INVESTIGATION OF GROUNDWATER PROSPECT USING THE VERTICAL ELECTRICAL SOUNDING METHOD AT ISARA REMO, SOUTH WESTERN NIGERIA

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Abstract:

A geophysical evaluation of the groundwater potential of Isara area of Ogun state, South Western Nigeria was carried out. The investigation involved the Vertical electrical sounding (VES) technique that applied the Schlumberger array.

The study area is located within a contact zone between the basement complex and the sedimentary terrain of South Western Nigeria with Biotite Granite Gneiss and Sandstone underlying the area predominantly.

The various data acquired from the twelve (12) VES stations were interpreted using the partial curve matching method and later subjected to the computer based iteration technique. A maximum of six (6) subsurface layer comprising of Top soil, Sandy clay, Lateritic clay, Fractured basement and Weathered basement were observed in the basement portion while Topsoil, Sandy clay, Clay ,sand, Sandstone, Wet sand and were delineated in the sedimentary portion of the study area. The overburden thickness is between 32.5m and 39.3m in the basement portion with resistivity values ranging between 13.5 ohm-m and 896.0 ohm-m while the depth of penetration varies from 11.8m to 84.1m in the sedimentary portion with resistivity values ranging between 7.7ohm-m to 16219.7ohm-m.

The geophysical study gave an insight to the groundwater potential of the are with the entire area within the study area having good potential for groundwater but it only occurs at variable depth from one VES point to another due to the variation in overburden thickness and that underlain each VES station.

Introduction:

For thousands of years, wells and natural springs have supplied clean, abundant groundwater to human communities throughout the World. Surprisingly, water underground is about 60 times as plentiful as fresh water in lakes and rivers on the land surface (not including water stored as ice in glaciers) hence groundwater is tremendously an important resource. The basement complex in Nigeria is made up of a suite of crystalline Igneous and metamorphic rocks which are essentially Precambrian in age while the sedimentary area are made up of sedimentary rocks(Rahaman, 1986).

The occurrence of groundwater in these rocks is largely due to the development of porosity, permeability resulting from weathering and fracturing (Ofodile 1972). Geophysical investigations are being increasingly used for groundwater exploration programs. Vertical electrical resistivity method (VES) is widely employed to locate zones of relatively high conductivity corresponding to saturated strata depth. The method provides adequate depth penetration, qualitative results as well as proper and promising sites for drilling (Olorunfemi, et al 1991, Olayinka, 1991, Ariyo, et al 2007).

Since the study area is within the basement and sedimentary complex of south-western Nigeria, the objective of the study was to determine the aquifer characteristics of the two terrains and delineate the area into low, medium and high groundwater potentials.

Objectives of the Study:

The investigation was carried out to give an insight into the subsurface geology with the objectives of:

(a) Determining the aquifer characteristics of the study area.
(b) Delineating the potential for groundwater in the study area
(c) Detecting the subsurface layering and thickness
(d) Determining the depth to the bedrock

Location and Cimate of the Study Area:

Isara is located within longitudes 6°58.5'N and 7.00°.5N and latitudes 003°.41E and 003°.43'E within the Remo North local government area of Ogun state. It is bounded by Ode Remo in the North, by Ipara in the East, by Akaka on the west and by Ilara in the south (fig 1).

The study area has a tropical wet and dry climate characterized by heavy annual rainfall, high temperature and relative humidity. The mean annual rainfall ranges between 1200mm and 1500mm with the peak of rainfall often reached in the months of June and July (Onakomaya 1992). The minimum temperature is about 23°C around March.

