Global Journal of human social science
Geography, Geo-Sciences & Environmental Science & Disaster Management
Volume 13 Issue 2 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460X & Print ISSN: 0975-587X

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

By Ariyo, S.O & Adeyemi, G.O.
Olabisi Onabanjo.University, Ago-Iwoye, Nigeria

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).

GJHSS-B Classification : FOR Code: 260199p, 260501

SIGNIFICANTOFGEOLOGYANDGEOPHYSICALINVESTIGATIONSINGROUNDWATERPROSPECTINGACASESTUDYFROMHARDROCKTERRAINOFSOUTHWESTERNNIGERIA

Strictly as per the compliance and regulations of:

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

Ariyo, S.O [α] & Adeyemi, G.O. [σ]

I. Introduction

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).

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.

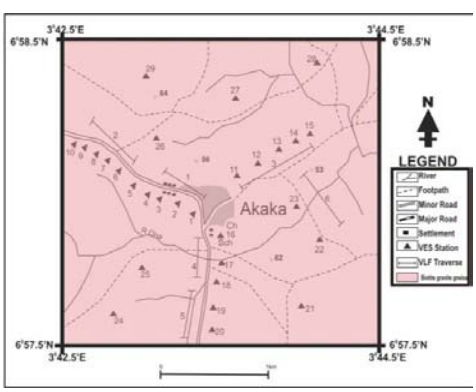

Figure 1 : Site and Geological Map of Akaka, Southwestern Nigeria

Author α : Department of Earth Sciences, Olabisi Onabanjo.University, Ago-Iwoye. Nigeria. E-mail : ariyof@yahoo.com
Author σ : Department of Geology, University of Ibadan. Ibadan. Nigeria.

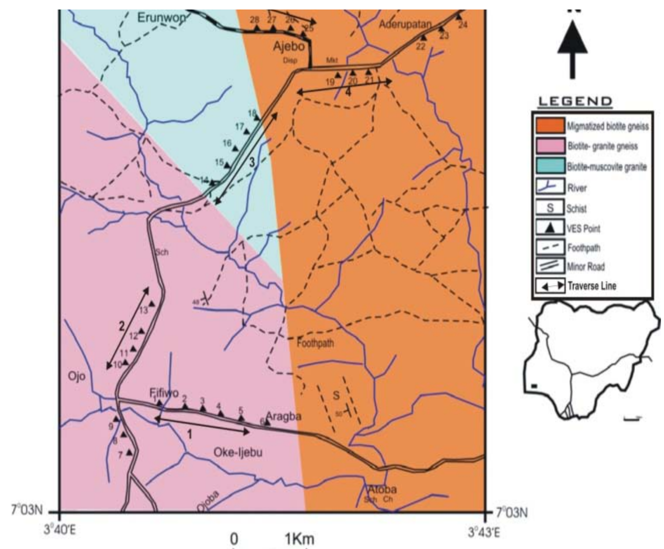

Figure 2 : Site and Geological Map of Fidiwo/Ajebo, Southwestern Nigeria

II. Materials and Methods

A detailed geological mapping and interpretation of satellite imageries map of the area were carried out before as a reconnaissance tools before the detailed geophysical investigation was carried out.

Two geophysical methods were employed in the course of this research work and these are Very Low Frequency Electromagnetic (VLF-EM) and Electrical Resistivity methods.

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 of the various geoelectric layers at each VES station were obtained. These were later used as a starting model for a fast computer interpretation (iteration) technique called Resist (Vander Velpen, 1988).

