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GEOELECTRIC DRILLING OF PART OF ABAJI AND ENVIRONS ABAJI AREA COUNCIL FEDERAL CAPITAL TERRITORY ABUJA NORTH-CENTRAL NIGERIA

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Abstract: *Geoelectrical drilling was carried out in parts of Abaji Area Council, Federal Capital Territory of North-Central Nigeria, with the aim of establishing the groundwater potential of the area. Seventy-two (72) Vertical Electrical Sounding points established at various stations using Abem Terrameter SAS 300C/GPS12 Garmix with a maximum cable spread of AB/2=300m and MN/2=20m. The results obtained from the field data were interpreted using the IXID and IPI2WIN 2004 software for quantitative analysis, while the GIS software was used for the qualitative analysis. The study area shows four units of water system in some places at 30m, 60m, 90m and 120m. The apparent resistivities value ranges from as low as 56*Ω*m to as high as 3000*Ω*m. The study area revealed 5-7 lithologic sequences consisting of top soil, laterite, clay, siltstone, fine sand and sandstone of various thicknesses. The water bearing zones are within the fourth to sixth lithologic layers as a result of the moderate resistivity values obtained which ranges between 50*Ω*m to about 650*Ω*m. The clay units often reach thickness of 5 to 15m. This lithostratigraphy controls the occurrence, type and behavior of the aquifer units. The sand and clay intercalation constitute a system of aquifers separated by aquitards. The aquifer- aquitard units form multi-aquifer systems. The results correlate well with existing geology*.

Keywords: Geoeletric drilling. Lithostratigraphy, Lithology, aquitards and muti-aquifer system.

INTRODUCTION

Nigeria is relatively rich in water resources, well-drained by collection of river system (Ayoade & Oyebande, 1976), however the relative abundance of water resources in contrast to its scarcity and limited access by the Nigerian populace stands a sad situation. This situation calls for critical reviews as water constitutes an essential resource for physical and human development. Water resources need to be adequately utilized for all forms of development, it therefore becomes imperative and expedient that efforts must be geared toward identifying, conserving and effectively harnessing the numerous water resources that exists in the nation. The need to have adequate and current information on the availability, distribution and amount of water resources can be obtained on regular basis particularly for the purposes of planning. This study is aimed at delineating the various lithologies, aquifers resistivities and thicknesses, depth to bedrock and infers such groundwater potentials in the area. This would provide good information in management, evaluation and planning of groundwater resources in the area. The area of study falls within the Guinea Savannah Belt of Nigeria in Abaji Area Council of the Federal Capital Territory in the North-Central Nigeria consisting of thirty communities, it shares boundary with Nasarawa, Kogi and Niger States. The annual rainfall is in excess of 1623mm with mean annual temperature is 80 ^{0}F with a mean annual range not exceeding 20^0 F (Ayoade & Oyebande.1976). The area is bounded by Latitudes 8^0 25' 00'', 8^0 35' 55''and Longitudes 6^0 45 00'', 6^0 55' 51''with a total coverage of 138km^2 (Fig.1).

GEOLOGY SETTING

The study area falls majorly within the Patti Formation of the Sedimentary Basin which appears to be connected to the Nupe sandstone of the Upper Niger Basin and extends southeastward through the Lower Niger Basin(Fig.2). It shows some lateral facies changes and is reportedly equivalent to the Lokoja sandstone, which in succession overlies the basement. The Patti Formation with a maximum thickness of about 100m of fine to medium grained sandstones, clay, carbonaceous silt and ironstones which is equivalent to Mamu Formation, east of the Niger and tins out northwards where it overlies 300m of Lokoja sandstone (Murat, 1972, Adeleye, 1976). The Abuja-Kotankarfi road section exemplifies the formation. The Older Lokoja sandstone, on the other hand overlies the basement directly and consists of pebbly clayey grits and sandstones. The formation which appears to underlie the Patti Formation, to the north of Lokoja in the Abaji area, is more promising as an aquifer than the overlying Patti Formation. However, there are no borehole records to justify this assertion (Adeleye, 1976). Mid-Niger Basin suggest that the basin is bounded by a system trending NW-SE (Kogbe et al., 1983). Gravity studies also confirm anomalies flanked by negative anomalies as shown for the adjacent and typical of rift structures (Ojo, 1984; Ojo and Ajakaiye, 1989).The origin of the Bida Basin has been a principal subject of several workers (Ladipo et al., 1994; Abimbola. 1997).

