GEOLOGICAL AND GEO-ELECTRICAL INVESIGATION OF DIORITE DEPOSITS IN PARTS OF SOUTHERN BENUE TROUGH, NIGERIA

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CERTIFICATION

This is to certify that this work entitled **'Geological and Geo-Electrical Investigation of Diorite Deposit in parts of Southern Benue Trough** was carried out by Okoli Stella Chigozie (20134871458) in partial fulfillment for the award of a degree of M.Sc in geophysics in the Department Of Geology, Federal University Of Technology, Owerri, Imo State, Nigeria.

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DEDICATION

I dedicate this work to Almighty God.

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ABSTRACT

Diorite deposit investigation in Lokpaukwu and environs in Abia State, southern Nigeria has been carried out in Amaubiri, Umuneochi and Obiagu Lekwesi. The aim of the study is to determine the subsurface deposit and downward trend of the diorite deposit through variations in resistivity values. Thirty Eight (38) vertical electrical sounding (VES) was acquired withing the study area using schlumberger Array configuration. Data acquired were processed and interpreted using resistivity software. 3 geo-electric layers in Amaubiri, 4 layers in Obiagu Lekwesi and 4 to 5 layers in Umuneochi Lokpaukwu Area was deduced. Mean density were done to estimate total reserve in these areas to value the quantity in those areas using Archimedes principles. Samples were viewed under microscope to confirm the rock type in the areas. The variation in resistivity values show possibilities of the outcrop occurrences at shallow depths. The estimated reserve in Amaubiri is expected to be more than Lekwesi and Umuneochi. The use of electrical resistivity has proven useful evaluation of the quantity and downward trend of diorite rock in these areas.

Keywords: Diorite, Geoelectric, Quarry, Schlumberger Array, Obiagu, Amaubiri, Umuneochi Lokpaukwu.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Recent increase and advancement in the construction industry in Nigeria in particular and in West African sub-region in general has put greater demand for constructional material. One of such material is rock aggregates. Rocks are used for production and construction of building, road, ballast, airport, seaport and must be readily available and in right quantity but must also be the right material. Although some sedimentary rocks such as marls and outright limestone are currently being quarried for aggregates. Igneous are more preferable.

Igneous rocks are formed from solidification of molten rock material which is of two types, the intrusive and extrusive igneous rocks. Intrusive Igneous rocks crystallized below the earth's surface and the slow cooling that occurs there allows large crystal to form. Examples of such rocks are diorite, gabbro, granite, pegmatite and peridotite. Extrusive rocks erupt onto the surface, where they cool quickly to form small crystals. Some cool so quickly that they form an amorphous glass. These rocks include andesite, basalt, obsidian, pumice, rhyolite, scoria, and tuff.

Diorite is an intrusive igneous rock composed principally of the silicate minerals: plagioclase feldspar (typically andesine), biotite, hornblende, and/or pyroxene. The chemical composition of diorite is intermediate, between that of mafic gabbro and felsic granite. Diorite is usually grey to dark-grey in colour, but it can also be black or bluish-grey, and frequently has a greenish cast. It is distinguished from gabbro on the basis of the composition of the plagioclase species; the plagioclase in diorite is richer in sodium and poorer in calcium.

According to due high impact strength of igneous rock than the metamorphic rocks from previous investigations, the intermediate and extrusive igneous rocks are better suitable in term of density and impact strength. Cement aggregates reactions are less in such intermediate rocks than in highly siliceous rock type. Diorite is the plutonic equivalent of andesite. Texturally, diorite is phaneritic (medium to coarse grained), contain mostly plagioclase, amphibole (hornblende) and / or pyroxene (augite). It is known to contain 52%-63% silica. Thus, diorites, dolerites, basalt are best and sought after by most quarrying companies. Famous igneous areas in Nigeria include Ishiagu, but recently, these rocks are being quarried in most parts of Umuchieze, Umuneochi area of Southeastern Nigeria.

Quarrying is a very old technology, used since the time of the ancient Egyptians for the limestone used in their immense pyramids, temples and monuments (Loupasakis and Kafakis 2008). Evidence at a quarry might also show available technology in the form of tools left behind and cut marks in the walls of the excavation pits. According to Bloxam (2011), the historical value of quarry site is listed as four data elements:

I. The resource itself (that is, the raw material);
II. The production remains (tools, and discarded products);
III. The logistics (what it takes to get the raw material out of the quarry);
IV. The social infrastructure (the organization of people required to use the quarry, make the objects and transport them away).

A quarry is a type of open-pit mine from which rock or minerals are extracted (Lameed and Ayodele 2010). Quarries are generally used for extracting building materials, such as dimension stone, construction aggregate, riprap, sand, and gravel. They are often collocated with concrete and asphalt plants due to the requirement for large amounts of aggregate in those materials (Webmaster 2012). According to recent studies, the recent growth in populations in the southeastern part of Nigeria has imposed significant stress on the existing inadequate building materials for construction. Consequently, it became very expedient to expand the existing quarry sites in the area as a result of the daily increase in the demand of crushed rock for building construction. This has caused the need for the exploration for more competent rocks to serve as quarry sites so as to meet this ever increasing demand. A number of factors determine whether a rock can be quarried for construction. These include the volume of material that can to quarry, the ease with which it can be quarried; the wastage consequent upon quarrying; and the cost of transportation as well as its appearance and physical properties (Yavuz et al, 2005). Furthermore, the volume must sustain not less than 20 years of quarrying (Bell, 2008).

1.2 Statement of The Problem

Due to high demand of diorite in Nigeria for construction of roads, airports, and seaports, residence around potential areas where diorite rock were found, claimed to have these materials in large quantity without proper investigation on the quantity of the material. Some sedimentary material such as marls and outright limestone are being quarried for aggregates, therefore there is need to carry out proper geological and geophysical investigation to know the quantity of the rock in those acclaimed areas and speculate the reserve. Again, some companies have already engaged in exploitation of the exposed rocks and never cared to find out the downward trend of few outcrop seen on isolated areas but went ahead to establish an expensive quarry which without proper geophysical investigation might run into huge debts in two years.

1.3 LOCATION OF THE STUDY AREA

LOCATION 1: Amaubiri Lokpaukwu, measuring 464-150m^2 or about 7 hectares is located at about 1.3km southeast of Amaubiri Lokpaukwu community. It is located on an uninhabited land that is used mostly for Agriculture. The North Eastern part of the land is highly undulating with major ridge trending 310^0. The land occupies a position that has Asphalt Unity quarries to the Northeast and Southeast while the UCHIVA quarry site lies to the northwest. The Enugu escarpment is seen to the western part of the study area.

LOCATION 2: ObiaguLekwesi community is located at about 2km east of Lekwesi-Achara road junction. However, the land investigated is located at about 15km east of the Okigwe – Enugu road at Achara junction.

LOCATION 3: Lokpaukwu area is located at about 1km east of the N – S trending Okigwe – Enugu highway. An area of 11.46 acres or 4.4-hectare land which is about 18 hectares was investigated.

1.4 AIM AND OBJECTIVES

The aim of this work is to carry out the geological and geo-electrical investigation of the diorite deposit at these areas: Amaubiri Lokpaukwu, Obiagu Lekwesi, and Umuneochi Lokpaukwu, south eastern Nigeria.

In order to achieve this aim above, the following objectives are defined;

I. To evaluate the geological parameters that will influence the economic viability of quarrying the rock.
II. To determine the overburden thickness, the downward trend and quality of diorite rock found in the area and map out the outcrop.
III. To produce a geological map showing the rock unit identified in the study area.
IV. To carry out vertical electrical sounding to determine the subsurface trends of the rock unit.
V. To estimate the total reserve and viability of a quarrying site in the area.

1.5 CLIMATE AND VEGETATION

Lokpaukwu area lies within the Guinea forest region with scattered tress and glassy undergrowth. Most parts are marshy and a prominent stream valley is seen at periphery of the area. Rainy season commences from April and lasts till October.

Amaubiri Lokpaukwu lies in the Guinea forest region. Apart from organized palm, cassava and vegetable farms, the land is left bare, overgrown with elephant and other grasses. This makes the terrain very vulnerable to wild fire during the months of October to March. Rainy season commences from April and last till late October. While the lowland areas are relatively marshy by the climate of the rainy period, the lowland areas by the North and Northeast are prone to being marshy while the highland areas at the central and southern portions are relatively dry.
The study area is bounded by lattitudes $5^0 54.800^1$N to $5^0 55.100^1$N and by longitudes $7^0 26.900^1$E to $7^0 27.180^1$E. In general, the study area, bounded on the northeast and southwest by Asphalt Unity Quarries and to the west by the Uchiva company trends NE –
SW. Heights above sea level range from 264ft(80.5m) to 342ft(104.3m) to the northeast and southwest of the study area respectively. The area that trends NE –SW, transverses a NW –SE trending ridge at the central region and NW –SE trending valley that trend to separate the area from the Asphalt Unity lease to the NE.

Obiagu Lekwesi area lies in the Guinea forest region. Apart from organized palm plantation, scattered trees characterized the area. In fact, most of the portion of the land has not been cultivated for over 60 years. Rainy season commences from April and last till late October. By the climax of the rainy periods, most areas are marshy.

The study area is bounded by latitudes $5^0 56.999^1$N - $5^0 57.290^1$N and longitudes $7^0 28.113^1$E - $7^0 28.290^1$E, covering an area of about 12, 2071.7 hectares. Heights above sea level range from 254ft (77.4m) to 368ft(112.2m), the lowest areas being to the northern fringes. The study area is highly accessible although the Northeastern stream valley (Njaka Stream) needs to be filled fortified for heavy trucks. The roads linking the site with PH – Enugu expressway have been built, leaving a small portion. Thus accessibility is only through the PH – expressway at Lekwesi Junction.

1.6 Activities, Settlement and People of the Area

Farming, furniture making are the major occupation in the Community. The major produce is pepper, fruits, cashew, palm and cassava produce. The settlements in the area are nuclear and inhabitants are mainly Igbo speaking people. There are some schools, churches and local eatery centers were observed in the area, while there were no hospitals but the area has a quarrying site which is some kilometer from the area.

1.7 Justification of the Study

In 2003, CCC contracted a geographer, to investigate diorite outcrop in Uru area for quarry site for the construction of Owerri – Onitsha Express Way. As a geographer, he reported to have enormous diorite large enough for construction, and equipment was moved to the site for quarrying. The material found on the site was limestone which was later discovered by a geologist after detailed geological mapping. Therefore, there is need for good knowledge of geology and geophysics for detailed geological and geo-electrical investigation on any exploratory work because it is highly capital intensive to companies and individuals running into depth from the Bank.

In reference to (fig.1.4), was an investigation made by an individual for a quarry site for exploration. After geological mapping, the geology reveals that diorite deposit cannot possibly be found around the Ngodo area due the nature of the formation which has no igneous rock intrusion in Nkporo formation. Therefore, good knowledge of the geology of study area by a geologist can prevent individuals from running into debts.

1.8 Scope of the Study

A reconnaissance trip to the study areas showed the various rock units such sandstones, shale, diorite, and the formations associated with them such as Asu River Group and Eze-Aku Group. The study of the particular trend in the study areas helped in planning the geophysical and geological transverses. Geological transverse was carried out along these lines for rock outcrops. The site was visited to also know the extent of overburden. Also, mapping out the outcrops, rock units, collection of rock samples found in the study area for investigation and confirmation of rock type. Vertical electrical Sounding was then carried out using ABEM TERRAMETER SAS 300 and the evaluation was made using Schlumberger configuration. The Geological and Geophysical interpretation were made on the results obtained from the investigation in connection with the geology of the study area.

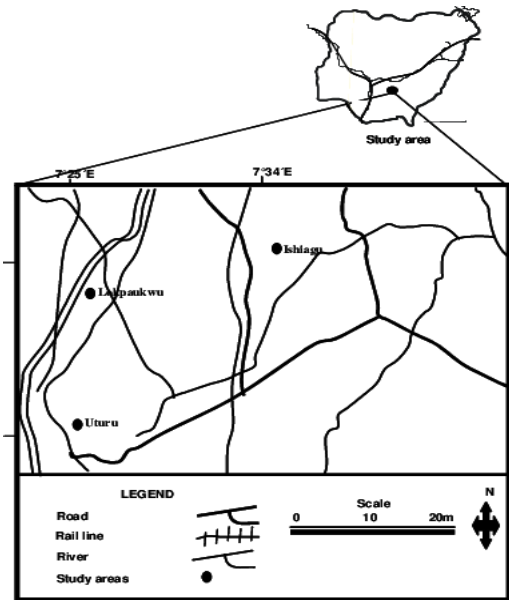


Fig 1.1 Location Map of The Study Area

Fig 1.2: ObiaguLekwesi Area.

Fig. 1.3: Amaubiri Lokpaukwu Area

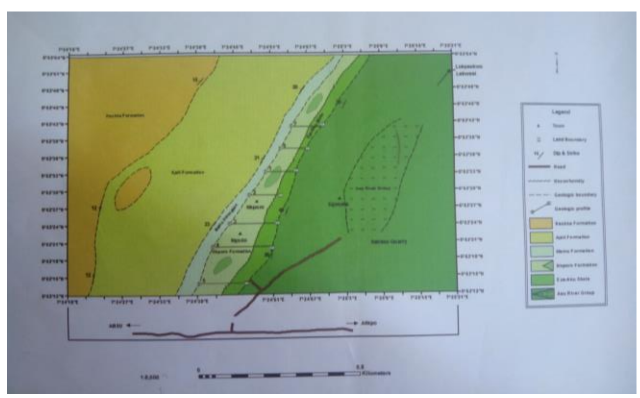


Fig 1.4: Geologic Map of parts of Ngodo, Isuikwuato Area.

CHAPTER TWO

LITERATURE REVIEW

Diorite deposits are relatively rare, and most commonly occur as sills, dikes, or stocks, or in the form of large masses as batholiths, and are often associated with gabbro and granite deposits. Deposits of diorite rock are found in scattered areas all over the world. Namely, deposits occur in certain localities of such countries as the United Kingdom (Aberdeenshire and Leicestershire), Germany (Saxony and Thuringia), Romania, Italy (Sondrio, Guernsey), New Zealand (Coromandel peninsula, Stewart Island, Fiordland), Turkey, Finland, central Sweden, Egypt, Chile, and Peru, as well as the U.S. states of Nevada, Utah and Minnesota. In Corsica, a Mediterranean island belonging to France, an orbicular (spheroidical) variety of diorite is found which is referred to as "Corsite" or "Napoleonite", in homage to its place of origin and the French leader, respectively.

The tectonic setting in the area by literature involves partial melting of oceanic plates which resulted in the production of basaltic magma. As this magma rises up, it reaches the granitic rock of the continental plate. As the basaltic magma melts the granite, it produces granitic magma, and such a mixture of magma has a composition of both granite and basalt. If this magma cools and crystallizes before it reaches the surface of the earth, it results in the formation of diorite deposits. Diorite formations usually take place in volcanic arc regions above sub- ducting plates.

Diorite's durability is comparable to that of granite, and hence it is often used as a base material in the construction of roads and buildings. It is also used to control soil erosion by being utilized as a drainage stone. The dimension stone industry also uses diorite to create such sculpted rock products as ashlars, pavers, and facing stones. Ancient civilizations, including the Inca and Maya of the New World, used this stone as a structural stone in building their marvelous architectural wonders. Many cobblestone streets in England, Scotland, and other places around the world were constructed using diorite. The St. Paul's Cathedral, in London, has steps made of Diorite. Even though this stone was used by sculptors of the Middle East in ancient times, its hardness makes it difficult to use for sculpting, and hence it is not favored as a sculpting stone by artists of our present day and age. The Code of Hammurabi, one of the first sets of codified laws, was carved into one of the most famous diorite sculptures. The code's tablet is designed as a 7-foot-tall, black pillar with inscriptions of these early Babylonian laws. Occasionally, Diorite has been used as a gemstone, especially as cabochons.

Unlike many other minerals, there is little data related to the diorite mining and processing industries available to the public. Diorite is commercially mined in small pockets of areas where its deposits occur, such as the United Kingdom and some other European countries, New Zealand, and a few sub-Saharan African, South American, and North American countries. Diorite was also mined in the ancient world, as is evident by the extensive use of this rock in ancient architecture.

2.1 Geologic Literature

Previous geophysical works carried out in the study area and an example has always shown a trend in parts of Uru Ugwuorji that the area is a quarrying site. Ibe (2003), carried out a geological and geophysical survey of the Uru area, South Eastern Nigeria which deposits the correlation between geological and geoelectric section of the study area. Shell B.P. in their search for hydrocarbon carried out both geophysical and geological survey of the South Eastern Nigeria between 1950 and 1960. They were able through the survey to name stratigraphic units which are still in use today. They produced a generalized geologic map of the South Eastern part of Nigeria. Reyment (1965), on the marine Albian of Nigeria constitute a separate entity isolated from the Sahara “Sea” where the lower cretaceous is entirely continental origin and rich in ammonities. Murat (1970) attempted a paleographic description of the cretaceous and lower. Tertiary in South Nigeria based on major depositional cycles resulting from three main tectonic episodes. Kogbe (1972), described the stratigraphy and paleography of individual or part of different basin found in South Eastern Nigeria.

2.2 REGIONAL GEOLOGIC SETTING OF THE STUDY AREA

The study areas are located within the Lower Benue Trough of Nigeria, (Fig.2.2.) and it accommodates discontinuous exposures of eroded volcanic and hyperbyssal features (Adighije 2009). Lodged in the bowels of Lokpaukwu, Umunneochi local government area are vintage accumulation of lead, zinc and copper (John-Onwualu and Ukegbu 2009). Lead is used for the manufacture of car batteries and X-ray equipments, as it protects doctors and nurses working the machines from the rays. Still at Lokpaukwu is found gypsum – a raw material which is utilized in the production of cement, pharmaceuticals, Plaster of Paris (POP). The Benue Trough formed as a result of series of tectonism, accompanied by magmatism and repetitive sedimentation in the Cretaceous during the separation of South America from Africa. This separation left the Benue Trough as an aulacogen, a failed arm of an RRR Triple Junction (Burke, 1972; Olade, 1975). The Benue Trough is itself a part of the very expansive West and Central African rift system in which it opened as an extensive sinistral wrench complex (Emery *et al*., 1975; Whiteman, 1982; Genik, 1993). A reconstruction by Murat (1972) shows the southern part of the Benue Trough as longitudinally faulted, with its eastern half subsiding preferentially to become the Abakiliki depression. During the filling of the Abakiliki-Benue sector of the Benue Trough in the Albian-Santonian times, the proto-Anambra Basin was a platform that became only thinly sediment-draped (Etuk et al., 2008). Basin subsidence in the southern Benue Trough was spasmodic. It was at a high rate in pre-Albian time, low in lower Cenomanian, and very high in Turonian; the latter was an important phase of platform subsidence (Ojoh, 1990). This is thought to be the actual time of initiation of the Anambra Basin; a process that gained momentum in the Coniacian and climaxed during the Santonian thermotectonic event (Nwajide, 1990). Careful synthesis of the works of several authors (Murat, 1972; Nwachukwu, 1972; Olade, 1979; Benkhelil, 1982; Nwajide and Reijers, 1996; Mode and Onuoha, 2001; Ukegbu 2008) reveals that the Santonian movement or tectonic pulses (or compressional uplift) dating back to 84 Ma, was accompanied by widespread magmatism, folding and faulting that caused the Abakiliki area to become flexurally inverted to form the Abakiliki Anticlinorium. These forces displaced the depocentres to the west and southeastwards, forming the Anambra Basin and Afikpo syncline, respectively (Murat, 1972; Burke, 1972).

