aquifer. The fact that the troughs are somewhat linear and offset from the river may imply the existence of a fracture of relatively high vertical permeability acting as a line source of discharge from the Floridan aquifer. Stewart (1966, p. 27) reports that piezometric troughs along the Peace River in Polk County, immediately to the north, are caused by upward leakage along the river.

CHEMICAL QUALITY OF WATER

In general, the temperature and chemical character of ground water depend on several variables, such as composition of the aquifer, distance from recharge areas, residence time the water has been in contact with the aquifer, and the overall pattern of ground-water circulation. Increases in mineral content relate to direction of water flow, allowing greater opportunity for dissolution of the aquifer minerals in the downgradient direction. Increases in temperature are related primarily to increased depths of ground-water circulation.

Figure 4 shows the distribution and depth of wells sampled for temperature and chemical determinations and the types of analyses available. The chemical character and temperature of artesian water is depicted both areally and in section in figures 5 through 11. The maps portray horizontal variations as represented by water from existing wells irrespective of depth while the sections portray vertical variations within the aquifer across the Peace River. In a few instances several formations may yield water to a single well. The chemical character of artesian water varies both areally and vertically, the character of water from wells being dependent upon location and depth.

The patterns of distribution of temperature, mineral content, and chemical character portrayed in figures 5 through 11 are caused by combinations of the several variables mentioned above. The pattern of ground-water circulation is complex because of the existence of solution channels and fractures, which result in heterogeneous movement of ground water within the Floridan aquifer. This means that the water being recharged to the aquifer in one area will not necessarily all travel the same distance or to the same depth within the aquifer before being discharged.

Interpretation of figures 5 through 11 in more detail is discussed in the following paragraphs:

The areal distribution of chloride in the Floridan aquifer in the southern Peace River basin is shown in figure 5. Chloride concentrations increase toward the southwest in accord with the general direction of ground-water movement and are greatest in the southernmost part of the basin near Charlotte Harbor and the mouth of the Peace River. A comparison of records from 1949 with those from 1965 show essentially no change in the chloride concentrations nor in the piezometric surface. The chloride content and stability may be related to slow movement and incomplete flushing of artesian water from the portion of the aquifer farthest downgradient from the areas of recharge.

Figures 6 through 9 portray the areal distribution of temperature, total dissolved solids, sulfate, and hardness. The

patterns are caused in part by variations in vertical and horizontal permeability and in part by artesian pressure differences within the aquifer, resulting in large variations in the movement of ground water within the Floridan aquifer. Examination of the maps indicates that an approximate northeast-southwest trending linear zone of relatively warm, highly mineralized water occurs in the general vicinity of the Peace River and also in northwestern DeSoto and southeastern Sarasota counties.

To obtain an insight into the chemical character of artesian water in the southern Peace River basin, the water samples were classified into three major types, based on percent equivalents per million. (See figure 10). A classification by chemical types aids in understanding the origin and movement of the artesian water.

Water in western and eastern Hardee County and eastern DeSoto County is primarily a calcium bicarbonate type. In the vicinity of the Peace River in central Hardee County and western DeSoto and southeastern Sarasota counties, the water is predominantly a calcium-magnesium sulfate type; whereas, in most of Charlotte County, the water is of a sodium chloride type.

Interpretation of these maps and a better understanding of the hydrochemical relations within the southern Peace River basin is given by the three sections showing the vertical distribution of temperature, total dissolved solids, and sulfate content. The sections are at right angles to the Peace River in central Hardee County (see figure 11).

The patterns on the sections of figure 11 suggest an upward coning of warm, mineralized water beneath the Peace River. An N-S line source of water into the aquifer from depth which is different in quality and temperature from the overlying waters is therefore indicated. Water in the Floridan aquifer underlying the Peace River is generally higher in temperature and mineral content than at equivalent depths somewhat to the east or west of the river. For example, wells drilled in the vicinity of the Peace River to depths of 600 to 700 feet below msl (mean sea level) yield water with a dissolved solids content greater than 500 ppm (parts per million), whereas wells drilled east or west of the river to depths greater than 1,000 feet below msl yield water with less than 250 ppm dissolved solids. The warm, mineralized water, as it ascends and moves away from its source, tends to be diluted by the addition of water circulating at more shallow depths.

The fact that the linear zones of high temperature and high mineral content that occur beneath the Peace River generally coincide, and that the high mineral content is primarily due to calcium, magnesium, and sulfate suggests deep ground-water circulation and active solution of evaporites.

The Lake City and younger (overlying) formations that comprise the Floridan aquifer contain little or no evaporites within the area of the report. According to Chen (1965, p. 44, 45, figures 27, 31), the underlying Cedar Keys Limestone of Paleocene age and the Oldsmar Limestone of early Eocene age contain extensive evaporites (gypsum and anhydrite) in the southern Peace River basin area. These formations occur below the Floridan aquifer and represent the probable source for the calcium-magnesium sulfate waters. The higher temperatures of these waters reflect their deeper circulation.

