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CASE STUDY OF WASE AND ITS ENVIRONMENT: GROUNDWATER DEVELOPMENT IN PLATEAU STATE, CENTRAL NIGERIA

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Abstract

Groundwater occurrence of Wase and it's environ, plateau state, central Nigeria, was carried out using the application of geology, hydrogeology and electrical resistivity method with the aim of correlating the groundwater potential of Wase Town. The study area is underlain by crystalline rock (granite) and sedimentary rocks (sandstone and shale). Eighteen (18) Vertical Electrical Sounding (VES) was conducted for geoelectrical resistivity measurements using Schlumberger array configuration. Six to four layers were delineated, top soil with resistivity values ranges from 28-4190 Ωm with thickness of 0.5 to 2.1m, lateritic layer ranges from 80-800Ωm and thickness 1.4m to 21m; weathered basement (79-325Ωm) with thickness range from 6m to 14m; fractured basement (397-658Ωm) with thickness 5m to 20m and finally, fresh basement (700-2152Ωm) to infinity. Marrying geology, hydrogeology and geophysical methods, it can be concluded that the weathered and fractured basement forms the aquiferious unit in the area, as such depth to aquifer ranges between 35m and 70m and corresponding thickness between 6 and 20m.

Keywords: electrical resistivity, basement terrain, sedimentary formation, water level and groundwater potential

1. INTRODUCTION

Subsurface water exploration is an important operation that marrying detailed application of geology, hydrogeology and electrical resistivity method of wase and it's environ. Sources of surface and subsurface water in some locations in wase comes from boreholes, hand dug and stream channel in the basement and sedimentary rock (weathered and fractured).The occurrence of groundwater in the area can be attributed to recharge and discharge mechanism also the porosity and permeability of the underlain rocks (granite,sandstone and shale).Marrying and have general overview on these mechanism mention above will ensuring adequate harness of groundwater potential, help in controlling contamination and professional advices for proper useage and withdrawal in the area. Offodile, (2002), saw that despite the poor hydrogeological response of the Basement Complex rocks of Nigeria, the Basement Complex still remains an important source of water since more than half of the country seats on it. He further explained the need of adequate hydro-geophysical surveys and improved drilling techniques to harness better results or more productive boreholes within the Basement Complex terrains.

2. GEOGRAPHICAL AND GEOLOGICAL SETTING

Wase and it environ lies between latitudes 9°04′00″–09°14′00 ″N and longitudes 09° 55′ 00″–9°10′ 40″ E. It is divided into several communities which are Wase Tofa, Plagore, Sabo fegi Wase, and Yola wakat, Takdany, Gyambar, Takalafiya Kamba and Gandu.

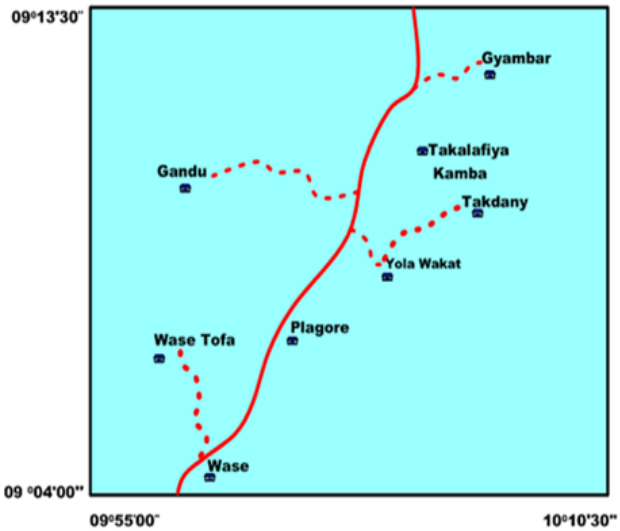

Figure 1 Location map of Wase and environ

The climatic condition of the area is characterised by rainy season (April to October) and dry season (November to March) with annual rainfall and temperature varying between 1300 mm – 1500 mm and 28 °C – 36 °C, respectively (Adefolalu, 2002). Part of Wase is cover by hornblende granite while other locations are underlain by Mesozoic sedimentary rocks (Sandstone and shale) of the upper Benue Basin (Maurin et al. (1985).

