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GEOPHYSICAL INVESTIGATION OF MINERAL OCCURRENCES IN USEN, OVIA SOUTH WEST L.G.A, NIGERIA.

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Abstract

Economic diversity into the exploration and exploitation of solid mineral has been the interest of government even till date. This has prompted this research for the exploration for solid mineral at the study location.
2D Electrical Resistivity Tomography [ERT] was used for this survey at pre-selected locations within Usen community located within longitudes $6^0\,44'$, $6^0 45'$ ***East and latitude*** $5^0\,20'$, $5^0 22'$ ***North. 2D geoelectrical resistivity data acquisition was carried out on these locations using Dipole-dipole and Wenner-Schlumberger electrode configuration with ABEM resistivity meter SAS 1000 – using electrode separations of (a) = 5m making a total of 60m by length for each line. The 2D data sets were inverted separately using RES2DINV software producing 2D model for each line. The images were presented as 2D models. The total depth attained was 15.7m (51.81ft). The materials or aggregate that fall within the resistivity range (37.9Ωm to 46928Ωm) observed from the models are; dolomite, maris, clay, alluvium, moraine, soil 40% clay, soil 20% clay, lateritic soil, sand clay/ clay sand, limonite, quartz, rock salt, lignite, syenite, basalt, schists, marble, conglomerates, and sandstone.***
The physical properties of lateritic soil, sand, sandstone, shale, clay and dolomite agree with some of the outcrop minerals found in the study area. This research has acknowledged the fact that the minerals that can be found in Usen are clay, sand, laterite, sand clay, sandstone, and dolomite.

Keywords: Tomography, geoelectrical, acquisition, electrode, configuration.

1.0 INTRODUCTION

SUBSURFACE ROCKS AND MINERAL OCCURRENCE

Subsurface rocks are generally made up of a variety of minerals, which are insulators, The study of rocks, known as petrology, concerns itself to a large degree with the identification of the individual minerals in a rock, their textures, abundances, and grain size. This type of information is fundamental to the understanding of the origin of a rock and its classification. Rocks can be classified into three major groups; igneous, sedimentary and metamorphic [1].

2.0 MINERALSAND THEIR PHYSICAL PROPERTIES

According to [1], "although it is difficult to formulate a succinct definition for the word mineral, the following is generally accepted".
A mineral is a naturally occurring homogeneous inorganic material with a definite (but generally not fixed) chemical composition and a highly ordered atomic arrangement. It is usually formed by inorganic process and can be expressed by a chemical formula [1].

3.0 MOTIVATION FOR THE RESEARCH

The drastic fall in prices of petroleum products in the international market had made the country to experience hard economic situation leading into recession. This drastic fall has propelled the country to consider other ways of reducing the harsh economic realities by considering the exploration and exploitation of solid minerals. This led to the embarkation of this research.
In addition, the outcrop of aggregates collected at the study area forms part of the motivation for this research.

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4.0 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to use Electrical Resistivity Tomoghapy (ERT) methods to delineate the presence of mineral deposits at Usen, Ovia South West Area of Southern Nigeria.

The objectives are to:

1. Acquire 2D resistivity data in locations of the survey using Dipole- dipole and Wenner - schlumberger arrays
2. Invert the 2D data set using RES2DINV software to Produce 2D models;
3. Determine the thickness of lithologic formation from depth to surface using the 2D model.
4. Determine the depth extent to any buried mineral and aggregate deposited in the study area using the 2D model.

5.0 LOCATION, ACCESSIBILITYAND TOPOGRAPHICAL MAP OF STUDY AREA

Usen town is a nuclear settlement in Ovia South-West area of Southern Nigeria. It lies approximately 4km North-West of Okada the administrative headquarter of Ovia North-East Area.

There are two (2) major climatic seasons in Usen, the wet season (April- October) and dry season (November - March). Rain storm runoff is very high, thus infiltration into the ground is expected to be small around some part of the study area. This climate falls within the transition zone vegetation of tropical and equatorial climate. The vegetation pattern of Usen falls within the humid tropical rainforest region. The river exhibits a general dentritic pattern of drainage, with denser vegetation cover along the stream channels. Some sections within the study area have been designated forest reserve, thereby limiting accessibility.