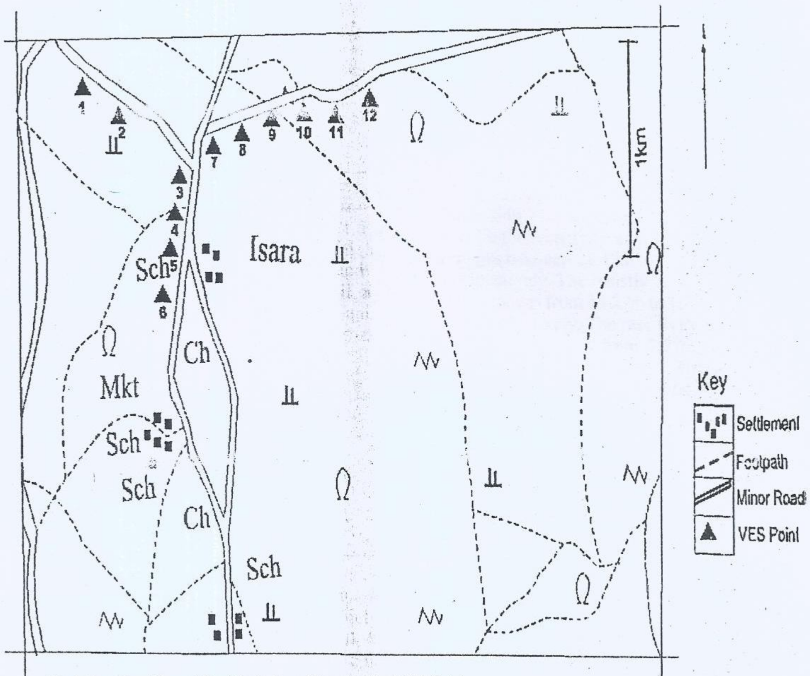

Fig 2: Location Map of the Study Area Showing the VES Point

Fig.1. Location map of the study area showing the VES points,

Geology of the Study Area:

Two major rock types were found and this includes;

(1) Biotite granite gneiss

(2) Sandstone

Biotite granite gneiss

This shows that gneiss has only undergone low to moderate metamorphism. In the study area, biotite granite gneiss was found principally around the North East and South Eastern which is overlain by sandstone. Biotite granite gneiss occurred as a low lying rock body.

Sandstone

The zone of sedimentary rock is underlain by basement rock. In the study area, sandstone was found dominating about most part of the study area. It dominates the North West and south western part of the area. The sandstone belongs to the Abeokuta group.

Methodology:

The electrical resistivity method by vertical electrical sounding (VES) using Schlumberger electrode configuration was adopted in order to determine the thickness, distribution and possible nature of the overburden, and the depth to bedrock.

For many decades of application of the VES method, an important tool in the interpretation of the data has been the comparison of the apparent resistivity curves derived from the field observation with theoretical curves computed for assumed models of subsurface stratification and this is refer to as partial curve matching technique (Bhattacharya & Patra 1968). This was one of the methods used in this work and the second method is computer iteration technique. The former provides model input for the latter.

Result and Discussion:

The interpretation of the vertical electrical sounding was done both quantitatively and qualitatively. The quantitative interpretation involves the observation for the curves as plotted on the bi-logarithm graph paper and applying the curve matching technique while the qualitative interpretation involves the computer iteration program.

In the study area, twelve (12) VES points were probed using the Schlumberger array, which revealed a range of 3 to 6 geoelectric layers. The results obtained as shown in table 2 revealed the under listed geoelectric parameters of various layers.

As previously stated, the aquiferous potential of a unit of rock is determined by its resistivity which is dependent on porosity and permeability and its overburden thickness in a basement environment and total thickness in the sedimentary portion. This section is divided into two:

Basement Terrain Section

The lithology of VES 1 and 2, which were located in the basement complex, varies from Topsoil to sandy clay, Lateritic clay, fractured basement, weathered basement depending on their corresponding resistivity. They reveal four geoelectric layers. The resistivities of the first layers are 484.5?m and 13.5?m with thickness of 1.0 and 2.3m respectively. The resistivities of the second layer are 896.0?m and 258.7?m with thickness of 8.8m and 21.0m. The third layer has resistivity of 426.6?m and 365.7?m with thickness of 22.7m and 16.0m respectively. Resistivity of the fourth varies between 51.9?m and 215.0?m while their thickness is infinity. Their overburden thicknesses are 32.5m and 39.3m. The occurrence of weathered and fractured basement in this section and their considerably high overburden thickness make it a productive zone for groundwater development (Ariyo et al, 2007). This geoelectric layers are also shown in the geoelectric section in fig 3 below.

Sedimentary terrain section

VES 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 were located within the sedimentary terrain in the study area. They reveal three to six geoelectric layers. Their lithologies vary between Topsoil to sand, sandstone, sandy clay, wet sand. The resistivity's of the first layer ranges from 73.2?m to 649.7?m with thickness between 0.8m and 1.3m while the resistivity and thickness of the second layer ranges between 28.4?m to 2392.4?m and 1.5m to 8.5m respectively. The resistivity and thickness of the third layer ranges from 44.2?m to 16219.7?m and 5.2m to 43.4m respectively. The resistivity and thickness of the fourth layer ranges from 7.7?m to 404.7?m and 110.m to 71.6m respectively. The resistivity and thickness of the fifth layer is from 64.4?m to 1137.5?m and 27.3m.