METHODOLOGY

The research involves Geoelectrical drilling using Schlumberger array. A total of seventy-two (72) soundings were carried out with maximum cable spread of AB/2=300m and MN/2=50m. The apparent resistivities obtained were plotted against electrode spacing and the field curves KAH types were produced on a log graph sheet (Keller & Frischknecht, 1966). The sounding curves were evaluated using IX1D and IPI2WIN interpretation computer software package (2004).

RESULTS

The quantitative analysis and interpretation of the data revealed 5-7 lithologic layers, thicknesses, resistivities value, depth to aquifers and basement were used to deduce the qualitative deductions in terms of resistivity model maps at various depth, basement map, and geoeletric section for correlation with existing geology were produced for some parts of the study area (Figs.3-5). The regional trend of aquifer units and depth to basement made it possible to deduce shallow and deep basins as well as groundwater potential of the study area (Olorunniwo & Olorunfemi, 1987; Jatau & Ajodo, 2006; 2005; Jatau & Bajeh, 2007).

Apparent Resistitivity Maps

This is to actually see the trend of the different formation, water potential and possibly the basins in the study area Figs.3-5. The legend shows the different colours ascribed to different resistivity values. The green colour shows low resistivity values of less than 200**Ω**m which represent clayey to lateritic fine sand lithology, the blue colour shows moderate resistivity values 200**Ω**m to 450**Ω**m which represent a good water bearing formation such as sandstone. Resistivity values less than 800**Ω**m falls within the blue colour and this might contain little water. The white colour shows high values of more than 1000**Ω**m which is an indication of a more consolidated formation that is likely to have little porosity and permeability. The dark colour with higher resistivity value represents the crystalline basement rocks that contain no water with values above 1000**Ω**m. The blue colour in the map indicates the water bearing area as well as the basins.

DISCUSSION

The study area shows 5-7 geoelectric sections of various thicknesses consisting of probable clay, siltstone, laterite, fine sand, sandstone and basement. The fine sand and sandstone are the major aquifer units with reasonable thicknesses, and the resistivities values obtained at these areas show some good degree of permeability and porosity. The apparent resistivity map (Figs.3) show areas that have same water potential as well as the basin, at 30m depth the water aquifer is generally good except for areas like Rimba, Ebagi, Naharati, Naharati sabo, Naharati Tsoho, Agyana, Maderegi, Basakpa and Gbogbodo which show poor water potential. This is at best described as overburden aquifer. At a depth of 60m from the Map (Fig.4) depicts a good groundwater potential spread over most areas, only few areas like Baskpa, Alu, Gbogbodo, Rimba and Orukpisaka do not have good water potential at this depth. At this depth the map depicts moderate resistivities at various depths which are an indication of highly good aquifer potential zone. Though the volume might vary from point to point due to the differences in resistivities but the entire area generally show the presence of water (Fig.5) are seen to have some water traces at 90m depth. At 120m which is basement in some areas groundwater traces is seen as a result of low resistivity. This conforms to the undulating nature of the topography seen in Adagba, Tekpesha, Ashara, Gurdi, Mmagi, Mawogi, Ebagi, Naharati Tsoho, Orukpisaka, Lowcost, Kwakirata, Yewuni and Maderegi (Fig.6). The depth to basement map (Fig.7) shows that Nomadic Agyana, Kwakirata, Abaji North, Lowcost, Abaji and Orukpisaka have a depth to basement ranging between 125m to 150m which are the deepest areas, this is followed by Naharati Sabo, Tupa, Ekki, Agyena, Alu. Maderegi, Wadagi, and Ebagi which show a range between 100m to 125m and finally Rimba, Rimba Gwari, Pandagi Gwako, Nanda, Gbogbodo, Baskpa, Mmagi, Adagba, Abo Mada, Ashara, and Tekpesha show a depth range between 75 to 100m. From these observations, it can be deduced that averagely the water potential of the area is good though, the volume may vary from point to point depending on the resistivity, thickness and aquifer characteristics that can be determine after drilling and pump testing.

