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Significant of Geology and Geophysical Investigations in Groundwater Prospecting. A Case Study from Hard Rock Terrain of Southwestern Nigeria

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Abstract

Electromagnetic (EM) profiling and VES are the two complementary and widely used geophysical methods in the delineation of basement regolith and location of fissured media and associated zones of deep weathering in crystalline terrains. In many instance, reconnaissance EM surveys are used to locate aquiferous zones such as fractures, faults and joints while Vertical Electrical Sounding on the other hand provides information on the vertical variation in electrical resistivity with depth. It is commonly used to assess the reliability of the fractures delineated from EM survey (Ariyo, et al, 2008, Olayinka et al, 2004).

Index terms—

1 Introduction

This study is focused on the significant of geologic mapping and integrated geophysical methods in assessing the groundwater prospect of a typical basement terrain in some parts of Southwestern Nigeria. Figures 1 and 2 shows the VLF-EM traverse and VES points superimposed on the geological map of the study area. Fig. 1 is Akaka area and Fig. 2 is Fidiwo/Ajebo area of Southwestern Nigeria. The study area is underlain by the Precambrian Basement complex rock of Southwestern Nigeria (Rahaman, 1988). The basic rock identified in Fig. 1 is Biotite granite gneiss while in Fig. 2 the area is underlain by Biotite Granite Gneiss, Migmatite Biotite Gneiss and Schists.

2 II.

3 Materials and Methods

A detailed geological mapping and interprettation of satellite imageries map of the area were carried These two methods are both responsive to water bearing fractures columns due to their relatively high-bulk electrical conductivities. Fifty-seven (57) Vertical Electrical Sounding (VES) points were probed in the study area and Eleven (11) VLF-EM traverses were also occupied.

The VLF-EM data were presented as profile by plotting filtered real and imaginary values against their station positions while partial curve matching and computer iteration techniques were adopted in the interpretation of VES data. From the curve matching technique initial estimates of the resistivity and thickness III.

