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Geophysical Investigation for Groundwater Potential in Mamu Area, Southwestern Nigeria

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Abstract: Geophysical investigation for groundwater potential of Mamu, South Western Nigeria was carried out with the aim of delineating suitable site for groundwater development. Vertical electrical sounding using Schlumberger configuration was used to delineate the sub-surface geology of the study area. Ten VES stations were probed within the study area and the data obtained were interpreted through partial curve matching and computer iteration method. The interpreted data indicate 3-4 geoelectric layers, namely top soil, clayey sand/sandy clay, lateritic cap rock, fractured/weathered/fresh basement. The resistivity of 1st layer ranges from 61.6-503.5 Ωm, 2nd layer has resistivity value ranging from 69.9-3504.0 Ωm, the 3rd layer has the resistivity between 149.5-2964.4 Ωm and in the 4th layer the resistivity ranges from 116.50-6052.4 Ωm. It is believed that there is a correlation between large depth to bedrock and high conductance of geoelectric layers. Based on these, VES 1, 2, 5 and 8 has high potential for groundwater development because of their large overburden thickness and low resistively values.

Key words: Geophysical, investigation, groundwater, potential, South Western Nigeria

INTRODUCTION

It is predicted that by the year 2010 half of the world's population of 6500 million will be living in town or cities. A high populations of these urban dwellers will depend on groundwater for day-to-day domestic, industrial and commercial water supply, since surface water cannot be dependable throughout the year because of the effects of drought. The successful exploitation of basement terrain groundwater requires a proper understanding of its hydrogeological characteristics. This is particularly important in view of the discontinuous nature of basement aquifers (Satpathy and Kanungo, 1976). Hence, drilling programme for groundwater development in areas underlained by basement terrain is generally preceded by detailed geophysical investigations.

In basement complex terrain, groundwater occurs either in the weathered mantle or in the joints and fracture system in the unweathered rocks (Olorunfemi and Olorunmiwo, 1985; Ako and Olorunfemi, 1989; Olayinka and Olorunfemi, 1992).

The highest groundwater yield in basement terrain is found in areas, where thick overburden overlies fractured zones (Olorunniwo and Olorunfemi, 1987; Olorunfemi and Fasuyi, 1993). These zones are often characterized by relatively low resistivity.

The Vertical Electrical Sounding (VES) was used to delineate the different sub-surface geoeletric layers, aquifers units and their characteristics, the sub surface units and their characteristics, the sub surface structure and its influence on the general hydrogeophysical investigation in the study area. The objectives of the study are as follows; to determine the overburden thickness, the resistivity of geoelectric layers present in the study area, locating potential site for groundwater and for proper sitting of borehole and to delineate fractured zone in the sub-surface.

Description of the study area: Mamu, the study area is located within the basement complex of the present Ogun state, South Western Nigeria (Fig. 1). It lies between latitude 7°04' and 7°06'N and longitudes 3°54' and 3°56' East. The area is accessible via major roads from Ibadan in the north and Ijebu Ode in the South. The area is underlain by basement complex rock of southwestern Nigeria and the predominant rocks found within the study area are granite gneiss and Biotite gneiss, with some pegmatite intrusion within the granite gneiss.

