GEOPHYSICAL STUDIES OF GROUNDWATER POTENTIAL OF PARTS OF *ETIM EKPO* LOCAL GOVERNMENT AREA OF AKWA IBOM STATE, NIGERIA

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Abstract

A vertical electrical sounding (VES) utilizing the Schlumberger electrode configuration has been used to investigate the groundwater resource potential of some villages in Etim Ekpo local government area of Nigeria. Data was acquired using a SAS 300B model of ABEM terrameter. Current electrode separation varied from 600-800m. Results show that the sampled subsurface can be approximated by a 3-5 layer subsurface structure. The first layer is conducting topsoil with an average resistivity of 339.5Ωm and average thickness of 2.75m. The second layer has a mean resistivity of 2886.5Ωm and average thickness of 6m and was interpreted to be a lateritic sand layer. The third layer was interpreted to be a medium sand layer with a mean resistivity 3921.6Ωm and is 8.7Ωm thick. The fourth layer that was interpreted to be an aquifer has a mean resistivity of 6790Ωm and is located at a mean depth of 18.5m below the surface. This layer consists of medium coarse grained (gravely) sands. This layer was not detected in the eastern side of the study area. The fifth layer that was interpreted to be a sandstone layer has a mean resistivity of 40,373.5Ωm. The thickness of this layer and some parts of the fourth layer could not be determined by the maximum current electrode separation employed in the field.

***Keywords:** Etim Ekpo, aquifer, gravelly sand, resistivity and thickness.*

1.0 Introduction

People in the rural communities have always been dependent on surface water sources for their domestic water supply from time immemorial. Recent research results have shown that such water is not good in quality (Uchegbu, 2002; Esu and Amah, 1999; Edet, 1993 and Etu-Effeotor, 1981) while the underground water has better quality provided it is not degraded by human activities (Noguera et al., 2002; Adepelumi et al., 2001; Karlik and Kaya, 2001; Singh, 2000 and Alao, 1985). Several enlightenment programmes mounted by public health workers, non-governmental organisations and other concerned bodies have helped in disseminating these findings to the people in the rural areas and they are now changing to other sources of water especially groundwater. Groundwater is not found everywhere though fairly distributed all over the world. Its availability in a particular place can only be ascertained using geophysical techniques in which vertical electrical sounding (VES) is widely used (Egeh et al., 2004; Edet and Okereke, 2002; Noguera et al., 2002; Adepelumi et al., 2001; Karlik and Kaya, 2001; Singh, 2000; Esu et al., 1999; Mbonu et al., 1991; Okereke et al., 1998; Okwueze et al., 1995 and Alao, 1985).

This study applies the VES method in delineating aquifers in some villages in *Etim Ekpo* local government area of Akwa Ibom State, Nigeria. It is hoped that our findings will serve as an information pool to developers and would-be developers on what the optimum depth of a functional borehole should be and the type of rock that will host good quality water.

2.0 Location, geology and hydrogeology of the study area

The study area lies between latitude 4°55'N and latitude 5°00'N and longitude 7°30'E and longitude 7°40'E in Akwa Ibom State of Nigeria

Recent to Tertiary sediments belonging to the Benin Formation covers the study area. It is the youngest geologic unit in the Niger-Delta

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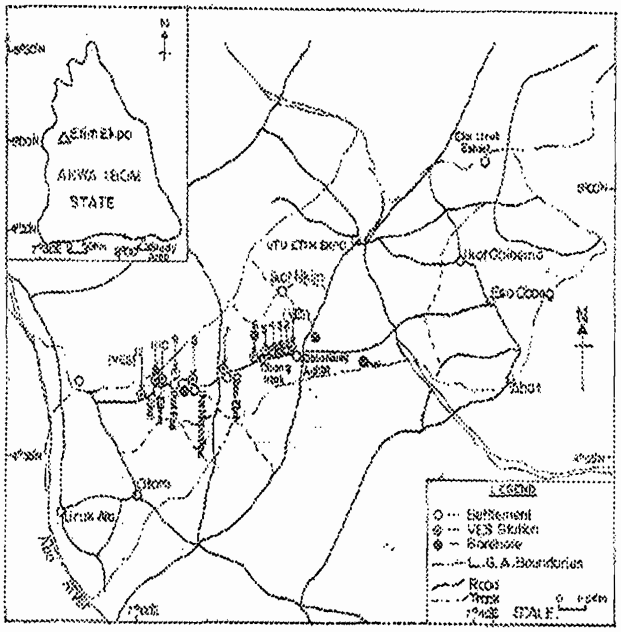