4 Results and Discussion

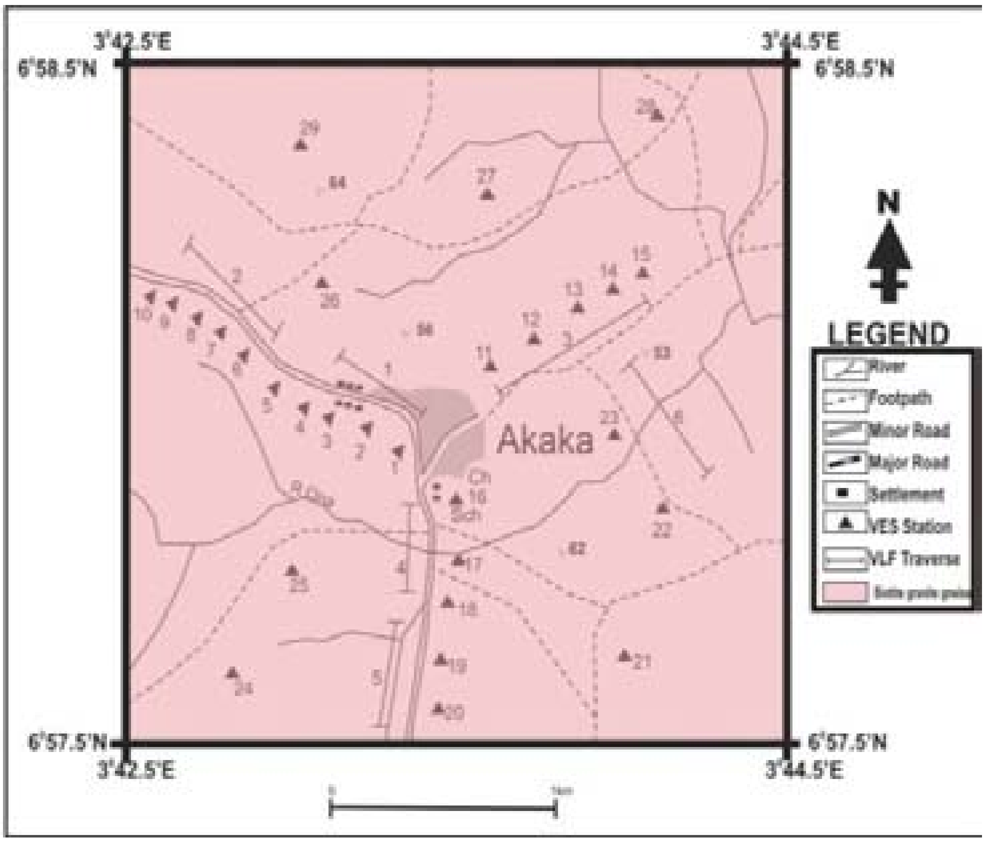
The results obtained from the EM and VES data interpretation are presented as profiles, geoelectric section and maps. Fig. 3a-c shows typical VLF-EM anomaly profiles from the study area. The EM anomalies vary greatly; some of the anomaly peaks are narrow and sharp while others are broad with varying width extent. Several major linear features (suspected geological interfaces, with positive peak filtered real amplitude were delineated using characteristic feature of coincident inflection on real component anomaly curves with positive peak on filtered real anomaly and only small anomaly in the imaginary parts. Zones with peaks positive filtered real anomalies are considered priority areas for groundwater accumulation since they often correspond to zones with high conductivity characteristic of water-filled fractures or fault (Olorunfemi et al, 2004, Ariyo et al, 2009) or effect of appreciable depth to bedrock or lithological variations within the consolidated regolith. The results of the soundings conducted in the area studies reveal the existing of 3 to 5 geoelectric layers. The geoelectric layers comprise of topsoil made up of sandy clay, clayey sand and gravel. The weathered layers, which constitute the 2 nd to 4 th layers as the case may be has layer have it resistivity varied from one place to another and constitute part of aquiferous layer in the study areas. The last layer which consists of fracture/fresh bedrock depending on their resistivity values. The overburden thickness varies from 16.3 to The H type curve is the most predominant in the study areas, which typifies a typical basement complex environment contains a low resistivity intermediate layer underlain and overlain by more resistant materials **??**Olayinka and Mhachi, 1992). In Basement area, the intermediate layer of the 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 weathered as produced a gravel-like material of moderate to high permeability (Jones, 1985 andAcworth, (1987). like material of moderate to high permeability (Jones, 1985 andAcworth, (1987). Fig. 3a & b shows the geoelectric sections that relate the VES stations. The geoelectric section reveals the subsurface variation in electrical resistivity and attempts to correlate the geoelectric sequence across the profiles. The geoelectric intersand, sandy and sandy clay and the basement which may be fractured or fresh basement base on their resistively values. The figure shows that the study area is characterized by moderately thin weathered layer in pretation inferred for the VES station are topsoil, weathered layer, which may be lateritic clay, clayey © 2013 some of the VES stations which are < 20m thick. However the partly weathered/fractured basement unit is significantly thick and extensive with tendency for large storage capacity and significant groundwater yields capacity. Also, from the interpreted data, it was observed that the thickness and resistivity value of the aquiferous layers varies from one rock to another. This variation is attributed to the fact that different rocks respond to weathering activities differently. From Both VES and VLF-EM data interpreted results, it was observed that aquiferous layers were encountered at shallower depth in area occupied by Schists than area occupied by Gneiss.

5 IV.

6 Conclusion

Geological features suspected to be basement fractures identified from VLF-EM anomaly curves were confirmed by geoelectric subsurface images developed from interpretation results of Vertical Electrical Soundings. VLF can detect shallow fracture zones if the weathered layers are not too thick or too conductive like the case of the study areas. The presence of sandy layer in Fig. 4a will enhance availability of groundwater. Based on this, area underlay by granite gneiss will be more prolific in term of groundwater exploitation than area underlay by migmatised gneiss. The VLF method can be a tool for detailed groundwater exploration because of its rapid data acquisition, and lower cost than the conventional [1] [2]