III. 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.

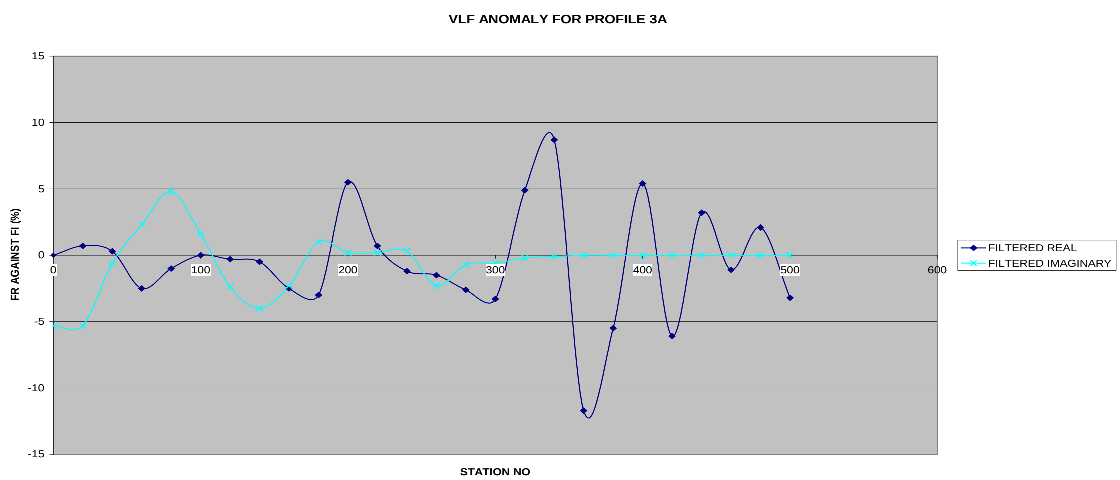

Figure 3a : VLF-EM anomaly Curve for Ajebo Profile

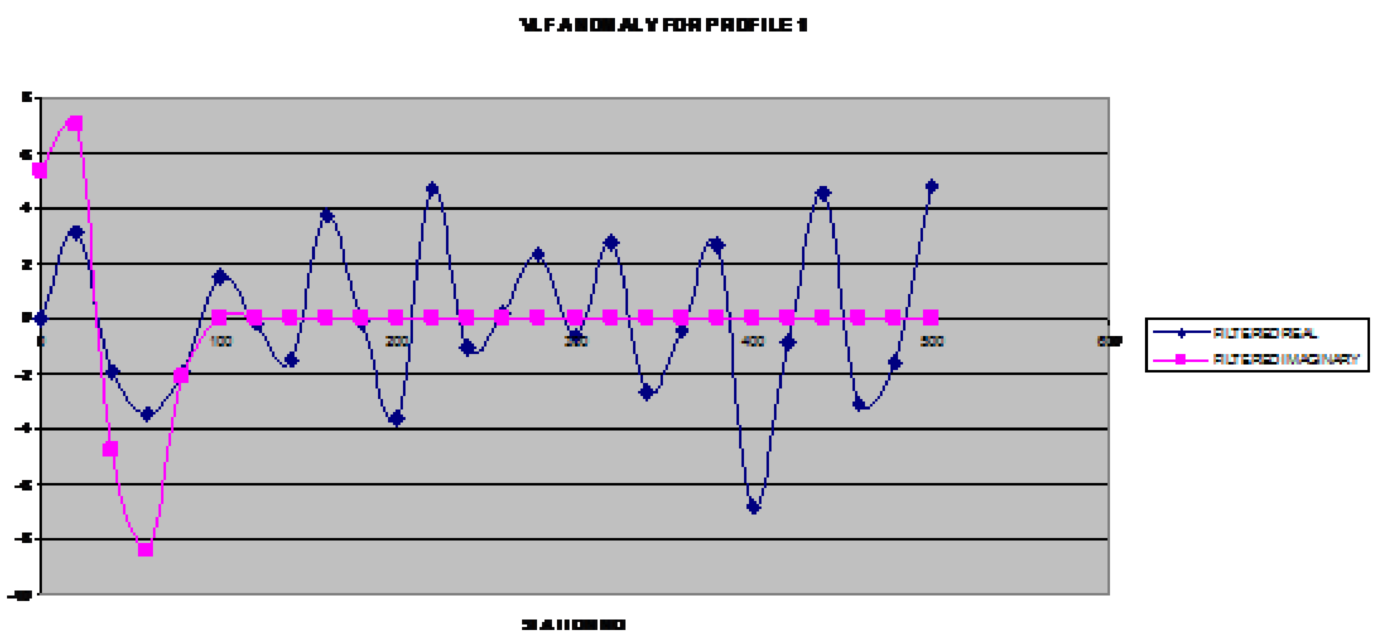

Figure 3b : VLF-EM anomaly Curve for Fidiwo profile 1

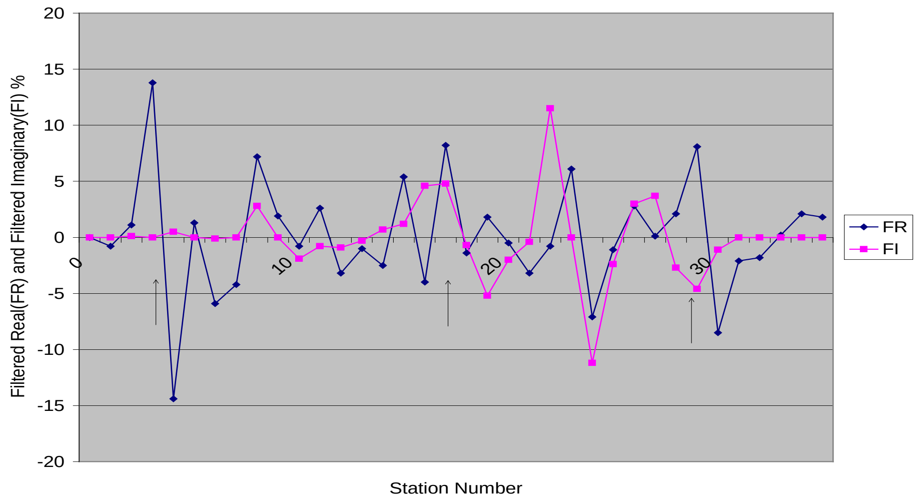

Figure 3c : VLF-EM anomaly Curve for Akaka profile 1

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 2nd to 4th 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 91.5m.

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 and Acworth, (1987). like material of moderate to high permeability (Jones, 1985 and Acworth, (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 interpretation inferred for the VES station are topsoil, weathered layer, which may be lateritic clay, clayey sand, 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 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.