Fig.8 depicts a good degree of correlation of a typical geoelectric-section with an existing geology.

CONCLUSION

The study area reveals 5-7 lithologic sequences of various thicknesses and apparent resistivities. The apparent resistivities values ranges from as low 13**Ω**m to as high as 7342**Ω**m. This is an indication that some areas might be clay formation while others areas are highly consolidated. Water bearing zones are within the fourth and sixth lithologic layer, this is due to the moderate resistivity values obtained which range between 50**Ω**m to 650**Ω**m. The lithologies underlying the area are a typical Patti Formation consisting of thick unconsolidated sands interfingered with clay bands, lenses and stringers. In some areas, the clay units are more prominent and often reach thickness of 5 to 15m. This lithostratigraphy controls the occurrence, type and behavior of the aquifer units. The sand and clay intercalation constitute a system of aquifers separated by aquitards. The aquifer-aquitard units form multi-aquifer systems. There are an upper unconfined or water table, a middle confined to semi-confined aquifer system and a lower confined aquifer system. The unconfined aquifer zone exists almost throughout the study area from 20m to about 40m. At the Northern area the upper confining layer is less defined and frequently occurs as clay lenses, stringers or fined grained clayey sand this attribute to the low resistivities range of 13**Ω**m to 25**Ω**m obtained in some areas. Depths to aquifers vary considerably from point to point usually deeper in the southern area. The middle aquifer system is confined to semi-confined in nature. It consists of thick medium to coarse-grained sands. The sand units are interfingered with thin clay lenses and fine-grained clayey sands. The average thickness increases from 50m in the north to about 80m in the south. The thickness of the middle aquifer is less defined. Southwards, the confining beds are fine grained sands and clayey sands. The middle aquifer in this area is generally semi confined. The average total thickness of the study area is about 120m. Deeper drilling may encounter more aquiferous horizons as reveals by the modeled resistivity maps. This unexploited aquifer system forms the lower confined aquifer system as the apparent resistivity maps depicts groundwater potential at 60 to 90m depth. Based on the geoelectrical drilling carried out it is therefore, recommended that other geophysical methods than the vertical electrical sounding should be carried out and the result compared to this, for example magnetic/gravity method. Deep boreholes should be drilled to actually determine the aquifers thicknesses and depth to basement. Aquifers characteristic be determine as well as their yields through pumping test, borehole logging to ascertain the lithologic sequence as revealed by the resistivity method. The need to harness the water system in the area as the potential is enormous and will go a long way in easing water problems in the area.

