WELL LOCATION TECHNOLOGY FOR THE GEORGIA PIEDMONT

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INTRODUCTION

Knowledge of the groundwater resources of the Georgia Piedmont (Figure 1) is becoming a valuable management aid for the water resource planner. But, the effective location of water-bearing fractures still presents technical problems. Before the groundwater resource can be effectively utilized, it must be located within interconnecting fractures to ensure a sustained yield. "Well Location Technology for the Georgia Piedmont" illustrates an effective aid in locating Piedmont groundwater.

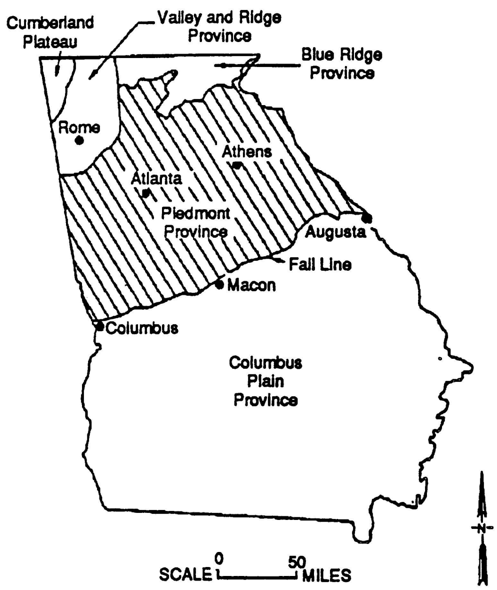
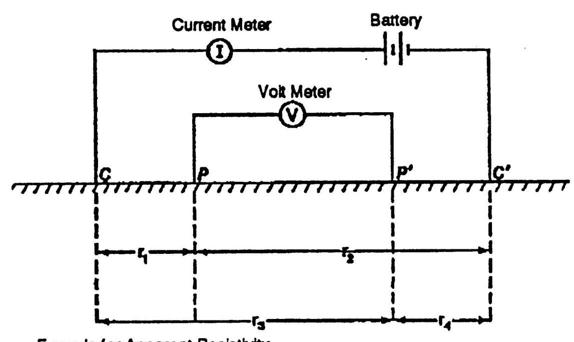


Figure 1. Georgia Geographic Provinces (Base Map From U.S. Department of Commerce; Provinces From USGS).

LOCATION TECHNOLOGY

The purpose of any well location technique is to locate water-bearing fractures through which sufficient groundwater is flowing. Geological mapping and aerial photography aid in the general area identification for detailed studies. Surface geophysical surveys, especially electrical resistivity methods, can yield the details of the subsurface prior to drilling the first test well. The "Modified Wenner" electrode array, as shown in Figure 2, allows a detailed interpretation of the subsurface. Metal electrodes are pushed into the ground in the array as shown. An electrical current is induced into the subsurface through the C and C' electrodes, and the corresponding electrical response of the subsurface is measured through the P and P' electrodes. The P and P' spacing across the ground surface closely approximates the depth of investigation. The empirical interpretation of the vertical sounding data plot allows a detailed interpretation of the subsurface.



Formula for Apparent Resistivity

$$p = (2\pi R)\left[\frac{1}{1/r_1 - 1/r_2 - 1/r_3 + 1/r_4}\right]$$

Figure 2. "Modified Wenner" Array, Diagram of Electrode Spacing (From Carrington & Watson, 1981).

CASE STUDY

As an example of the effectiveness of the electrical resistivity technique, Figure 3 illustrates a sounding conducted in metamorphic rock of the Georgia Piedmont. The data plot is depth in feet versus apparent resistivity in ohm-feet. The plot shows the variation of resistivity with depth through clay, hard rock, soft rock and another hard rock zone. The lowest resistivity values below the uppermost hard rock layer is between 70 and 110 feet. This zone was interpreted, prior to drilling, as containing water-bearing fractures.