2.2.1 GEOLOGY OF SOUTH-EASTHERN NIGERIA

The oldest exposed sedimentary unit is the Asu River (Albian) which is succeeded by Eze-Aku (Turonian), Awgu – Ndeaboh (Coniacian), Nkporo (Coniacian), Mamu (Coniacian), Ajali (Maastrichtian) and Nsuka (Upper Maastichtian) Formations respectively overlie each other conformably. Other Formations include the Paleocene Imo Shale, the Eocene Ameki Formation. Quaternary Ogwashi-Asaba, Quanternary Benin and Recent Alluvium. These Formations generally dip at low angles ($<10^0$) towards the basin center (Uma, 1997).

Sediments of Albian age consist of Limestone, shale, mudstone with diorite, silt stone and sandstone represented by Asu – River.

Sediments of Turonian age consist of shales and limestone. It is represented by Eze-Aku shale. The Formation comprises of hard grey to black shales and silt stone with frequent facies changes to sandstone, the Amasiri sandstone is an evidence of the trend. The formation is a shallow water deposit (Reyment 1965) with a thickness of about 1000m.

The Agwu- Ndeaoh shale consist of bluish grey, well bedded shales with occasional intercalations of fine grained, pale yellow, calcareous sandstone and shelly limestone marks the Coniacian stage. The formation is about 800m thick. It is gently folded and in conformable with the underlying Eze- Aku shale.

The base of Nkporo Formation is probably Campanian but the major part is Maastichtan. This formation marks the beginning of the third Cretaceous marine depositional cycle. It is characterized by dark grey, often friable shales with occasional thins of limestone and sandstone. It grades laterally into Owelli sandstone and has the Enugu shale as its lateral equivalent.

Mamu Formation is a paralic sequence containing coal seam at several levels (Simpson, 1955) and shales. It contains a distinctive assemblage of sandstone, shale, mudstone and sandy shale with coal seams t several horizons. The sandstone, which are fine to medium grained and white or yellow in colour, are normally well bedded, although cross-bedding may be seen in places. The shales and mudstone are dark blue or grey, and grade into the sandstone. They frequently alternate with bands and lenses of sandstone to form characteristics striped rock. The Mamu Formation is easily recognized in the upper and middle reaches of the Northern tributaries of the Mamu River, but further south, there are no coal seams, and the coal measures facies cannot be readily identified. Lying comfortably on the Mamu Formation is the Ajalli Formation which consist of friable, poorly sorted sandstone, typically white in colour and sometimes strained. A marked banding of coarse and fine layers is displayed. The sand grains are sub-angular with sparse cement of white clay. Large scale cross-bedding is characterized and the angle of inclination of the fore set climate ranges up to the Ajali Formation is often overlaid by a mass of red earth which constituted the Nsukka Formation. It is Maastichtian in age and paralic. The lithology of the Formation is very similar to that of Mamu Formation and rocks consist of alternating succession of ferroginized sandstone, dark shale and sandy shale, with thin coal seam at various horizon. There is also presence of limestone in some areas.

Nsukka Formation conformably overlies the Ajali sandstone and occupies a relatively broader stretch of land west of the area (Uma, 1986). The rock unit consist of an alternating succession of sandstone, dark shales and sandy shales with thin coal seams at various horizons.

The oldest tertiary Formation is the Imo Formation. It consists of thick clay shale, dark blueish grey with occasional mixture of clay, iron stone and then iron stone bands. The formation shows lateral variation in sandstone in some areas. These are Ebenebe, Igbabu, and Umuna stone.

Overlying the Imo shale is the Eocene Ameki Formation. I consist of a series of highly fossiliferous grayish -grey sandy clay with calcareous concretions and with clayey sandstone. The formation has the lithographical groups, the lower fine to coarse sandstone and intercalation of calcareous shale and thin, shelly limestone and upper with coarse, cross bedded sandstone, bands of fine grey-green sandstone and sandy clay. The formation has Nanka sand as its lateral equivalent.

Ogwasi – Asaba Formation (Oligocene to Miocene) is generally made up of clays, sands, grits and seams of lignite alternating with gritty clay (Dessauvagie, 1972). A characteristics feature of the formation within the Imo Basin is the up dip and down dip pinch outs.

Benin Formation is the youngest formation in Anambra Basin, the sediments consist of yellow and white sand with pebble levels; the sands are sometimes cross-bedded.

TABLE 2.1: Stratigraphic Column of Southeastern Nigeria

FORMATION	AGE	ROCK TYPE	LOCATION
Alluvium	Recent	Sand, shale	Onitsha
Benin	Quaternary	Sandstone, shale	Umuahia, Onitsha
Ogwashi – Asaba	Quaternary	Shale, coal, mudstone, sandstone	Umuahia, Asaba
Ameki	Eocene	Limestone, shale, sandstone, mudstone	Bende
Imo	Tertiary	Sandstone, shale,limestone	Abam
Nsukka	Upper Maastichtian	Sandstone, coal, limestone, shale	Okigwe, Ohaofia
Ajali	Maastrichtian	Sandstone	
Mamu	Coniacian	Coal, shale, sandstone	
Nkporo	Coniacian	Limestone, sandstone, mudstone	Afikpo, Nkporo
Agwu – Ndeabor	Coniacian	Shale, sandstone, limestone	Ndeabor
EzeAku	Turonian	Intrusion, mudstone, diorite, shale, sandstone, limestone	Amasiri
Asu River	Albian	Limestone, shale, mudstone, sandstone, diorite	Abakiliki

The above mentioned formations are those of the Southeastern Nigeria, However, the scope of this work is only restricted to two geological formations identified in the area which includes the Asu River and EzeAku Formation.

Geologic sections of the various rock units and formations found in the study are studied. One geological formation was found in the area and it is the Asu River Group which of the Albian age and another is the Eze-Aku Formation.

The geological formation is the South Eastern Nigeria consists of sediments ranging from Albian times to Miocene times. The oldest sedimentary formation in the Abakilikibasin is the ASU RIVER GROUP, which is Albian in age. It consists of shale, sandstone, silt stone and limestone. It also contains salt and water which is due to ocean transgression whereby salt was deposited and the sediments were folded in the NE-SW trend formation (Ibe, K.K, 2013). Sedimentary formation of the Turonian age consists of limestone, shale, silt stone and sandstone which are found in EzeAku. The name EzeAku was derived from Ake-Eze River in Ebonyi State, South Eastern Nigeria. The Awgu shale consists of bluish grey shale, well-bedded with intercalations of fine grained pale yellow, calcareous sandstone and limestone indicating the santonian stage.

2.3 GEOLOGIC SETTING OF THE AREA

Umuneochi Lokpaukwu area is bounded by Latitude $5^{0}56.36^{1}$N and $5^{0}56.78^{1}$N and between longitudes $7^{0}25.36^{1}$E and $7^{0}26.16^{1}$E. Height above sea level ranges from 377ft (115m) to 456ft (139m) in the area that are underlined by suspected igneous rock.

Amaubiri area is bounded by latitudes $5^{0}54.800^{1}$N to $5^{0}55.100^{1}$N and by longitudes $7^{0}26.900^{1}$E to $7^{0}27.180^{1}$E. In general, the study area trends NE –SW. It is bounded on the northeast and southwest by Asphalt Unity Quarries and to the west by the Uchiva Company. Heights above sea level range from 264ft(80.5m) to 342ft (104.3m) to the northeast and southwest of the study area respectively. The area that trends NE –SW, transverses a NW –SE trending ridge at the central region and NW –SE trending valley that trend to separate the area from the Asphalt Unity lease to the NE.

Obiagu Lekwesi area is bounded by latitudes $5^{0}56.999^{1}$N - $5^{0}57.290^{1}$N and longitudes $7^{0}28.113^{1}$E - $7^{0}28.290^{1}$E, covering an area of about 12,2071.7 hectares. Heights above sea level range from 254ft (77.4m) to 368ft (112.2m), the lowest areas being to the northern fringes.

From the field studies, most of these igneous rock bodies strike E-W and NW-SE. The dips vary largely due to the faulting that characterizes the SW arm of the Abakaliki anticlinorium of which forms part of the study.

2.4 GEOPHYSICAL STUDY

Geophysical methods are now worldwide standard components especially resistivity methods are commonly used for site investigations.

2.5 THEORY OF METHOD (RESISTIVITY)

Potential about a single current electrode is based on two principles, the current density flowing in isotropic medium that is homogenous and infinite homogenous medium.

IF current density j in Im^{-2} then the electric field potential E is related to the resistivity e through Ohm's law

$$Є = \ell j \qquad (1)$$

Then the electric potential

$$Є = -\text{grad } U$$

Thus, $j = -\sigma \nabla U$, recall that $Є = -\nabla U$ (a)

Substituting equation (a) into (1)

$$\ell = 1/\sigma$$

For a charge in conservation in a Gausian surface area A

$$I = \int j \, . \, dA = 0$$

Since charge is conserved, $dq/dt = 0 = \blacktriangledown j$ (2)

Therefore, $\blacktriangledown.E = 0$

For charge conservation, unless there is a sink or source, in a given material,

Current inflow = current outflow

Combining equation (1) and (2)

$\blacktriangledown.j = 1/\ell \ \blacktriangledown.E = 1/\varrho \ \blacktriangledown^2 U$, where U = scalar potential function define as 0

E = grad U

$\blacktriangledown.j = 1/\varrho(\blacktriangledown^2 U) = 0$ (3)

Since $1/\ell \neq 0$, $\blacktriangledown^2 U = 0$ (This is a fundamental equation in electrical prospecting with D.C)

In a homogeneous region, ϱ is independent of coordinate axis.

From equation (3), we have $\blacktriangledown^2 U = 0$ (Laplace Equation) (4)

From equation (4), we observed that in a homogenous isotropic medium, that the equation satisfies laplace equation.

For a current in an infinite homogenous medium, the potential U from any point P is a function of r

$U = f(r)$

Then, if so, we replace laplace equation to

$\Delta^2 u / \Delta^2 r - 2/r\ \delta u/\delta r = 0$

With a general solution

$A - B/r = U$ (5)

The equation above cannot be satisfying with condition; potential as r $\rightarrow$ infinity, A= 0

Where A and B are arbituary contants, then,

$U = -B/r$ (6)

J at point is given by

$J = -1/\ell\ (\delta u/\delta r)$, $j = \sigma E$

From equation (6), $j = B/\varrho r^2$

Fom guasian law, total current I flowing out of a spherical surface of radius r is given by

$I = \int J.\ dA = \int j.4\pi^2 r$ (7)

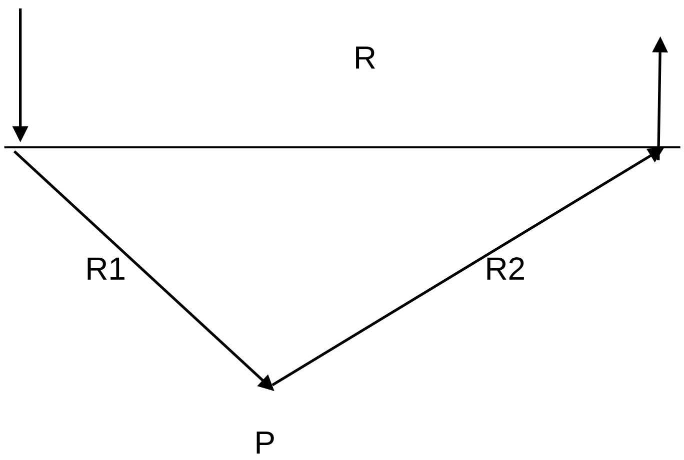
$B = \ell I/4\pi$ (for spherical surface) and for semi infinite homogenous earth, total current is half of the equation

$J = \ell I/2\pi$ (8)

From equation (6), $U = B/r = \ell I/2\pi$ (9)

Since in practice, we have a bipolar arrangement where current geos in at one point and comes out through another, potential at any point due to this bipolar arrangement is given by;

$$U = I\ell/2\pi(1/r1 - 1/r2) \quad (10)$$



Where r is distances from the measuring point.

With the use of the electrical method one would be able to know the conductivity (or its inverse, resistivity) of the subsurface. The subsurface is probed by passing of the current (DC) into the earth with the following determinant;

I. Average number of geoelectric layers
II. The vertical changes in the resistivity of the subsurface layer and the depth to the discontinuous horizons.
III. Possible rock types and productive potentials of suitable aquifers and their lithological characteristics.

Geophysical methods themselves will not discover groundwater, soil type or mineral deposit; they indicate the presence of these substances. A drill hole must always be put down to make the actual confirmation.

However, the principle behind the use of resistivity lies on the fact that the subsurface variation in conductivity alters the form of current flow within the earth and this in turn affects the distribution of electric potential. The usual practice in resistivity surveying techniques is to pass current through electrode and to measure potential drop through a second pair of electrode called potential electrode. Thus, it is possible to search for anomalies in an otherwise stationary current electric fields established in the ground but the introduction of a direct current with which to delineate the boundaries between rock unit and rock strata of different water content though the observation contrast in resistivity between two boundaries or strata (Lowerie, 1997) passed through the current electrodes, the measuring instrument has important feature of measuring the resistance value (R) which is V/I according to Ohm's law (V=IR) where V is the potential difference.

Resistance (R) is a property of the path followed by the current. R is related to the resisivity (), through both the length L and the cross sectional area (A) through which the current flows.

That is, $R = \ell L/A$

ℓ = Resitivity in Ωm

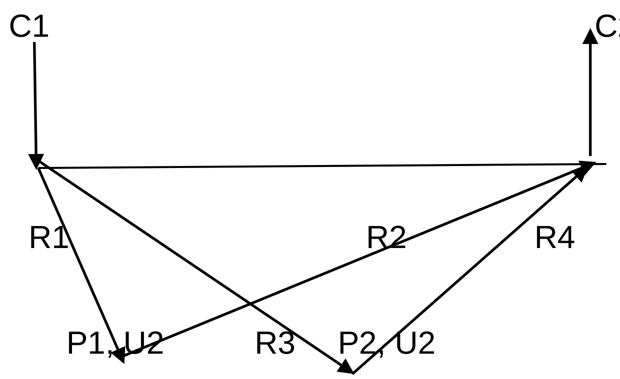
L = Path Length (m)

A = Cross-sectional area (m^2)

$\ell = RA/L$

$R = V/I$

Considering the diagram below the potential difference U and the current in the resistivity measurement, the direct currents (dc) are introduced into the ground through two points electrodes C1 and C2, and the resulting potential different measured between the point electrodes P1 and P2.



Potential t P1 due to current flow

U1 = Iℓ/2π(1/c1p1 – 1/c2p2)

The current at C1 is positive while current at C2 is negative (return current) for a standard measurement circuit, the potentials at P1 is the superposition of the potentials due to current sources at C1 and C2 (Telford, et al, 1976).

Similarly, the potential at P2 is the superposition of the potential due to current C1 and C2.

U2 = Iℓ/2π(1/c1p2 – 1/c2p2)

Potential difference is deduced as P.D = U= U2 – U1

= Iℓ/2π(1/c1p2 – 1/c2p2) - Iℓ/2π(1/c1p1 – 1/c2p2)

P.D = Iℓ/2ΠG, (11) where G is the Geometric Factor representing the effect of electrode spacing (ft,m or yards)

Therefore, Δu = Iℓ/2ΠG, ℓa = 2Π/G(Δu/I) (12)

Apparent Resistivity = (2Π/G) R (13)

For homogenous earth, R, G and ℓ are constant, but in practice, inhomogeneous conditions are met either vertically or laterally. Thus, the value of ℓ change either by changing the separation between C1, P2, C2 or any of the electrode separation or by moving the entire setup into another location. Therefore, the resistivity obtained is called the Apparent resistivity.

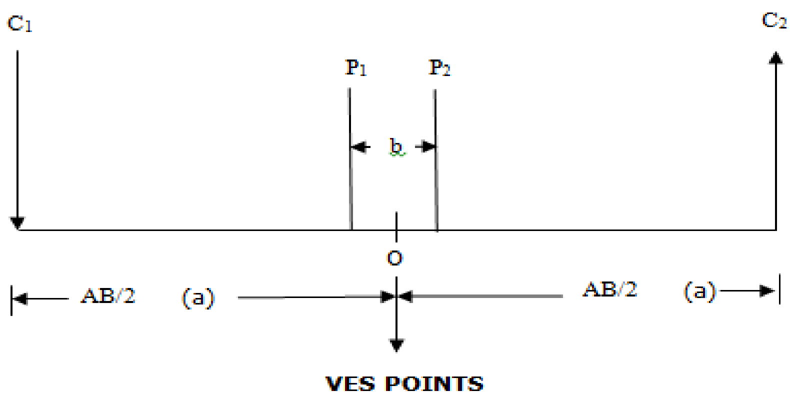


Fig.2.4: Schlumberger Array Configuration

$C_10 = AB/2 = a$

$C_1P_1 = a - b/2$ (14)

$C_2P_2 = a - b/2$ (15)

Putting equation (14) into (15), we get

$\ell a(s) = \Pi(a2/b - b/4)R$ (16)

This equation is called the expanding array/schlumberger array.

$ℓa(s) = Π(a^2/b – b/4)R$

$ℓa$ = Apparent Resistivity in Ohm-meter

a = half electrode separation in meters

b = Potential electrode separation in meters

R = instrument readings in ohms

Using these formulae above, the apparent resistivity value for each electrode separate is calculated using the resistance value displayed by the measuring instrument (terremeter) and the schlumbeger geometric factor $K= (a^2/b – b/4)π$.

Conduction of electricity in the ground occurs through the interstical fluid (or water) which is usually present in the rock and invariably contains some dissolved salt. The chemistry of the fluid in the pores spaces of rocks matters as it determines whether the rock will be conductive or not. Low resistivity value usually indicates the presence of water (or shale) in the formation (Azm et al, 1994). The clay minerals have high actions exchanged and would thus act as if a fluid of high conductivity is present in the pore spaces of the rock. Shales have generally low resistivity of a wet formation and a dry formation of the same rock may differ by factor of up to ten (Az, et al, 1994). Wet shales layers/lenses have a resistivity in the range of 0 – 20 ohm-meters (Ωm). Sandstones saturated with fresh water has a resistivity range of about 30 - 100Ωm. This can be reduced in the presence of specific shale but can increase many times, if the sandstone is dry (Robert and Hatheway, 1986)

Resistivity study is one of the electrical prospecting methods that involve the detection of the surface effects by electric current flow in the ground. Electrical Resistivity method is usually employed for one or more of the following applications listed below:

I. To traverse or survey areas for locating subsurface materials with abnormally high or low resistivity compared to the surroundings.

II. To estimate depth to subsurface boundaries separating layers of different resistivity, and to estimate these resistivity values.