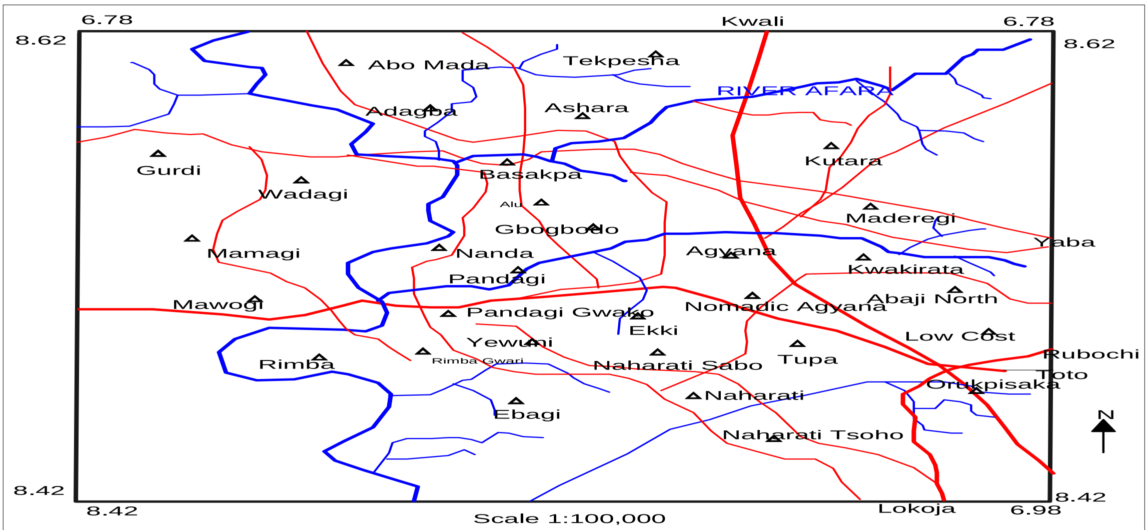


Figure 1. Location and Accessibity map

Modified from Topo map published by Land and Survey Department FCDA, Abuja 1992.

