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SEISMIC REFRACTION AND ELECTRICAL RESISTIVITY INVESTIGATION FOR GROUNDWATER AT FATU MAIMASA ALONG KOGIN GABAS ROAD NASARAWA L.G.A. NASARAWA STATE

[1]Mohammed B.I.; [2]Yakubu, W.L and [2]Annu U.J.

[1]Department of Agricultural Engineering and [2]Department of Agricultural Technology

Nasarawa State College of Agriculture, Lafia

Email: mbabaibraheem@yahoo.com

ABSTRACT

A geophysical survey involving vertical Electrical sounding (VES) and seismic refraction was carried out in Salri Integrated Farm along Kogin Gabas area of Nasarawa Local Government Area. A 12- channel ABEM Teraloc MKVI seismograph and ABEM Terameter model SAS 3OOC were used with their accessories in the surveys. The results of the survey showed that the depths to Basement rock rang from 24m to 47m at different places .The VES investigation further revealed that the over burden (regolith) generally consists of lateritic top soil coarse or gravelly sand, clayey sand or finely weather Basement rock and fractured Basement all overlying the fresh crystalline Basement rock. The lithologic section obtained from nearby boreholes showed good correlation with the interpreted geoelectric sections. The results of this study suggest that the area studied has good potential for ground water development or borehole programme.

INTRODUCTION

The study area is located along Kogin Gabas Road in Nasarawa local Government Area (L.G.A). The area plays host to Salri Integrated Farm consisting of orchard and livestock production. While the bulk of the land is used for farming of various crops. The relief of the area is fairly undulating, with gentle slopes characterized by guillies. The drainage pattern is dendritic while stream flow fluctuates seasonally. The vegetation is of the savannah region type. It comprised of a derived sparsely Spaced trees with short and tall grasses and shrubs. Most of the crops grown in the area comprised legumes and creels e.g. maize, sorghum, soybean, groundnut etc. The climate of Nasarawa is the tropical type which has distinctive wet and dry seasons. Annual rainfall ranging between 100-1500m occurs between April and October, while Maximum temperatures vary between 38o c in march/ April and as low as 24oc in other months but became far less in peak rainy periods (July/August) and in harmatan months (November to February) (Olaniyan and Olabode, 1998).

Geology and Hydrogeolgy

The entire land area of Nasarawa state is underlain by the Precambrian migmatitegneiss complex . metasedments/ metavolcanics. Pan -African granitoids and calc -alkaline granites and volcanic of jurasssic age towards the south eastern border of the state (David and Ofrey,1989; Oluyide,1995) in the study area the Basement complex is overlain by a thick mantle of decomposed kaolinized weathered schists and gneiss, which is in turn capped by a superficial laterite clay regolith (figure 2) lgneous and matamorphic processes on a regional scale had led to the formation of all these rocks (Olugboye , 1977). Generally, the Basement complex has very poor primary characteristics for ground water accumulation and movement, especially the fresh Basement, which has low percentage of joints and fractures. (Clark, 1985: Shemange and Umar, 1994). The rocks are aquiferous only when they are weathered and or fractured. Groundwater in the area exists mostly within the laterites and weathered parts of metasediments and granite-gneiss. The later are water table aquifers which are uniconfined, hence the water level change with change in seasons. The kaolinized weathered met sediment underlying the lateritic crust is also aquiferous. These are many fracture zones within the rock of the study area. The exposed solid rocks are well jointed and occasionally fractured which form moderately good aquifers. It has became a common ground -water exploration strategy in crystalline Basement terrain to site water supply bore holes where the regolith is thickest, with the expectation that the saturated thickness and frequency of bedrock fissures are also greatest. The main source of recharge in the area is from precipitation (Olayinka *et al*, 1997, Okereke *et al*, 1998), other previous scholars in Basement aquifer studies in parts of North and meddle belt Nigeria include Du preez and Barber (1965), Hazel et al (1992) Offodile (1992), Wright (1992) and Uma and Kehinde (1994).