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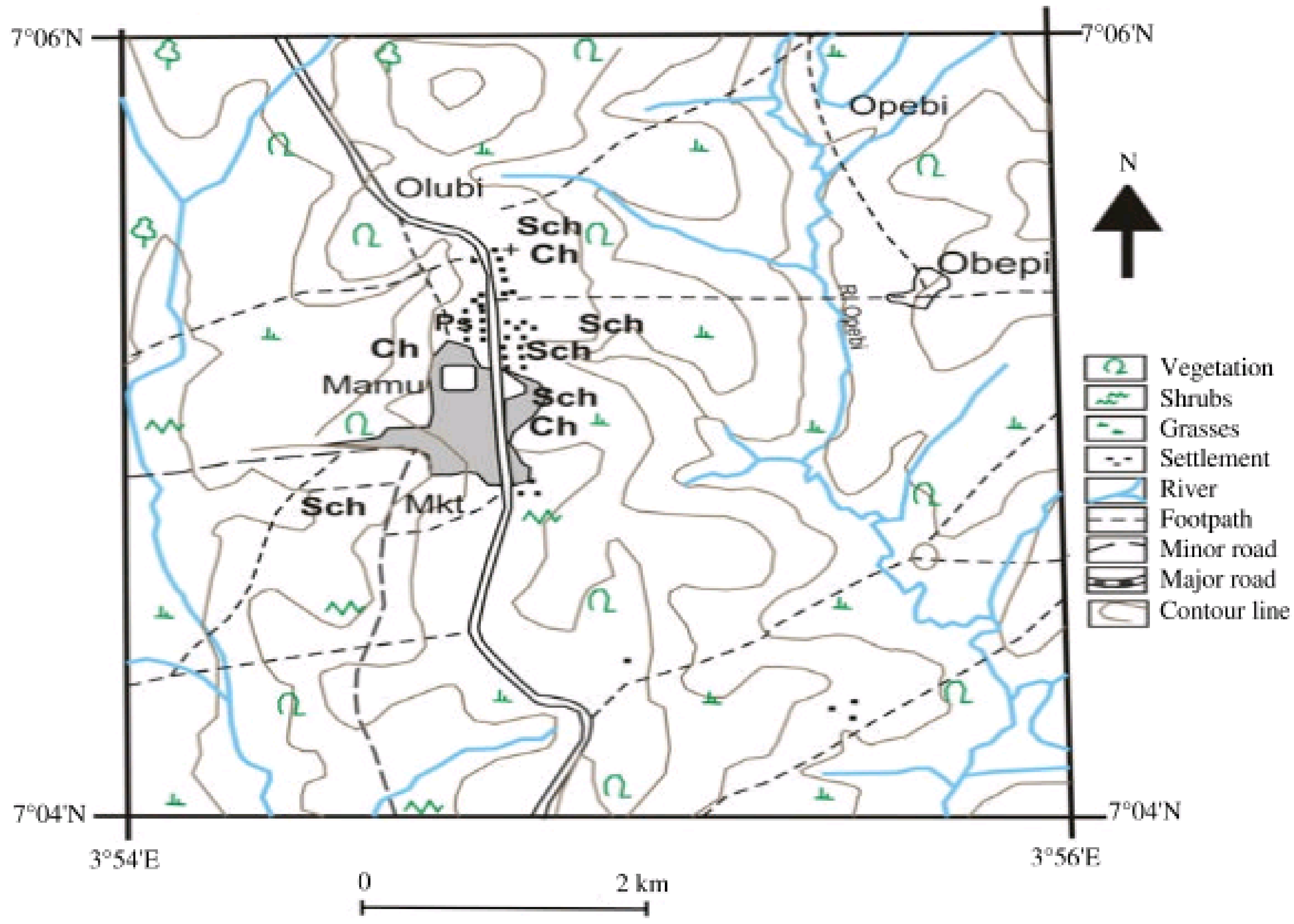

Fig. 1: Topographical map of Mamu South Western Nigeria

MATERIALS AND METHODS

For the aim of this study, 10 vertical electrical sounding stations were occupied within the study area with the help of syscal junior resistivity meter. These stations were chosen at different locations within the study area, the Schlumberger electrode array was employed for this research. Current was introduced into the ground through a pair of current electrode and the resulting potential difference were obtained through a pair of potential electrode and then recorded on the resistivity recording sheets. For the aim of this study, 2 method of interpretation of VES curves were employed. They are the partial matching and computer iteration methods.

RESULTS AND DISCUSSION

Ten vertical electrical sounding stations were occupied in the study area. The interpreted results through the use curve matching and computer iteration techniques revealed the present of 3-4geoelectric layers.

Five out of 10 schlumberger curves obtained from the study area show 3-layer H-type curve while, the remaining 5 displays a 4-layer, KH-type of curve. This H-type curve, which typifies a basement complex environment, contains a low resistivity intermediate layer underlain and overlain by more resistant materials (Olayinka and Mbachi, 1992). Layers 1 and 2 are, respectively the high resistant lateritic/sandy clay topsoil and the low resistant weathered basement. In basement complex terrains, the intermediate layer of H-type is commonly water saturated and it is often characterized by low resistivity, high porosity, low specific yield and low permeability (Jones, 1985) with the main aquifers found at the base of the weathered profile where mineral decomposition resulting from *in situ* chemical weathering has produced a gravel like material of moderate to high permeability (Acworth, 1987).