The coincidence, in northeast Manatee and northwest and northeast Hardee counties, of relatively low temperature, low mineral content, and a calcium bicarbonate type water, occurring in conjunction with a pressure head decrease with depth, indicates downward movement of artesian water and local recharge. The coincidence, in the vicinity of the Peace River, of relatively high temperature, high mineral content and a calcium-magnesium sulfate type water, occurring in conjunction with a pressure head increase with depth, indicates upward movement of artesian water and local discharge.

Based on the above analysis, artesian water from the Floridan aquifer in the vicinity of the Peace River should be both older and more saturated with respect to calcium carbonate than artesian waters located in areas to the east and to the west-northwest of the river.

The natural variations in permeability and artesian pressure gradients cause local deviations in the general hydrologic system and result in a complex pattern of ground-water circulation. The circulation in turn is responsible for the observed chemical character and temperature distribution patterns in the southern Peace River basin.

The temperature and chemical distributions appear to indicate deep ground-water circulation and active solution of evaporites at depth, possibly in the Cedar Keys or the Oldsmar Limestones, and indicate that these waters ascend along a linear zone (fault?) of greater vertical permeability. The temperature and chemical data are consistent with the piezometric data, which suggest that a fracture of relatively high vertical permeability exists and acts as a line source of discharge from the Floridan aquifer.

An analysis of temperature and water chemistry distributions, in conjunction with the detailed mapping of the piezometric surface and the measurement of pressure head variations with depth, leads to a more thorough understanding of the hydrologic flow system. Also, it provides an explanation for the observed variations in water quality and the hydrochemical mapping indicates the existence of a subsurface fracture or fault.

From the practical standpoint of water utilization, the maps and sections indicate ranges in concentrations and temperatures and should permit the user to determine if the water is suitable for his needs. In general, waters in the area of influence of the ascending artesian water will be of a poorer quality than waters outside this area, excluding the sodium chloride waters of Charlotte County. Large quantities of water, meeting the recommended limits for potable water (U.S. Public Health Service, 1962), may be obtained in northeast Manatee County, northwest and east Hardee counties, and northeast DeSoto County.

REFERENCES

- Black, A.P.
1953 (and Brown, Eugene) *Chemical character of Florida's waters-1951*: Florida State Bd. Conserv., Div. Water Survey and Research Paper 6.
- Brown, Eugene (see Black, A.P.)
- Chen, C.S.
1965 *The regional lithostratigraphic analysis of Paleocene and Eocene rocks of Florida*: Florida Geol. Survey Bull. 45.
- Finney, S.N.
1961 (and Miller, J.B.) *Some physical and chemical characteristics of selected Florida waters*: Florida State Bd. Health, Jacksonville.
- Hem, J.D.
1959 *Study and interpretation of the chemical characteristics of natural waters*: U.S. Geol. Survey Water-Supply Paper 1473.
- Miller, J.B. (see Finney, S.N.)
- Stewart, H.G., Jr.
1966 *Ground-water resources of Polk County*: Florida Geol. Survey Rept. Inv. 44.
- U.S. Public Health Service
1962 *Drinking water standards*: PHS Pub. No. 956.
- Woodard, H.J.
1964 *Preliminary report on the geology and ground-water resources of Hardee and DeSoto counties, Florida*: Florida State Bd. Conserv., Div. Water Resources and Conserv., Tallahassee.

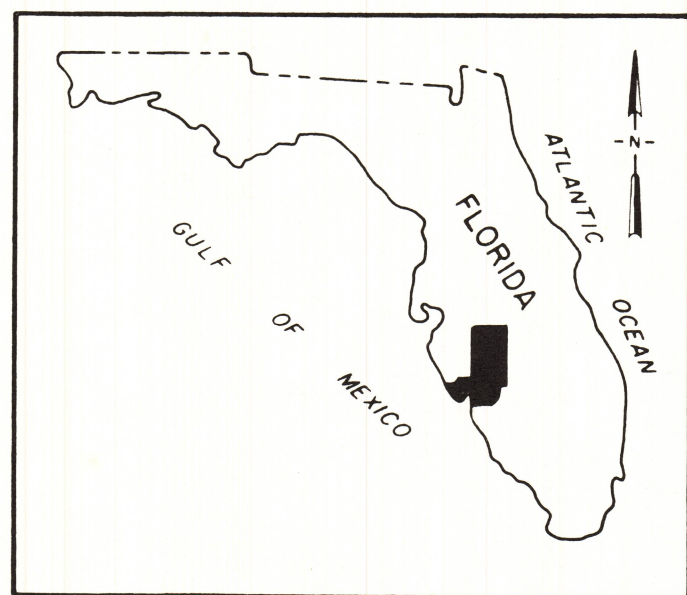


Figure 1. Location of area.

