NATURE OF GROUNDWATER AQUIFERS IN THE UPPER COASTAL PLAIN OF GEORGIA AND SOUTH CAROLINA

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Abstract. The Upper Coastal Plain contains aquifers capable of yielding large quantities of water with low dissolved solids. There are commonly three aquifers present with water flow directions in each aquifer controlled by the proximity of surface streams and rivers. The very low cation exchange capacity of the Upper Coastal Plain sediments makes these aquifers unusually susceptible to contamination.

INTRODUCTION

This paper discusses the portion of the Upper Coastal Plain extending from the Fall Line about 20 miles to the Southeast (Figure 1). Aquifers in this region are capable of producing large quantities of groundwater containing low concentrations of dissolved solids. Other regions of the state cannot duplicate the combination of very low dissolved solids and large available quantity of the groundwater resource of the Upper Coastal Plain.

North of the Fall Line, water is obtained from surface streams and rivers, man-made reservoirs, and generally small-capacity groundwater wells. The limitations on the water resources are being recognized, and many substantial capital projects are underway to assure continued adequate supply of water.

In the Lower Coastal Plain, water is available from rivers and streams and from groundwater aquifers. The aquifers are capable of yielding large quantities of water; however, there are localized problems of salt-water incursion or aquifer depletion. The groundwater contains much higher concentrations of dissolved ions (is harder) than the groundwater of the Upper Coastal Plain. Surface waters are available but require treatment prior to use.

BACKGROUND

Geohydrology of the Upper Coastal Plain

The Upper Coastal Plain consists of a southeastward thickening sequence of sands and clays (Figure 2), forming a band of sandy hills. The lowest units exposed at the Fall Line are Cretaceaous Age with progressively younger Tertiary Age units exposed towards the southeast.

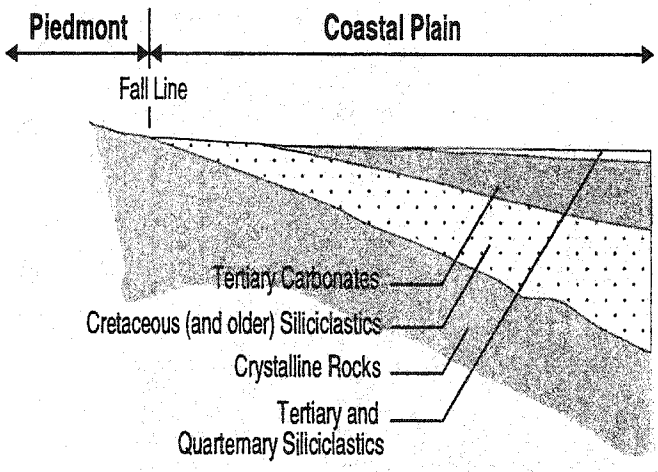

Figure 2. Cross section of the Upper Coastal Plain.

Quaternary Age valley fill and terraces occur along major streams and rivers.

The Upper Coastal Plain sediments generally consist of sands and clays with low cation exchange capacities (CEC). Large quantities of kaolin, a highly weathered clay with low CEC, are mined here. The groundwater is characterized by low pH, conductivity, and total dissolved solids, reflecting the lack of soluble material in the sediments. Further to the southeast, carbonaceous sediment layers are common in the Coastal Plain, and groundwaters have higher pH and conductivity.

The groundwater commonly occurs in three distinct zones in these sediments. The lowest zone resides within thick permeable sand layers in the Cretaceous Age sediments. This aquifer is capable of producing large quantities of very clean water and is used by major water users. This is the major water-producing aquifer of the Upper Coastal Plain.

A smaller aquifer commonly occurs in sand units near the base of the Tertiary Age sediments above the Cretaceous Aquifer. A relatively impermeable clay separates these two aquifers in many areas. This aquifer is locally used for water production. Further to the southeast, this aquifer becomes the major source of groundwater production in the Middle and Lower Coastal Plains.

The highest zone of saturated sediments consists of interbedded sands and clays. This thick sequence generally does not contain very productive sand units and is only used by individual homes or other small-volume water users.