III. Locate and map sand and gravel deposits.

IV. To determine depth to rock and thickness of soil.

V. To map regional variations in soil layers (sand and gravel verses clay for example).

VI. To locate fault zones.

VII. To locate and map mineral deposits.

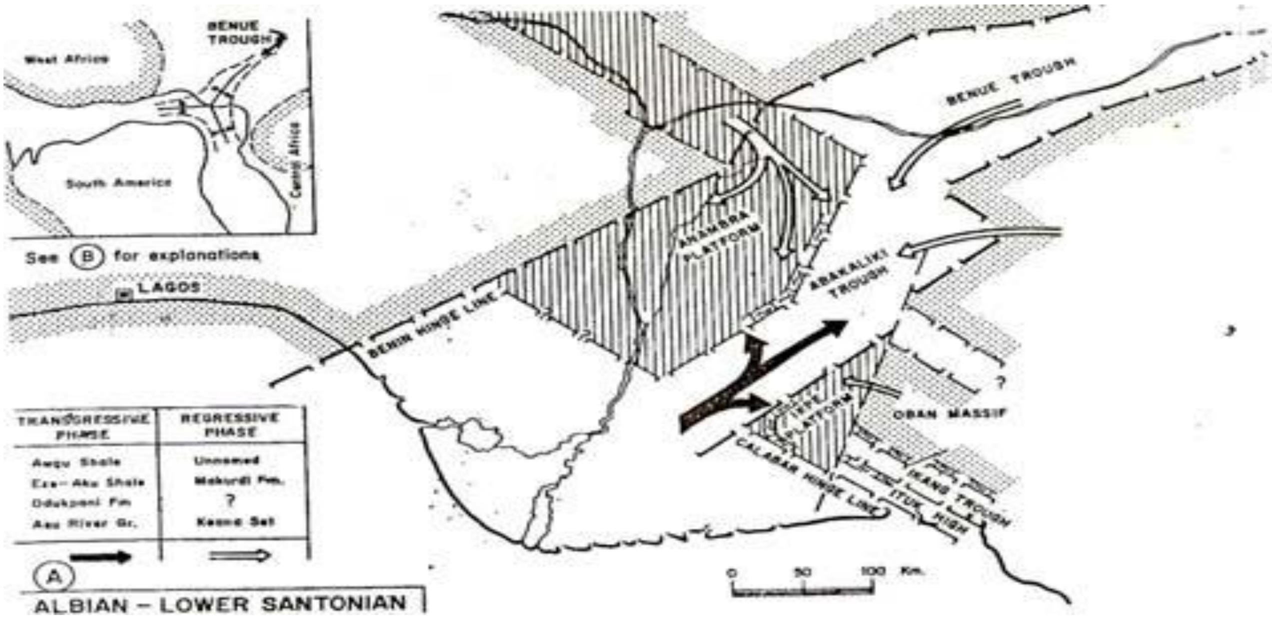


Fig 2.1 Tectonic Map of Southeastern Nigeria (Albian–Lower Santonian). (Adapted from Murat,

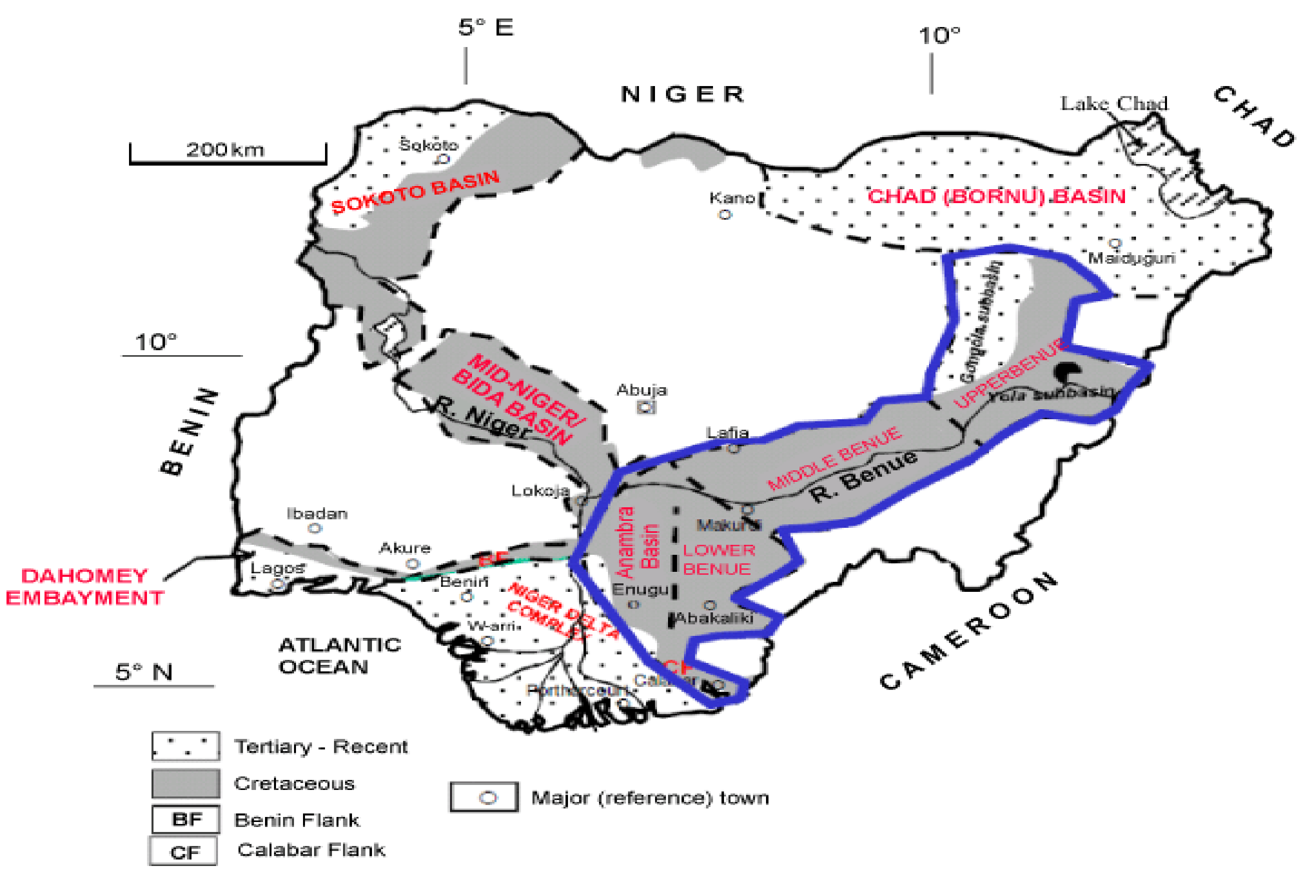
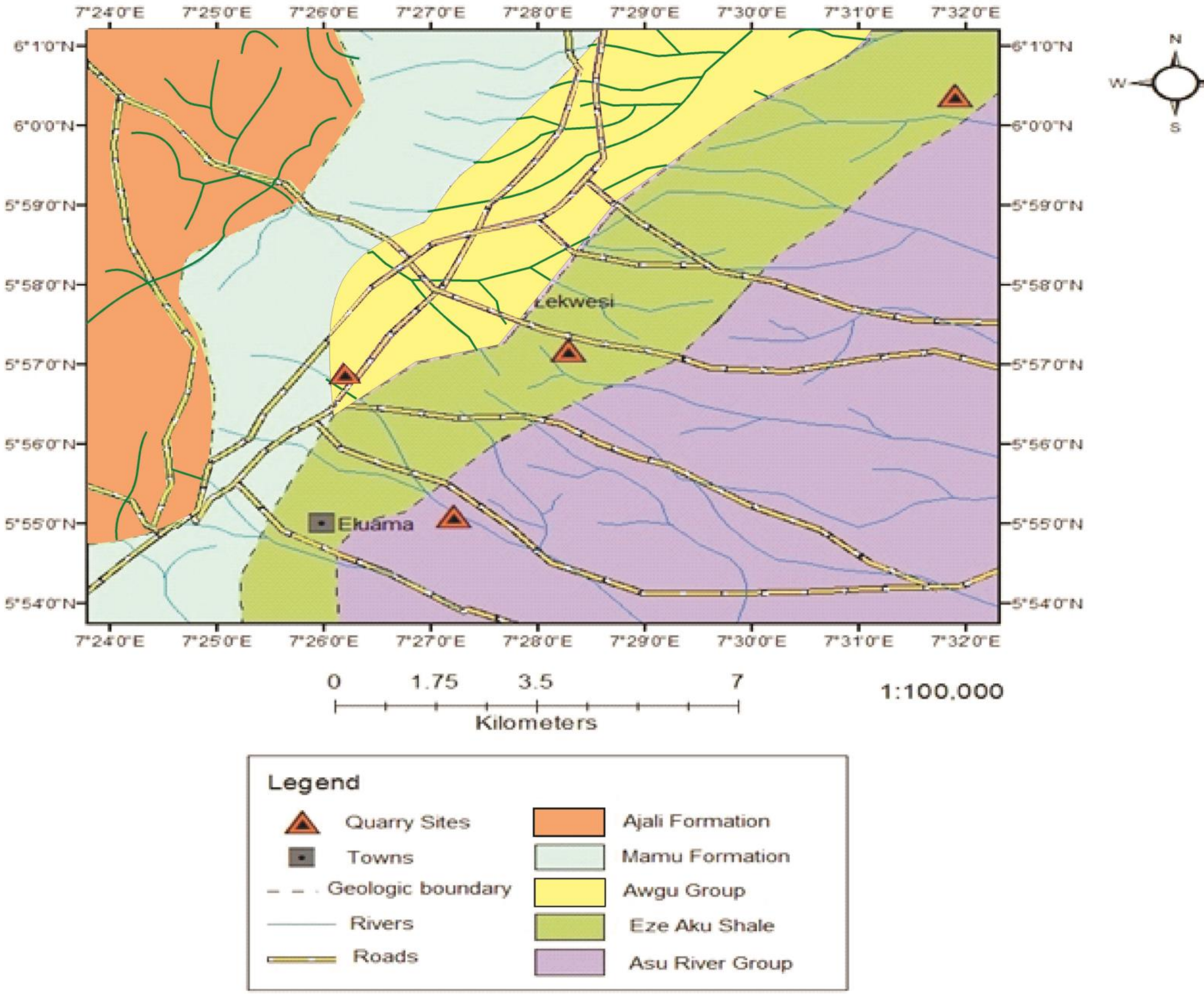


Fig. 2.2 Geologic Map of Nigeria howing the Location of the Benue Trough

Fig. 2.3: Geologic Map of Part of Southern Benue Trough



CHAPTER THREE

MATERIALS AND METHOD

3.1 FIELD PROCEDURE

The material and methods employed in acquiring field data are discussed. The field procedures, instrumentation, data acquisition techniques and data reduction are presented.

3.2 RECONNAISSANCE TRIP

The investigation started with preliminary visit to the site to study the area and also intended to critically observe the geographic settings of the area.

3.3 GEOLOGICAL MAPPING

This involves mapping outcrop; obtain the dip and strike and elevation. The elevation measurements of the area were made using the Garmin 76CSx Global Positioning System (GPS), with a view to determining the spatial distribution of the rock mass. The GPS was also used in the location of the VES and sample points and this helped in the production of maps and other interpretations. A reconnaissance trip to the study areas showed the various rock units such sandstones, shale, diorite, and the formations associated with them such as Asu River Group and Eze-Aku Group. The study of the particular trend in the study areas helped in planning the geophysical and geological transverses. Geological transverse was carried out along these lines for rock outcrops. The site was visited to also know the extent of overburden. Also, mapping out the outcrops, rock units, collection of rock samples found in the study area for investigation of the minerals in the rock unit.

3.4 DENSITY STUDIES OF SAMPLES FROM STUDY AREAS.

In order to confirm quality, samples were subjected to analysis, using the Archimedes Principles. Samples were weighed in air and in water to know the dry density soaked in clean water for 48 hours; the process was repeated to determine wet density. The value (d+w/2) {d=dry density, w= wet density} was taken as the mean density. Five samples were used for the study from 5 samples points.

The values obtained geo-electric sounding were then plotted on a log-log paper as points with the apparent resistivity values being on the vertical axis and the electrode spacing (AB/2) on the horizontal axis. The field curves were manually interpreted (Koefoed, 1979), using master curves (Orellana, and Mooney, 1966) and auxiliary point charts (Zohdy, 1965 and Keller and Frischknecht, 1966). Geo-electric parameters obtained from manual interpretation were then used as an input model for computer aided iteration of Zohdy Program for the interpretation (Vander Velpen, 1988; Ehirola et al., 2009) until it finds a final geo-electric model that is satisfactorily best of fits for the data.

3.5 FIELD DATA ACQUIZATION

The field data used in this study was acquired using vertical electrical sounding in Schlumberger array. Altogether, a total of 25 sounding in Amaubiri, 26 in Lokpaukwu, and 13 in Obiagu Lekwesi, points were acquired.

The instrument used for the survey is the ABEM TERRAMETER SAS 300C. The ABEM TERRAMETER SAS 300C is a basic unit that can be used for potential survey as well as resistivity surveys. It contains three main units, all housed in a single casing: the transmitter, receiver and microprocessor. The electrically isolated transmitter sends out well defined and regulated signal currents. The receiver discriminates noise and measures voltage correlated by microprocessor's monitor and controls operations and calculated results. The SAS meaning signal average system is a method whereby consecutive readings are taken automatically and the results are averaged continuously. The continuously updated running average is presented automatically on the display. This continues until the operator is satisfied with the stability of the results. In order to obtain accurate and reliable data the current and potential electrodes were made of non-polarizable copper electrodes which are driven deep into the ground to exclude spurious current. The current and potential drums are connected to the terminals of the ABEM TERRAMETER SAS 4000C is placed at the Centre. The potential electrodes are fixed while the current electrodes are moved out in logarithmic steps. This is continued until the readings become erratic then the potential electrode separation is increased; the reading for the potential electrode at that point is repeated. At the end of each reading at a point the instrument is put off. The necessary instruments used for making resistivity measurements include a power source, meters for measuring current and voltage (which may be combined in one meter to read resistance) electrodes, cables and reels. The power may be either D.C. or low frequency A.C, preferably (< 60Hz). The current is measured with a D.C milliammeter, whose range should be from about 1 to 20A, depending on the electrode spread, type of ground and power used. Potential is normally measured with a D.C. voltmeter of high input impedance (1 mega-ohm or greater) and 10mV to 20V.

Other equipment includes:

I. Copper stakes and connecting wires
II. Reels of wire and hammers
III. Wooden survey peg (marked according to the list of electrodes spacing chosen)
IV. Measuring tape, Compass, salt and water (brine)
V. Calculator, formulae, field computation sheets and log-log paper

3.5.1 PRECAUTIONS

I. All the connections were properly done before the terrameter is on, the electrodes should be more than four in case of any misplacement.
II. Field readings are recorded instantly on the recording sheet to prevent mishandling of field data.
III. Insulated wires were properly checked to make sure that there were no current leakages. To prevent this, cellotape is used to cover the area exposed.

Fig.3.1: Outcrop of Diorite in Amaubiri Lokpaukwu.

Fig. 3.2: Exposed Diorite Rock in Obiagu Lekwesi

Fig. 3.3: VES Sounding Along Profiles in the study Area

Fig.3.4: Moving Electrodes along Profiles

Fig. 3.5: Field Layout of Schlumberger Array

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 GEOLOGICAL MAPPING RESULTS OF OUTCROP

The geologic mapping result from OBIAGU LEKWESI (fig 4.2) area reveals E-W trend with Ajaka stream being at NE-W boundary of the surface area. In lokpaukwu umuneochi weathered rocks were found mostly confined in the Northern potion of the mapped area which are highly weathered.

The geological mapping in the area was found to have 50m of diorite which constitute the width of about 50m; length is about 530m, from the models presented in (Fig.4.6). The rock was not encountered at location P14. The mean thickness of the deposit modelled 37m is about 5.8m. In **LOKPAUKWU UMUNEOCHI**, the outcrop width ranges from 50 to 105m although the rock is mixed with weathered portions. These are mostly confined to the Northern portion of the study area (Fig.4.2). The measurement of outcrop length and thickness was not easy since most outcrops were highly weathered. Fresh samples were used for calculating the rock width. The length varies from 75 to 150m. In general, a width of 75m and length of 120m were used for the reserve estimates. From the modelled work, an average thickness of 15m with maximum value of 19.1m at location P22 and minimum value of 5.1m in P24 position were used. In **AMAUBIRI LOKPAUKWU**, in this area, no outcrop width, length and thickness. No outcrop was observed due to the thick overburden made of Mudstone and weathered shale (Fig.4.6). However, a sub-surface width of 140m, a length of 330m and maximum of 19m (modelled depth = 37m and maximum overburden of 18m leaves 19m as thickness).

4.2 GEOLOGIC INTERPRETATION

4.2.1 ANALYSIS OF THE ROCK TYPES IN LOKPAUKWU UMUNNOECHI

The highest point in the area is underlain by very coarse to conglomerate sandstones. These sandstones stand out and are blended with the highly weathered diorite rock masses. A NE- SW trending diorite mass occurs in P32 – P34 VES points but is highly weathered to be of any use. Shales are common in P51 –P53 and P61 – P62 points. Thus the major rock in the area is the shale often introduce by the diorite. Although highly weathered, the fresh sample that is exposed near point P24 is medium grained, grey in colour and has numerous iron-filled cracks and joint.

4.2.1.1 Petromicrograph OF ROCK IN UMUNEOCHI LOKPAUKWU

Under the petrographic microscope, laths of plagiosclase / Labradorite were set in a groundmass of smaller laths, iron oxide, olivine and pyrite. This texture is seen to be ophitic, similar to that of dolerite (diabase).

4.2.2 ANALYSIS OF THE ROCK TYPES IN AMAUBIRI LOKPAUKWU

In this area, no diorite outcrops were observed. While the NE end is underlain by alluvium, the central region is NW – SE trending mudstone while the southern and western areas are underlain by shales. However, a pit belonging to Uchiva Company indicates that the mudstones shales have been fired by the igneous bodies to near slates. The mudstones have mica, quartz and are carbonaceous. Outcrops of the mudstones trending NW – SE. Samples from the Uchiva pit have veins filled with calcite ($CaCo3$). Minor faulting must have caused this calcite enrichment. The calcite veins are purely visible, medium-grained with visible olivine and pyrite mineral, the colour of the diorite is dark grey.

4.2.2.1 PETROMOCROGRAPH OF ROCK IN AMUBIRI LOKPAUKWU

Under the petrographic microscope, laths of plagiosclase / Labradorite were set in a groundmass of smaller laths, iron oxide, olivine and pyrite. This texture is seen to be ophitic, similar to that of dolerite (diabase). The views under 5.8m.

OBSERVATION OFOUTCROP IN AMAUBIRI LOKPAUKWU

The study area has no outcrop observed due to the thick overburden made up of mudstones and weathered shale matter. However, a subsurface width of 140m, a length of 330mand maximum thickness of 19m (modeled depth = 37m and maximum overburden of 18m leaves 19m as thickness).

From the map presented, the trend of rock in the area is in NE-SW direction. The outcrop noted at the SE comes in another lot and confirms the NE-SW trend. It is along a stream channel that trends 210^0 SW. Dip values near VES 5 point of 45^0 indicates higher angle possibly due to faulting or folding associated with the Santonian event in Eastern Nigeria. Shale occupies over two-third (2/3) of the map area surface.

4.2.3 ANALYSIS OF THE ROCK IN OBIAGU LEKWESI AREA

Apart from the shales that are exposed near the Ajaaka valley, and the diorite intrusion, no other rock type was observed. However, they are variations in the diorite, some portions have been faulted and calcite ($CaCO_3$) veins are common. Along the N- S faults, are these veins. This has been confirmed from the microscopic study. This is a typical of URU diorite some 1km south of the study area. It is thus concluded that the URU diorite signatures are seen in the ObiaguLekwesi area.

In hand specimen, recrystallized calcite formed geodes along fault-generated cracks and micro cracks re seen in this section of the sample.

OBSERVATION OF OUTCROP IN OBIAGU LEKWESI

The outcrop width in Lekwesi from the geological mapping is 50m of the diorite constitute trending E- W which is shown in (Fig.4.8). The Ajaaka stream seems to be the Northern E-W boundary on the surface. The Length of the outcrop is about 530m, from the models; the rock was not encountered at location P14. The mean thickness of the deposit is modeled to be 37m is about 5.8m.