In the study area, the lithology varied from top soil to weathered layer and fresh basement. The resistivity of the 1st layer ranges from 61.6-503.5 Ωm and the thickness ranges between 0.2 and 2.8 m and this is described as the top soil. The resistivity of the 2nd layer ranges from 69.9-3,504.0 Ωm and the thickness ranges between 1.0 and 11.6 m. The 3rd layer has resistivity values between 149.5 and 2964.4 Ωm and the thickness ranges from 4.3-19.6 m, while the resistivity of the 4th layer ranges from 116.5-6052.4 Ωm.

Inferred geological section: In order to have good understanding of the subsurface geology of the study area, geological/geoelectric section was drawn for each of the location in the study area.

The geoelectric section relating the 10 VES stations are shown in Fig. 2-4. Figure 2-4 are geoelectric sections that relate the VES stations. The geoelectric section

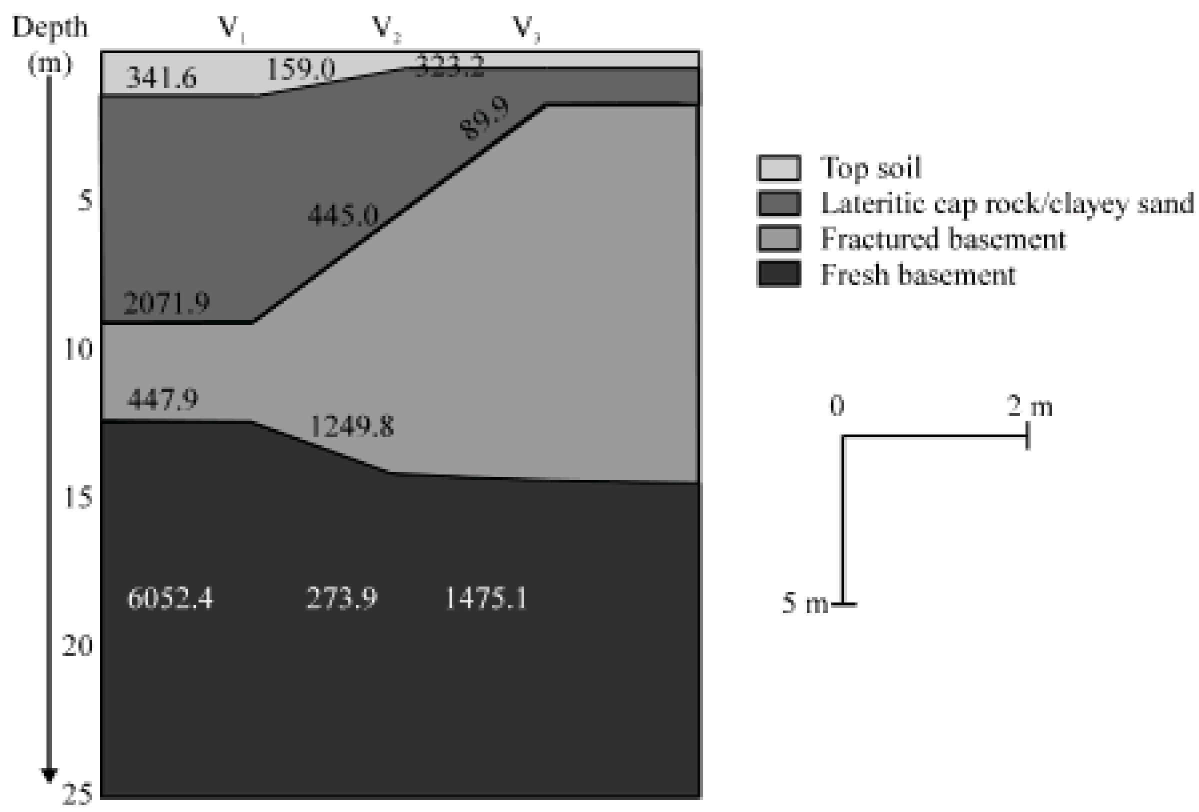

Fig. 2: Geoelectric section relation VES 1-3

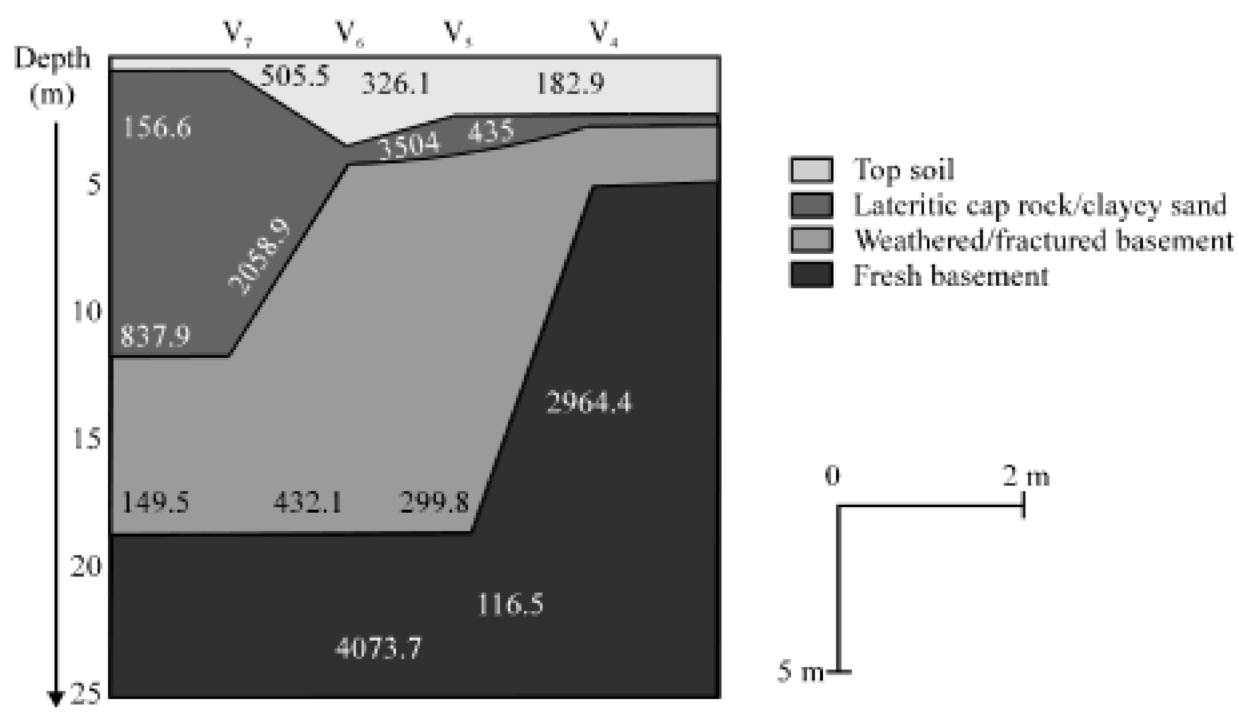