Groundwater flow paths

The streams and rivers of the Upper Coastal Plain control the groundwater flow paths. A prediction of the groundwater flow path for water entering the top of the groundwater can be made based on the distance to small streams, larger streams, and the major streams and rivers.

Ultimately, all of the groundwater in the Upper Coastal Plain is either discharged to rivers or moves downdip into aquifers of the Middle and Lower Coastal Plain. The major river valleys cut deeply into the sediments and form the major drains for groundwater. These rivers include the Savannah River, Brier Creek, the Ogeechee River, the Oconee River, the Ocmulgee River, the Flint River, and the Chattahoochee River.

The rivers have perennial stream tributaries. All perennial streams in the Upper Coastal Plain are drains for groundwater. Typically, the major stream tributaries have smaller perennial streams as tributaries. The pattern for surface drainage consists of three levels: major rivers, major tributaries of rivers, and minor tributaries.

A stream valley that cuts down into an aquifer forms a drain for that aquifer. Water in the aquifer near the valley will flow toward the stream. As the distance to the stream increases, the effect of the drain decreases and alternative paths for groundwater become more likely. The alternative paths are moving horizontally through the aquifer toward some other discharge point or moving up or down into another aquifer. This pattern allows the prediction of the likely flow path for water within each aquifer.

Near the major river valleys (Table 1), water from all of the near-surface aquifers moves toward and discharges into the rivers. There is very little downward movement of groundwater in the upper aquifers because the adjacent valley creates an easy way for the water to drain. Water is moving upward from the lower aquifer to get to the river drain. Only in aquifers buried deep under the river valley can water not move toward the river.

The major tributaries commonly do not cut as deeply into the sediments as the rivers. Toward the Southeast, the lower aquifer in the Cretaceous sediments is isolated from these streams by the clay aquitard. The groundwater in the upper zones moves toward these streams, but the lower zone aquifer is largely unaffected. The minor tributaries at the highest elevations intersect only the uppermost aquifer. The lower aquifers are generally unaffected by these streams.

Susceptibility to Contamination

The Upper Coastal Plain sediments are highly weathered and have low CEC. The soils are very sandy and permeable, absorbing and passing water downward relatively rapidly. Potential groundwater contaminants pass through these sediments much more readily than in most other soils and rocks. The roots of vegetation can retard some of the contaminants, but if the contaminants get below the root zone, the contamination can become widespread. At the Savannah River Site in the Upper Coastal Plain of South Carolina, contaminated groundwater has spread over three miles laterally within 30 years, or at a rate of about 500 feet per year.

Table 1. General Distance in Miles Water in the Aquifers Moves HorizontallyToward Surface Drainage

	Cretaceous Aquifer	Tertiary Aquifer	Upper Saturated Zone
River	5–10	2–3	1–2
Major Tributary	0–2	2–3	0.5–1
Minor Tributary	0	0	0.5

The location of potential groundwater contamination sources affects the potential size of groundwater contamination plumes. If contamination enters the groundwater near a perennial stream or river, the contamination will move toward that surface drain. If contamination enters the groundwater away from streams and rivers, it will spread horizontally and vertically, creating a large plume.

CONCLUSIONS

The aquifers of the Upper Coastal Plain are a valuable resource that is very susceptible to contamination. This resource could potentially be a major attraction to industries and others who desire large quantities of low dissolved solids water. The sediments of the Upper Coastal Plain are very susceptible to contamination because they do not interact much with contaminants. This makes the aquifers of the Upper Coastal Plain very susceptible to widespread contamination.

The placement of potential sources of contamination affects the potential size of groundwater plumes. Planners should consider the potential for major degradation of the groundwater resource when siting these facilities.