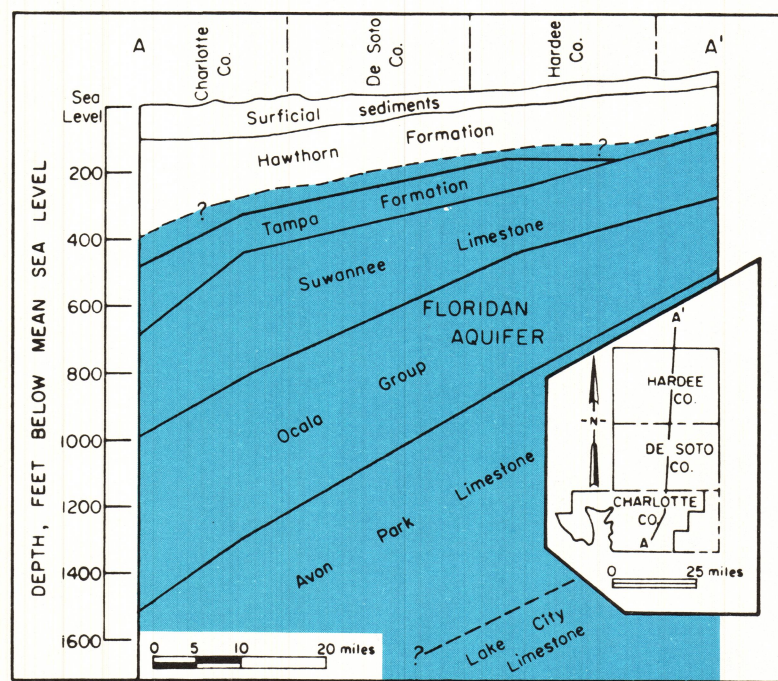


Figure 2. Generalized N-S geologic section across the southern Peace River basin.

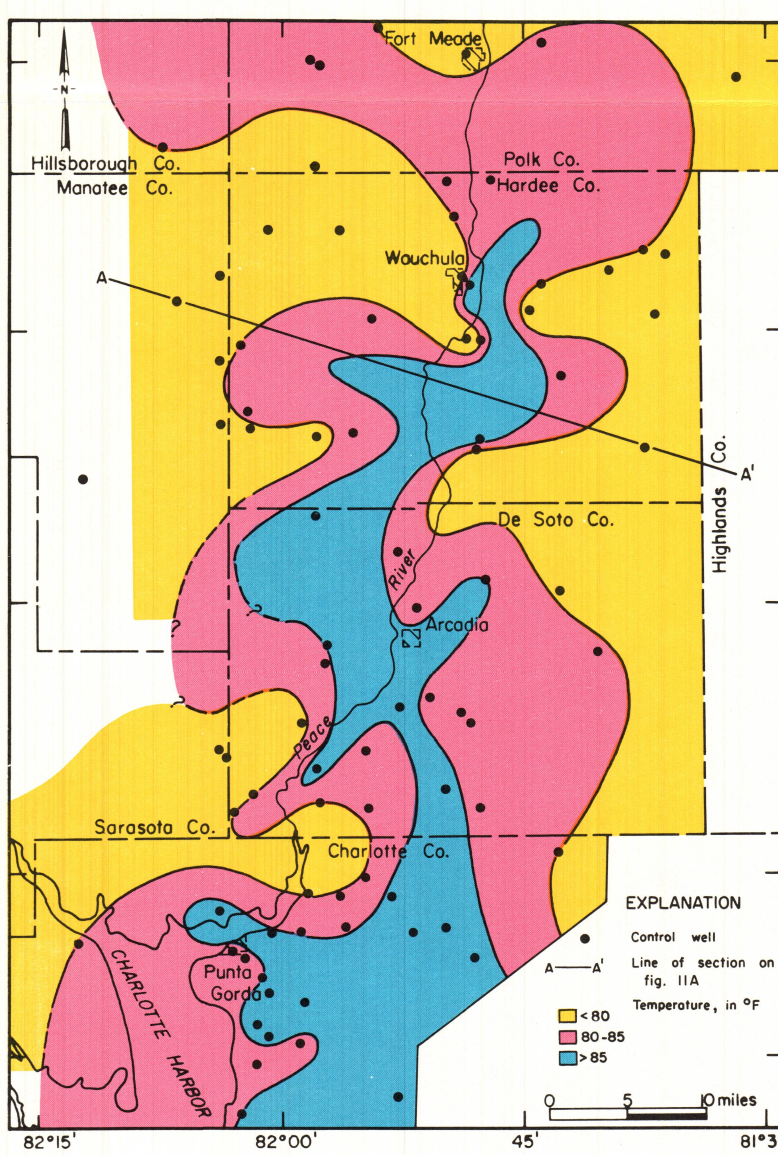


Figure 3. Piezometric surface of the upper part of the Floridan aquifer, May 1965.