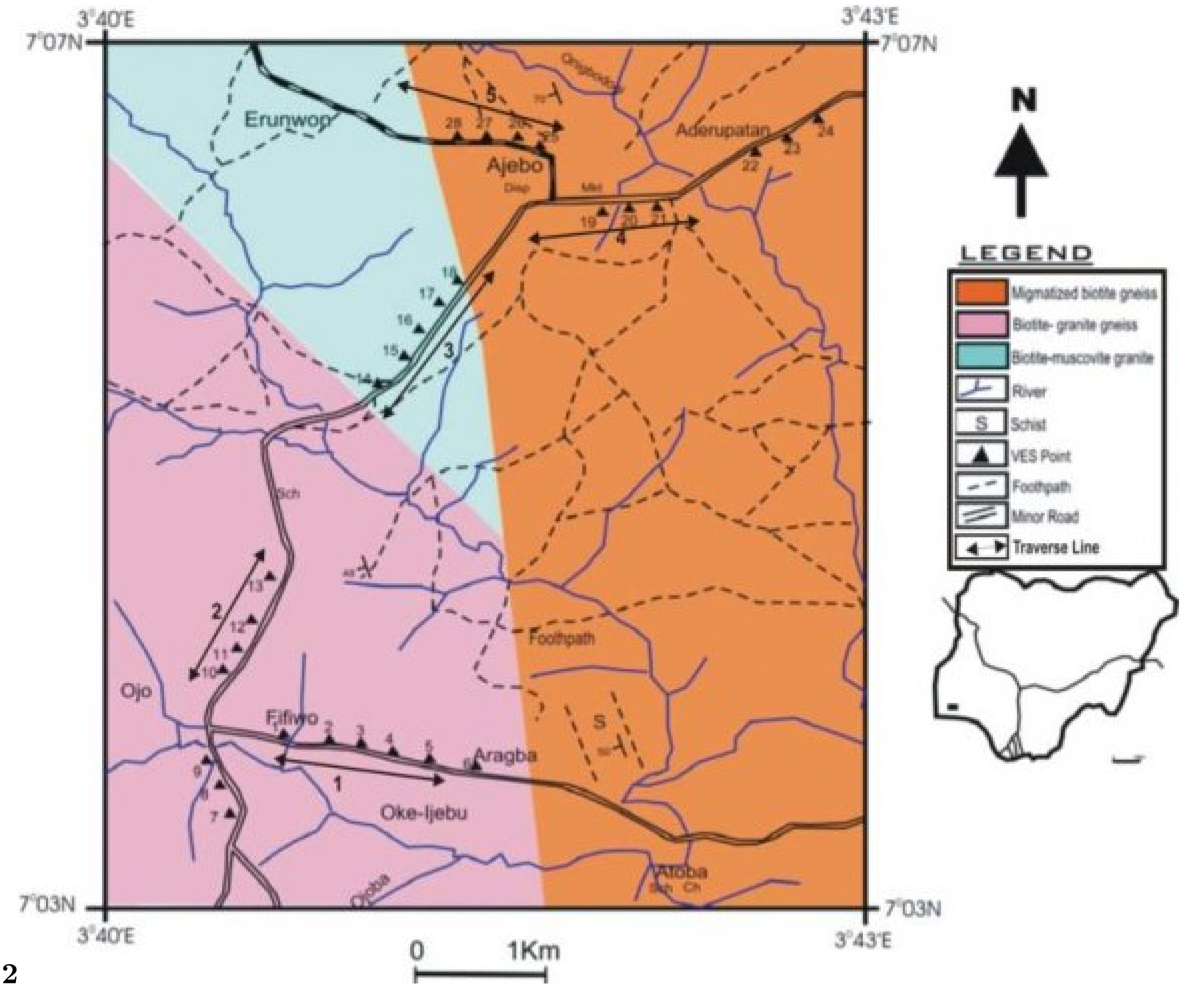
Figure 1:



1

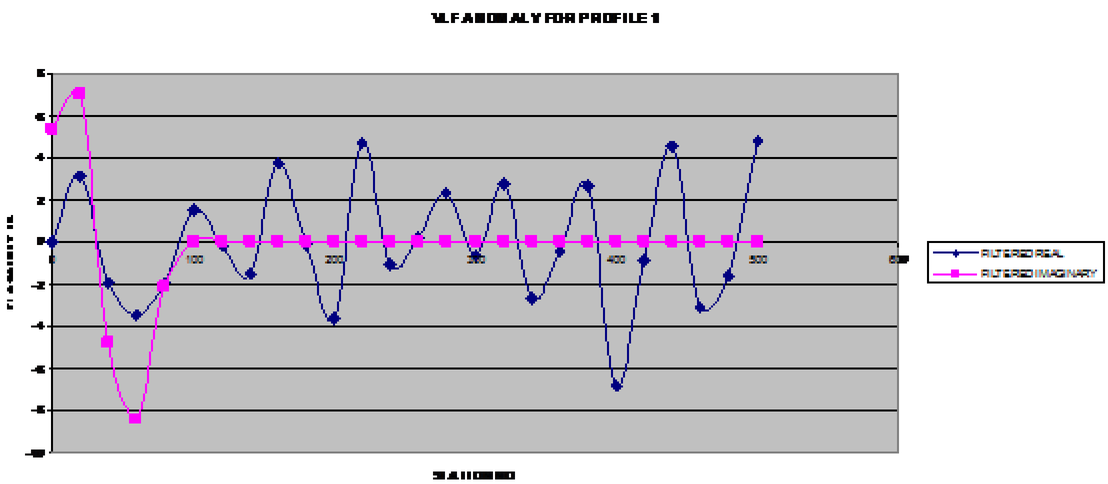
Figure 2: EFigure 1 :