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3. STATEMENT OF THE PROBLEM

The demand for potable water for human consumption and activities has increased immensely and in some locations limit success is achieved and failure in other part in regardless of the geophysical exploration hence, marrying geology, hydrogeology and electrical resistivity method most suitable for groundwater potential of Wase and it environ for proper harness.

4. MATERIALS AND METHOD

Challenges of groundwater development in Wase and it environ were achieved marrying geology, Hydrogeology and electrical resistivity method. The geology mapping was carried t with aim of delineating the rock formation in Wase and environ. The hydrogeology was carrying out to determine the water level of hand dug wells in the area. Eighteen (18) vertical electrical sounding (VES) points were carried out using ABEM SAS 1000 resistivity meter for data collection. These parameters were then used for the computer iteration technique using the win Resist software to give the actual resistivites, depths and thicknesses of the layers and Surfer 12 contouring software for plotting of contour maps of water levels, 3-D view and depth to aquifer in Wase and environ.

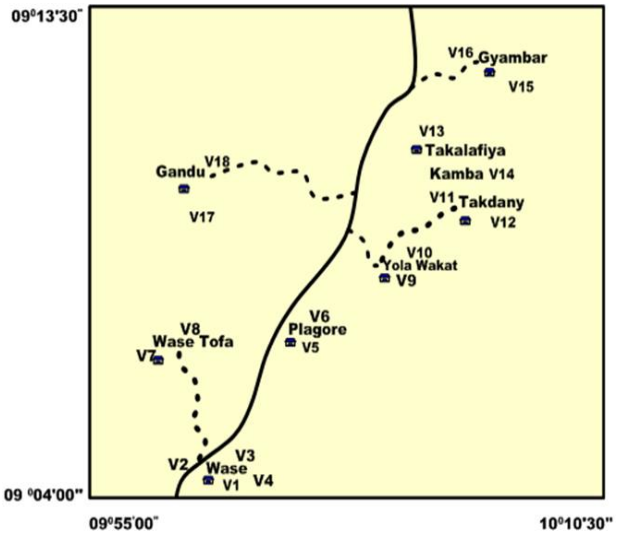

Figure 2 VES points location map

5. GEOLOGY AND HYDROGEOLOGY OF WASE AND ENVIRON.

The study area falls under the sedimentary and basement terrain of Nigeria geology, outcrops mapped in the study area were sandstone, shale and hornblende granite (Figure 3). The hydrogeology of Wase and it's environ is controlled by geology, climate and structure. This is because of the rock mapped and the subsurface features in them that porosity and permeability of the aquifers and their recharge while climate determines the amount and rate of recharge of the aquifer. Groundwater occurs in the Basement Complex in weathered mantle or in joint and fracture systems in the un-weathered rocks. These two aquifers have different groundwater characteristics and potentials. This depth of the weathered zone is variable and largely dependent on the composition and texture of the parent with the density of the regional fracture field.


plate 1:sandstone outcrop in plagore

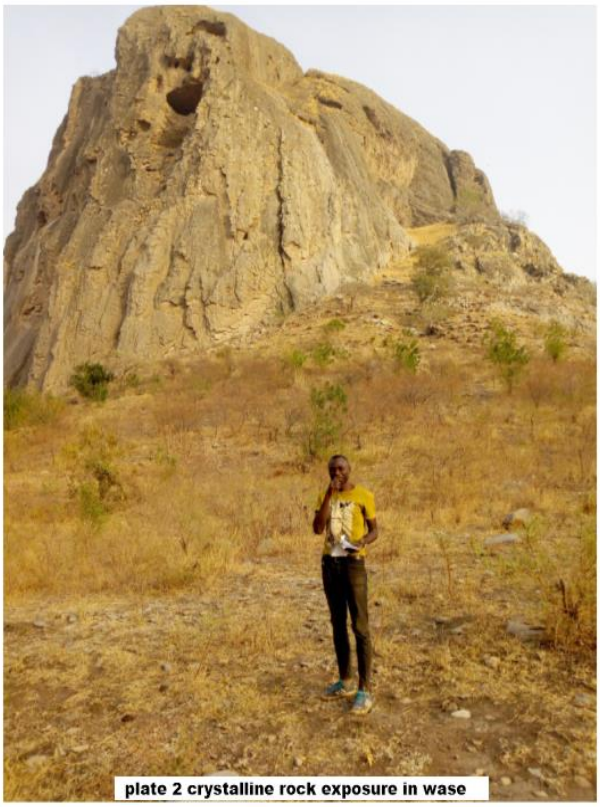
plate 2 crystalline rock exposure in wase