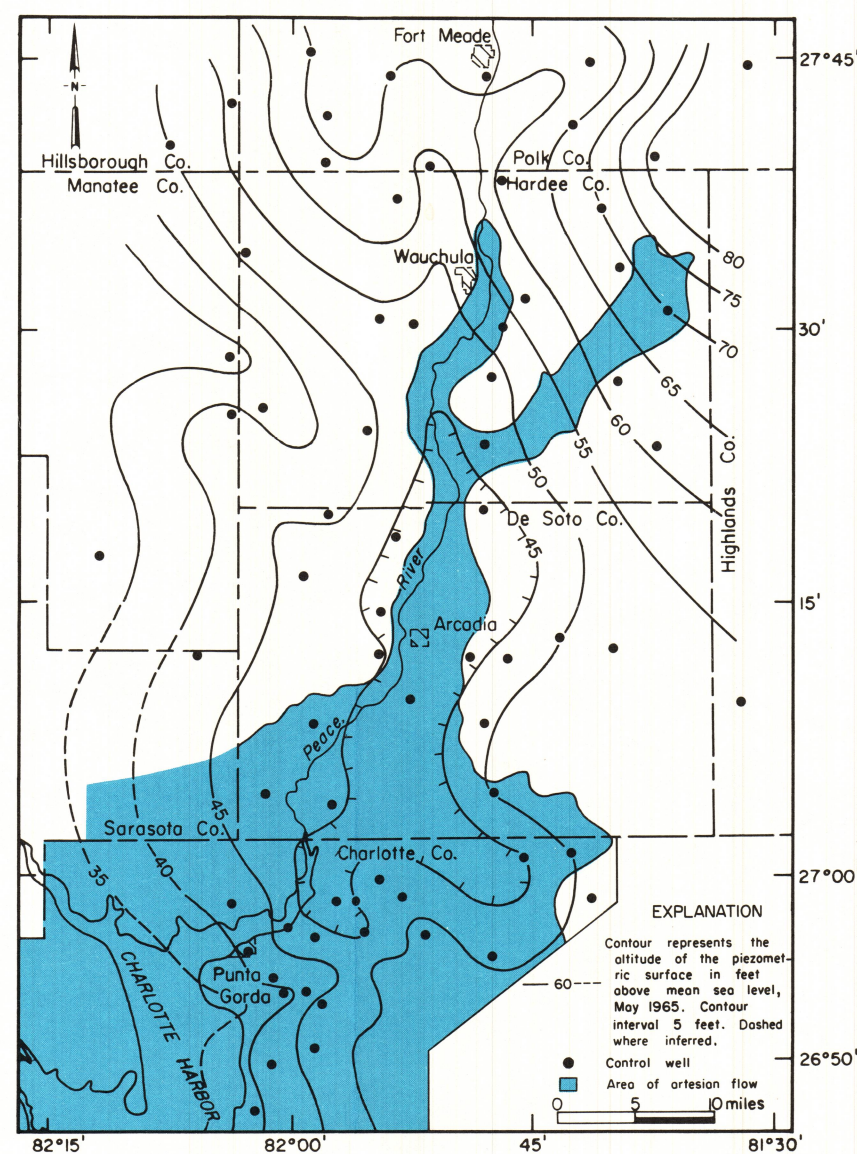


Figure 4. Distribution and depth of wells sampled for water temperature and chemical determinations.