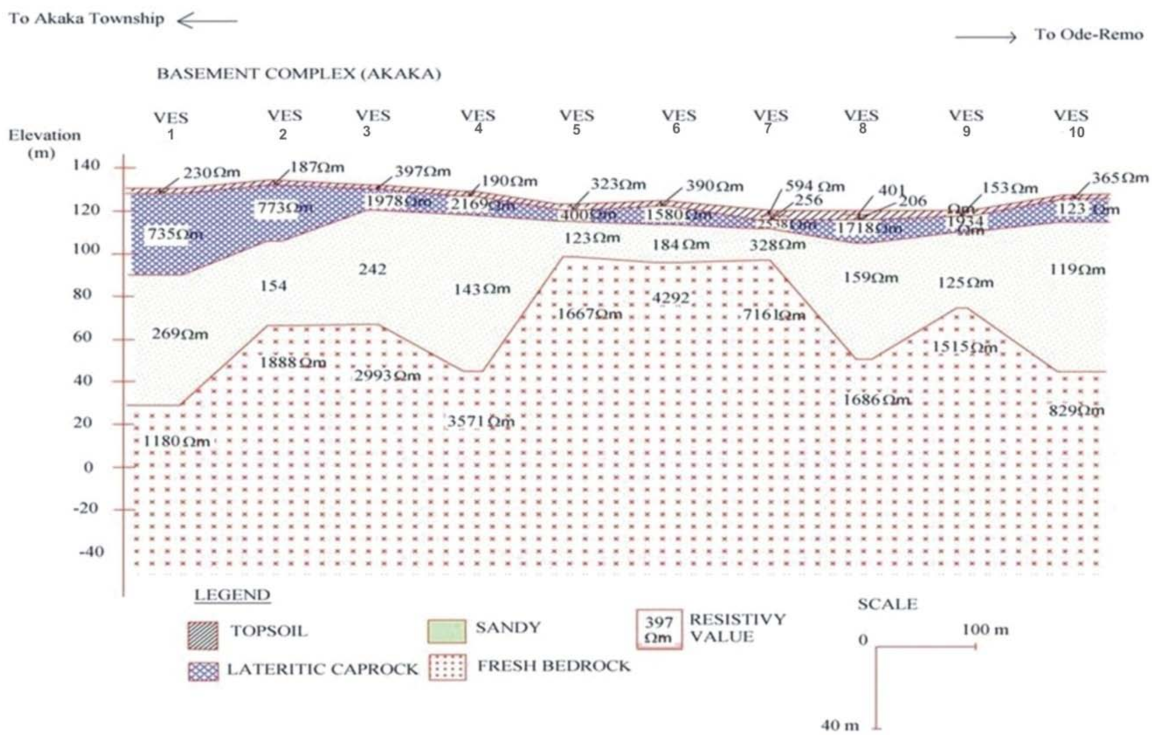

Figure 4a : Geoelectric Section Along VES 1-10 in Akaka area

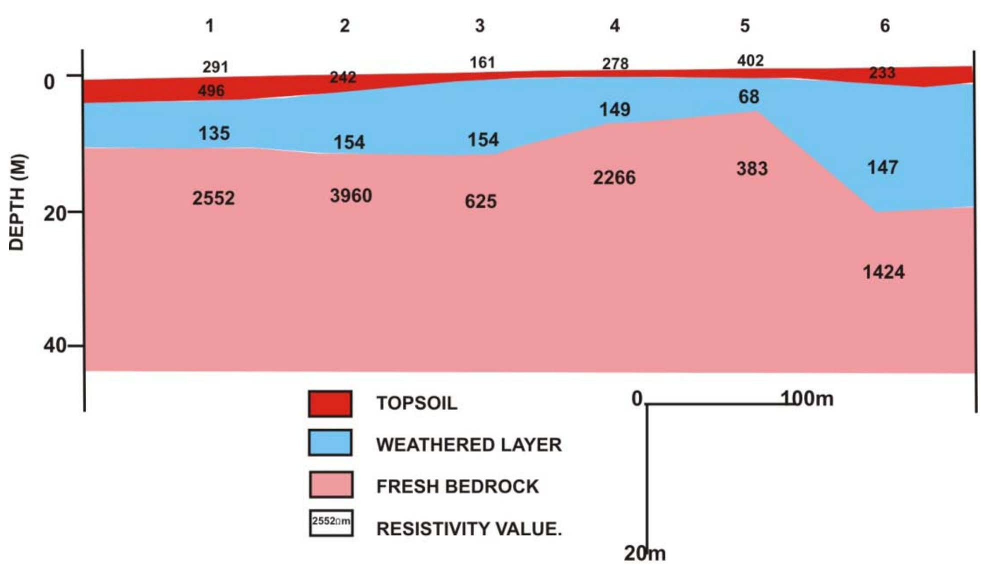

Figure 4b : Geoelectric Section of Along VES 1-6 in Fidiwo Area

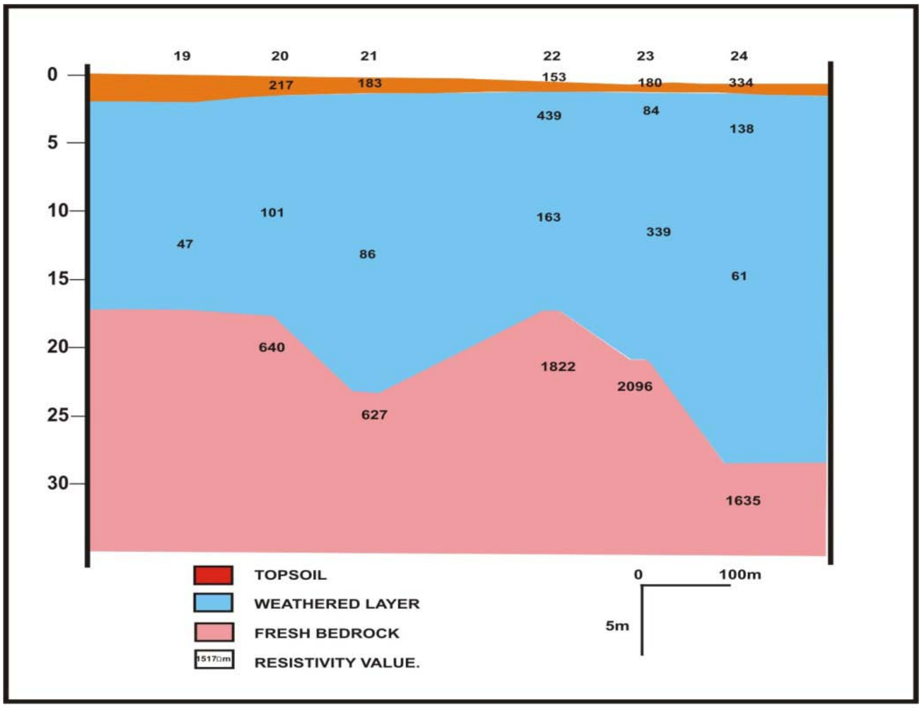

Figure 4c : Geoelectric Section of Along VES 19-24 in Ajebo Area

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.

IV. 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 cumbersome and time- consuming electrical method, particularly in hard-rock terrain. Based on the results obtained from this survey, it can be concluded that the integration of EM profiling and DC Electrical Method together with detailed geological mapping are efficient tools for borehole siting in groundwater exploration in a typical crystalline terrain.

References Références Referencias

1. Acworth, R. I. (1987): The development of crystalline basement aquifers in a tropical environment. Quarterly Journal of Engineering Geology. London, vol.20, Pp 265-272.
2. Ariyo, S.O. and Banjo, A.A. (2008). Application of electrical resistivity method for groundwater exploration in a sedimentary terrain, a case study of Ilara-Remo, Southwestern Nigeria. Continental Journal of Earth Sciences 3 : 53-58.
3. Ariyo, S.O. Adeyemi, G.O. and Oyebamiji, A.O. (2009). Electromagnetic VLF survey for groundwater development in a contact terrain. A case study of Ishara-Remo, Southwestern Nigeria. Journal of Applied Science Research. 5(9):1239-1246.
4. Jones, M.T, (1985). The weathered zone aquifers of the Basement complex area of Africa. Quarterly journal of Engineering Geology, 27 (2): 63-69.
5. Olayinka, A.I.and Mbachi, C.N.C (1992). A technique for the interpretation of electrical soundings from cry-stallline basement area of Nigeria. Journal of Mining Geology. 28: 403-412.
6. Olayinka, A.I., Amidu, S.A and Oladunjoye, M.A (2004). Use of electromagnetic profiling and sounding for groundwater exploration in the crystalline basement area of Igbeti, Southwestern Nigeria. Global Journal of Geological science, 2 (2): 243-253.
7. Rahaman, M.A. (1988): Recent advances in the study of the basement complex of Nigeria. A

publication of the Geological Survey of Nigeria. pp. 41-44.
8. Vander Velpen, B.P.A (1988). RESIST version 1.0. M.Sc Research project, ITC, Delft, Nertherlands.