LEGEND

Major River — Minor road

Stream

Major Road — Settlement/Town

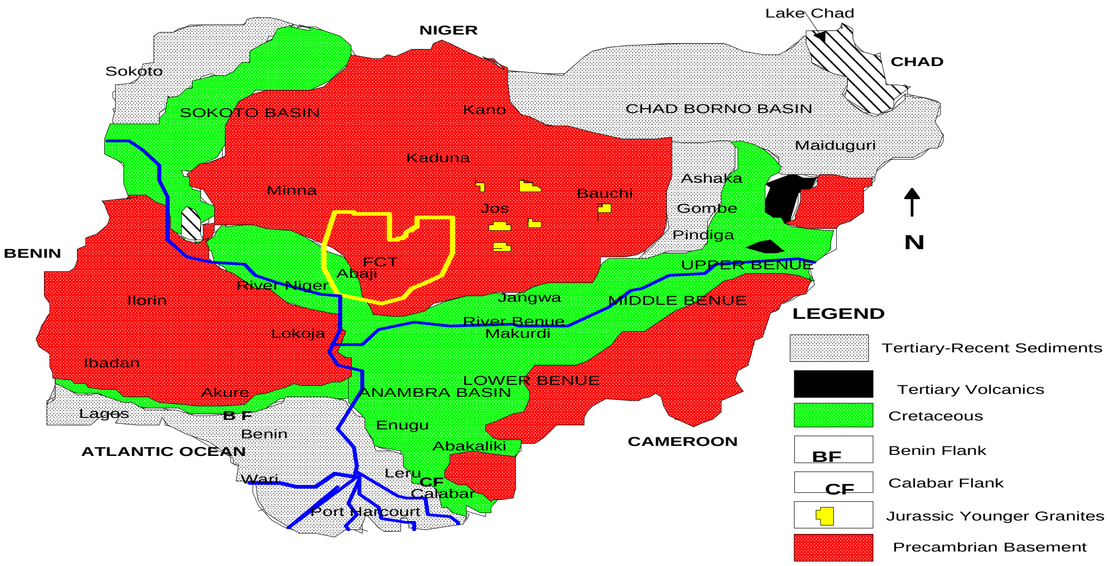
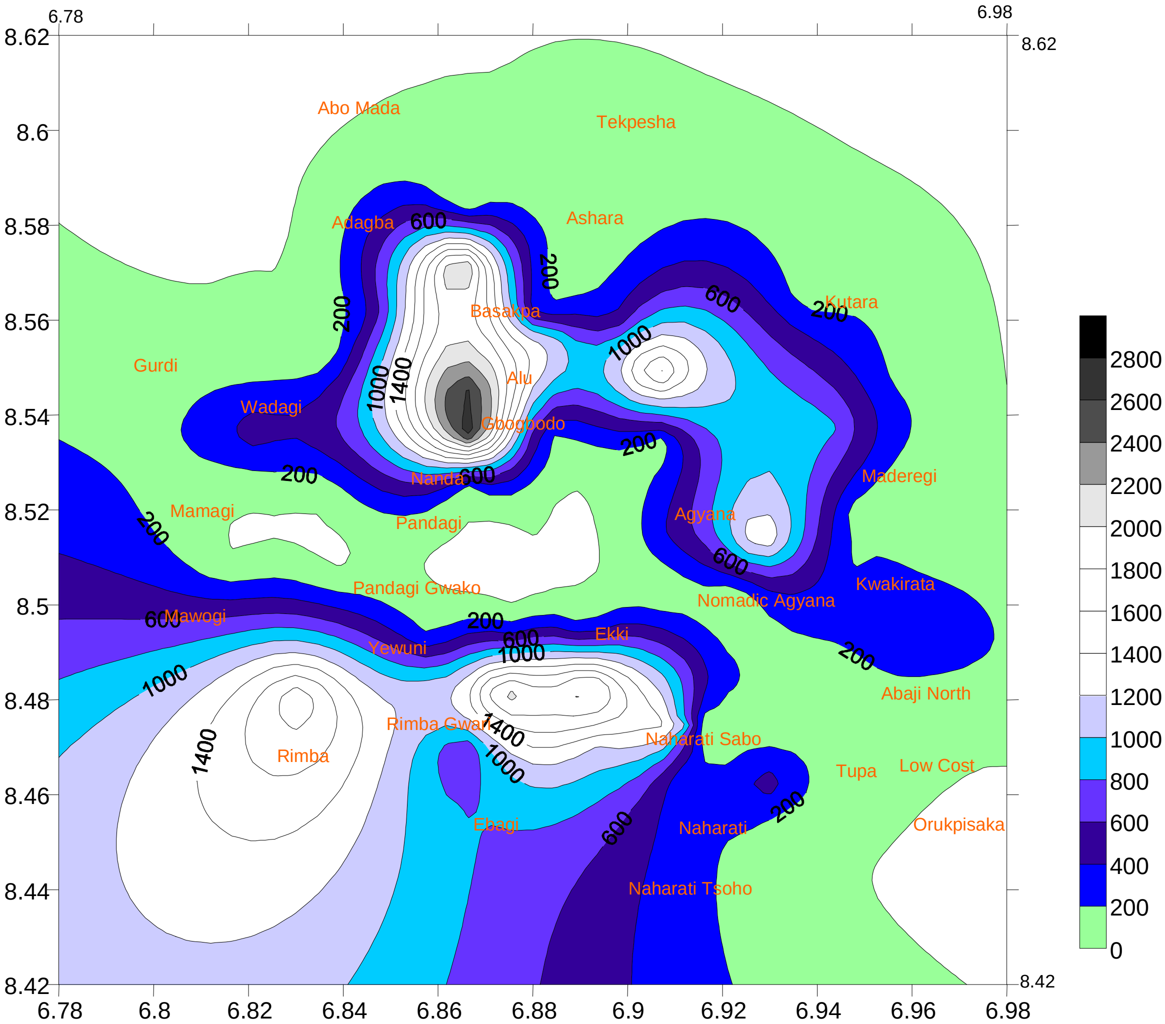