The location is accessable from Okada junction on Benin ore express road, the community is dually accessible by road through the Okha- Okada and Okha – Aden – Okoro route.

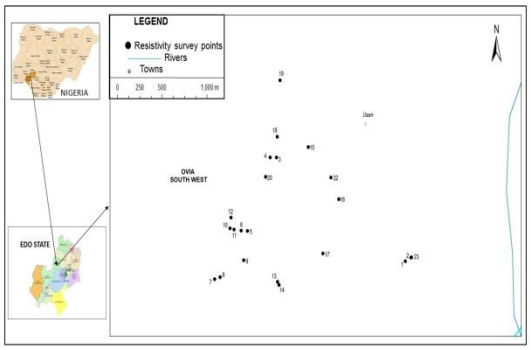


Figure 1**: Map of Usen showing points where the 2D surveys were done.**

DATA ACQUISITION

6.0 METHODOLOGY

2 – Dimensional survey was carried out at different locations as shown on figure 6 within Usen community which is located within longitudes $6^0\,44'$, $6^0 45'$ East and latitude $5^0\,20'$, $5^0 22'$ North respectively. The approximate average elevation is about 101m above mean sea level. The survey area is underlain by sedimentary rocks of Paleocene to recent age. The sedimentary rock contains about 90% of sand stone and shale intercalations [2].

7.0 Array Type for this 2–Dimensional (2D) Survey

Array(Configuration) adopted for this survey was Dipole – dipole.

1. Dipole- dipole Array

Dipole-dipole array is widely used in resistivity/I.P surveys because of the low E.M. coupling between the current and potential circuits. The arrangement of the electrodes is shown in (Figure 2). The spacing between the current electrodes pair, $C_2 – C_1$ is given as "a" which is the same as the distance between the potential electrodes pair $P_1 – P_2$. This array has another factor marked as "n" in (Figures 3). This is the ratio of the distance between the C_1 and P_1 electrodes to the $C_2 – C_1$ (or P_1-P_2) dipole separation "a".

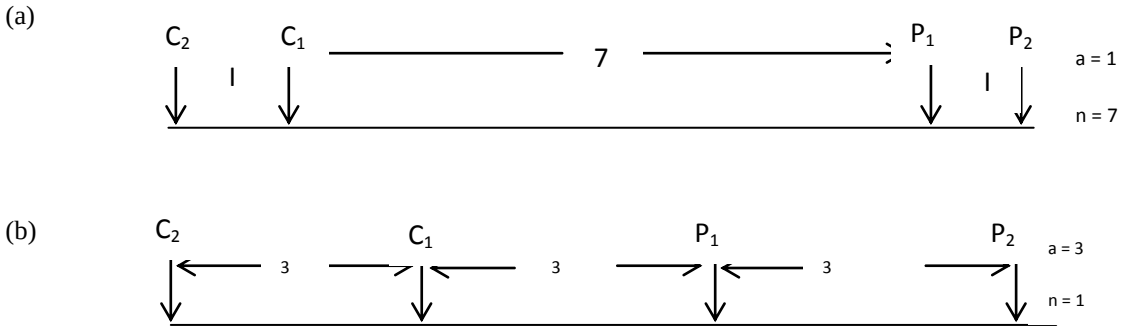
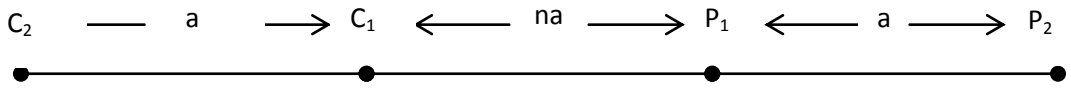


Figure 2: Two different arrangements of a dipole-dipole array measurement with the same array length but with different "a" and "n" factors resulting in very different signal strengths.