Fig. 3: Geoelectric section relation VES 4-7

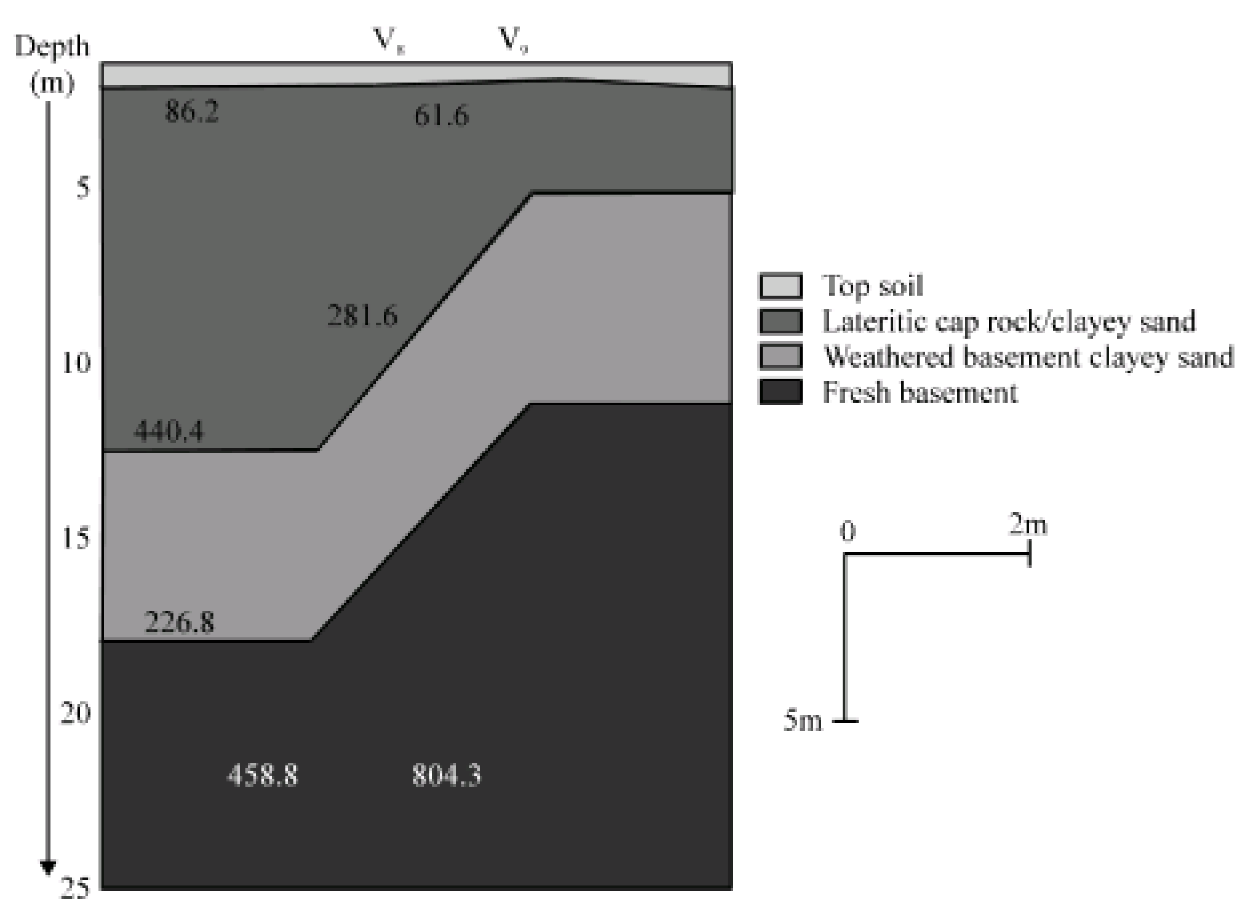

Fig. 4: Geoelectric section relation VES 8 and 9

reveals the subsurface variation in electrical resistivity and attempts to correlate the geoelectric sequence across the profiles.

From the geoelectric section, the geologic interpretation inferred for the VES stations are top soil, weathered layer, which may be lateritic clay, clayey sand or sandy clay and the basement, which may be fractured or fresh basement base on their resistivity values.

The Fig. 4 shows that the study area is characterised by relatively thin weathered layer most of which are <10 m thick. However, the partly weathered/fractured basement unit is significantly thick and extensive with tendency for large storage capacity and significant groundwater yielding capacity.

CONCLUSION

Based on the resistivity value of the sub-basement and basement layers, VES, 3-10 can be considered to be productive for groundwater. But base on overburden thickness VES 1, 2, 5 and 8 could also be considered to be productive zones.

Similar studies in basement complex terrain (Bala and Ike, 2001; Omosuyi *et al*., 2003; Ariyo and Osinawo, 2007) reveals that areas with thick overburden cover has high potential for groundwater. Consequently, areas with overburden thickness of 15 m and above are good for groundwater development.

Therefore, based on these 2 parameters i.e., overburden thickness and resistivity values, VES 1, 2, 5 and 8 will be suitable for groundwater development in the study area. The interpreted results from the area have also proved the important of carrying out a detailed pre-drilling geophysical investigation before drilling and the suitability of electrical resistivity as a tool for aquifer delineation.

RECOMMENDATION

Hence, we recommend that a detailed pre-drilling geophysical investigation be carry out in basement complex areas of southwestern Nigeria because this will prevent the common occurrence of borehole failure and lost of money.

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