Fig: 1 Location of study area

sedimentary basin. This formation comprises continental sands and gravels deposited in an upper deltaic plain environment. The sands range from coarse to fine in texture and are very poorly sorted (Reijers et al., 1997). They are also thick and friable with minor intercalations of clay, silts and sandstones. This alternating sequence builds up a multi-aquifer system in some areas (Edet et al., 2003; Edet and Okereke, 2002; Okereke et al., 1998; Esu et al., 1999 and Mbonu et al., 1991). Thus the aquifer systems have been found to be a combination of the different sands.

The Kwa Ibo River drains the study area that sits on a relatively flat terrain. It has a humid tropical climate made up of two seasons the wet and dry seasons.

3.0 Field procedure

The study that comprises twelve VES was executed using Schlumberger electrode configuration. Twelve of the VES points were executed along a profile that cuts across five villages *Obong Ntak, Obon Ebot, Ikot Mkporikpo, Ikot Ese* and *Edem Akai* villages. Maximum current electrode spread varied from 600m to 800m depending on accessibility of the area, human settlements and other infrastructures. The sounding points were 400m apart. The instrument used for the study was a SAS 300B model of ABEM terrameter. Necessary precautionary measures taken to ensure accurate results include wetting the electrodes to ensure proper electrical contacts with the ground, maintaining tight contact at all joints, switching off the terrameter and retaking the reading at all VES points to reduce polarization, maintaining a collinear arrangement of all the electrodes and ensuring that no green leaf touches the electrodes when measurement were in progress.

4.0 Data analysis/results

Apparent resistivity were calculated and plotted against half electrode separation on a bilogarithmic graph.

Data extracted from the plotted graphs were fed into a forward modeling programme developed by Zohdy and Bisdorf (1989). This yielded results that were again fed into an inverse modelling program developed by Hemkler (1985). Results (resistivities and depths) of the inverse programme were taken to represent final models of the area.

A typical field curve obtained at VES 9 of the study area is shown in Fig. 2. Results obtained were plotted along a traverse and a geo-electric section drawn as shown in Fig. 3.

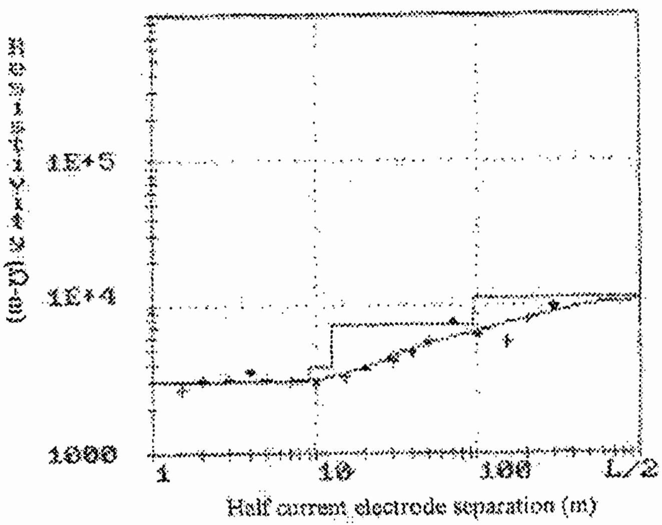

Fig. 2 A model (A-and HA curve)

5.0 Discussion of results

Two major curve types were prominent in the area. The first group consists of the A and HA (VES 9) curve type that depicted subsurface