ACKNOWLEDGMENTS

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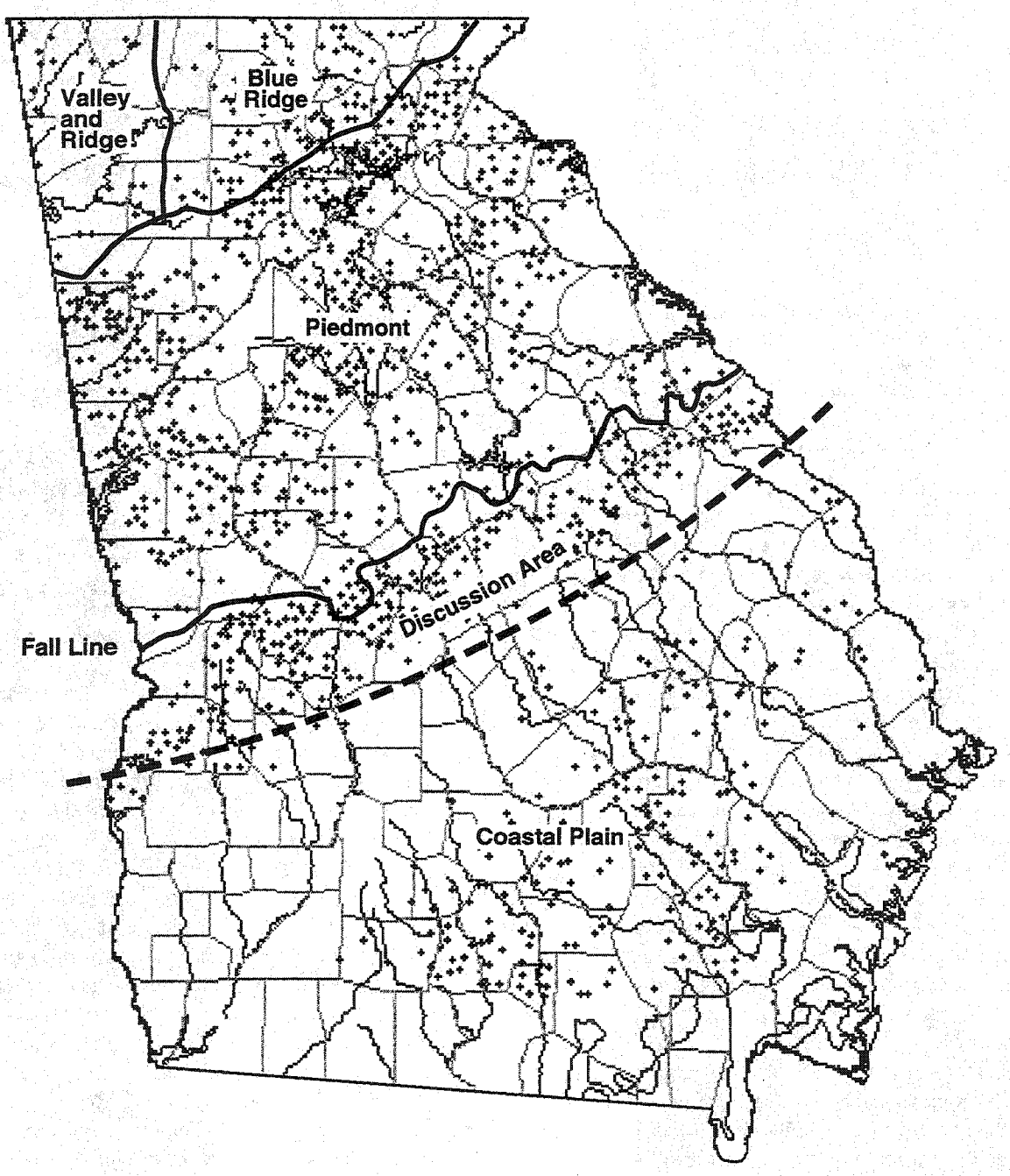

Note: Groundwater chemistry information is available for most of Georgia from the National Uranium Resource Evaluation (NURE) data (Hoffman and Buttleman, 1994). This program, conducted in the late 1970s, collected groundwater, streamwater, and stream sediment samples from much of the United States. Figure 1 shows the groundwater wells in Georgia that had water with specific conductance less than 50 µS/cm. These are the waters with the lowest levels of dissolved ions. Most of the samples were collected from wells serving individual homes.

Figure 1. The portion of the Upper Coastal Plain addressed by this paper.