Field Data acquisition

Although, surface geophysical methods cannot replace test drilling , they provide data that lead to a more intelligent selection of test drilling sites and drilling methods (Freeze and Cherry, 1979). In order to determine the thickness, distribution and possible nature of the overburden, the depth to fractured Basement , fresh bedrock and degree of fracturation (probable aquifer), geophysical investigations involving electrical resistively and seismic refracting method were carried out. In the Electrical resistivity survey, the wenner array was applied for profiling to obtain points of lowest resistivities along three (3) profiles, also ten (10) Vertical Electrical Sounding (VES) points were taken using the schlum berger array. The maximum spread for the survey was 150m and the instrument used was the ABEM terrameter model SAS300c with it's appurtenances. In the seismic Refraction survey, sixteen (16) seismic profiles were shot at different points in the north -east / south -west direction. The instrument used was a 12- chainel ABEM Teeraloc Mk6 seismograph. The energy source was a 2kg sledge hammer impacted on a rubber base plate on the ground surface . The shot -to- geophone and geophone -to-geophone distance was 10m. Both forward and reverse profiles were taken during the survey.

Data presentation and interpretation

The VES data obtained are presented as sounding curve plots of apparent resistively versus electrode spacing on a bi-log scale the data were interpreted using the automatic computer processing and interpretation programme developed by Zohdy (1989). Using the [illegible] lithology was [illegible] th to Basement [illegible] position. Typical field curves are shown in figure 3.

Seismic refraction data was processes by filtering through the band pass filter and interpreted by manual picking of arrival time on the seismic section in the ABEM

Terraloc MK VI system. First arrival times were picked from the seimic section and compressional wave velocities of layers were determined by plotting the time- distance graphs for each profile and taking the reciprocals. There are also provisions in the seismography for direct value of velocities once the arrival times are picked. Layer velocities were then converted depths to the primary refractor from the surface using the critical distance method. Figure 4 shows a typical time distance plot for both forward and reversed profiles.

Discussion of results

Generally four to five geoelectric units were delineated across the entire area covered by the investigation the overburden (regolith) was seen from VES data to consist mainly of lateritics top soil which range in thickness between 0.4-.1.5 m with resistivities of 186-2070 ohm-m followed by coarse sand or gravelly sand which is 0.6- 4.9m T thick resistivity range of 144-1865 ohm-m . These are underlain by clayey sand or finely - weathered Basement layer that is 1.3-13. 3m thick with resistivity between 171-3009 ohm-m, then the weathered to fractured Basement that range from 7.0m – 40m thick with maximum resistivity of 3900 ohm and finally the underlying fresh granitic- gneiss bedrock . The depths to water table at all the VES points range between 5 to 8 meters. The depth to fresh Basement rock varies from the Shallow overburden area at VES 1, 6 and 7 With values of 25m, 24m and 27m respectively, to medium depth area with a range of 32-36m along VES 3,4,5 and 9, while VES 2,8 and 10 have greater regolith thickness of 47m, 44m and 41m respectively. The seismic results showed that the top of the fresh Basement rock was reached at depths of about 25m with compressional wave velocity varying from 4.5km/s to 5.2km/s. However the Basement rock was not encountered at some areas probably due to the low intensity of the source of seismic energy. In such cases, weathered to fractured Basement rock with velocity range of 1.7km/s to 3.0 km/s were observed at depths of about 7m to 21m. The seismic profiles were oriented approximately in the north -south direction. The results from seismic survey showed very little variation with the VES results especially in terms of depth to top of fresh basement.

Geoelectric profile

A section across the field in the south west – north east direction through VES point 5,7 and 8 was constructed the interpreted geoelectric section for the station were used to prepared the lithlogic profile , which is a model representation of the lateral lithologic continuity between adjacent VES points. Figure 5 shows a geoelectric section across VES points 5, 7 and 8.

geoelectric units.

The geologic log of the borehole at federal polytechnic Nasarawa and the interpreted geolerictric section of VES 1 showed that the lithology is made up of nearly the same material but with slight differences in depths. The lithologic sequence for the two section consist of lateritic top soil coarse sand, clayey sand, gravelly sand, weathered Basement and finally the fresh Basement. The static water level occurs nearly at identical levels. Depth to water table for the borehole at federal polytechnic Nasarawa is 6.7m while that of VES is 7.3m given a difference in depth to water level 0.6m.

For the geologic log of the borehole at federal lowcost houses along GRA Nasarawa and VES 7, there is a close match in litho logy with only a little variation . The depth to water level is 8m and 6.5m respectively for federal lowcost houses along GR A road and VES 7. The difference in depth to water table is1.5m.