4.2.3.1 PHOTOMICROGRAPH OF ROCK IN OBIAGU LEKWESI

Under the petrographic microscope, laths of plagiosclase / Labradorite were set in a groundmass of smaller laths, iron oxide, olivine and pyrite. This texture is seen to be ophitic, similar to that of dolerite (diabase).

4.3 DENSITY ANALYSIS RESULT OF UMUNEOCHI LOKPAUKWU DIORITE

SAMPLES	**1** (kgm^{-3})	**2**(kgm^{-3})	**3**(kgm^{-3})	**4**(kgm^{-3})
	2.72	2.68	2.71	2.81
	2.69	2.62	2.68	2.75
	2.71	2.65	2.70	2.78
MEAN DENSITY	2.71 x 10 $^{3}Kgm^{-3}$			

Table 4.1 Density Analysis in Umuneochi Area

Variations of Samples in density values from Lokpaukwu between 2.65 and 2.78 x 10 $^{3}Kgm^{-3}$indicates the highly weathered nature of the sample. In fact, all samples at the highest point above mean sea level were so weathered that fresh samples were not seen which makes exploitation uncertain. Values of 2.6 to 2.78 x 10^3 Kgm^{-3}conforms to the average values for diorite of 2.60 to 2.95 x 10 ^{3}Kgm-3 range.

4.3 DENSITY INTERPRETATION OF AMAUBIRI, LOKPAUKWU OUTCROP

Table 4.2 Density Analysis in Amaubiri Area

SAMPLES	**1** (kgm^{-3})	**2** (kgm^{-3})	**3** (kgm^{-3})	**4** (kgm^{-3})	**5** (kgm^{-3})	**6** (kgm^{-3})	**7** (kgm^{-3})	**8** (kgm^{-3})
	2.85	2.78	2.89	2.81	2.86	2.91	2.88	2.88
	2.81	2.75	2.86	2.79	2.82	2.90	2.82	2.86
	2.83	2.77	2.88	2.80	2.84	2.91	2.85	2.87
MEAN DENSITY	2.84 x 10 ^{3} Kgm^{-3}							

The above table shows the result for the 8 samples. The value density ranges from 2.77 x 10^3(kgm^{-3})for calcite-rich variety to 2.91 x 10^3 (kgm^{-3})for iron-rich variety. The mean for the 8 samples is 2.84×10^{3} (kgm^{-3}) and this conforms to the value for diorite with stands at 2.60 to $2.95 \times 10^{3} Kgm^{-3}$

4.4 DENSITY INTERPRETATION OF OBIAGU LEKWESI OUTCROP

Table 4.3 Density Analysis in Obiagu Area

SAMPLES	**1**(kgm^{-3})	**2** (kgm^{-3})	**3** (kgm^{-3})	**4** (kgm^{-3})	**5** (kgm^{-3})
	2.85	2.77	2.95	2.84	3.10
	2.80	2.71	2.93	2.79	3.06
	2.83	2.74	2.94	2.82	3.08
MEAN DENSITY	$2.88 \times 10^{3} Kgm^{-3}$				

The mean values of dry and wet density ranges from 2.74 to 3.08×10^{3} Kgm^{-3}, the values conform to the values for diorites and also when blended, an average value for the sample of 2.88×10^{3} Kgm^{-3}conforms to diorite with 2.60 to 2.95×10^{3} Kgm^{-3}range.

Fig. 4.1 Samples from Obigu Lekwesi Area

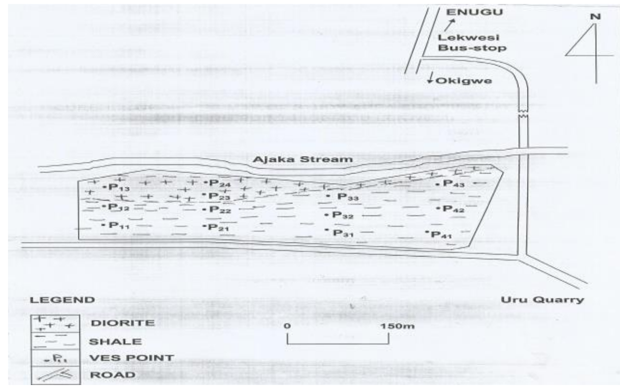


Fig. 4.2: Obiagu Lekwesi Showing Surface Geology and VES Point

Fig. 4.3 Sample from Amaubiri Area.

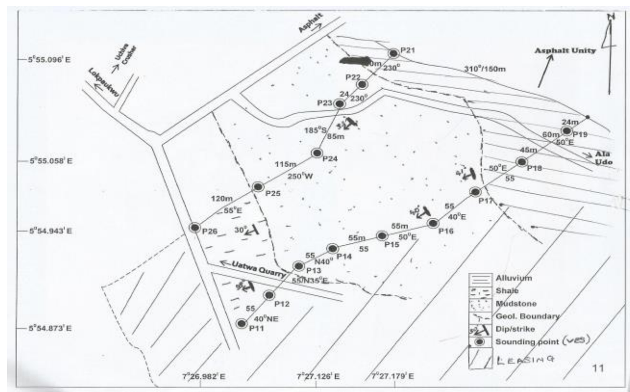


Fig. 4.4: Amaubiri Lokpaukwu Showing Surface Geology and VES Point

Fig 4.5: Exposed Rock in Umuneochi Area.

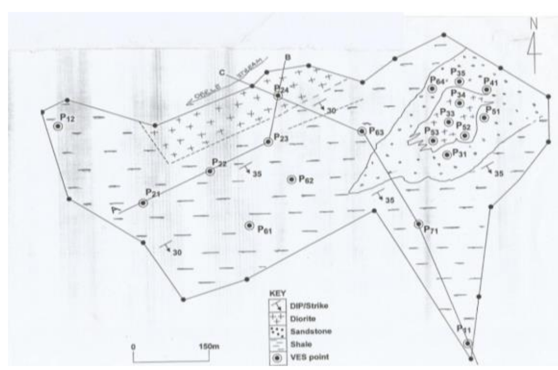


Fig.4.6: Umuneochi Area Showing Surface Geology and VES Point

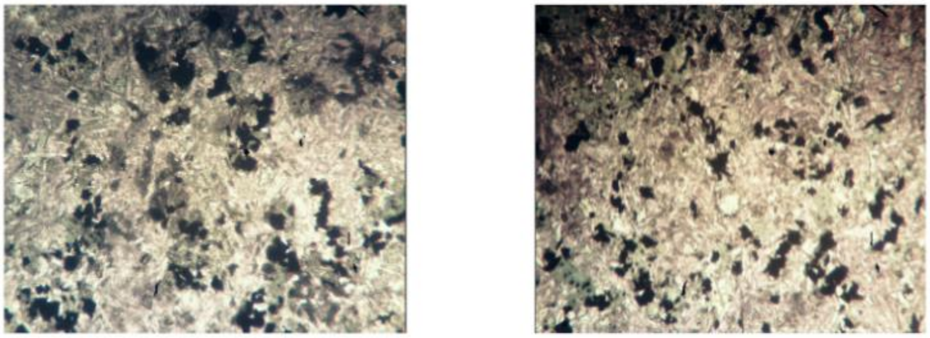


Fig 4.7: Photomicrograph of rock in Umuneochi Lokpaukwu

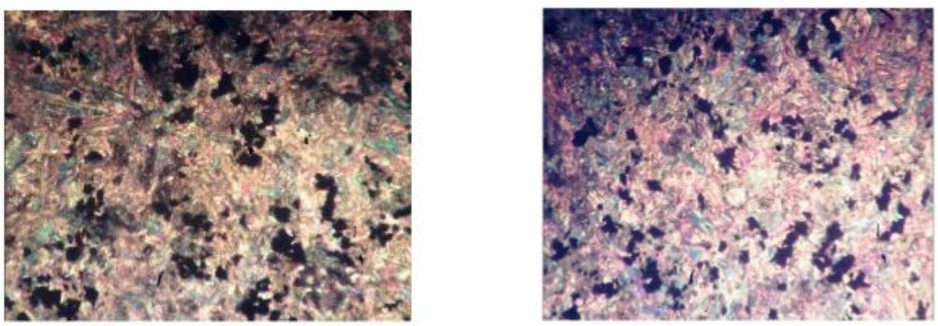


Fig 4.8 Photomicrograph of rock in Amaubiri Lokpaukwu Area

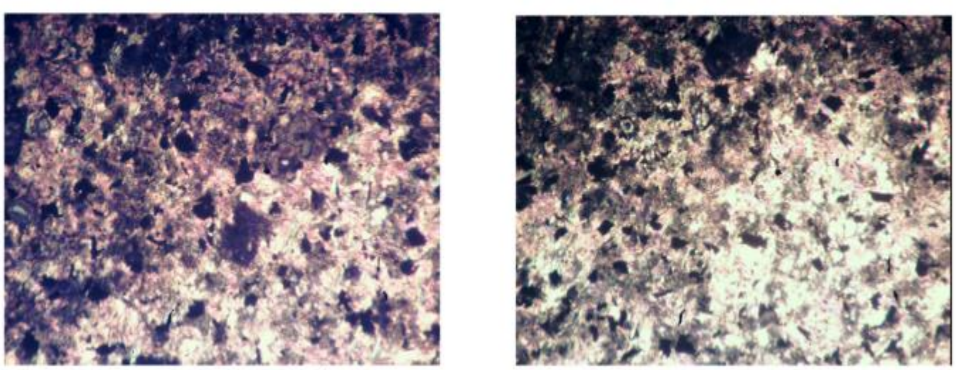


Fig 4.9 Photomicrograph of rock in Obiagu Lekwesi Area

4.6 GEOPHSICAL DATA RESULT AND INTERPRETATION

Field curves were plotted and presented manually on log-log graphs to enable the structures of curves to be shown, the field data were fed into Schlumberger software program to produce a computer printout of the curves. The curves gave different shapes of resistivity curves name, K, A, Q and H curves respectively.

Results of the curve matching were studied in details to estimate the layer parameter (table 4.4). The shape of the curve for each sounding curve gave an insight into the characteristics of the bed or layers between the surface and maximum depth of penetration. This is because the shape of a VES curve depends on the number of layers I the subsurface, the thickness and the ratio of resistivity of these areas. Some of the interpreted curves from VES data are shown in (appendices 1).

TABLE 4.4: Geophysical Data Results showing variations in Resistivity Values

LOCATION	SOUNDING POINTS	NO OF LAYERS	LAYER RESISTIVITY					CURVE TYPE	DEPTH TO TARGET	LAYER THICKNESS	
			ℓ_1	ℓ_2	ℓ_3	ℓ_4	ℓ_5				
AMAUBIRI LOKPAUKWU	P11	4	52.8	24.9	6.8	68.3		HK	27.7	0.9-15.9	
	P12	5	64.9	6.3	36.8	24.4	107.5	HKHA	12.6	0.7-7.8	
	P13	4	125.0	6.6	10.6	8.3		HK	8.4	0.5-6.2	
	P14	4	19.5	7.5	11.2	5.4		HK	20.9	1.2-11.7	
	P15	4	46.7	3.8	7.1	23.6		HK	21.7	0.5-19.7	
	P16	4	144.0	4.0	7.0	25.5		HK	13.7	0.6-10.5	
	P17	4	125.5	8.6	5.3	25.2		HK	5.3	1.0-5.3	
	P18	4	324.0	127.0	667.0	97.0		HKQ	7.2	1.6-3.1	
	P19	4	19.5	7.5	11.2	5.4		HK	20.9	1.2-8.0	

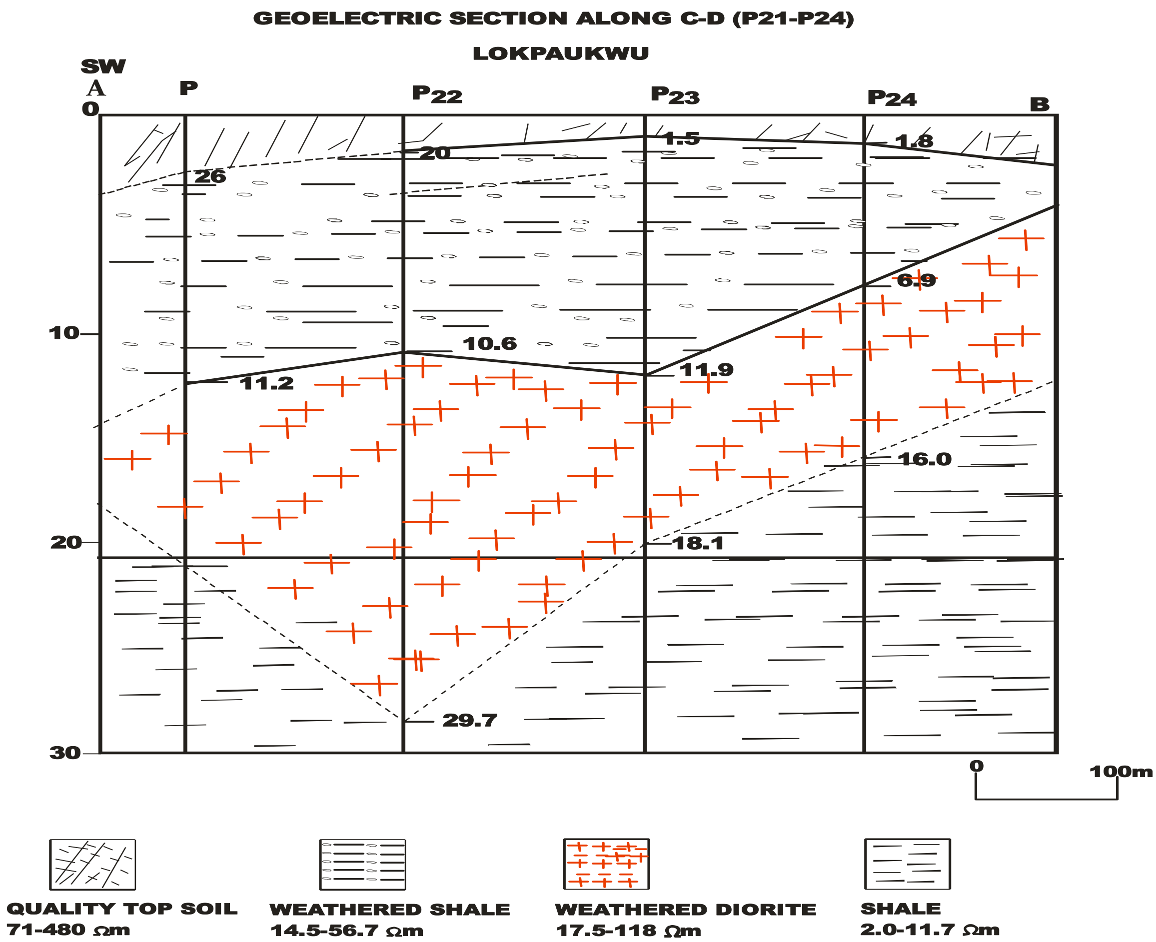
	P20	4	64.7	70.9	8.6	7.5		K Q	5.8	1.5-2.9	
	P221	3	104.0	14.3	6.9			Q	4.9	1.4-3.5	
	P22	4	91.0	23.0	11.2	21.4		QK	18.4	0.4-9.7	
	P23	4	49.3	13.2	2.8	11.1		QK	11.3	3.9-6.6	
	P24	4	216.0	31.8	12.8	24.7		QK	14.2	0.4-5.2	
	P25	4	199.0	7.7	45.3	4.0		HKQ	4.4	0.3-3.3	
	P26	5	715.0	29.8	2.9	25.0	22.0	HK	17.4	0.6-11.6	
OBIAGU LEKWESI	P11	4	236.0	11.7	16.2	2.2		HKQ	13.5	0.5-10.2	
	P12	4	81.0	11.6	13.9	0.6		HKQ	12.6	0.8-1.1	
	P13	4	89.0	7.6	16.6	0.6		HKQ	7.3	0.8-3.3	
	P21	4	42.9	12.9	0.8	0.1		Q	17.4	1.8-10.8	
	P22	4	299.0	14.5	8.3	0.6		Q	23.3	0.5-18.7	
	P23	4	67.7	7.3	13.8	1.5		HKQ	14.3	1.0-7.7	
	P24	4	12.6	13.8	15.5	0.9		KHQ	6.6	0.7-5.4	
	P31	4	47.6	2.5	2.2	0.4		Q	21.3	2.1-2.0	
	P32	4	72.2	10.2	14.9	2.3		HKQ	9.7	1.6-3.7	
	P33	4	22.0	3.5	2.8	1.4		Q	23.2	1.4-12.3	
	P41	4	79.0	627.0	10.8	1.1		KQ	15.7	0.6-12.8	
	P42	4	220.0	146.0	136.0	1.7		Q	12.4	2.1-3.5	
	P43	4	7.4	2.2	10.5	0.9		HK	14.1	0.9-9.0	
UMUNEOCHI	P11	4	36.9	25.4	114.0	0.3		HKQ	13.8	1.4-4.5	
	P12	5	90.0	30.1	36.4	23.4	22.5	HKQ	17.7	1.0-6.0	
	P21	4	489.0	14.5	17.1	2.6		HKQ	20.9	2.6-9.7	
	P22	4	77.7	18.7	19.3	11.3		HKQ	29.7	2.6-29.7	

	P23	4	156.0	56.7	142.0	4.6		HKQ	18.1	0.5-18.1	
	P24	4	71.1	36.9	118.0	4.6		HKQ	16.0	0.8-16.0	
	P31	4	93.0	9.7	61.5	17.1		HKQ	15.7	1.1-15.7	
	P32	4	64.3	16.2	38.8	54.4		HA	17.9	0.7-11.8	
	P33	4	341.0	34.9	85.0	5.2		KH	20.9	0.5-10.2	
	P34	4	183.0	29.7	123.0	13.3		HKQ	17.4	0.9-13.9	
	P35	4	64.3	16.2	38.8	54.4		HA	17.9	0.7-11.8	
	P41	4	185.0	5.4	37.4	1.1		HKQ	12.2	1.1-7.6	
	P51	3	198.0	51.2	24.3			Q	21.4	0.9-20.5	
	P52	4	225.0	55.0	60.4	39.0		HKQ	8.7	0.8-43	
	P53	4	238.0	53.0	109.0	41.0		HKQ	3.5	0.9-2.6	
	P61	4	386.0	801.0	15.3	1.6		KQ	24.4	0.1-22.4	
	P62	4	123.0	54.4	111.0	5.6		HKQ	18.7	0.8-9.6	
	P63	4	83.0	36.4	68.0	8.6		HKQ	18.4	0.9-12.2	
	P64	3	12.3	0.2	0.5			HK	5.4	1.2-4.2	
	P71	4	97.0	11.8	63.9	11.8		HKQ	20.1	0.9-15.4	

Curve shapes and not necessarily the resistivity values are employed in resistivity sounding interpretation. This is because the values of resistivity may vary due to wetness or dryness as during rainy or dry season respectively but the real depths to geo-electric layers remains constant. The curves were used to infer the number of geo-electric layers prior to modeling. The apparent resistivity curve for a three-layer structure generally has one of four typical shapes, determined by vertical sequence of resistivity in the layers.

The curve type identified ranges from (HK, Q, HKQ, HKHA and QK), all reflecting lithological variations in the area. The (HK) type is the most predominantly, followed by (Q) type. The general signature of the curves suggests an alternate sequence of resistivity-conductivity layers.