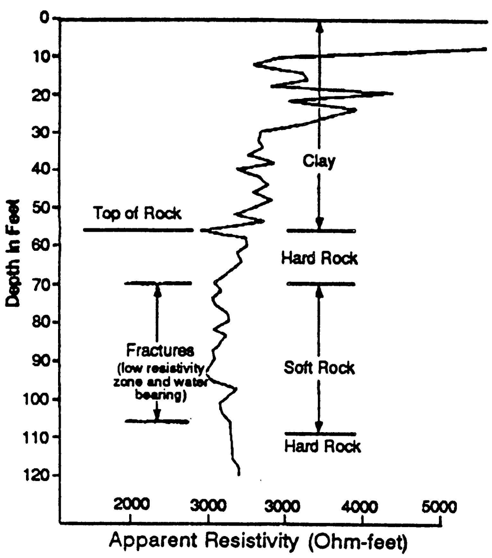


Figure 3. Electrical Resistivity Sounding In Metamorphic Rock

A well, yielding 20 gpm, was drilled at this location. Six-inch diameter casing was set into hard rock and the rock below the casing was drilled. Upon drilling completion, a caliper log was performed in the well to determine the actual diameter of the open hole and to identify discrete fracture zones (Figure 4). The caliper log shows a cavity of ten-inches at the top of the open hole section, another cavity below the first and fractures to a depth of 110 feet. The correlation of the resistivity sounding (Figure 3) and the caliper log (Figure 4) are very close. A good relationship is evident between the low resistivity values and the cavities and fractures within the rock.

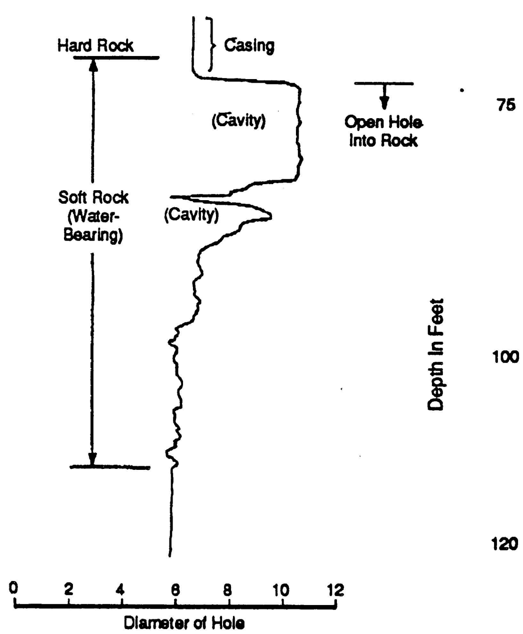


Figure 4. Caliper Log of Completed Well in Metamorphic Rock

SUMMARY

Groundwater on the Georgia Piedmont can be a viable primary and/or supplemental water resource for communities of North Georgia.

Proper well location is essential to an effective drilling program. Whereas geological mapping and aerial photography allow general areas to be selected, surface geophysical surveys, especially electrical resistivity, allow a more detailed investigation to be performed. Both the horizontal and vertical extent of fractures can be mapped using the electrical resistivity surveys. The surveys, when plotted as graphs, allow a comparison of several sites. The most optimum drilling location can then be selected based on the abundance of interpreted fractures plus other site specific hydrogeological factors such as recharge and thickness of the saprolite.

"Well Location Technology for the Georgia Piedmont" illustrates the electrical resistivity method, an interpretation of the data prior to drilling, a caliper log of the completed well showing fractures, and the development of water from the well. The geophysical survey, prior to drilling, can be an aid in locating the optimum well site.

LITERATURE CITED

Carrington, T. J. and D. A. Watson, 1981. Preliminary Evaluation of an Alternate Electrode Array for Use in Shallow-Subsurface Electrical Resistivity Studies. Ground Water: January-February 1981, Vol. 10, No. 1, pp. 48-57.