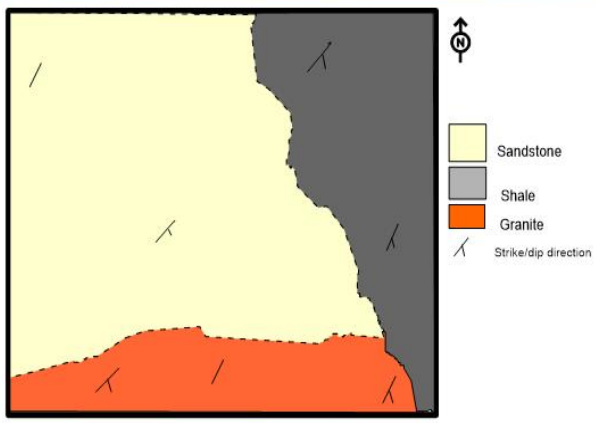

Figure 3 Geology of the Wase and environ

6. GEOPHYSICS

The electrical resistivity method (schlumberger array) was employed to determine the following subsurface parameter in the study area.

1. Aquifer depth
2. Aquifer resistivity value
3. Top soil resistivity value

7. RESULT AND DISCUSSION

From table 1 and 2 reveals the water level and interpreted model geoelectric parameters of selected parts of Wase and environ, it shows water level in both basement and sedimentary and geoelectric parameters of the eighteen (18) vertical electrical sounding points carry out in the study area. From figure 4, 5 and 6 reveals the contour plots and 3 D digital elevation models of water level in (basement and sedimentary area) and water level and depth to aquifer across the study area; this shows that deeper and shallow water levels occur at 10m depth in Takdany and Takalafiya Kamba and 4m depth in Gandu in sedimentary terrain, while moderate water level of 6m in noticed in Wase town in basement area. Aquifer depth in Wase ranges from 35m to 70m depth with shallow in Wase of 35m depth of moderate to high yield while deeper aquifer depth of 70m in Yola wakat of moderate yield (figure 6). Hand dug wells and boreholes in the study area are medium and productive while some low have low to medium yield.

Table 1 Interpreted hand dug wells total depth and water level in Wase and it environ.

S/N	Location	Northing	Easting	Elevation M	Terrain	Water Level(m)
1	Wase	9.079	9.954	244	Basement	8
2	Wase	9.081	9.740	246	Basement	8
3	Wase	9.691	9.819	239	Basement	6
4	Wase	9.067	9.890	245	Basement	6
5	Palgore	9.118	9.982	278	Sedimentary	7
6	Palgore	9.120	9.983	277	Sedimentary	5
7	Wase Tofa	9.133	9.921	239	Sedimentary	5
8	Wase Tofa	9.126	9.930	238	Sedimentary	5
9	Yola Wakat	9.156	9.989	269	Sedimentary	7
10	Yola Wakat	9.184	9.949	267	Sedimentary	6
11	Takdany	9.174	9.996	288	Sedimentary	9
12	Takdany	9.192	9.981	287	Sedimentary	10
13	Takalafiya Kamba	9.2001	9.977	253	Sedimentary	10
14	Takalafiya Kamba	9.2010	9.981	252	Sedimentary	8
15	Gyambar	9.223	9.981	262	Sedimentary	7
16	Gyambar	9.219	9.976	260	Sedimentary	8
17	Gandu	9.167	9.931	242	Sedimentary	5
18	Gandu	9.159	9.922	242	Sedimentary	4