4.7 Geoelectric Sections



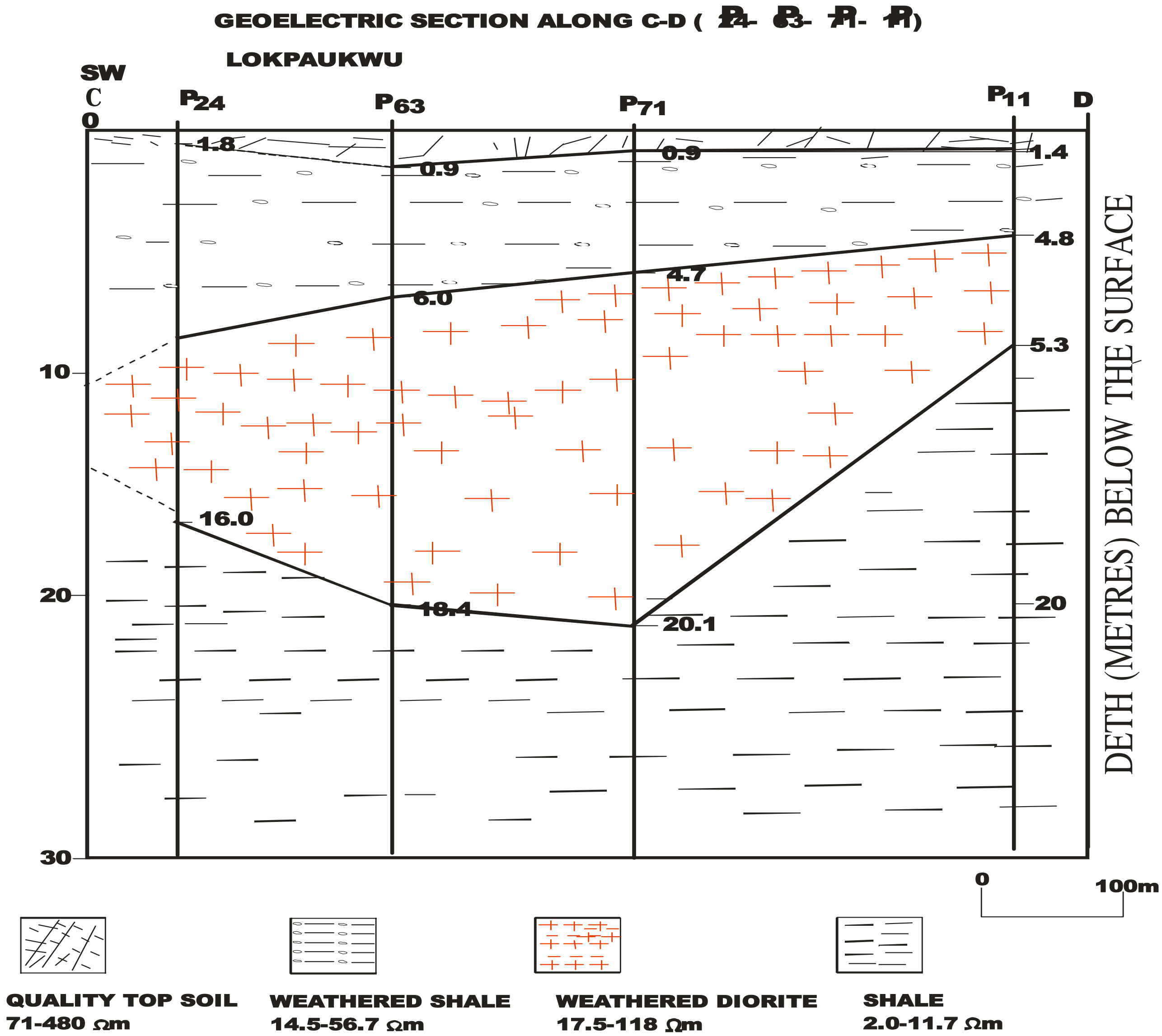


Fig 4.10: Geoelectric Section along the profile in Umuneochi

.

GEOELECTRIC SECTION ALONG P31-P33 AND P41- P43
(OBIAGU LEKWESI)

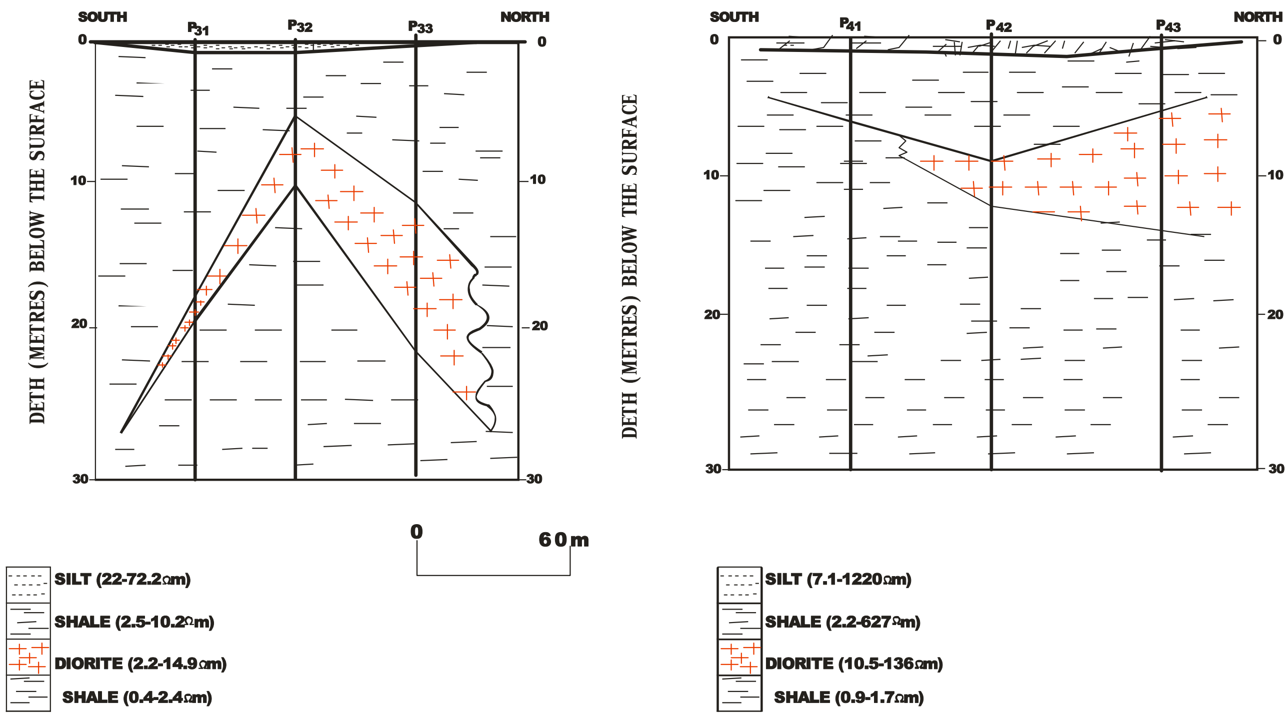
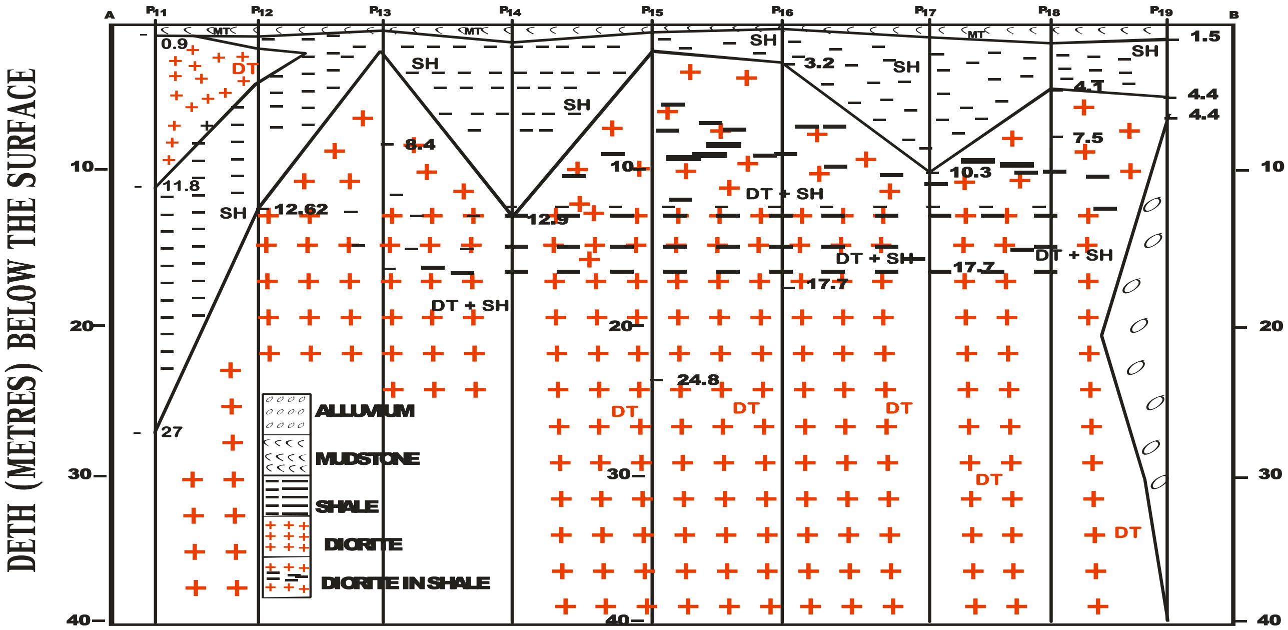


Fig 4.11: Geoelectric Section along profiles in Obiagu

Correlated Geoelectric Sections along P11-P19 Profile (A-B)



Correlated Geoelectric Sections along P26-P21 Profile (C-D)

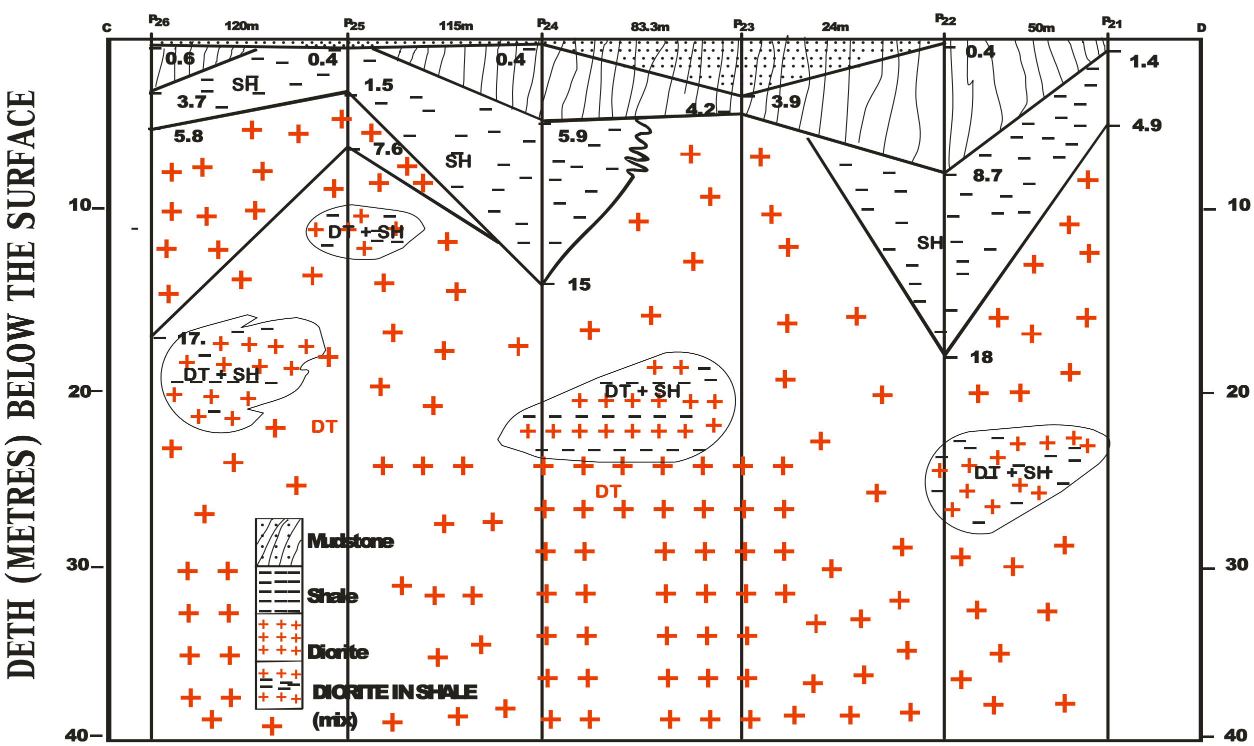


Fig 4.12: Geoelectric Section along the profile in Amaubiri

4.8 DICUSSION

From the geological mapping, surface trend and field relationship among rock units, difference in layering, the quarry material is diorite with strong inclination toward the dolerite suite. The material intruded pre-existing shale in a NE-SW trend, coming out in abnormal conical shape rather than the preferred inverted cone shape. The central and southern parts of the mapped area do not have near surface rock exposure but buried to depth. This is a lot of overburden. Such overburden made up of fractured shale and silty top soil may introduce quite a lot of underground water into any quarry site thereby increasing working cost or production expenses. Weathering is also advanced to depths of between 4.1 and 11.9m in Umuneochi study area which will require a lot of earthwork to be removed to encounter a very thin diorite. From the density and mineralogical data, there is high quality diorite in areas studied. The density conforms to that in Literature. The colour is dark grey unlike most intrusions that are grey.

In Umuneochi, Lokpaukwu area, using a total outcrop length of 120m, a width of 75m a total projected reserve of 0.365.85 million metric tons of rock material of diorite suite is available using a thickness of 4.1m and a density of 2.71 x 103km-3. This rock deposit is not economical because the material will be exhausted by the time people will expect more yields but will produce.

In ObiaguLekwesi, from the observation, the outcrop thickness of about 5.8m with very high overburden value of 10.49m may not produce the expected yield needed. The fault system in the area may introduce so much underground water into the quarry and this may cause so much to be drained.

In Amaubiri Lokpaukwu, It’s noted there was lack of outcrop of diorite in the area, only mud rock was seen. There were existing company near the study area and they seem to operate at the extreme NE and SW of the area. There was high weathering depth, which might be the reason of the absence of diorite rock that created great overburden. Most companied around do

massive overburden to get the diorite rock. There was low value of resistivity at great depth which indicates that there is high conducting overburden shale and those associated with diorite. Based on the calculated thickness of 19m, a length of 330m and a width of 140m using mean density of 2.8*10-3kgm-3, the total projected reserves of 2.49 Million metric tons. This is the value for a very high quality diorite in the area.

Table 5.1: **DIORITE RESERVE ESTIMATION IN THE AREA**

STUDY AREA	OUTCROP LENGTH(m)	OUTCROP WIDTH(m)	THICKNESS(m)	ESTIMATED VOLUME OF ROCK	ESTIMATED DENSITY(kgm^{-3})
AMAUBIRI LOKPAUKWU	140	330	19	877,800	2,820
OBIAGU LEKWESI	530	50	5.8	153,700	2,880
UMUNEOCHI LOKPAUKWU	120	75	15	135,000	2,710

	AMAUBIRI	OBIAGU	UMUNEOCHI
OVERBURDEN THICKNESS(M)	18.4	10.49	4.1

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSION

From the data presented in this research work, we conclude that

1. In Umuneochi, Lokpaukwu, a high quantity diorite of about 365.85 million metric tons occurs at the studied area at Umuneochi area of Southeastern Nigeria. The area shows very thick overburden and thin rock mass despite the 365.85MMT reserve, the deposit is not economical. So much might be spent on removing overburden.
2. High quality diorite rock was found in Obiagu Lekwesi of about 0.44million metric tons. On the basis of the high overburden with mean value of 10.49m and relatively low mean thickness of 5.80m of rock, excluding the calcite veins and fault traces to admit the underground water, it is concluded that the diorite rock in Obiagu Lekwesi is not economical for medium to large scale quarry. The establishment of any quarry site is predicated on the correct estimation of reserves.
3. Based on the interpretation of Amaubiri area, there is high weathering depth, a quarry could be established but extra care should be taken to prevent any pond development.

5.2 RECOMMENDATIONS

ObiaguLekwesi and Amaubiri Lokpaukwu area should have adequate dewatering system in place in case of siting a quarry in those areas.

5.3 CONTRIBUTION TO KNOWLEDGE

This study is an aspect of economic geology where detailed preliminary analysis aims at having detailed geological and geo- electrical investigation in the area. This study has enable us produced local geology map of the study areas in different location in Benue Trough, South Eastern Nigeria. It also established depth and lateral extent of diorite in the areas investigated. Reserve estimation of the investigated diorite rock was determined from the processed data gotten from the field.

Finally, the findings from this study are in agreement with the previous studies carried out around the area. The folded intrusive diorite rock in the area is consistence with the folded nature of the study area as seen in the model.

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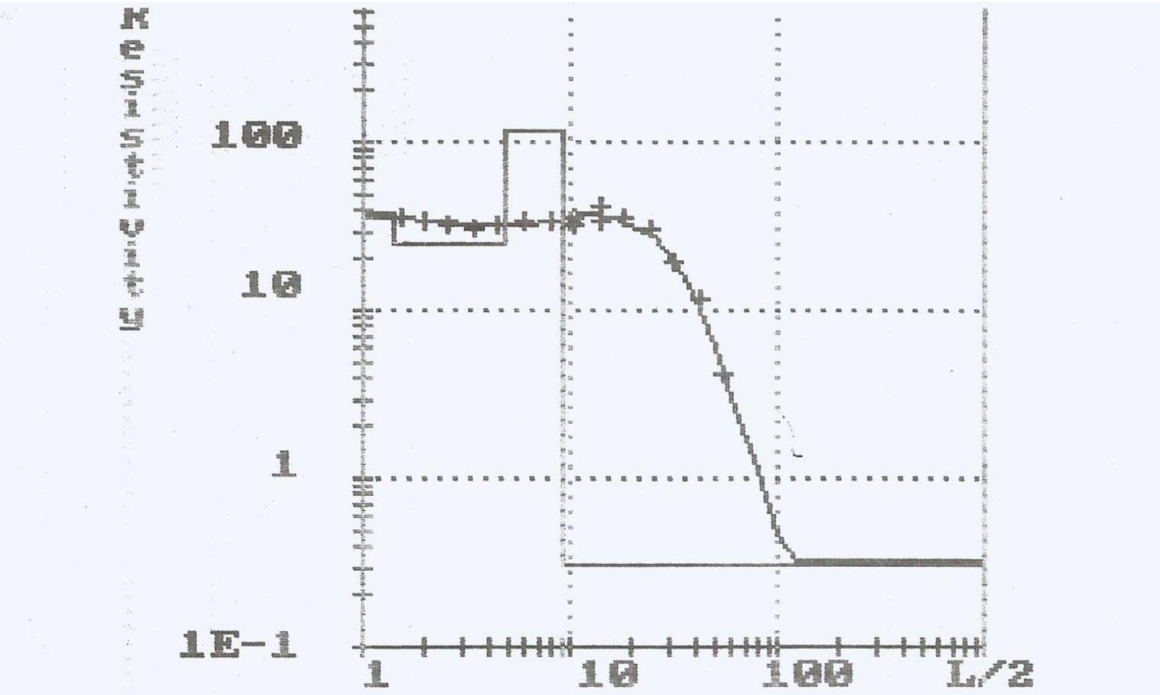
APPENDICES

I Results of Computer Iteration curve in the area.