Source: [3].

As measurements progresses, factor "a"=5m was kept constant and factor "n" increases from 1 to 8 to increase the depth of investigation. A total of 60m length was surveyed for each line. Measurements were displayed in earth resistance in ohms Ω and milli ohms mΩ and were converted to resistivity in ohms meter (Ωm) by evaluating with the geometric factor k of the array used.



$$K = \pi n(n+1)(n+2)a$$

Figure 3: Dipole-dipole array used for this survey and its geometric factor **Source: [3].**

8.0 DATA PROCESSING AND INVERSION

Inversion of 2D Data Set

The apparent resistivity data got over the series of 2D profile were inverted separately using the RES2DINV inversion code [4]. The RES2DINV computer program uses a nonlinear optimization technique which automatically determines a 2D resistivity model of the subsurface for the input apparent resistivity data [4] [5].

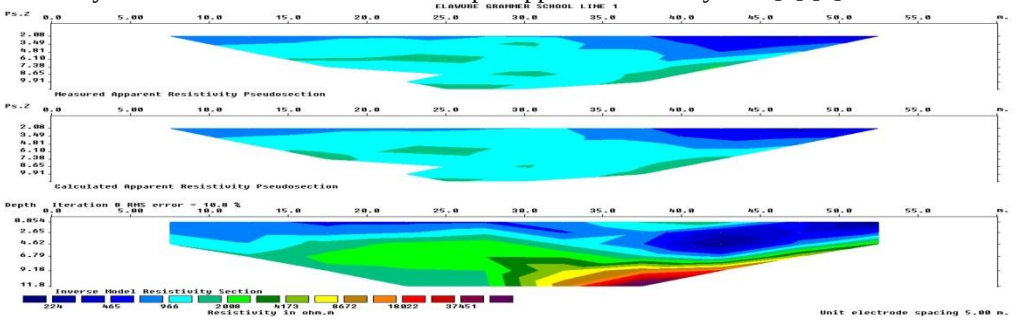


Figure 4: Elawure Gramma school environ 1, Line 1.

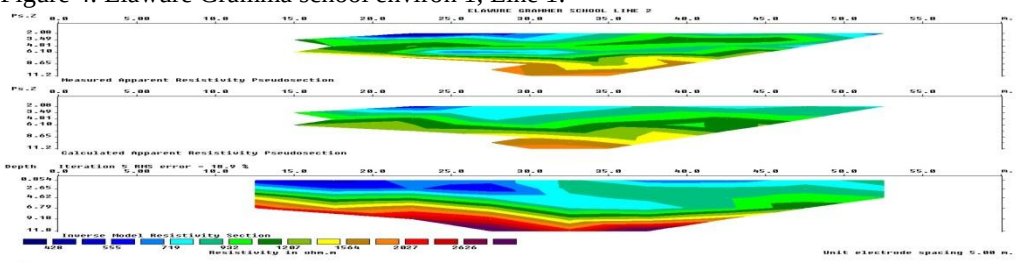


Figure 5: Elawure Gramma School area 2, Line 2.

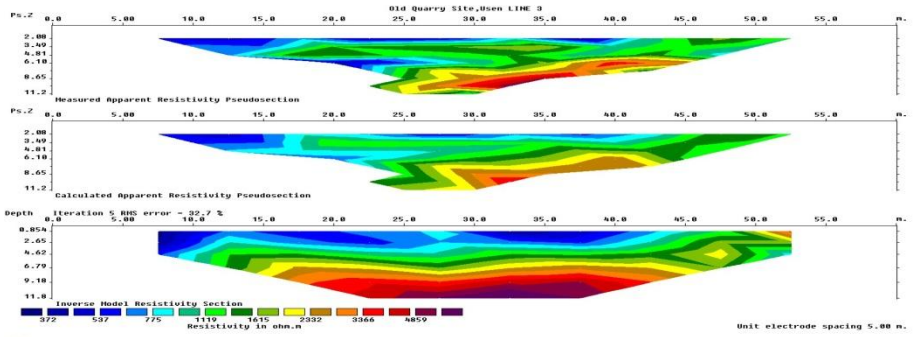


Figure 6: Old Quarry Site area 1, Line 3.

