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Existence of Sandstone Deposit in Isihor Village Area of Edo State, Nigeria

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ABSTRACT

The existence of sandstone deposit, in Isihor Village Area of Edo State, Nigeria was investigated geophysically by employing the Schlumberger array techniques of vertical electrical sounding (VES). The need to prospect for sandstone deposits became imperative in order to solve unemployment problems for the citizen of the area by way of setting up chemical industry that rely on sandstone as raw material for its manufacture purposes.

This investigation actually entailed carrying out ten (10) fairly distributed VES operation in six (6) different stations by employing six (6) points per decade for each of the VES to justify the operation of collecting apparent resistivity data. The resulting apparent resistivity data obtained was then interpreted by using the software or package IP12WIN utilising computer iteration.

The result of the geophysical survey showed that sandstone deposits were intercepted at depths varying from about 50.0m to 120.0m while the thicknesses varied from about 10.0m to 45.0m. The resistivity of the sandstone formation varied from about 2000 ohm-m to 5500 ohm-m.

Area of probable sandstone formations and their thicknesses have been identified especially for future mining of industries foundation, operations and drilling.

Keywords: *Existence, sandstone deposit, Isihor Village, Schlumberger array techniques, manufacture purposes, apparent resistivity data, thicknesses, operations and drilling.*

1. INTRODUCTION

Geophysical exploration is usually conducted to detect and locate significant accumulations of sandstone deposit, clay deposit, oil, natural gas and other minerals, including groundwater which are of economic importance to Nigeria as a nation in particular and the world in general. (Ezomo and Ifedili, 2004).

The use of sandstone in chemical industry for; flooring, wall-covering, making fireplaces and exterior cladding in sea-shore buildings had greatly aided many developed and developing nations of the world e.g. Nigeria, China, Spain, Brazil, Britain, U.S.A etc. (Ezomo and Ifedili, 2006).

Sandstone is a very common sedimentary rock and perhaps the best known sedimentary rock usually composed of sand. It is formed in many environments. Just about anywhere there is water, whether frozen or not, in a river or ocean, there is a chance to form sandstone. Even where there is no water as in a desert, there is sandstone formation under foot. (Ezomo and Ifedili, 2006).

Sandstone is formed by the cementation of sand grains such that any deposit of sand can lithify to sandstone. (Ezomo and Ifedili, 2005). The cementing agents also affect the porosity of a sandstone. When the initial sand is first deposited, there are lots of open spaces or pores. Water, for instance, flows right through sand due to all the pores. But as the sand turns into rock, the cement can fill in these pores making the sandstone less porous and less able to allow water to move through the rock. (Ezomo and Ifedili, 2007).In fact, sandstone is a very porous rock as rocks go and is the ideal rock for ground water. Hence, sandstone will house substantial aquifers and is also the best oil reservoir because petroleum is a fluid that primarily flows through sandstone. It has a high mechanical strength and is resistant to air, saline water,

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acids, alkalis, corrosion and weathering (Information internet, 2010). It is because of these properties enumerated above, the researcher decided to prospect for sandstone which is of high economic importance to Nigeria in particular and the world in general.

Geologically and geophysically, the research area which is Isihor village is underlained by Benin formation (Kogbe, 1976). It lies approximately on latitude and longitude of about $6^{0}25^{1}$N and $5^{0}34^{1}$E respectively (Information Centre, 2010).
The topography of the area are plane surface which has the following rock types or lithologies; topsoil, laterite, clay, sandy clay, coarse sand/sandstone and clean sand which is in close agreement with the Benin formation that ranges from miocent to recent (Reymen, 1965) The inhabitant of these surveys areas earns their source of livelihood from farming and peti trading (Information Centre, 2010).

This research paper tends to estimate the thickness of sandstone deposit and its depth below sea level in Isihor village area using geophysical survey method with the intention of providing detailed documentation of known sandstone deposits and recommend possible set up of an industry/factory in Isihor village that rely on sandstone for manufacture purposes.

2. MATERIALS AND METHODS

Schlumberger electrode configuration of vertical electrical sounding (VES) was employed for this research, full detail of the method have been documented. (Ezomo, 2004-2010).

Ten (10) VES, fairly distributed were conducted using the ABEM signal averaging system (SAS) 300 terrameter and its 2000 booster for deeper penetration.

Measurements were taken at increasing current electrodes distance such that the electric current passed into the earth's surface penetrates greater depths. The greatest current electrodes separation (AB) was 632m in a six (06) points per decade operation. The operational efficiency of six points per decade in subsurface geophysical study have been documented. (Ezomo, 2004-2010)

There are different types of electrical resistivity theoretical approach based on electrodes array for interpreting resistivity data.