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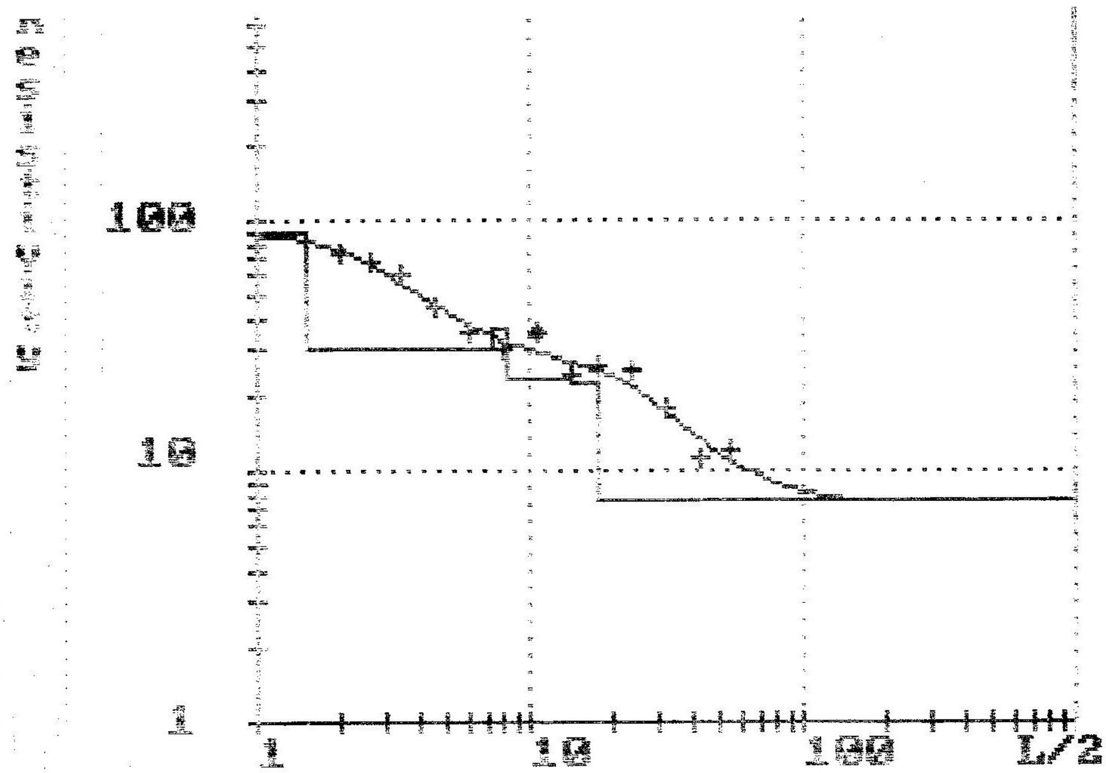
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	36.4	8.0	34.0	24.0	30.4
2.0	34.2	10.5	32.9	32.0	19.5
2.6	32.9	14.0	33.2	42.0	11.8
3.4	31.2	10.5	35.6	55.0	4.1
4.5	32.0	14.0	41.3		
6.0	33.7	18.0	35.0		

Resistivity (Ohm.m)	Depth (m)
36.9	1.4
25.4	4.8
114.0	9.3
0.3	



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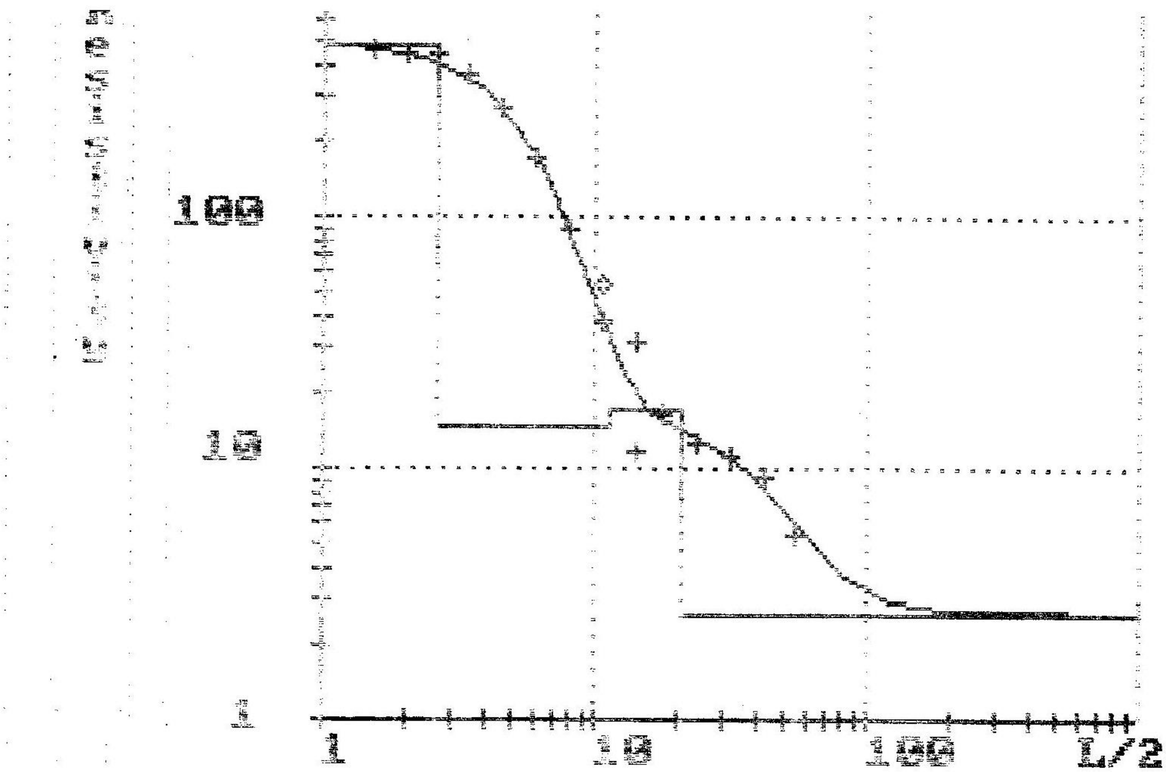
Code name	P-12	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	82.9	8.0	30.0	24.0	24.8
2.0	71.9	10.5	36.3	32.0	17.7
2.6	67.5	14.0	23.8	42.0	11.0
3.4	60.4	10.5	36.4	55.0	12.2
4.5	45.2	14.0	23.8		
6.0	35.9	18.0	25.9		

Resistivity (Ohm.m)	Depth (m)
90.0	1.5
30.1	7.3
36.4	8.3
23.4	14.1
22.5	17.7
7.5	



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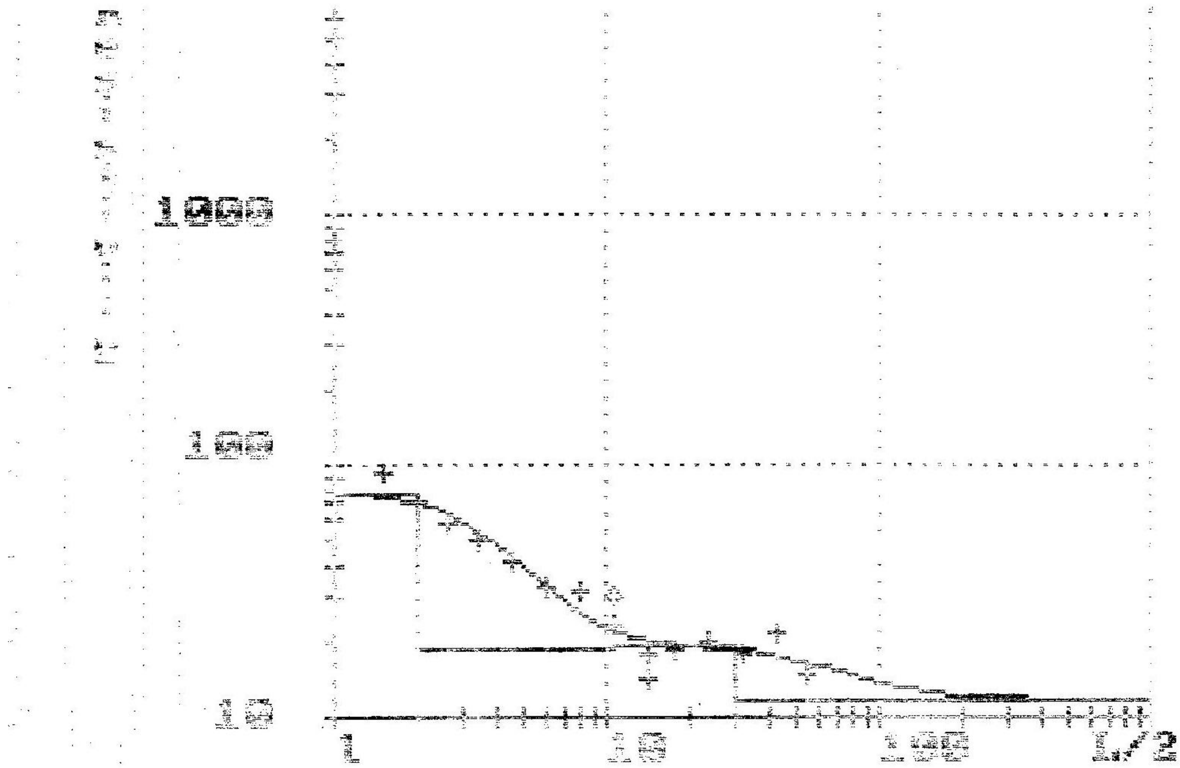
Code name P-11 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	454.7	8.0	90.0	24.0	12.4
2.0	446.6	10.5	38.4	32.0	11.4
2.6	437.6	14.0	11.7	42.0	9.4
3.4	361.2	10.5	54.6	55.0	5.4
4.5	270.0	14.0	31.7		
6.0	169.5	18.0	16.7		

Resistivity (Ohm.m)	Depth (m)
489.0	2.6
14.5	11.2
17.1	20.9
2.6	



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Code name	P-27	Remarks	ABIA STATE
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		Schlumberger	[illegible]

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	91.7	5.0	31.0	24.0	19.7
2.0	69.5	10.1	22.8	32.0	17.7
2.6	57.3	14.0	17.8	42.0	21.2
3.4	49.7	[illegible]	30.5	55.0	14.8
4.5	40.5	[illegible]	14.0		
6.0	32.9	19.0	17.4		

Resistivity (Ohm.m)	Depth (m)
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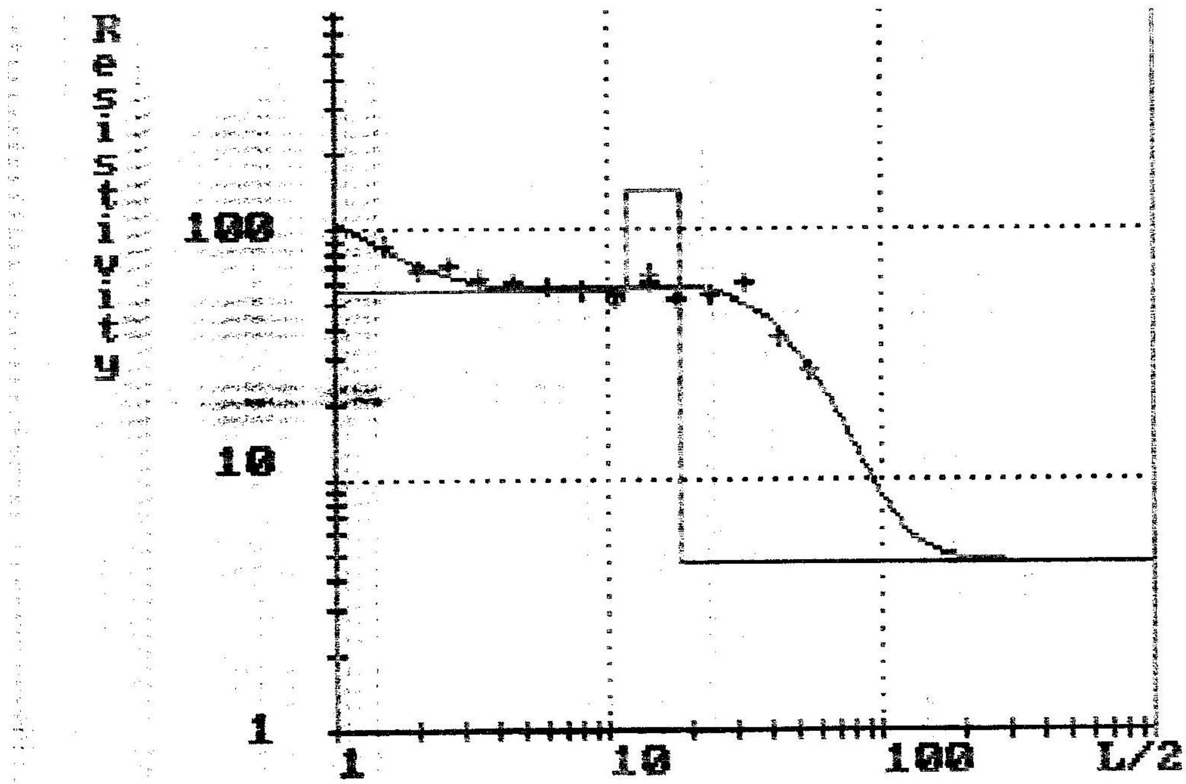
18.7	10.6
19.3	30.7
[illegible]	



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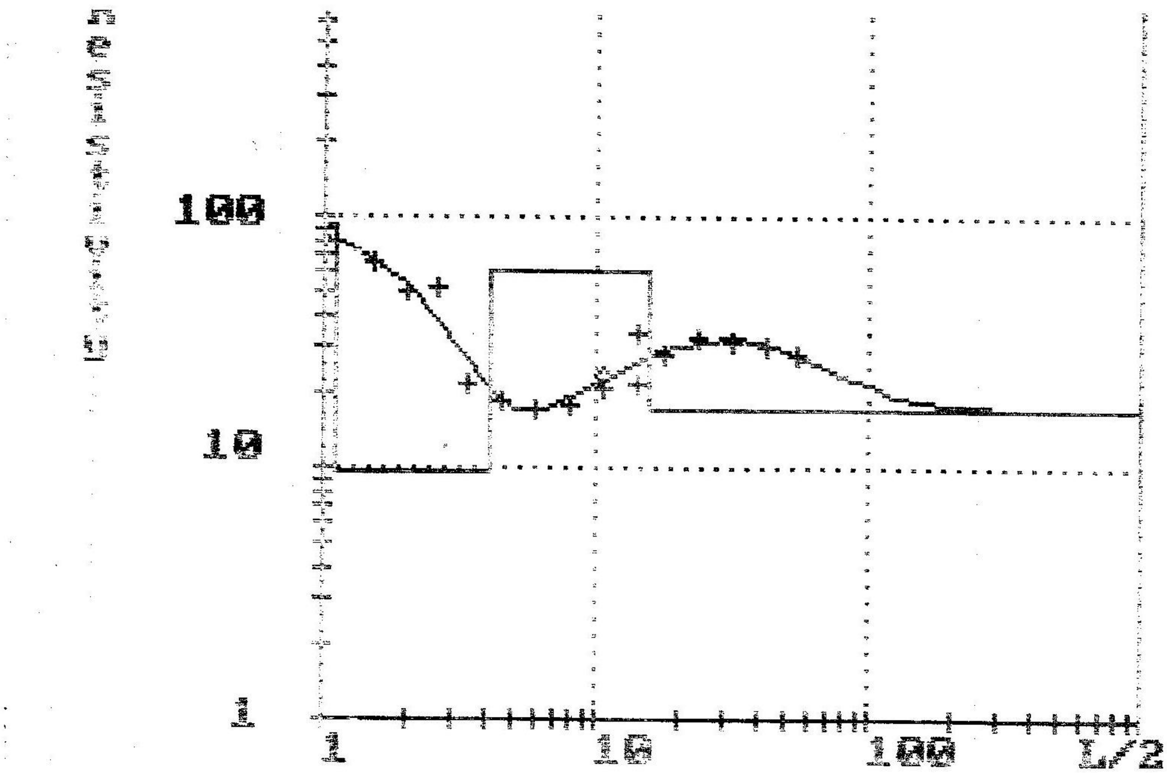
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	86.2	8.0	55.2	24.0	54.6
2.0	67.4	10.5	54.7	32.0	60.8
2.6	69.5	14.0	66.4	42.0	36.2
3.4	62.8	10.5	52.8	55.0	27.0
4.5	61.0	14.0	60.2		
6.0	58.1	18.0	52.5		

Resistivity (Ohm.m)	Depth (m)
156.0	0.5
56.7	11.9
142.0	18.1
4.6	



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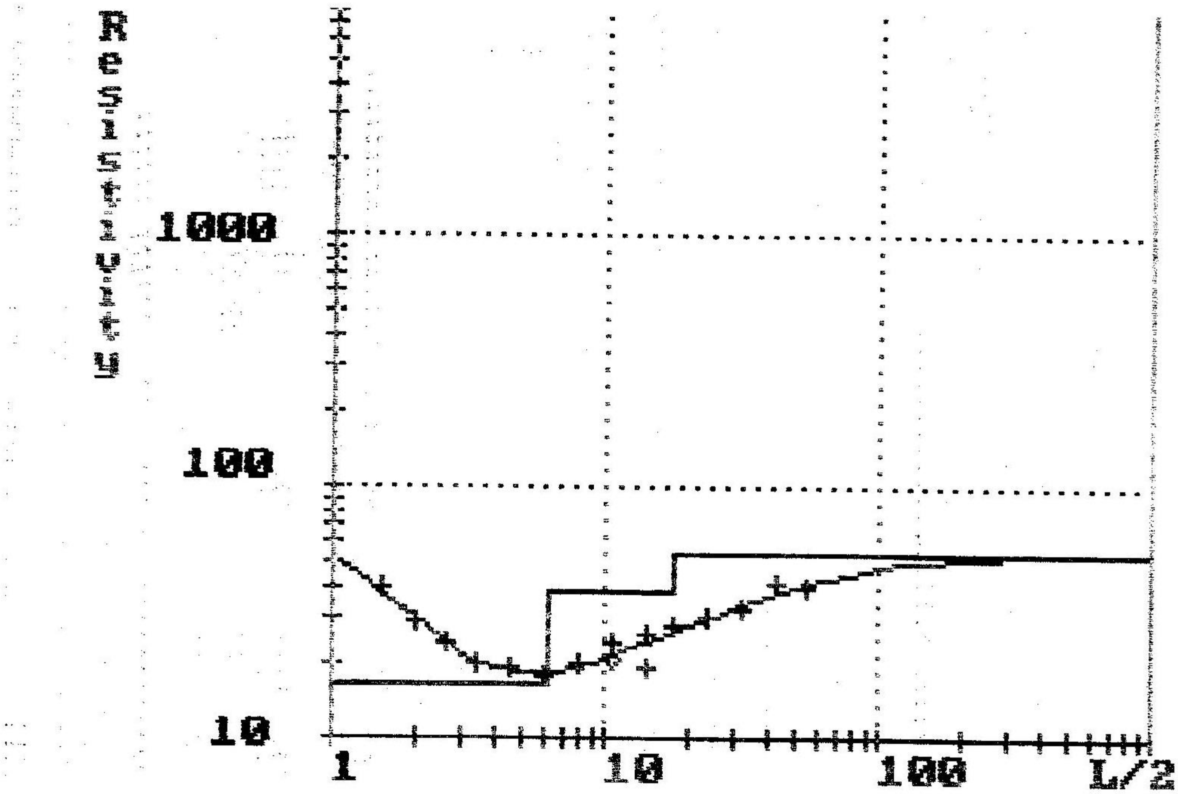
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.	Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	64.1	8.0	19.0	24.0	32.9
2.0	49.5	10.5	20.8	32.0	31.8
2.6	52.7	14.0	21.5	42.0	29.9
3.4	21.3	10.5	23.3	55.0	28.4
4.5	18.2	14.0	33.8		
6.0	16.9	18.0	28.0		