6 CONCLUSION



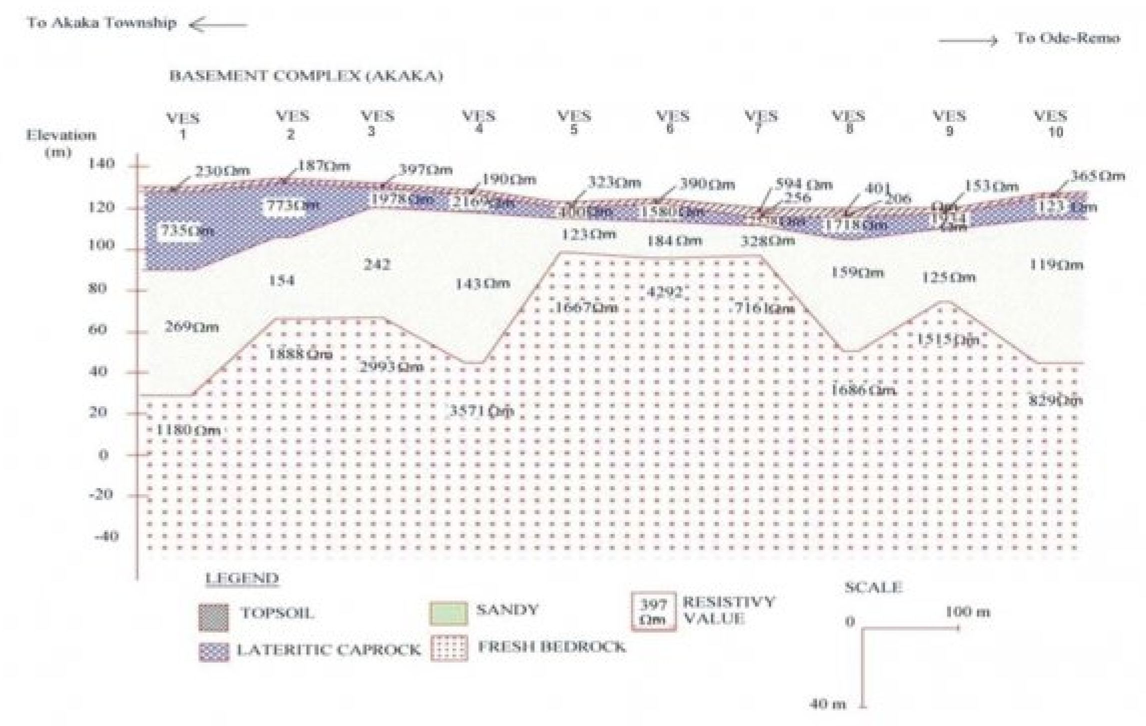
2

Figure 3: Figure 2 :