CONCLUSION

The result of this investigation showed that the best location for sinking a borehole is VES 7 which showed evidence of fracturing. Followed by VES 2. Drilling should be done to a depth of at least 40m at either VES 7 or VES2 for optimal production. This study provide evidence that VES and seismic Refraction surveys are complementary method for groundwater investigation. The result revealed that the study area has thick overburden (regolith) which aids groundwater , water storage in Basement areas. It is reasonable to assume that zones with large regolith thicknesses down to the weathered (decomposed) Basement where clay content is very low are zones with highest permeabilities . The interpreted geoelerictric sections show good correlation with geologic sections obtained from nearby wells.

REFERENCES:

Clark, (1985): Ground water abstraction the basement complex areas of African. *Quarterly Journal of Eng. Geol*. London Vol 18:25 34.

David L.M and Offery, O. (1989): An indirect method of estimating groundwater level in the Basement complex regolith . Water resources Journal of Nig. Assoc. of hydrgeol Vol. l. No.2.

Du Preez J.W. and Barber, W., (1965): The distribution and chemical quality of groundwater in northern Nigeria. Goel Surv. Nig. Bull. No 36.

Freeze, R.A. and Cherry, J.A (19790: Groundwater. Prentices Hall Inc. New Jersey.

Hazel, J.R.T Cratchley, C.R. and Jones C.R.C, (1992): The Hydrogeology of crystalline aquifers in northern Nigeria and geophysical techniques used in their exploration ydrogeology of c s in African Geol. Soc. Special Publication No. 66, London.

Jatau , B.S and Falodun , B.S, (2000): Ground water investigation in Sabon Tasha Area of Kaduna using vertical; Electrical sound

Offodile, M.E (1992): An approach to ground water study and development in Nigeria. Mecon Services Ltd. Jos, Nigeria.

Okereke, CS. Esu E.O and Edet. A., (1998): Determination of potential groundwater sites using geological and of techniques in the cross river state . South East Nigeria *Journal of Africa Earth Sciences*, No.1, Pp. 149-163. Elservier, Science Ltd, Gt. Britain.

Olaniyan, 1.O and Olabode, T.O., (1998): Assessment of ground water potential of a typical Fadama in Kaduna State. Nigeria, proc. 5th national engineering conference Kaduna State Polytechnic 10-11 Dec.

Olayinka, A I., Akpan, and Magbabeola, O.A (1997): Geoelectric sounding for estimating aquifer potential in the crystalline basement area around Shaki, South West Nigeria. *Water Resource Journal - Nigeria Association of Hydro Geologists*, Vol. 8, No 1 & 2.

Olugboye , M.O. (1977): notes on the Hydrogeogy of Kaduna Town GSN report No. 15399.

Oluyide, P.O., (1995): Mineral occurrences in Kaduna state and their geological environment. Proceeding of a workshop held by the Nigeria mining and Geosciences society (NMGS), Kaduna chapter in collaboration with Kaduna State Govt, 15 Dec.