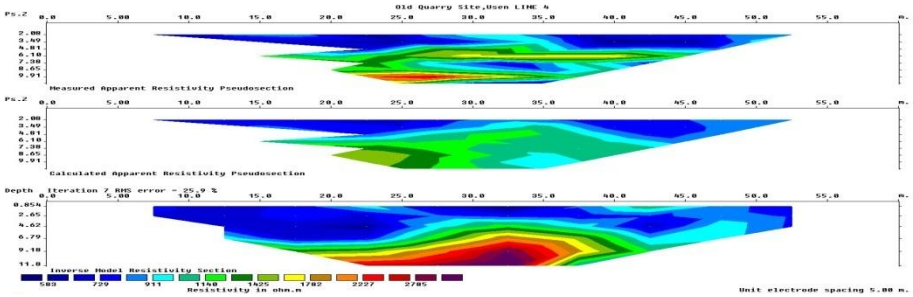


Figure 7: Old Quarry Site area 2, Line 4.

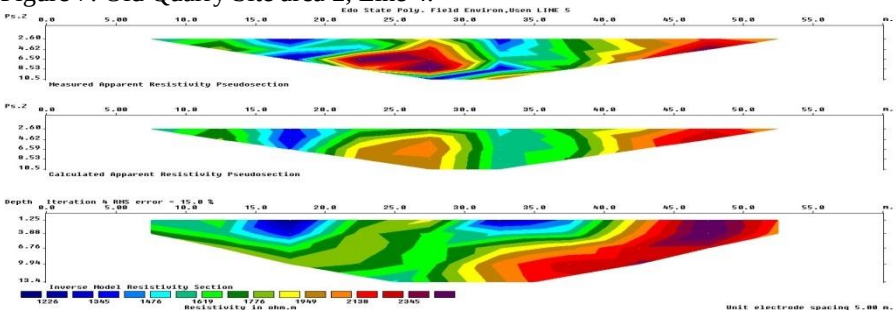


Figure 8: Edo state polytechnic. Field area 1, Line 5.

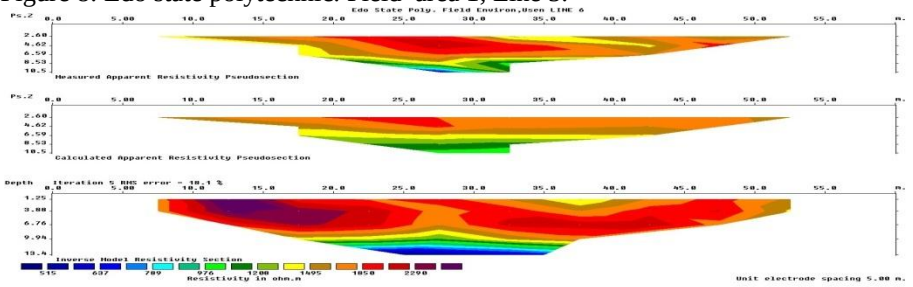


Figure 9: Edo State polytechnic. Field area 2, Line 6.

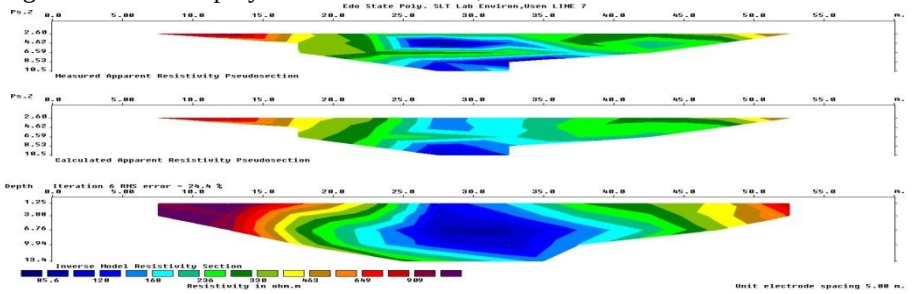


Figure 10: Edo State polytechnic SLT area 1, Line 7.