The techniques of data interpretation used involved seeking a solution to the inverse problem namely the determination of subsurface apparent resistivity distribution from surface measurements.

There is a function called Kernel function that represents a very good solution to the inverse problem. It describes the apparent resistivity measurements in terms of subsurface lithological variation with depths. The function assumes the earth to be locally horizontally stratified, in homogenous and isotropic layers, and unlike apparent resistivity function, it does not depend on electrode configuration. It cannot be measured in the field but has to be obtained from the transformation of measured apparent resistivities. The kernel function utilised in this work is documented in (Ezomo, 2008-2010), if the observed apparent resistivity is such that:

$$\ell_a(r)=r^2 \int_0^s \lambda T(\lambda)J_1(\lambda r)d\lambda \qquad (1)$$

Where the kernel function is given as

$$T(\lambda)=\int_0^s \frac{1}{r}\ell_a(r)J(\lambda r)d\lambda \qquad (2)$$

J_1 represent Bessel function of first order, first kind and $T(\lambda)$ is the transformed resistivity data.

However, when the earth is approximately composed of horizontally stratified isotropic and homogenous media such that the change of resistivity is a function of depth, the Schlumberger configuration is the most widely used array and may provide useful information in solving subsurface geophysical problems. A vital aspect of the Schlumberger is the less sensitivity of the array to the effect of near surface lateral heterogeneities and easy recognition of their effect. (Ezomo, 2004-2010).

In electrical resistivity sounding, four electrodes are earthed along a straight line in the order AMNB, where A and B are the current electrodes. M and N, the potential electrodes. The calculated apparent resistivity (ℓ_a) according to Schlumberger array condition of AB ≥5MN is

$$\ell_a = \pi\left(\frac{\frac{(AB)^2}{4} - \frac{(MN)^2}{4}}{MN}\right) - \frac{\Delta V}{1} \qquad (3)$$

AB = Current electrodes spacing
MN = potential electrodes spacing in metre
Δv = Potential difference in volts, I = electric current in Amperes, $\pi = 22/7$

3. RESULTS

Geophysical survey results employing electrical resistivity method are presented as field curves/computer iterated curves shown in figures 1 – 6. Their corresponding subsurface lithologies are shown in tables 1 – 6 below.

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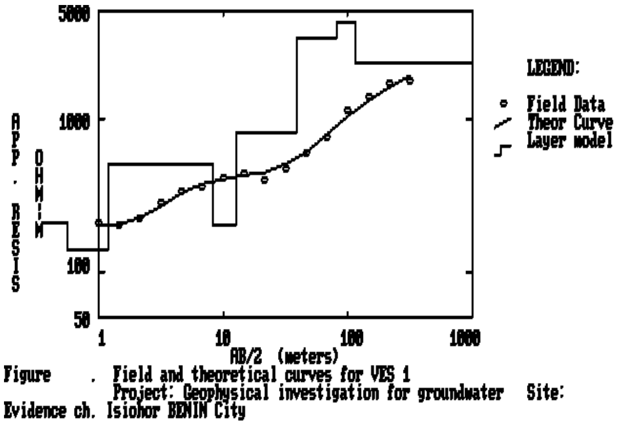

Fig 1 Iterated Sounding Curve For VES Station 1

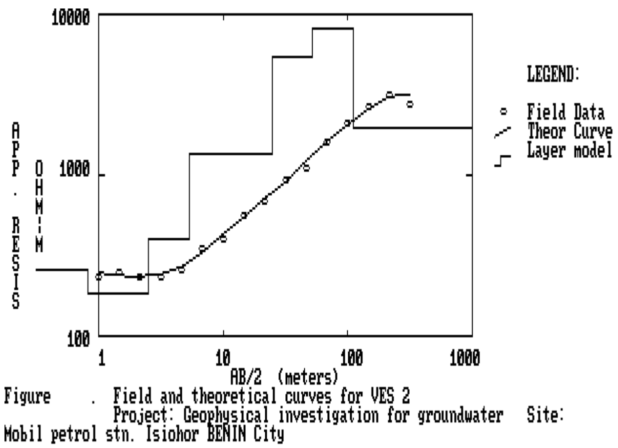

Fig 2 Iterated Sounding Curve For VES Station 2

Table 1: Lithology for VES station 1

Layer	Resistivity (ohm-m)	Thickness (m)	Cum thickness (m)	Inferred lithology
1	209.00	0.56	0.56	Top soil
2	138.99	0.64	1.20	clayey soil
3	500.89	7.01	8.21	Laterite
4	198.55	4.61	12.82	Clay soil
5	813.00	26.01	38.83	Laterite
6	3361.00	41.93	80.76	Sand stone
7	4303.00	34.33	115.09	Sand stone
8	2336.00	Infinity	Infinity	Clean sand