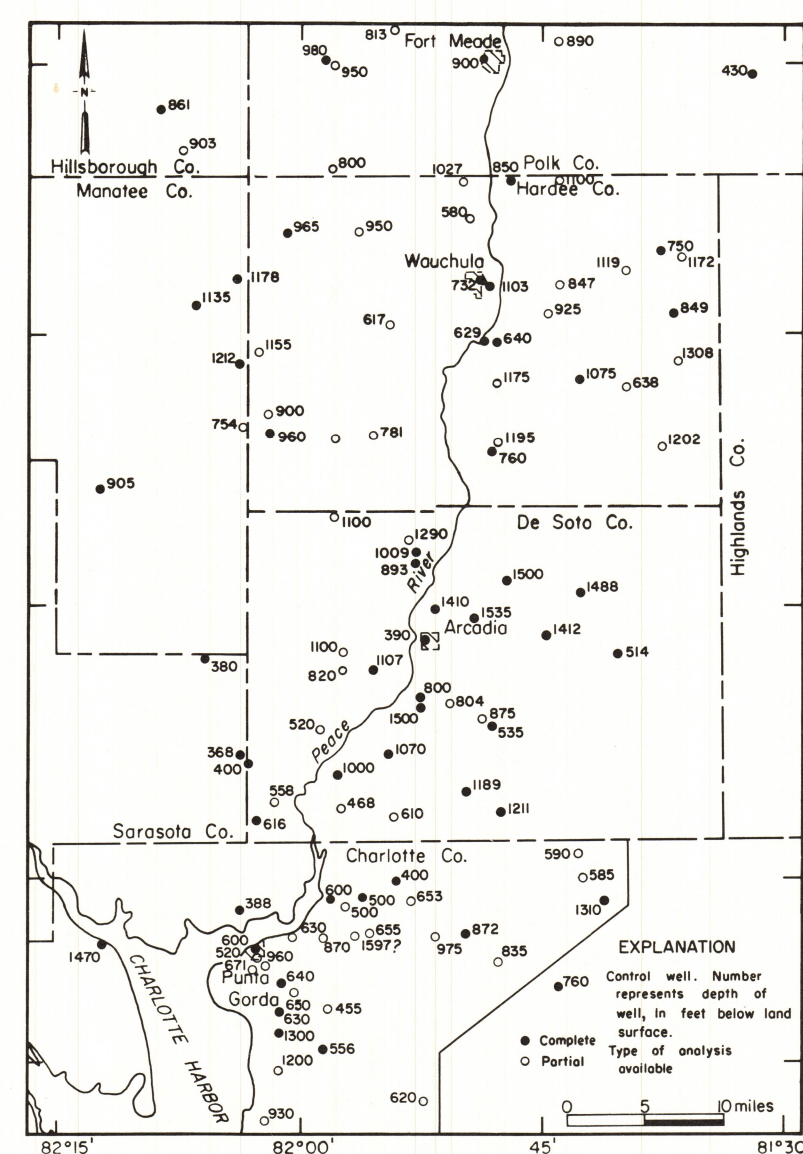


Figure 5. Chloride content of water in the Floridan aquifer.

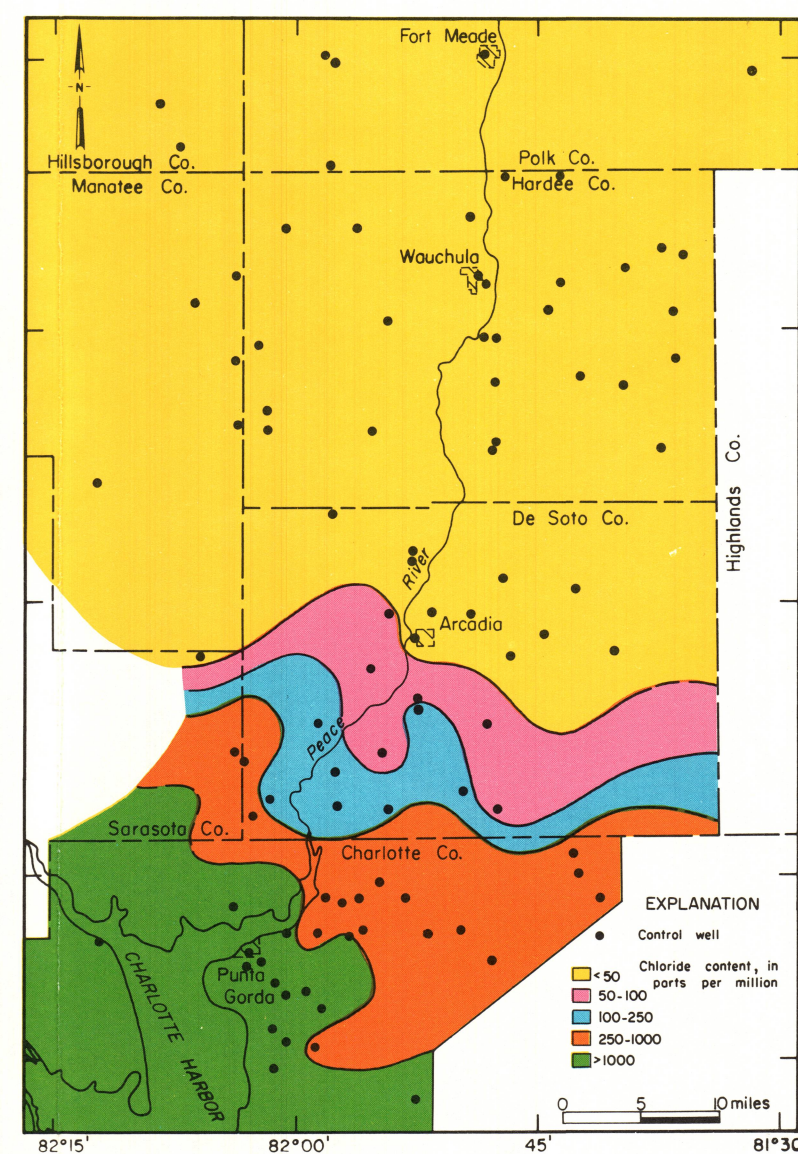


Figure 6. Temperature of water in the Floridan aquifer.