Fig. 5 Geological map of Nigeria

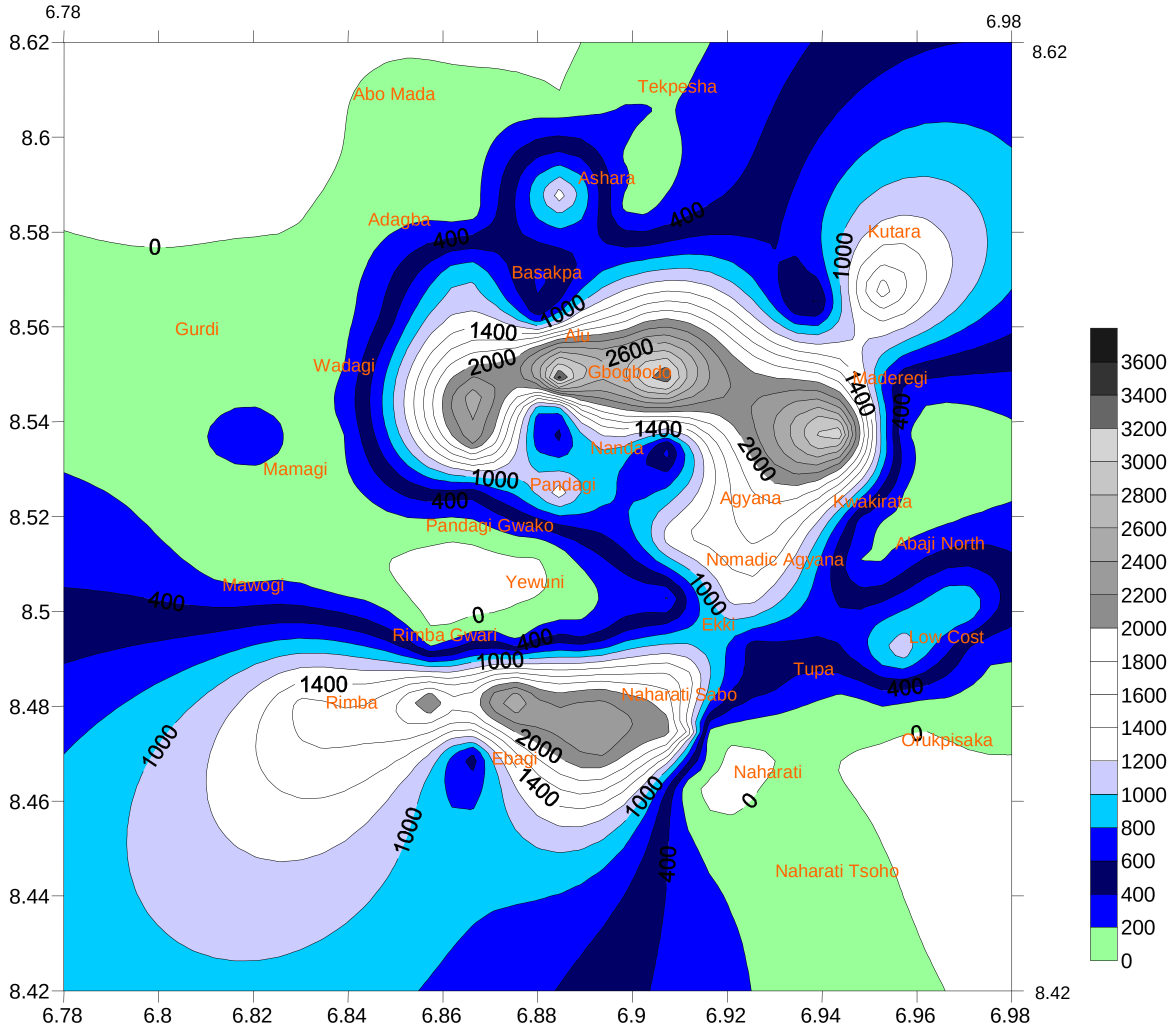
Fig. 2 Geological map of Nigeria showing study area adopted by Nigerian Geological Survey Agency of Nigeria(NGSA) 2009.