Table 2: Lithology for VES station 2

Layer	Resistivity (ohm-m)	Thicknes s (m)	Cum thicknes s (m)	Inferred lithology
1	256.50	0.82	0.82	Top soil
2	181.00	1.62	2.51	Clayey soil
3	394.00	2.85	5.36	Laterite
4	1376.00	19.35	24.71	Sandy clay
5	5416.00	27.06	51.77	Coarse sand/sand stone
6	8048.00	58.06	109.83	Clean sand
7	1990.00	Infinity	Infinity	Clean sand

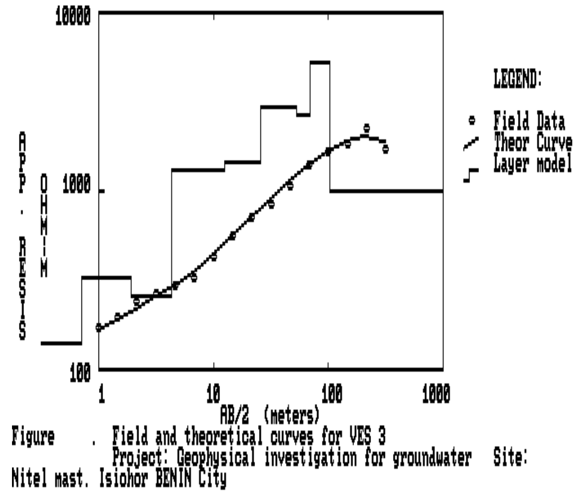

Fig 3 Iterated Sounding Curve for VES Station 3

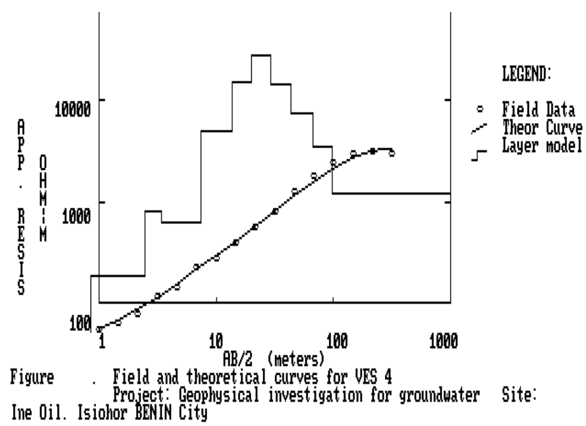

Fig 4 Iterated Sounding Curve for VES Station 4

Table 3: Lithology for VES station 3

Layer	Resistivity (ohm-m)	Thickness (m)	Cum thickness (m)	Inferred lithology

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1	141.00	0.71	0.71	Top soil
2	324.00	1.21	1.92	Laterite
3	260.00	2.36	4.28	Clayey soil
4	1310.00	8.20	12.48	Sand clay
5	1455.00	13.24	25.72	Coarse sand/sand stone
6	2907.00	27.06	52.78	Coarse sand/sand stone
7	2664.00	16.10	68.88	Coarse sand/sand stone
8	5250.00	34.33	103.21	Clean sand
9	1009.00	Infinity	Infinity	Clean

Table 4: Lithology for VES station 4

Layer	**Resistivity (ohm-m)**	**Thickness (m)**	**Cum thickness (m)**	Inferred lithology
1	42.67	0.86	0.86	Top soil/clay
2	186.12	1.59	2.45	Top soil/clayey soil
3	788.70	0.98	3.43	Laterite
4	621.11	3.99	7.42	Laterite
5	4994.23	6.22	13.64	Laterite
6	15,452.86	6.40	20.04	Loose sand
7	28014.02	8.87	28.91	Loose sand
8	14,199.97	14.49	43.40	Loose sand
9	7630.89	23.73	67.13	Clean sand
10	3512.61	30.90	98.03	Coarse sand/sand stone
11	1202.12	Infinity	Infinity	Clean sand