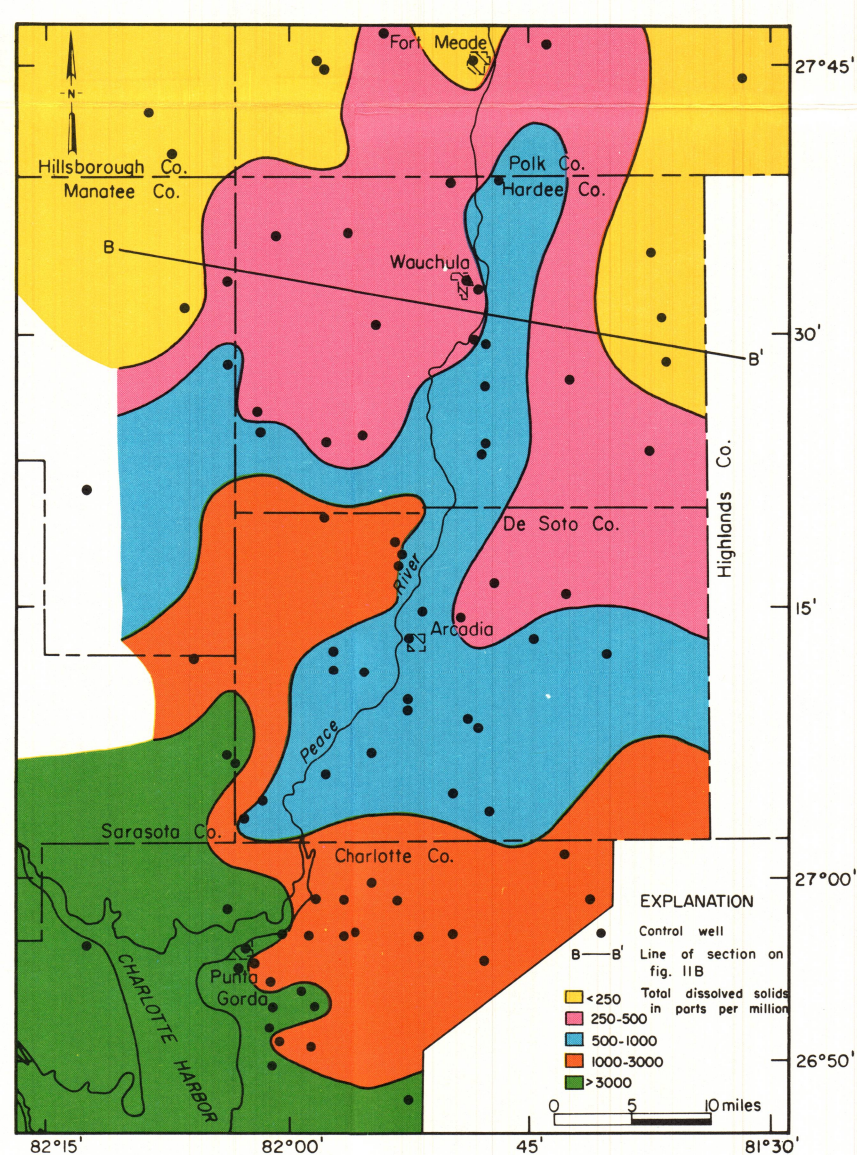


Figure 7. Total dissolved solids content of water in the Floridan aquifer.

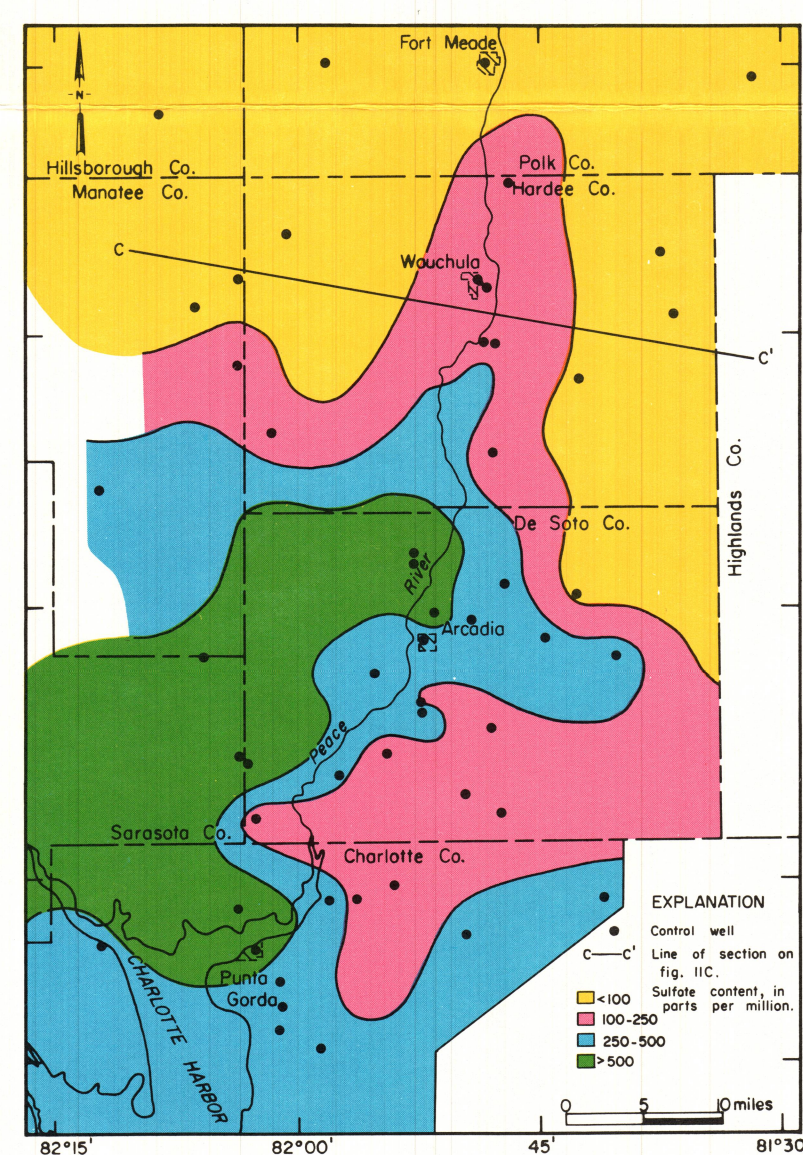


Figure 8. Sulfate content of water in the Floridan aquifer.