Scale 1:100,000

Contour Interval 200ohm-m

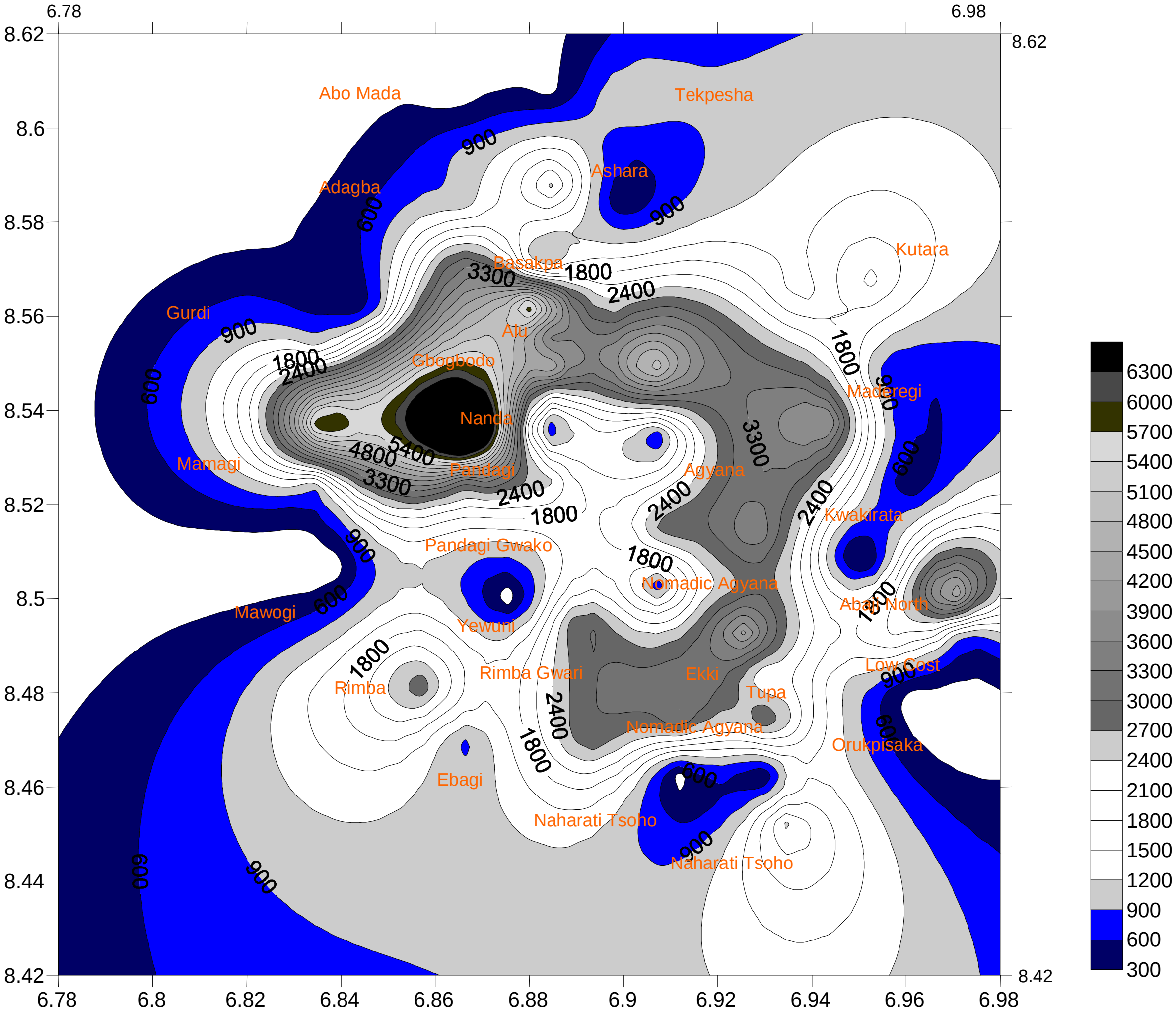
Fig. 4 Apparent Resistivity Map at 60m depht