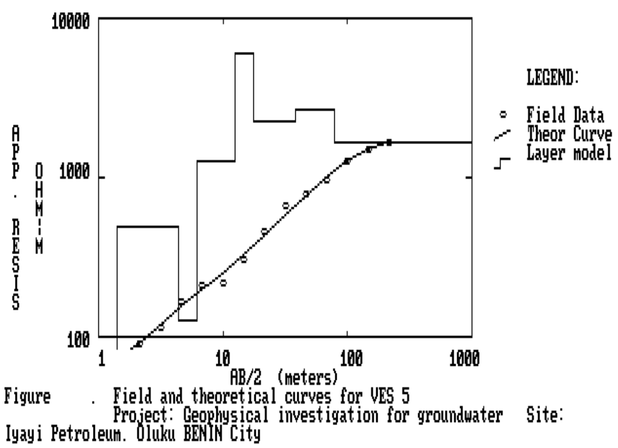

Fig 5 Iterated Sounding Curve for VES Station 5

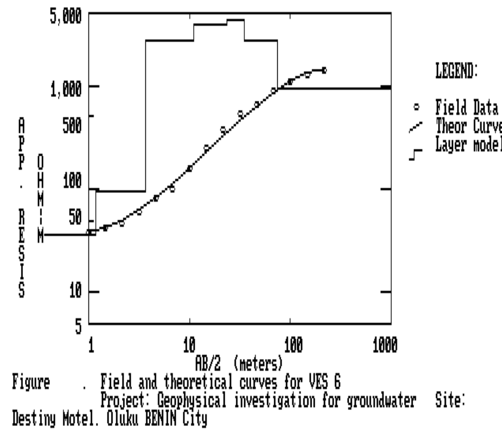

Fig 6 Iterated Sounding Curve for VES Station 6

Table 5: Lithology for VES station 5

Layer	**Resistivity (ohm-m)**	**Thickness (m)**	**Cum thickness (m)**	Inferred lithology
1	61.30	1.40	1.40	Top soil/clay
2	496.00	2.98	4.38	Laterite
3	125.00	1.78	6.16	Clayey soil
4	1285.00	6.42	12.58	Laterite
5	60.00	5.10	17.68	Sandy soil
6	2259.00	20.37	38.05	Coarse sand/sand stone
7	2635.74	39.83	77.88	Coarse sand/sand stone
8	1662.12	Infinity	Infinity	Clean sand

Table 6: Lithology for VES station 6

Layer	**Resistivity (ohm-m)**	**Thickness (m)**	**Cum thickness (m)**	Inferred lithology
1	31.73	0.25	0.25	Top soil/clay
2	37.00	0.92	1.17	Top soil/clay
3	94.00	2.48	3.65	Top soil/clay
4	27340.30	7.42	11.07	Laterite
5	3850.35	12.58	23.65	Laterite
6	4384.00	10.95	34.60	Coarse sand/sand stone
7	2786.40	39.83	74.43	Coarse sand/sand stone
8	933.16	Infinity	Infinity	Clean sand

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4. DISCUSSION

Results of the vertical electrical sounding (VES) interpretation showed that high resistive layers are limited to stations 4 and 2. The Benin formation is exposed in all the VES stations consisting of the lithologies top soil, laterite, clay, sandy clay, clavey sand, sand, fine sand and coarse sand.

A close examination of VES station 1 revealed the thickest layer of sandstone deposit of thickness 41.03m at a depth of 80.76m below sea level. This can be of economic value to the community by a way of citing chemical industry in this region that will produce sandstone, adequate enough for; flooring, wall covering, making fireplaces, exterior cladding in sea-shore building.

A thick layer of sandstone deposit is also found in VES station two (2) with a thickness of about 27.06m at depth of about 51.77m below sea level which can be of a high economic value in this region.

In fact, sandstone deposit is found in all the VES stations region. This is in concordance with the borehole driller's log of the area which again is in concordance with the Benin formation (Isihor village bore hole, 2010). In VES three (3), its thickness is about 27.00m at a depth of about 52.78m below sea level. It is about 30.90m thick in VES station four (4) at a depth of about 98.03m below the sea level. In VES stations five (5) and six (6). Their thicknesses are about 20.37m and 39.8m respectively at depths below sea level of 38.05m and 74.43m respectively.

In fact, sandstone has numerous uses that make it valuable for many economic and environmental reasons. Hence, the importance of sandstones to Nigeria in particular and the world in general cannot be over emphasised.

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5. CONCLUSION/ RECOMMENDATION

Sandstone deposits were intercepted in all the VES stations at depths varying from about 50.0m to 120.0m below sea level while its thicknesses varied from about 10.0m to 45.0m. The resistivity of the sandstone deposit formation varied from about 2000 ohm-m to 5500 ohm-m.

Area of probable sandstone formations and their thicknesses have been identified especially for future mining of industries foundation operations and drilling in Isihor village. This will however create job opportunities to arrest youth restiveness in the area which is a major problem where this youth will be gainfully employed and hence combating to some extent crime rate in Isihor village.

Geophysical exploration employing the notion of electrical resistivity method based on vertical electrical sounding (VES) have demonstrated its usefulness for delineating sandstones deposit which is of high economic importance to Nigeria in particular and the world in general.

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