Table 2 interpreted model geoelectric parameters of Wase and environ

S/NO	Location	Northing	Easting	Elevation M	Top soil	Overburden thickness(m)	Depth to aquifer	Aquifer resistivity
1	Wase	9.079	9.954	244	81.2	8	45	200
2	Wase	9.081	9.740	246	912	7	35	123
3	Wase	9.691	9.819	239	323	8	40	148
4	Wase	9.067	9.890	245	812	7	50	140
5	Plagore	9.118	9.982	278	4190	10	60	118
6	Plagore	9.120	9.983	277	3180	12	55	151
7	Wase Tofa	9.133	9.921	239	296	8	45	125
8	Wase Tofa	9.126	9.930	238	350	7	50	80
9	Yola Wakat	9.156	9.989	269	2302	10	70	79
10	Yola Wakat	9.184	9.949	267	1979	15	60	96
11	Takdany	9.174	9.996	288	267	10	60	189
12	Takdany	9.192	9.981	287	349	8	50	150
13	Takalafiya Kamba	9.2001	9.977	253	302	10	60	120
14	Takalafiya Kamba	9.2010	9.981	252	445	8	50	165
15	Gyambar	9.223	9.981	262	28	10	60	158
16	Gyambar	9.219	9.976	260	45	8	50	130
17	Gandu	9.167	9.931	242	4841	15	60	325
18	Gandu	9.159	9.922	242	3001	15	50	121

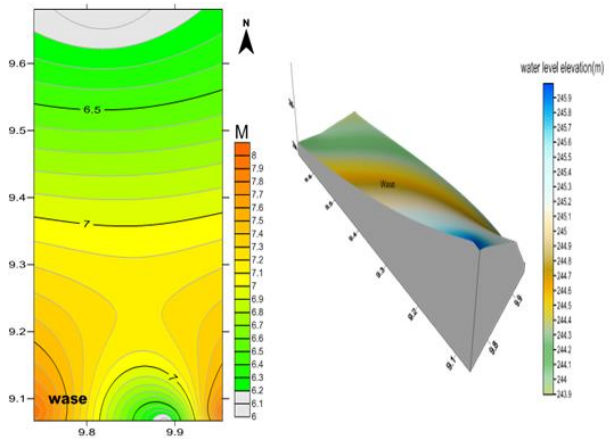

Figure 4 Water level contour map and 3-D digital elevation model in basement area

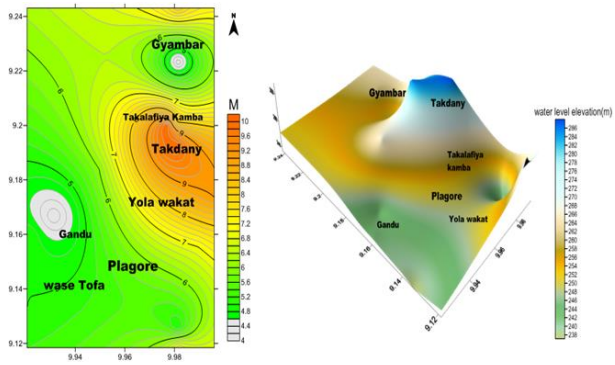

Figure 5 Water level contour map and 3-D digital elevation model in sedimentary area

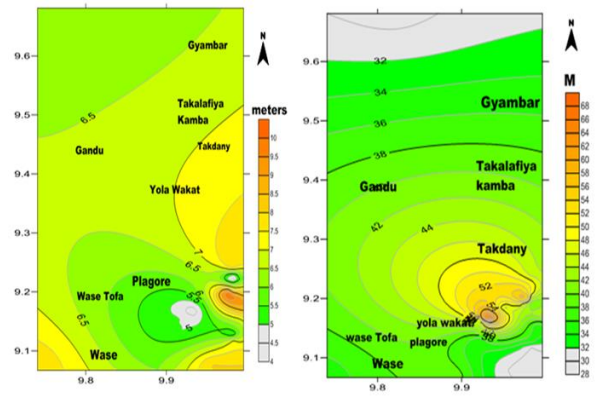

Figure 6 Contour plot of water levels and depth to aquifer across Wase and environ

8. CONCLUSION

Geological mapping revealed three major rock types, which consist of granite, sandstone and shale trending NE-SW. The application of geology, hydrogeology and schlumberger array use to method determines subsurface characteristics of the study area and 6 - 4 geoelectric sequences were delineated, topsoil, Laterite, weathered basement, fractured basement and fresh basement. The depth to aquifer in Wase ranges from 35m in Wase town to 70m Yola wakat. The area has a viable groundwater potential with medium to high yield but sometimes have low yield in area underlain by shale. Marrying geology, hydrogeology and schlumberger array in Wase and it environ will give general overview and optimal outputs.

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