Scale 1:100,000

Contour Interval 200ohm-m

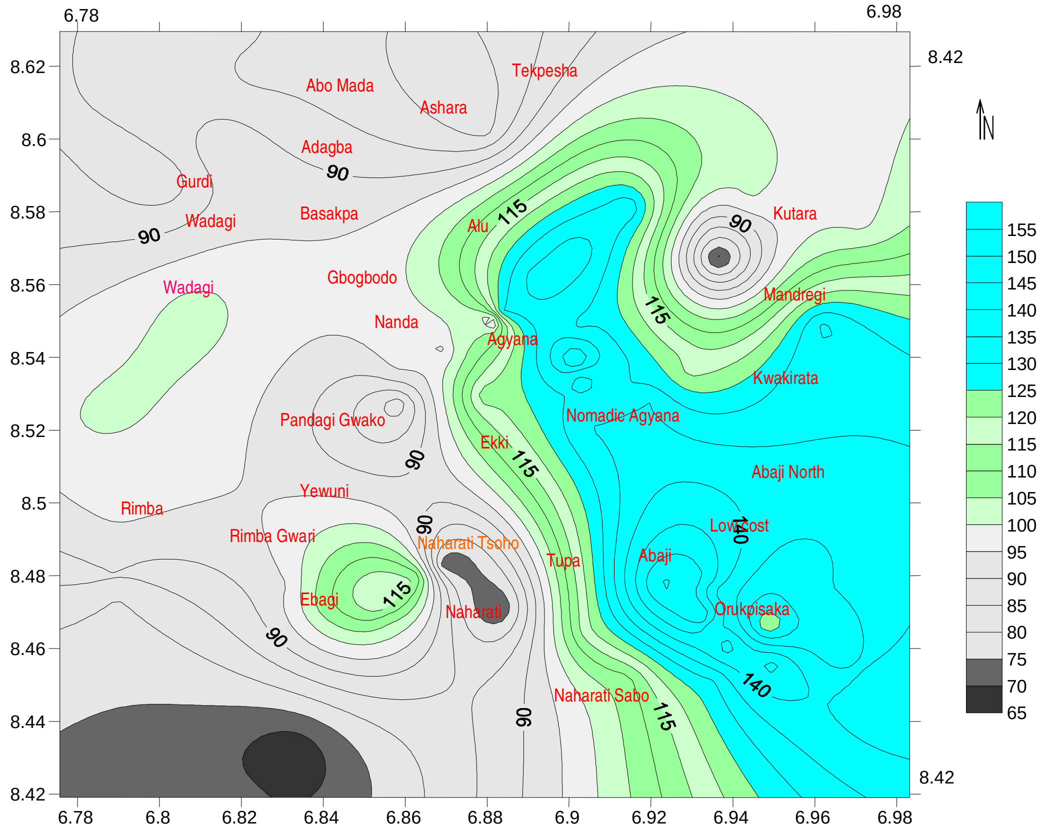
Fig. 5 Apparent Resistivity Map at 90m depht



Scale 1:100,000

Contour Interval 300ohm-m

Fig.6 Apparent Resistivity Map at 120m depth



Scale 1:100,000

Fig.7.Depth to Basement Map Showing the bedrock of the area

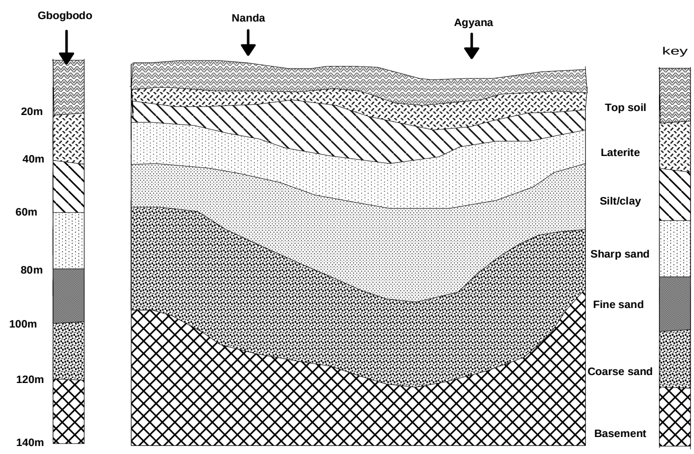


Fig.8 Correlation of geophysical data with existing BoreholeLog.

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