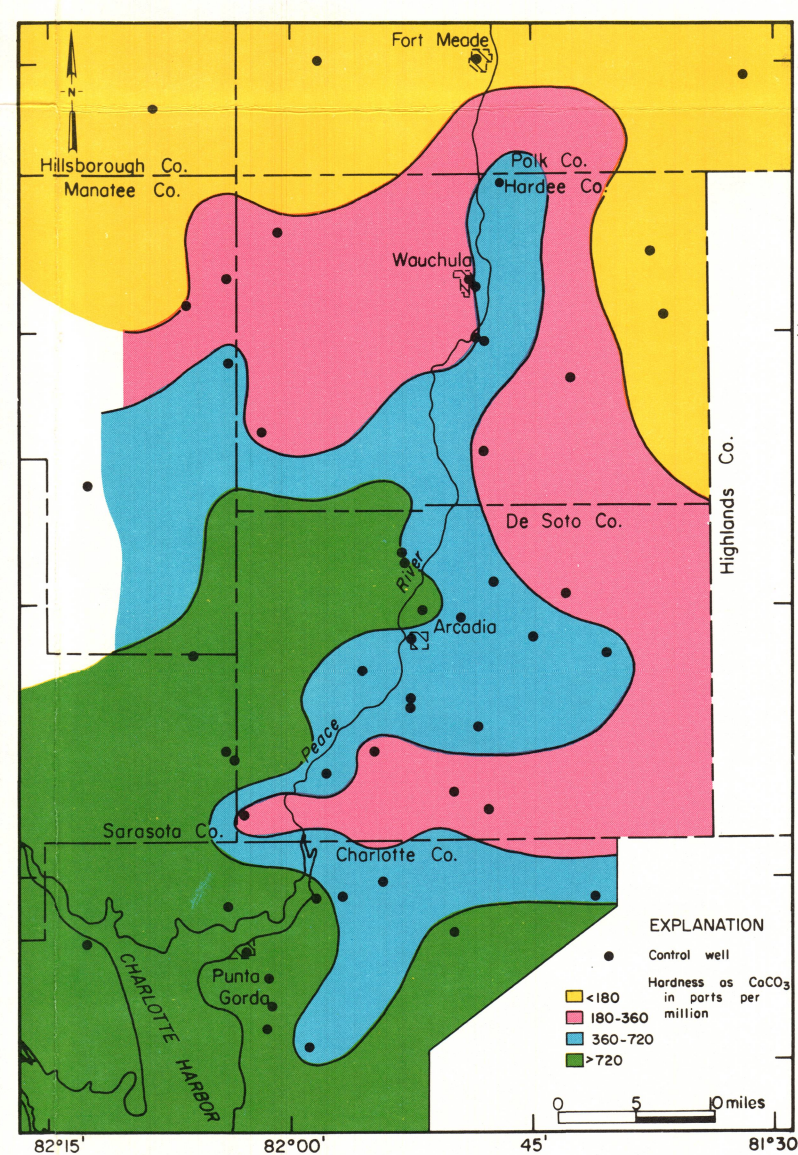


Figure 9. Hardness of water in the Floridan aquifer.