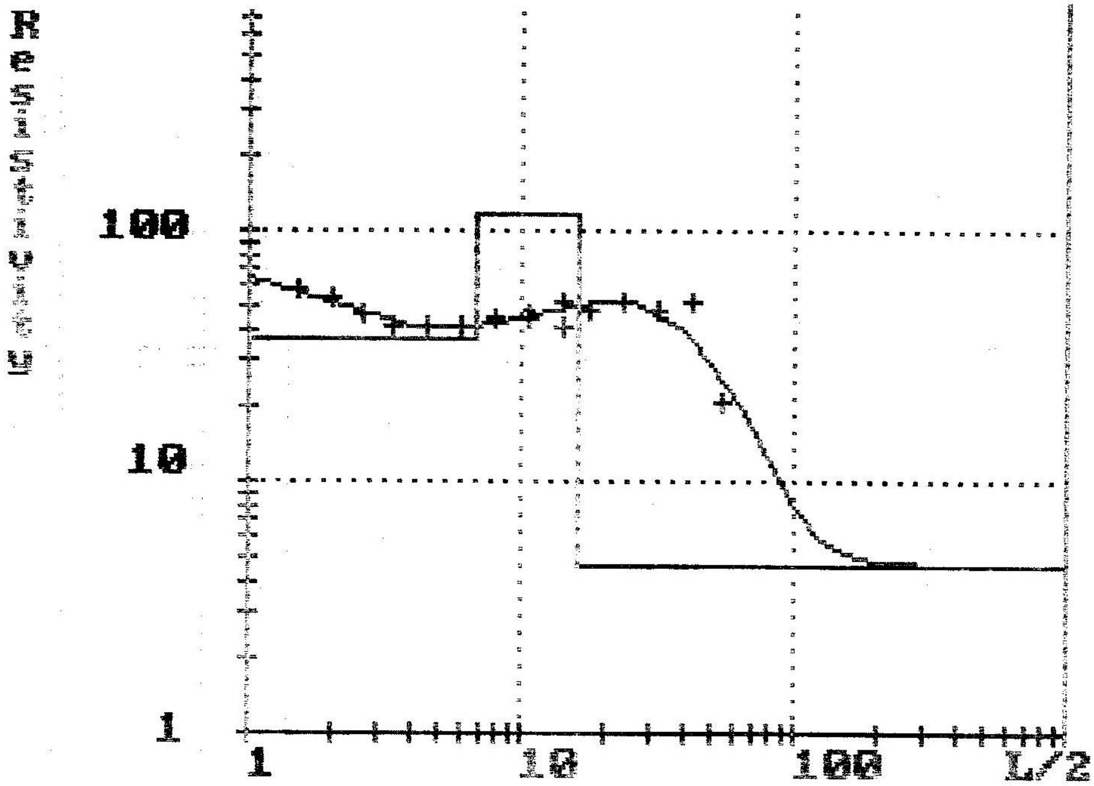
Rosistivity (Ohm.m)	Depth (m)
93.0	1.1
9.7	4.1
61.5	15.7
17.1	



Data (File) name P-32 Date 6-12-2014
Project name QUARRY STUDIES Direction lay out
NNE-SSW(5),N5 56.678',E7 26.055',H380ft
Code name P-32 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	40.2	8.0	20.0	24.0	30.4
2.0	29.5	10.5	24.2	32.0	33.1
2.6	24.5	14.0	26.5	42.0	40.9
3.4	19.9	10.5	20.7	55.0	39.2
4.5	18.8	14.0	19.0		
6.0	17.9	18.0	28.0		

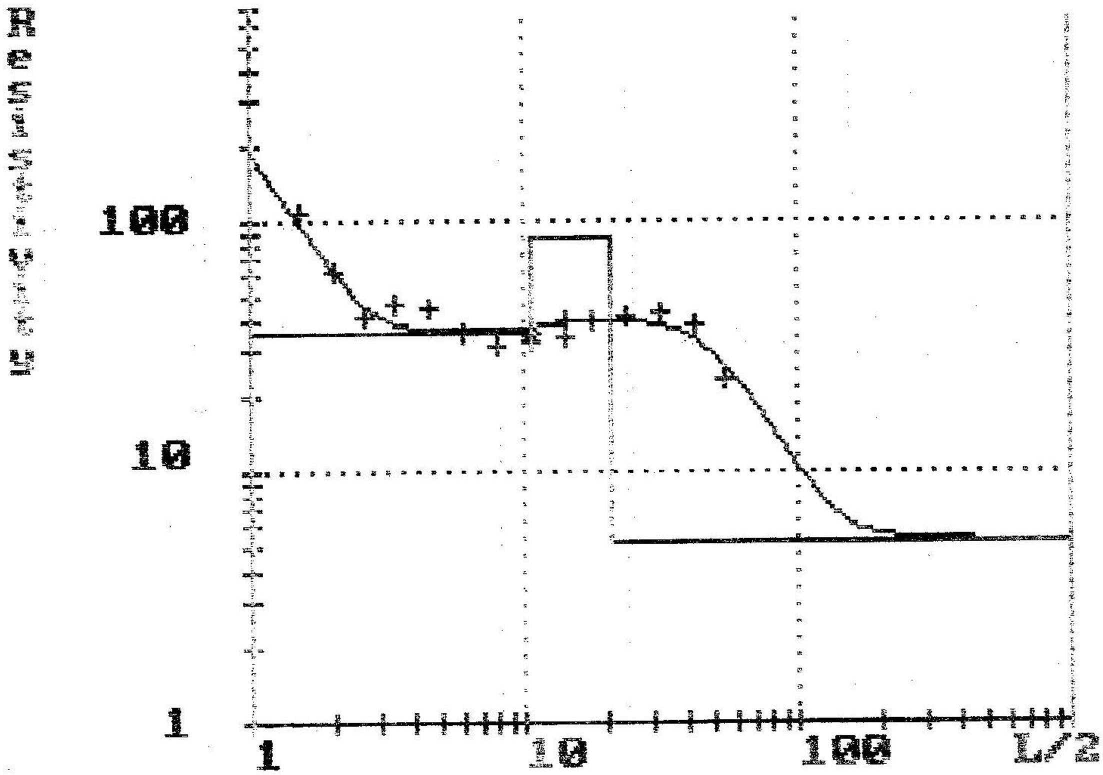
Resistivity (Ohm.m)	Depth (m)
64.3	0.7
16.2	6.1
38.8	17.9
54.4	



Data (File) name P-24 Date 05-12-2014
Project name QUARRY STUDIES Direction lay out
E-W(280),N5 56.727',E7 26.005',H385ft
Code name P-24 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	57.2	8.0	44.8	24.0	51.9
2.0	53.0	10.5	45.3	32.0	48.6
2.6	47.0	14.0	41.2	42.0	51.1
3.4	41.5	10.5	45.8	55.0	20.3
4.5	41.5	14.0	52.7		
6.0	41.4	18.0	47.6		

Resistivity (Ohm.m)	Depth (m)
71.1	0.8
36.9	6.9
118.0	16.0
4.6	



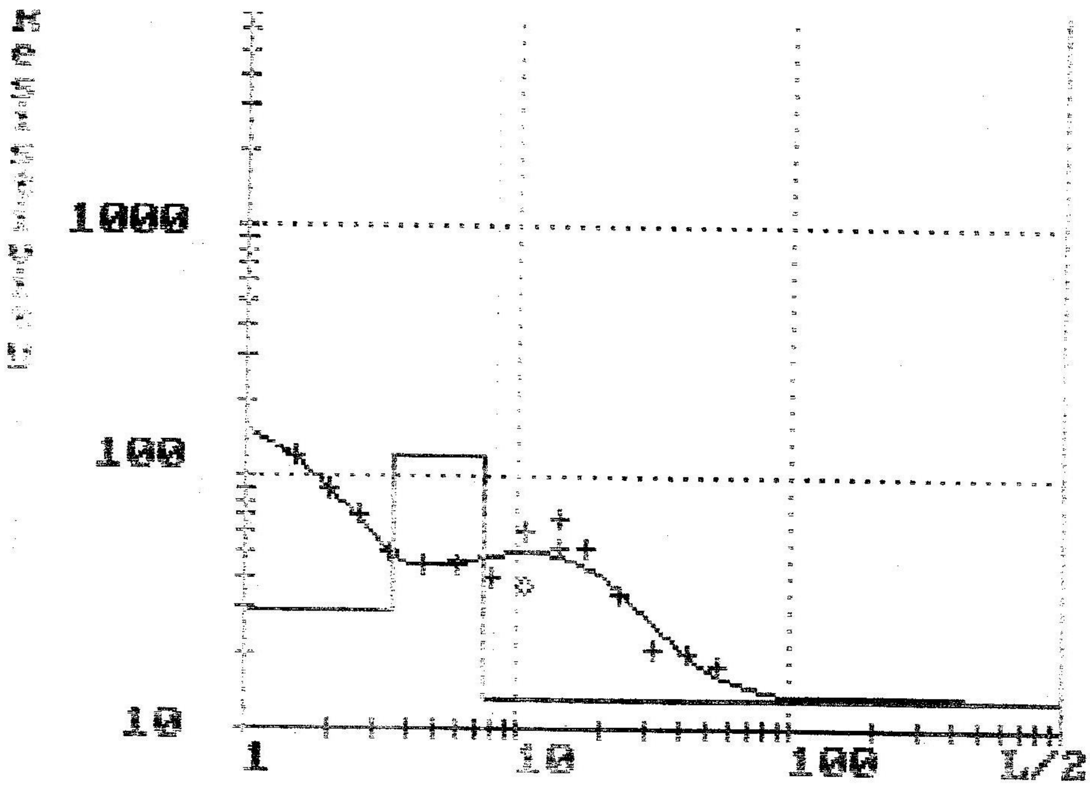
Data (File) name	P-33	Date	6-12-2014
Project name	QUARRY STUDIES	Direction lay out	

N-8,N5 56.706',E7 26.065',H414ft

Code name	P-33	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	105.5	8.0	32.0	24.0	41.2
2.0	63.6	10.5	33.2	32.0	42.7
2.6	40.9	14.0	34.4	42.0	38.5
3.4	46.2	10.5	35.7	55.0	23.0
4.5	43.9	14.0	40.3		
6.0	35.9	18.0	39.2		

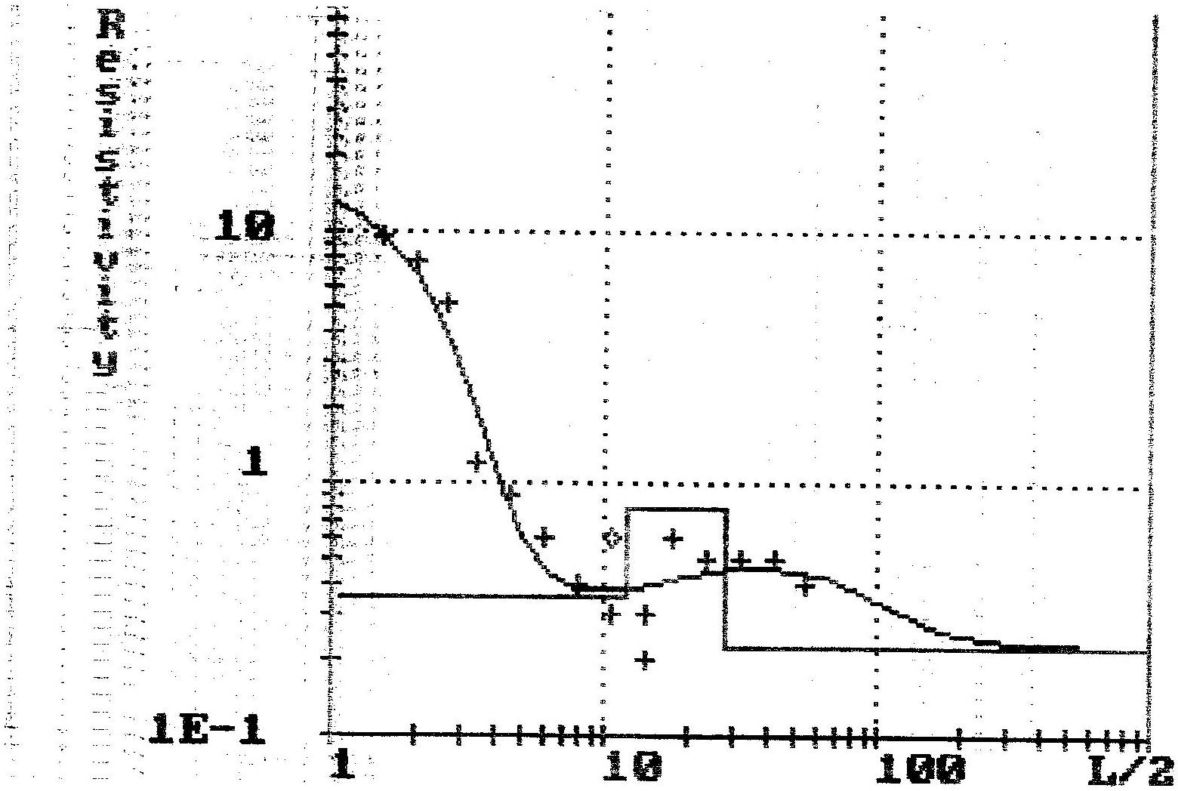
Resistivity (Ohm.m)	Depth (m)
341.0	0.5
34.9	10.7
85.0	20.8
5.2	



Data (File) name	P-34	Date	6-12-2014
Project name	QUARRY STUDIES	Direction lay out	
N-S,N5 56.727',E7 26.067',H388ft			
Code name	P-34	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	119.3	8.0	40.0	24.0	33.4
2.0	89.5	10.5	59.5	32.0	20.4
2.6	69.5	14.0	67.7	42.0	19.7
3.4	49.7	10.5	36.6	55.0	17.8
4.5	44.6	14.0	52 2		
6.0	44.9	18.0	50.9		

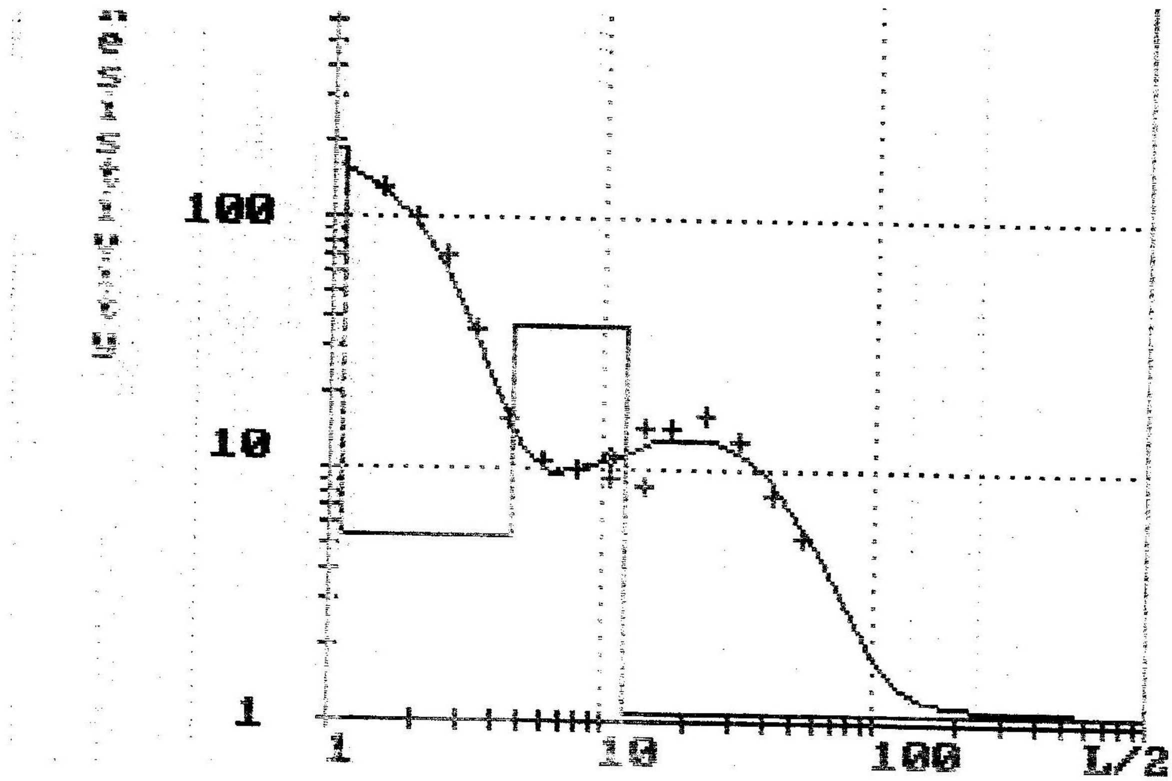
Resistivity (Ohm.m)	Depth (m)
183.0	0.9
29.7	3.5
123.0	7.4
13.3	



Data (File) name P-35 Date 6-12-2014
Project name QUARRY STUDIES Direction lay out
E-W,N5 56.754',E7 26.067',H387ft
Code name P-35 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	9.7	8.0	0.4	24.0	0.5
2.0	7.5	10.5	0.3	32.0	0.5
2.6	5.1	14.0	0.2	42.0	0.5
3.4	1.2	10.5	0.6	55.0	0.4
4.5	0.9	14.0	0.3		
6.0	0.6	18.0	0.6		

Resistivity (Ohm.m)	Depth (m)
15.7	1.0
0.4	12.1
0.8	27.7
0.2	

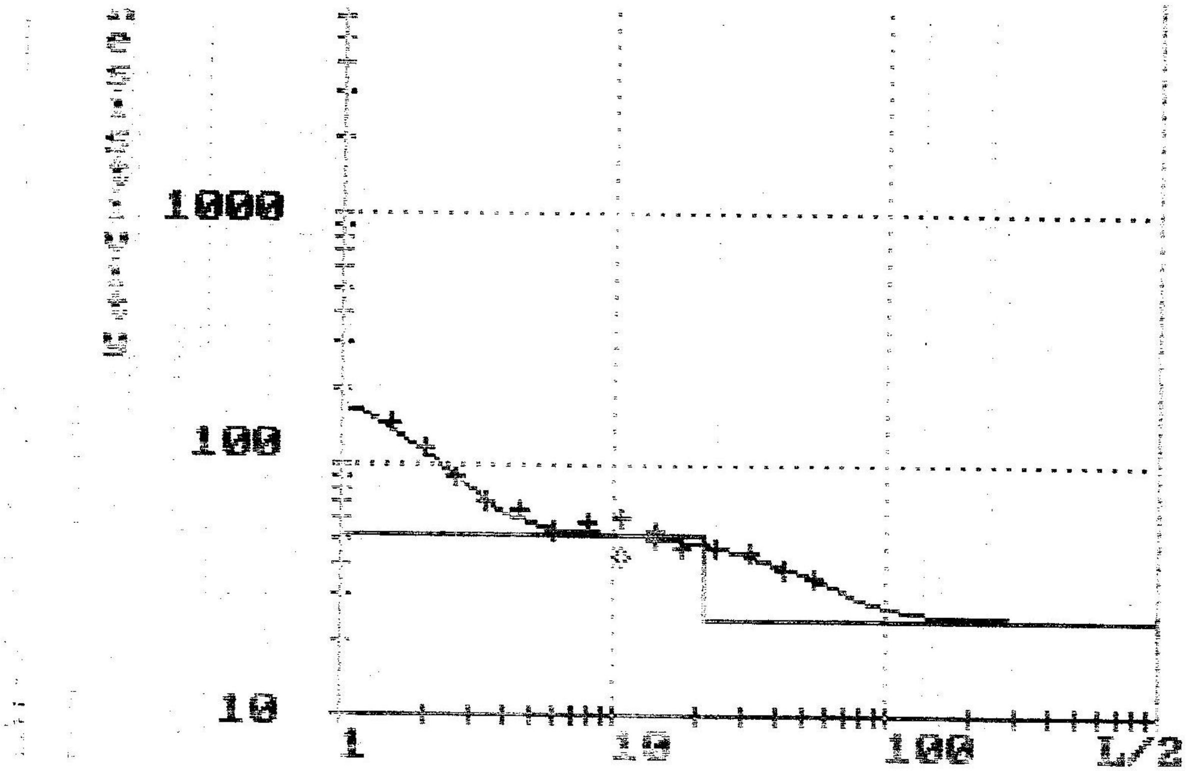


Data (File) name P-41
Project name QUARRY STUDIES
-W(100),N5 56.746',E7 26.110',H456ft
Code name P-41
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.