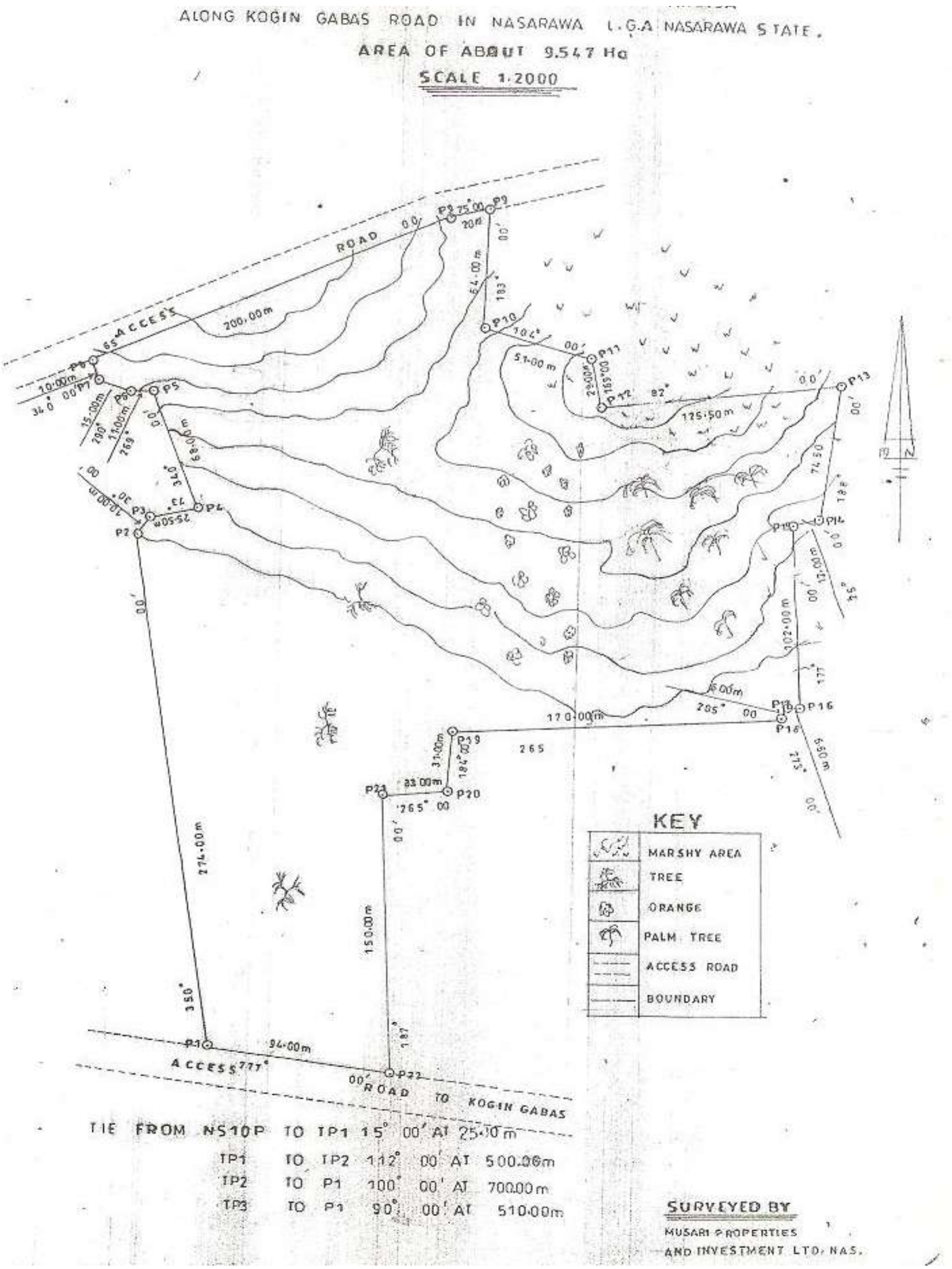
Shemang, E.M and Umaru , AFM (1994): Geophysical investigation for ground water supplies to rural communities: A Case study from part of northern Nigeria J. Of mining and Geol. Volt 30no.1.

Uma, K.O and Kehinde, umaru M.O (1994): Potential of regality aquifers in relation to water supplies to rural communities : A case study from part of northern Nigeria .J. of mining and Geol.vol. 30 No.1.

Wright E.P., (1992): The Hydrogeology of crystalline Basement aquifers in: Wright E.P. & Burgess, W.G.(eds.): hydrogeology of crystalline baseman aquifers in African geol. Soc. Special publication .No . 66, London.

Zohdy, A.A.R., (1989): A New method for the automatic interpretation of Schlumberger and Wennersounding Curves. Geophysics Vol. 54.

Figure 1: Topographic map of the study area



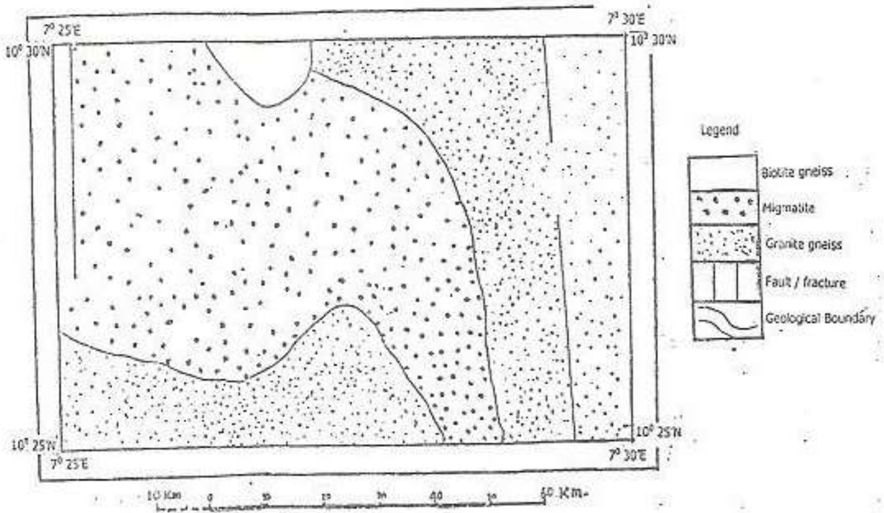


Figure 2: Geological Map of the Study Area

Source: Jatau and Falodun (2001)