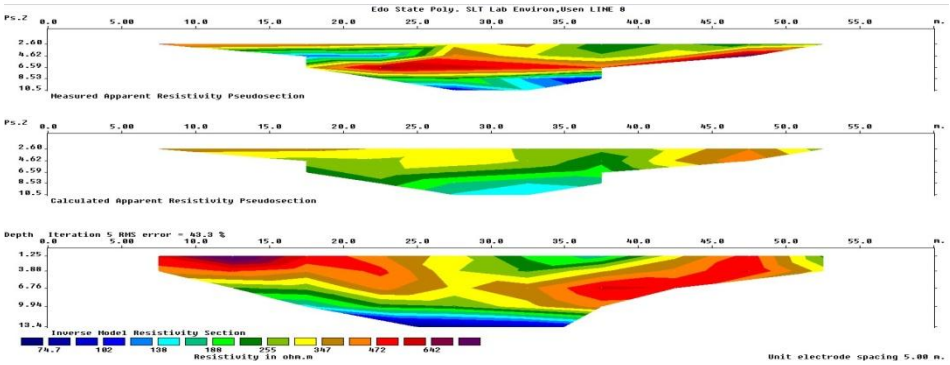


Figure 11: Edo State polytechnic. SLT area 2, Line 8.

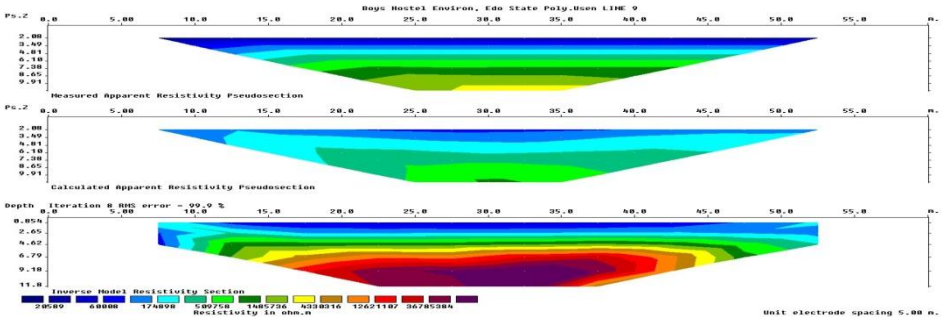


Figure 12: Edo State polytechnic. Boys hostel area, Line 9.

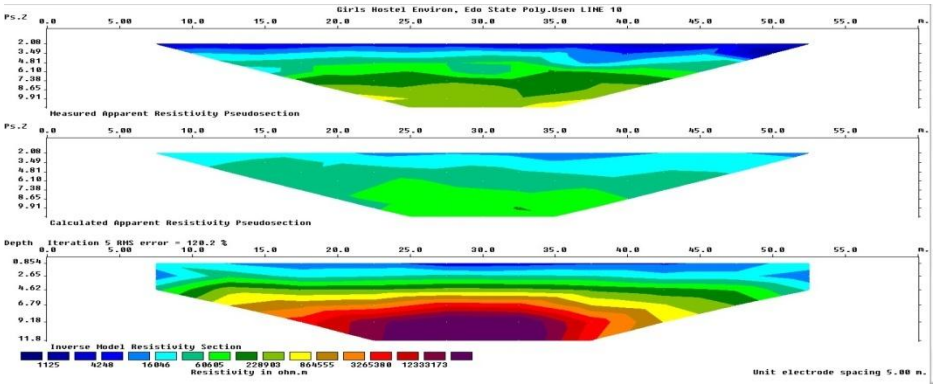


Figure 13: Edo State polytechnic. Girls hostel area, Line 10.