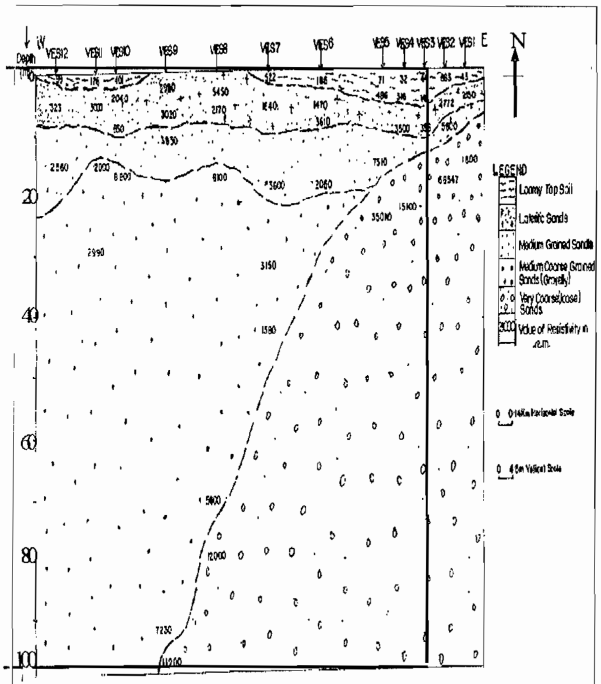

Fig 3 East-West geoelectric section from the study area

layering whose resistivity increases with depth. The second group comprises AK, KH, AKQ and KHK curve type. Representative curves for these two groups are shown in Figs 2 and 4 respectively. Fig. 5 shows a correlation between VES result and the only logged borehole available in the area as at when this study was carried out.