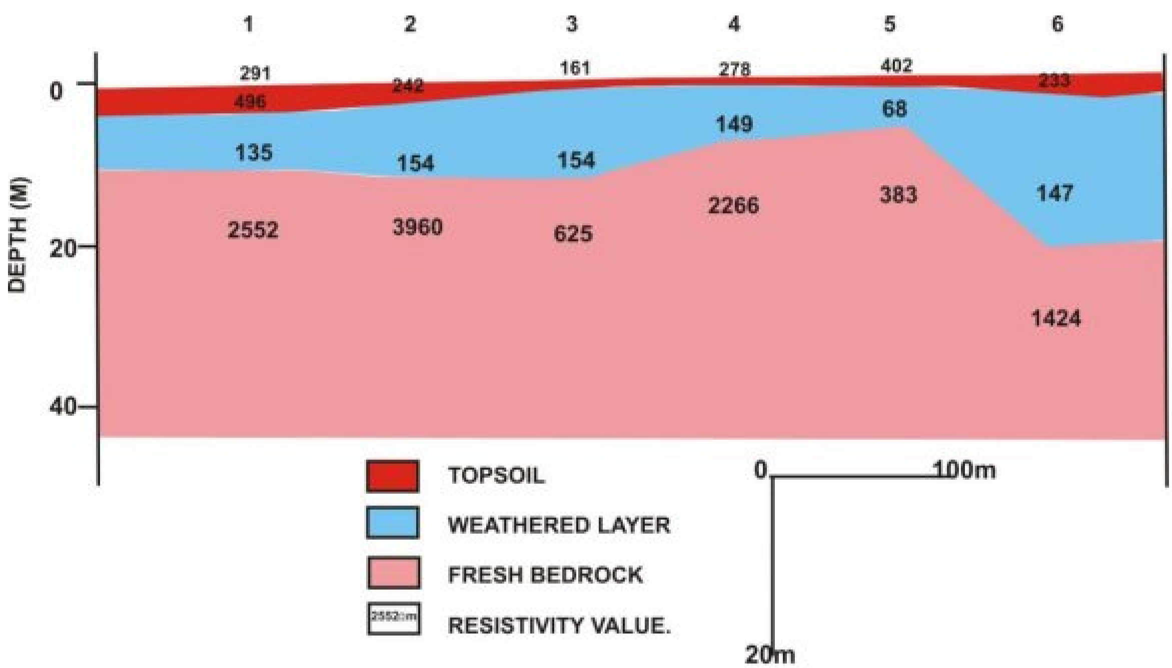
3a

Figure 4: Figure 3a :B



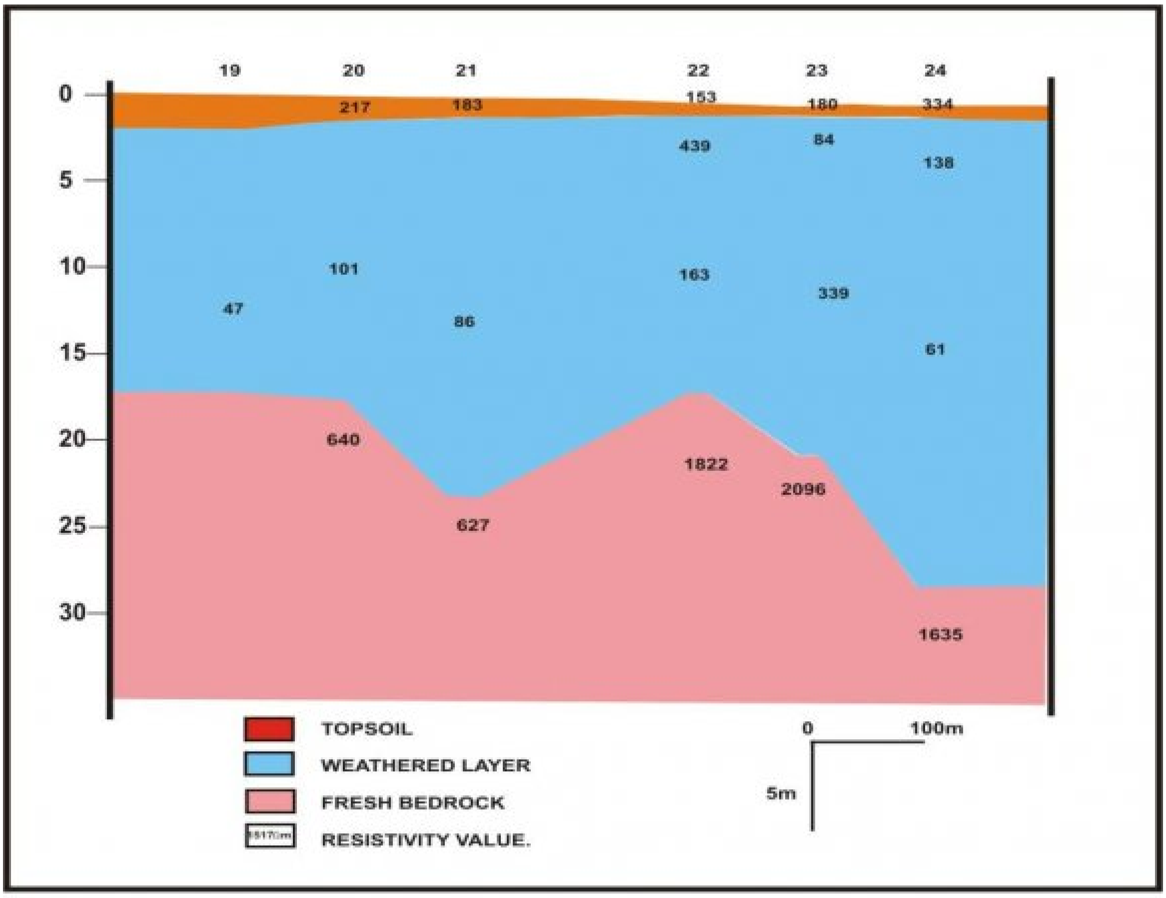
4a

Figure 5: Figure 4a :



4b

Figure 6: Figure 4b :B



4c

Figure 7: Figure 4c :

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Figure 8:

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