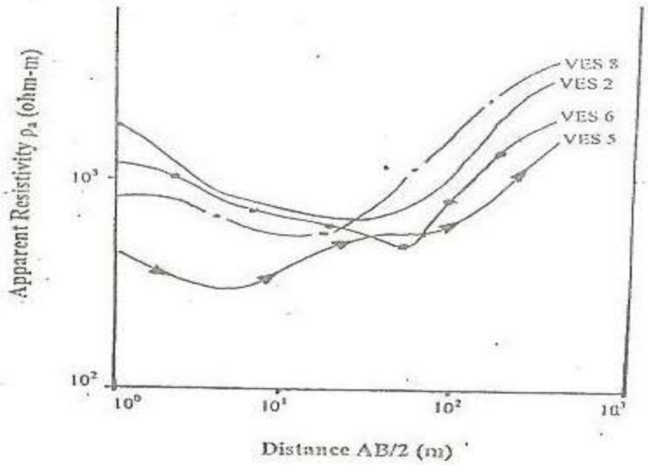


FIGURE 3: TYPICAL FIELD CURVES

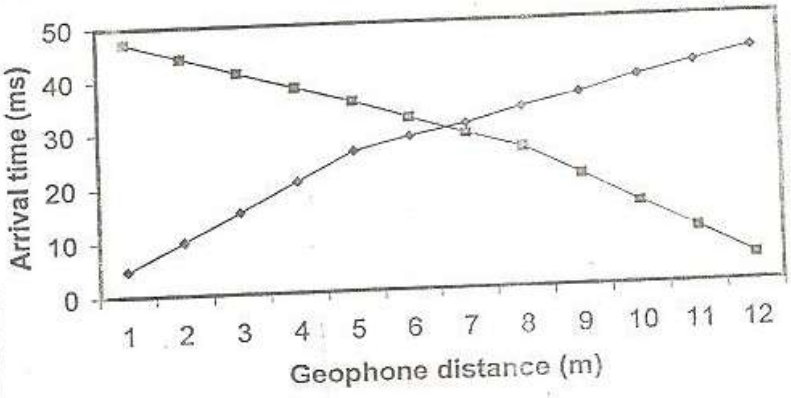


Figure 4:Typical time-distance graph

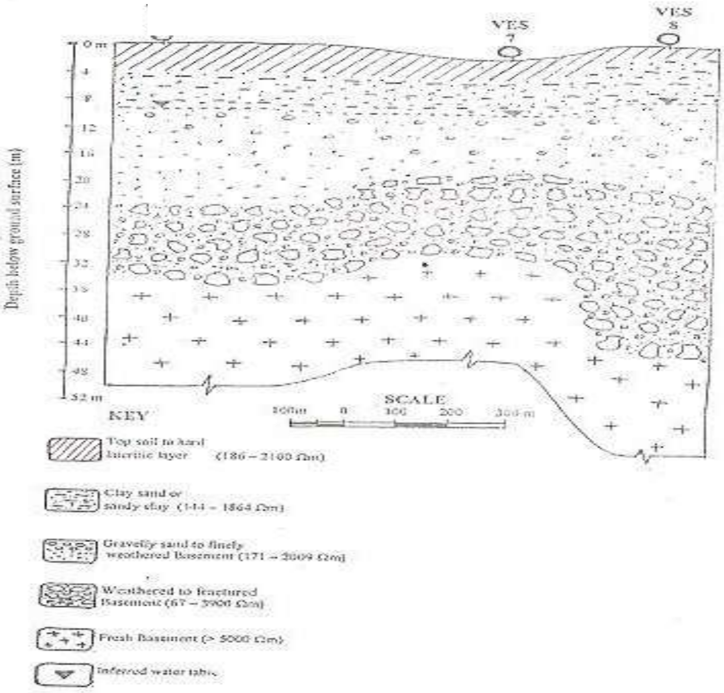


FIGURE 5: GEOELECTRIC PROFILE THROUGH VES 5 – 7 – 8