

HYDROGEOLOGIC EVALUATIONS FOR HIGH-YIELDING WELLS IN THE PIEDMONT PROVINCE OF GEORGIA AND ALABAMA

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INTRODUCTION

Since the mid-1980's, there has been a dramatic increase in the number of non-residential water wells drilled in the Piedmont province of Georgia and Alabama. Water shortages and interrupted services related to prolonged drought conditions and reduced services from municipal, county, or water-district systems have resulted in the need for a more reliable water-supply source. Recent hydrogeologic investigations indicate that adequate ground-water supplies are available in metamorphic rocks of this region to supplement surface-water resources for meeting municipal, industrial, irrigation, and domestic water demands. Evaluations of ground-water availability in Fulton County near Dunwoody, Georgia and in Cleburne County near Heflin, Alabama, were initiated to better determine and understand the factors controlling ground-water occurrence and yield in the Piedmont (Figure 1).

GEORGIA STUDY AREA

The Georgia study area occupies deeply incised hill slopes along a small tributary to the Chattahoochee River. The area is underlain by sillimanite-kyanite-garnet-feldspar-quartz-muscovite schist. The size and abundance of concordant pegmatites and quartz veins in the schist greatly increases the ability of the rock to store and transmit water. Depth of weathering ranges from a few feet to a few tens of feet. Foliation in the schist trends east-west and is inclined to the south at angles of 30 to 35 degrees. Four well-developed joint sets were measured (1) east-west, inclined 80N to vertical; (2) north-south, 75E to vertical; (3) N50E, vertical; and (4) N50W, vertical. The east-west and north-south discontinuities have exerted the dominant influence on topography, surface-water movement, and potential for ground-water flow.

Because the rock type is the same throughout the Georgia study area, the ranking of areas favorable for ground-water development was based on the spatial relation of discontinuities to each other, and to topography, depth of weathering, and recharge area. The area judged to have the best potential for ground-water development and the largest recharge area (well 1) is located at the intersection of linear topographic features that are controlled by east-west foliation and the east-west joint set with the north-south joint set. The area with the second greatest potential (well 2) is located along the east-west foliation and east-west joint set, along the same discontinuity, and also has a large potential recharge area. Well 3 is at the intersection of east-west-trending foliation with the N50W joint set. Well 4 has similar structural characteristics as area one, but is topographically less favorable. Wells 5 and 6 are along the N50W joint set, in rather narrow, steep-sided valleys.

Wells were drilled in these areas to depths ranging from 224 to 500 feet. Wells 3, 5, and 6 produced about 25 gallons per minute, and are not currently being utilized. Wells 1, 2, and 4 are producing at rates of 185, 180, and 100 gallons per minute, respectively. Sustained production from the three wells is approximately 670,000 gallons per day.

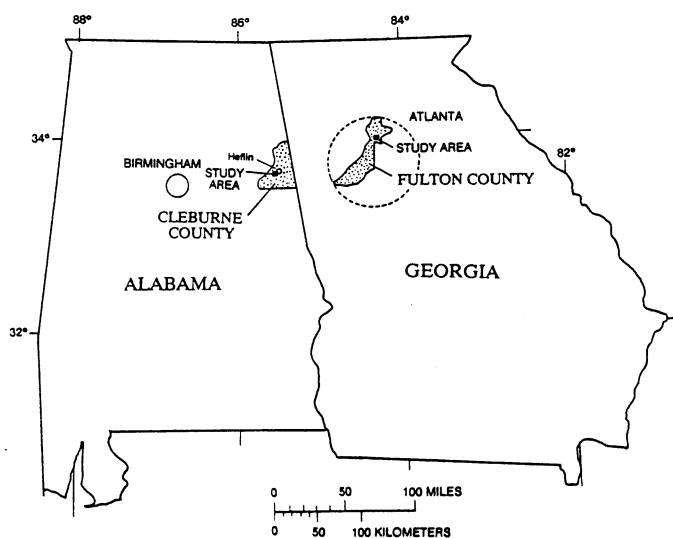


Figure 1. Location of study areas in Georgia and Alabama.

ALABAMA STUDY AREA

Wells for industrial use were drilled on a site near Heflin, Alabama without conducting a hydrogeologic evaluation. Prior to 1974, more than 30 wells had been drilled to depths ranging from 82 to 348 feet. The majority of the wells yielded from 2 to 20 gallons per minute; five produced 40 to 60 gallons per minute; and at least five were dry. These wells were drilled mainly in hornblende gneiss, usually considered less favorable for high-yielding wells. Because the wells had to be pumped at maximum yield to satisfy demand, dewatering occurred and insufficient water was available for operations.

An evaluation of a nearby area in 1974 showed that it was underlain by quartzite, metagraywacke, and feldspar-quartz-muscovite schist. A major fault zone having intense folding and brecciation, separates these lithologies from the hornblende gneisses of the first area. The geologic and topographic setting of this adjacent area indicated a good potential for high-yielding wells. The following geological factors noted in this area were conducive to the development of high-yielding wells (1) well-developed compositional layering having moderate dip angles; (2) a brecciated fault zone having moderate dips (3) two sets of closely spaced high-angle joints; and (4) major differences in rock types juxtaposed by faulting. These discontinuities controlled the

development of straight valley segments and hollows that trend northeast and northwest through the site. In addition, rocks on the footwall (northwest) side of the fault are weathered to a depth of about 50 feet, considerably deeper than in the first area.

Wells were drilled along northeast-trending discontinuities, and at the intersection of northeast- and northwest-trending discontinuities. The first well was drilled in 1974 to a depth of 300 feet. The well flowed 43 gallons per minute and was pumped at a rate of 200 gallons per minute. It recovered to flowing 38 minutes after pumping ceased. The second well was drilled in 1984 to a depth of 298 feet, and produced 250 gallons per minute. During the past six years, combined production from the two wells has been about 685,000 gallons per day.

RECOMMENDATIONS AND CONCLUSIONS

Results from these two case studies indicate that appropriate hydrogeologic investigations produce positive results in groundwater evaluation, exploration, and development in areas of igneous and metamorphic rocks. The controlling variables are numerous, and their degree of influence on the hydrogeology is more often relative than absolute. In addition, the hydrogeologic character of these rocks can vary over short distances, making it imperative that investigations be site specific.