A sixth layer occurred only once with resistivity value of 77.6?m and its thickness is to infinity. The maximum depth of penetration ranges from 11.8m to 84.1m. A typical example of geoelectric section for this sedimentary section of the study area is shown in Fig.4 below

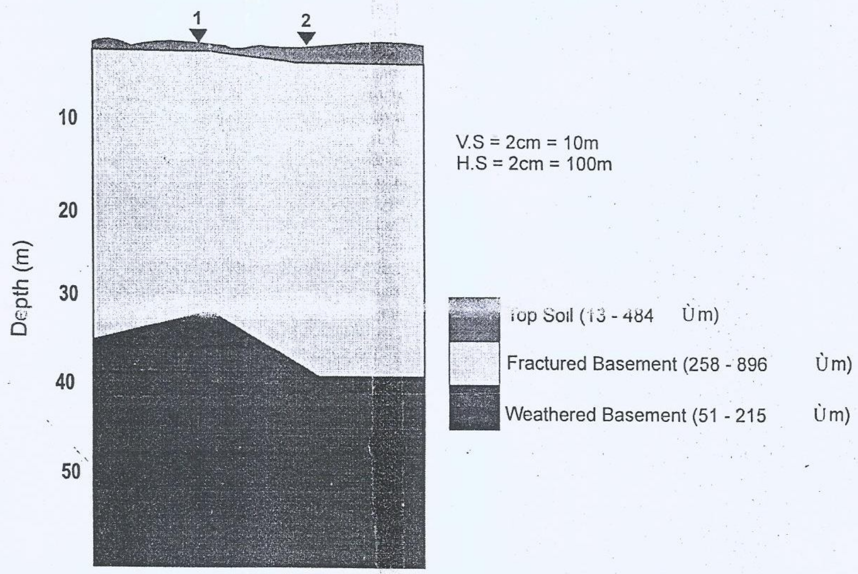

Fig 3: Geoelectric Section for VES 1 and 2

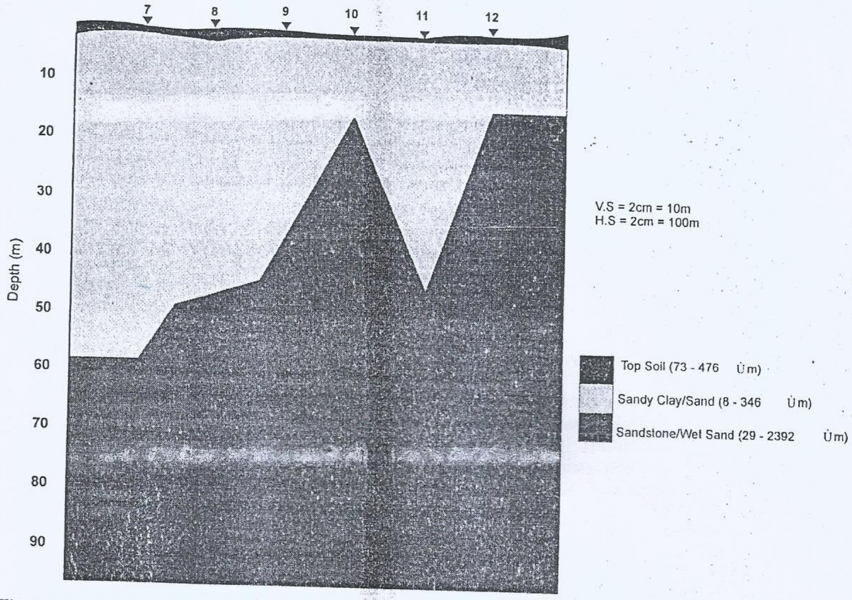

Fig 4: Geoelectric section for VES 7-12

Conclusion

The application of electrical resistivity method (Schlumberger configuration) for groundwater exploration has been used to validate the groundwater potential of Isara area South Western Nigeria.

It can be concluded that water occurs at shallower depth in the basement complex while at greater depth in the sedimentary terrain of the study area. It is recommend that the application and combination of two or more suitable geophysical methods such as electrical resistivity and gravity method, electrical resistivity and seismic refraction should be used for adequate acquisition of data in the study area before a final decision is made in the location of a productive borehole.

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