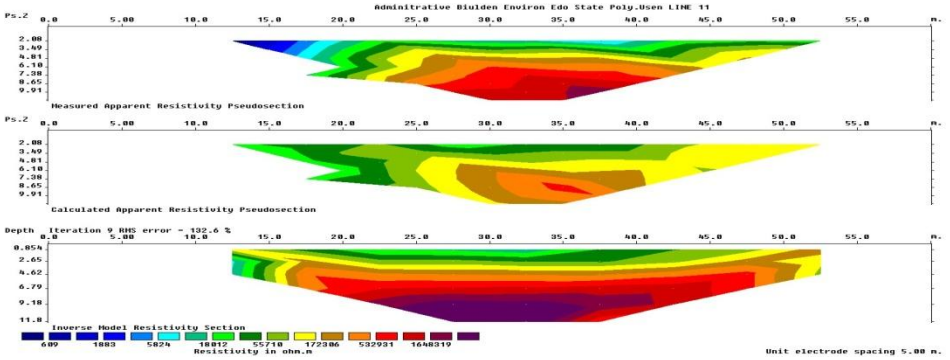


Figure 14: Edo State polytechnic. Administrative block area, Line 11.

The 2D models are shown from figure. (4 -14) with the measured apparent resistivity pseudosection, calculated apparent resistivity pseudosection and the inverse model. The resistivity interval for each survey location is as shown on table 1
Table 1

S/N	SURVEY LOCATIONS	RESISTIVITY RANGE Ω*m*
1	Elawure Gramma school area 1, Line 1	**224- 37451**
2	Elawure Gramma School area 2, Line 2	**420- 2626**
3	Old Quarry Site area 1, Line 3	**372- 4059**
4	Old Quarry Site area 2, Line 4	**583 -2705**
5	Edo state polytechnic Field area 1, Line 5	**1226- 2345**
6	Edo State polytechnic Field area 2, Line 6	**515 -2290**
7	Edo State polytechnic SLT area 1, Line 7	**856- 909**
8	Edo State polytechnic SLT area 2, Line 8	**74.7- 642**
9	Edo State polytechnic Boys Hostel area, Line 9	**20509- 36785384**
10	Edo State polytechnic Girls Hostel area, Line 10	**1125- 12333173**
11	Edo State polytechnic Admin Block area, Line 11	**609- 1648319**

Discussion

Sixteen (16) 2D geoelectrical resistivity data acquisition was carried out on these locations using Dipole-dipole and Wenner-Schlumberger electrode configuration with ABEM resistivity meter SAS 1000 – using electrode separations of (a) = 5m making a total of 60m by length for each line. The 2D data sets were inverted separately using RES2DINV software producing 2D model for each line. From the models it is observed that the subsurface is stratified into different lithologic formation with lower resistivity range of 37.9 Ω*m* to 37451 Ω*m* and that of higher resistivity range 20509 Ω*m* to 36785384Ω*m* which show that the minerals that possibly falls within the resistivity range (37.9Ω*m* to 223732304 Ω*m)* observed from the 2D models are; limestone, dolomite, maris, clay, alluvium, moraine, soil 40 % clay, soil 20 % clay, lateritic soil, sand clay/ clay sand, limonite, quartz, rock salt, lignite, basalt, schists, marble, consolidated shale, conglomerates, and sandstone.

The physical properties of lateritic soil, sand, sand stone, clay and dolomite agrees with some of the outcrop minerals found in the study area.

The minerals that are suspected to be found on the study areas in Usen are lateritic soil, sand, sand stone, clay and dolomite.

CONCLUSION

This study has shown that ERT gives one of the best prospecting methods for the investigation of mineral deposits in any survey location.

It reveals that the use of two electrode configuration which are Dipole-dipole and wenner schlumberger arrays showed the subsurface features in terms of depth range and good resolution.

The methods makes it possible to carry out 2D electrical resistivity tomography using a many-electrode system with single-channel equipment to achieve the same results as if a multi channel equipment were used.

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