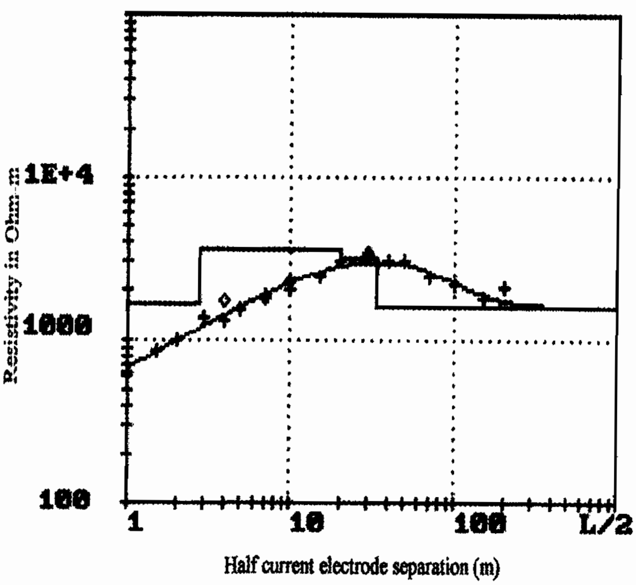

Fig. 4: AK, KH, AKQ and KHK curve type

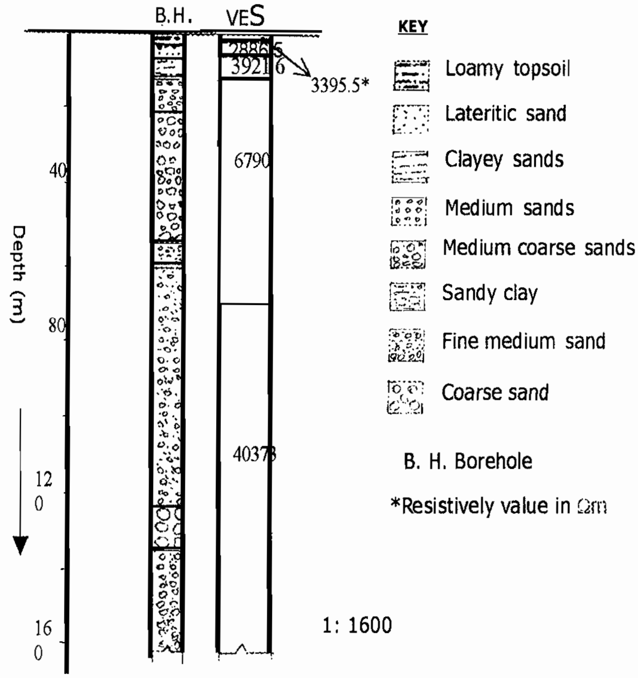

Fig. 5: Correlation between VES result and borehole lithology log

In all, a 3 5 subsurface layering was interpreted. The first layer is thin and less resistive (16- 663 m) and 0.5- 5 m thick. This layer was interpreted to be loamy topsoil. This layer was not observed in VES 8 and VES 9. The second layer that runs across the study area has resistivity that ranges from 323- 5450 m and is 3- 9 m thick. This layer is interpreted to be lateritic sand. The third layer is suspected to be medium grained sand layer with resistivity that varies from 2,050- 7510 m and it extends from 2m to 16m in depth. The fourth layer is probably medium coarse grained (gravelly) sand. Resistivity of this layer varies from 1,580-12,000 m and it is locate at about 15-22 m below the surface. This porous layer is identified to be the first aquifer terrain similar to the one described by Edet and Okereke (2002). This layer was well developed in the western side of the study area than in the eastern side where it was not detected. The last identified layer that is probably sandstone layer has resistivity values that varies from 11,200 to 69,547 m and was observed in the eastern part of the study area.

The depth to the aquifer compares favourably with the static water level of a functional borehole (22.23m) located near VES 11. This

Table 1 : Summary of VES results from computer modelling

VES station number	Location	Number of layers	Resistivities of layers in ohm.metre					Thickness of layers (m)				Depth to bottom (m)			
			ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	T_1	T_2	T_3	T_4	D_1	D_2	D_3	D_4
1	Obong Ntak	3	45	2,150	11,800	-	-	2.00	2.50	-	-	2.00	4.50	-	-
2	Obong Ntak	4	663	2,772	6,600	69,947	-	1.30	4.50	6.70	-	1.30	5.80	12.50	-
3	Obong Ntak	4	44	16	358	16,100	-	1.60	5.70	4.70	-	1.60	7.30	12.00	-
4	Obong Ntak	3	32	316	3,500	-	-	2.50	2.90	-	-	2.50	5.40	-	-
5	Obong Ntak	4	71	498	7,510	35,010	-	2.70	3.30	10.00	-	2.70	6.00	16.00	-
6	Obong Ntak	4	186	1,470	3,610	2,080	-	1.00	1.40	5.60	-	1.00	2.40	8.00	-
7	Obon Ebot	5	522	1,840	3,630	3,150	1,580	0.80	2.20	17.60	13.00	0.80	2.80	20.40	33.40
8	Ikot Mkporikpo	5	5,540	2,170	8,100	5,600	12,200	1.10	2.00	15.80	51.00	1.10	3.10	19.00	70.00
9	Ikot Ese	5	2,990	3,030	3,830	7,230	11,200	0.89	8.11	3.40	81.00	0.89	9.00	12.40	93.40
10	Edem Akai	4	401	2,040	550	8,800	-	0.65	4.55	4.85	-	0.65	5.20	10.05	-
11	Edem Akai	4	175	3,000	12,000	2,290	-	1.30	4.20	10.00	-	1.30	5.50	15.50	-
12	Edem Akai	3	88	323	2,580	-	-	0.80	7.40	-	-	0.80	8.20	-	-

layer has very good prospect for fresh water based on its resistivity value (Zohdy et al., 1974 and Griffiths and King, 1985) eventhough it is vulnerable to surface contamination (Edet and Okereke, 2002).

5.0 Conclusion

Etim Ekpo has good prospect for groundwater. Aquifers in the area comprise medium-coarse grained sands located at a depth that is not less than 20m below the surface. This area has very good prospect for fresh water but should be protected from contamination arising from human activities.

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