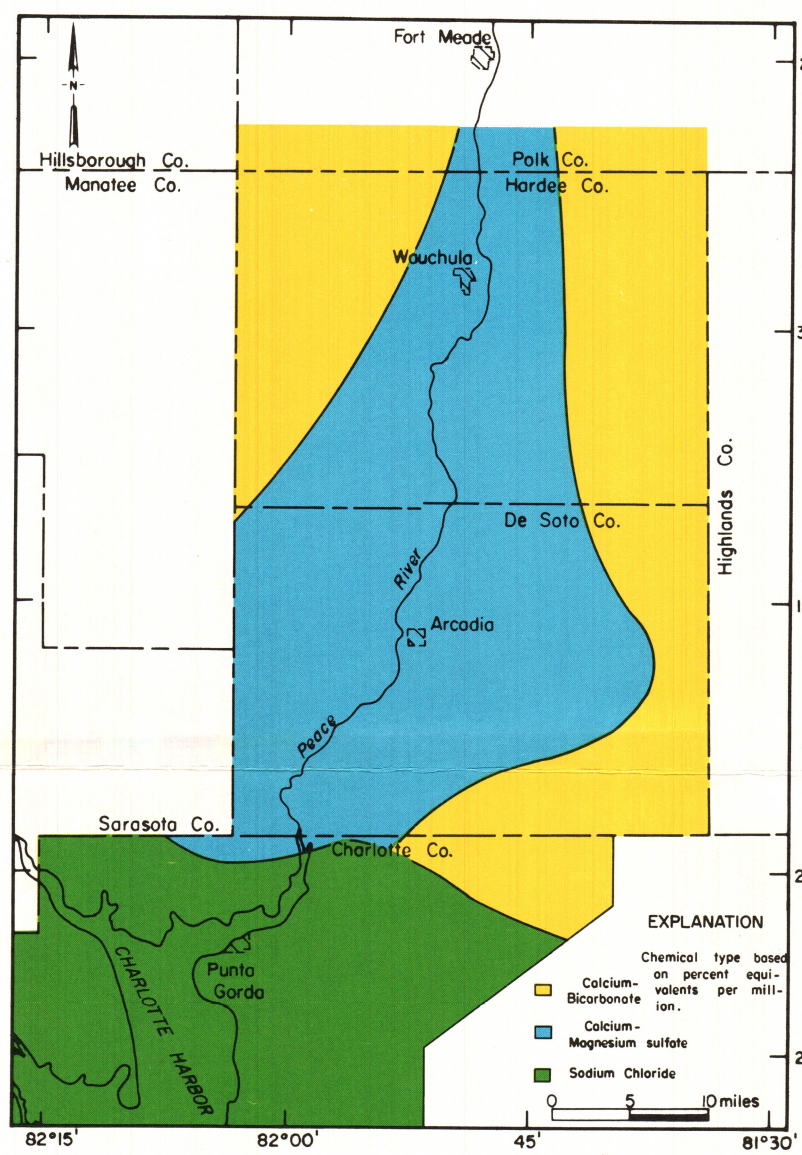


Figure 10. Chemical types of water in the Floridan aquifer.

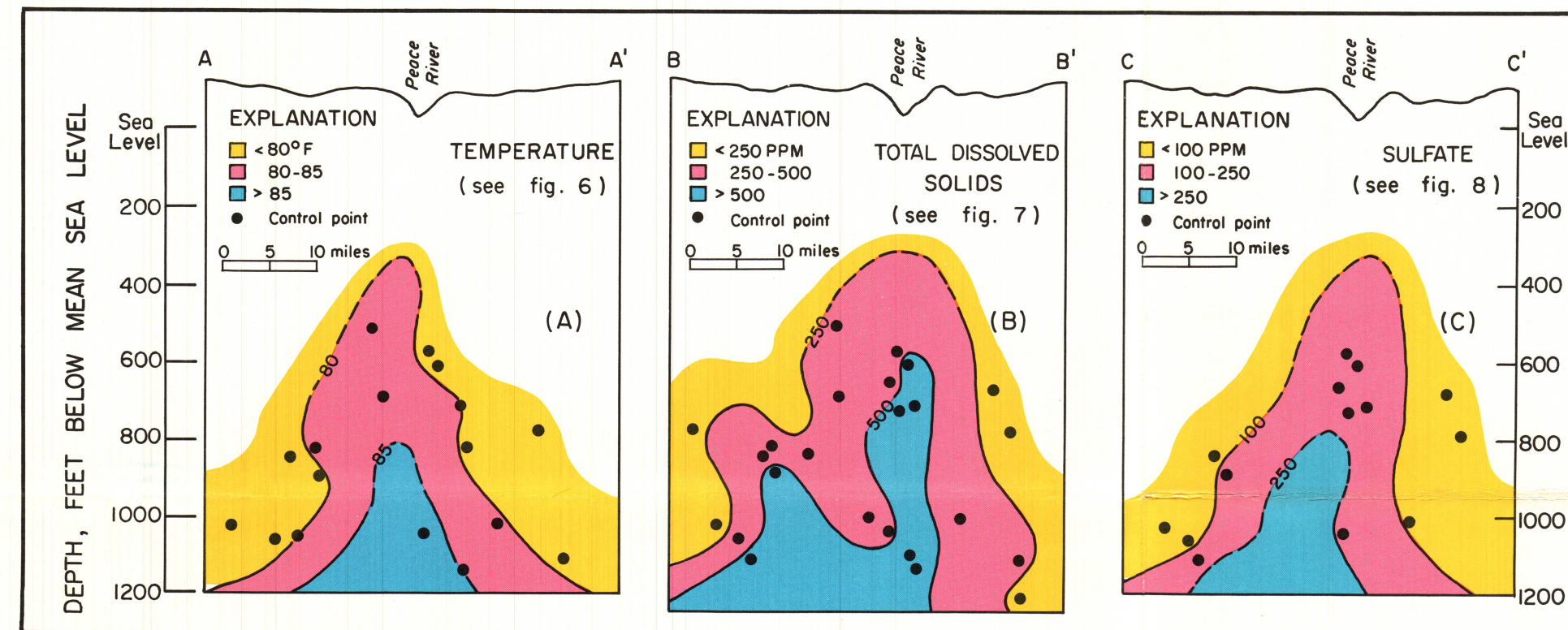


Figure 11. Sections showing the vertical distribution of temperature, total dissolved solids, and sulfate.