Date 6-12-2014
Direction lay out
Remarks ABIA STATE
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	129.9	8.0	10.0	24.0	16.7
2.0	97.9	10.5	9.3	32.0	13.2
2.6	70.8	14.0	8.6	42.0	7.9
3.4	33.9	10.5	11.4	55.0	5.4
4.5	15.9	14.0	14.4		
6.0	10.8	18.0	14.8		

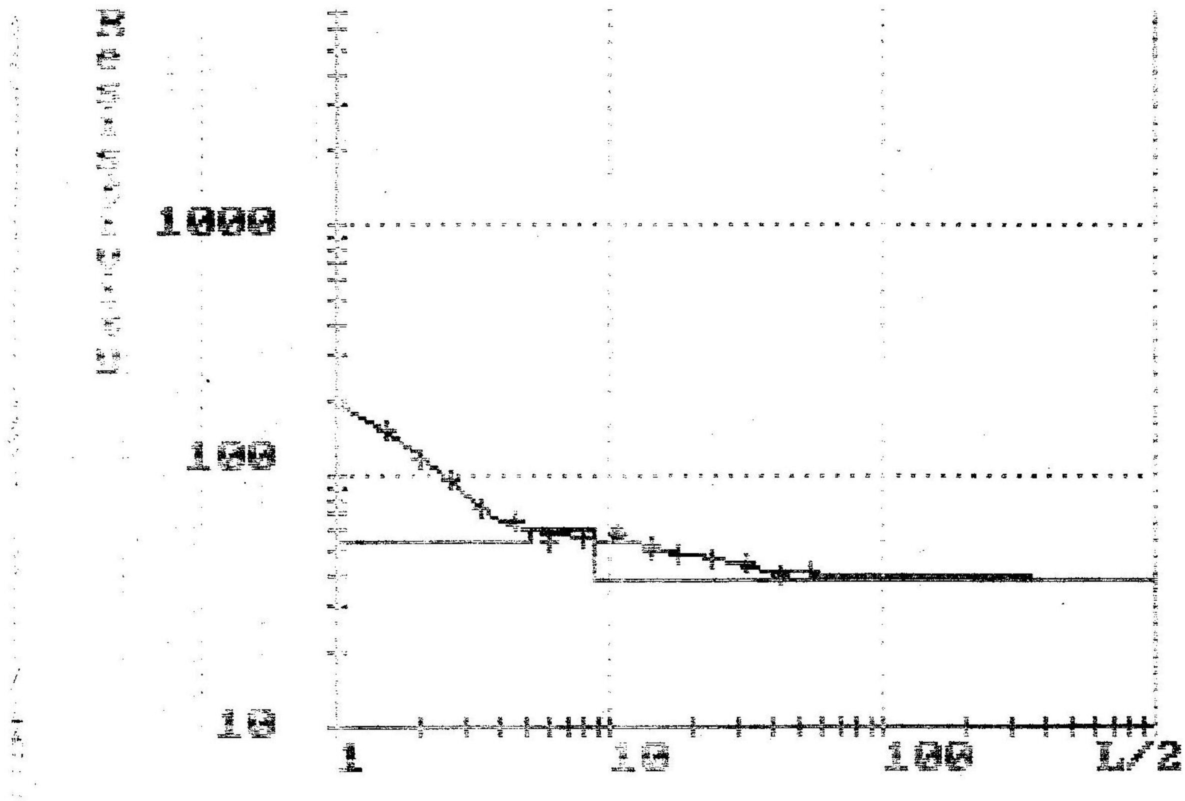
Resistivity (Ohm.m)	Depth (m)
185.0	1.1
5.4	4.6
37.4	12.2
1.1	



Data (File) name P-51 Date 6-12-2014
Project name QUARRY STUDIES Direction lay out
E-W,N5 56.701',E7 26.111',H403ft
Code name P-51 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	144.4	8.0	57.8	24.0	46.3
2.0	114.7	10.5	59.5	32.0	44.9
2.6	88.2	14.0	49.2	42.0	38.5
3.4	69.2	10.5	43.3	55.0	35.2
4.5	64.1	14.0	53.6		
6.0	54.1	18.0	46.2		

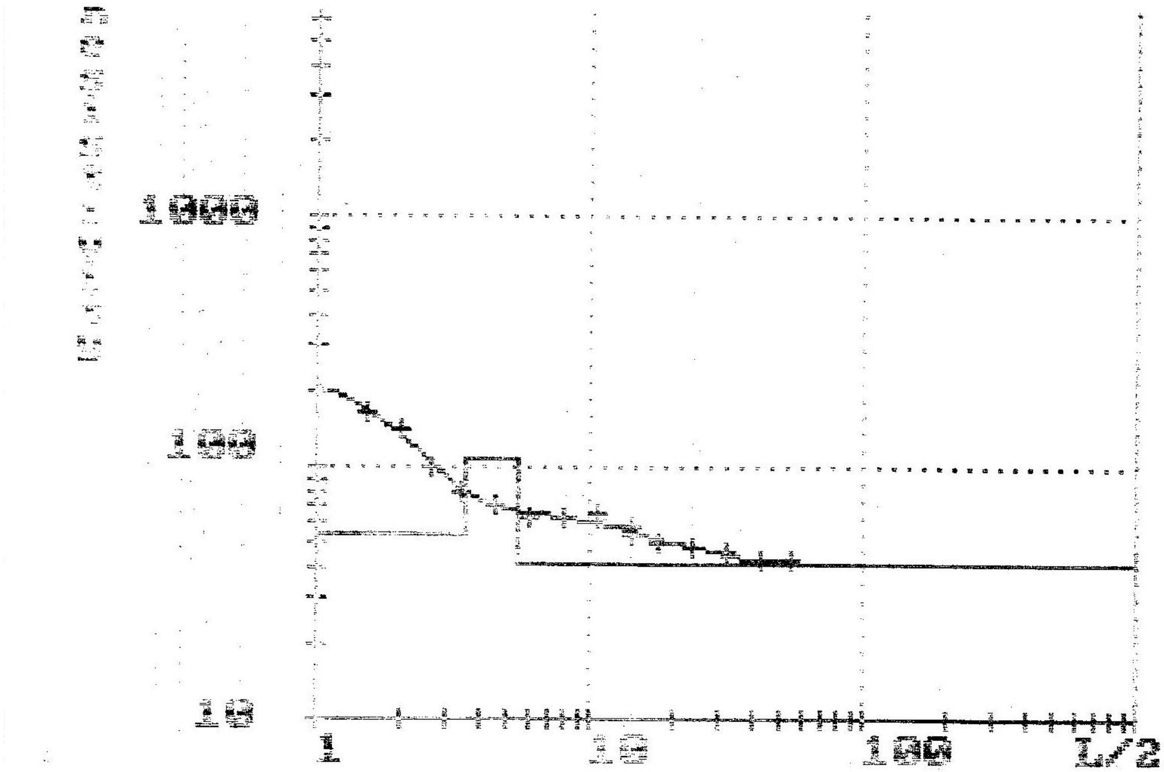
Resistivity (Ohm.m)	Depth (m)
198.0	0.9
51.2	21.4
24.3	



Data (File) name P-32 Date 6-12-2014
Project name QUARRY STUDIES Direction lay out
N-S,N5 56.680',E7 26.072',H413ft
Code name P-32 Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	153.3	8.0	56.2	24.0	46.9
2.0	115.2	10.5	58.3	32.0	45.3
2.6	95.6	14.0	50.2	42.0	40.2
3.4	72.5	10.5	57.9	55.0	41.2
4.8	65.2	14.0	51.0		
6.0	54.8	18.0	47.3		

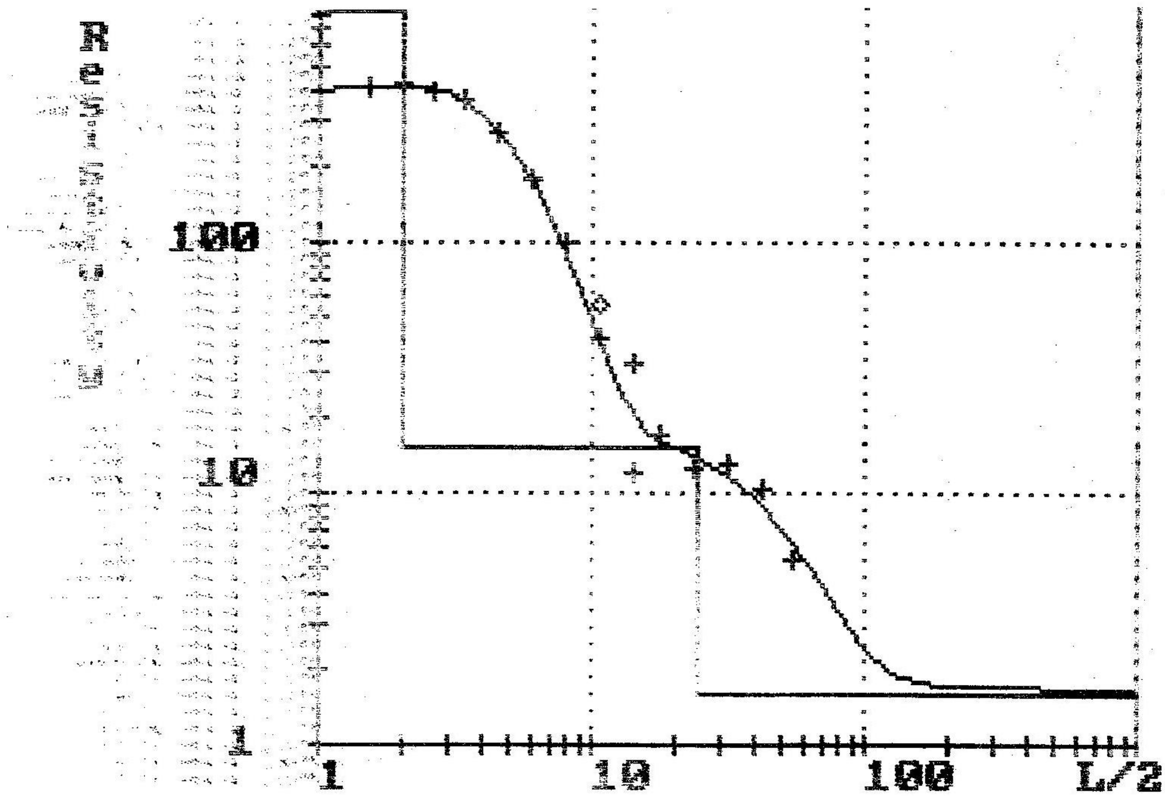
Resistivity (Ohm.m)	Depth (m)
225.0	0.8
55.0	5.1
60.4	8.7
39.0	



Data (File) name P-53 Date 6-12-2014
Project name QUARRY STUDIES Direction lay out
E-SW(30),N5 54.685',E7 26.050',H374ft
Code name P-53 Remarks ABIA STATE
Coordinates LONFAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	165.1	8.0	63.1	24.0	47.5
2.0	142.0	10.5	63.3	32.0	46.1
2.5	101.3	14.0	59.1	42.0	43.3
3.4	80.3	10.5	67.5	55.0	42.5
4.5	71.5	14.0	54.2		
6.0	62.1	18.0	49.3		

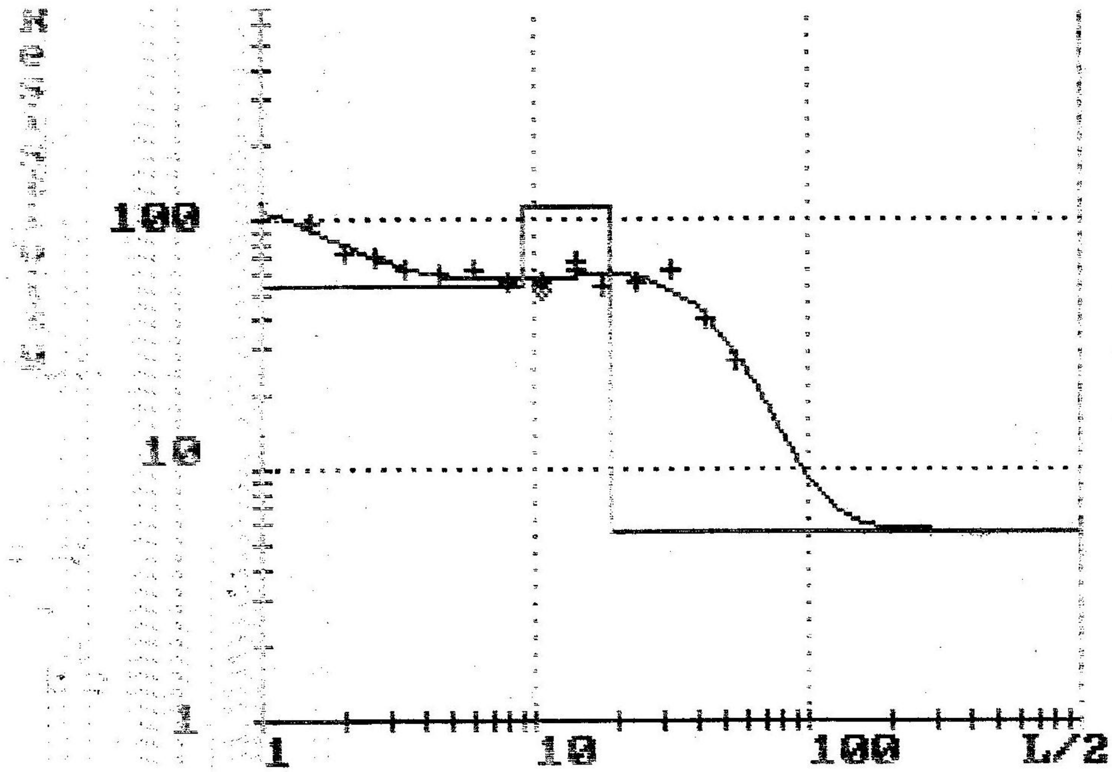
Resistivity (Ohm.m)	Depth (m)
238.0	0.9
53.1	1.5
105.0	3.8
41.0	



Data (File) name	PG 1	Date	5-12-2014
Project name	QUARRY STUDIES	Direction lay out	
IE-SW(40)',N5 56.521',E/	25.661',H381ft		
Code name	VES P61	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	409.5	8.0	100.0	24.0	12.7
2.0	425.8	10.5	41.5	32.0	13.2
2.6	394.7	14.0	12.3	42.0	10.2
3.4	362.1	10.5	55.0	55.0	5.4
4.5	270.0	14.0	32.2		
6.0	179.7	18.0	16.8		

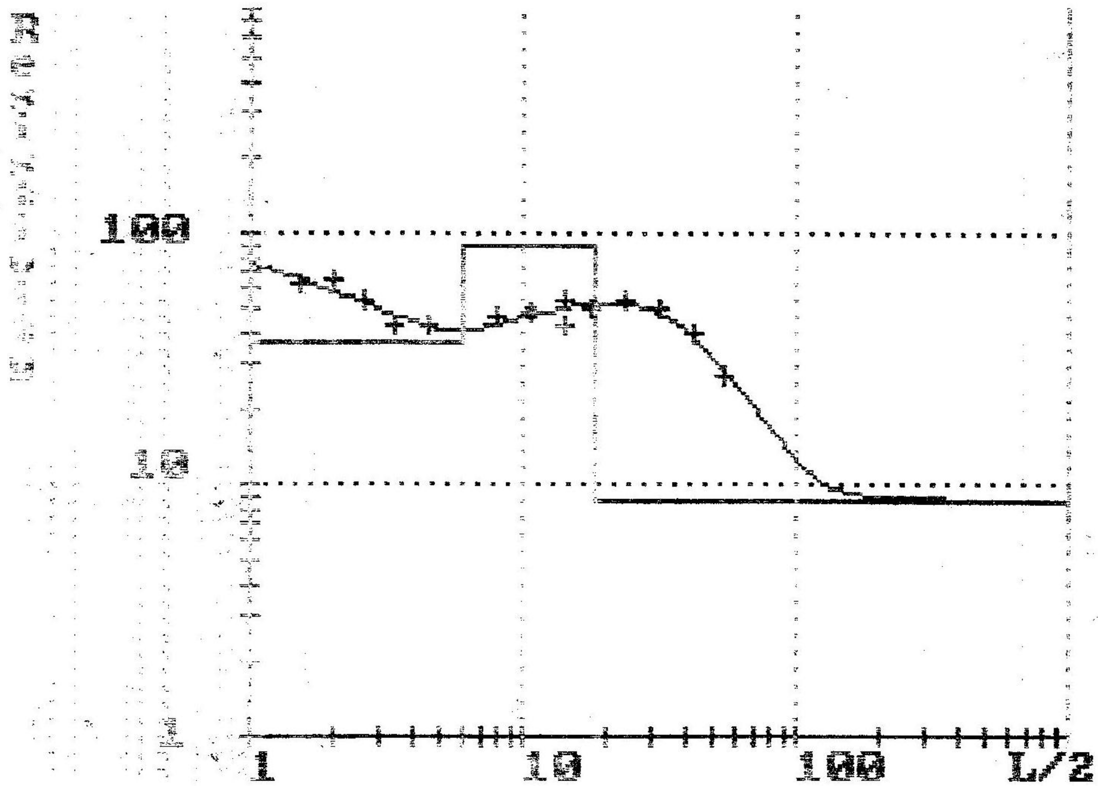
Resistivity (Ohm.m)	Depth (m)
386.0	1.0
810.0	2.0
15.3	24.4
1.6	



Data (File) name	P62	Date	5-12-2014
Project name	QUARRY STUDIES	Direction lay out	
NW-SE(340),N5 56.381',E7 25.741',H392ft			
Code name	VES P62	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	97.3	8.0	56.0	24.0	55.7
2.0	74.2	10.5	55.4	32.0	63.6
2.6	71.6	14.0	67.7	42.0	39.3
3.4	63.9	10.5	52.8	55.0	27.0
4.5	61.5	14.0	61.9		
6.0	61.8	18.0	53.2		

Resistivity (Ohm.m)	Depth (m)
123.0	0.8
54.4	9.1
111.0	18.7
5.6	



Data (File) name P63 Date 5-12-2014

Project name QUARRY STUDIES . Direction lay out

NW-SE(350),N5 56.682',..7 25.801',H381ft

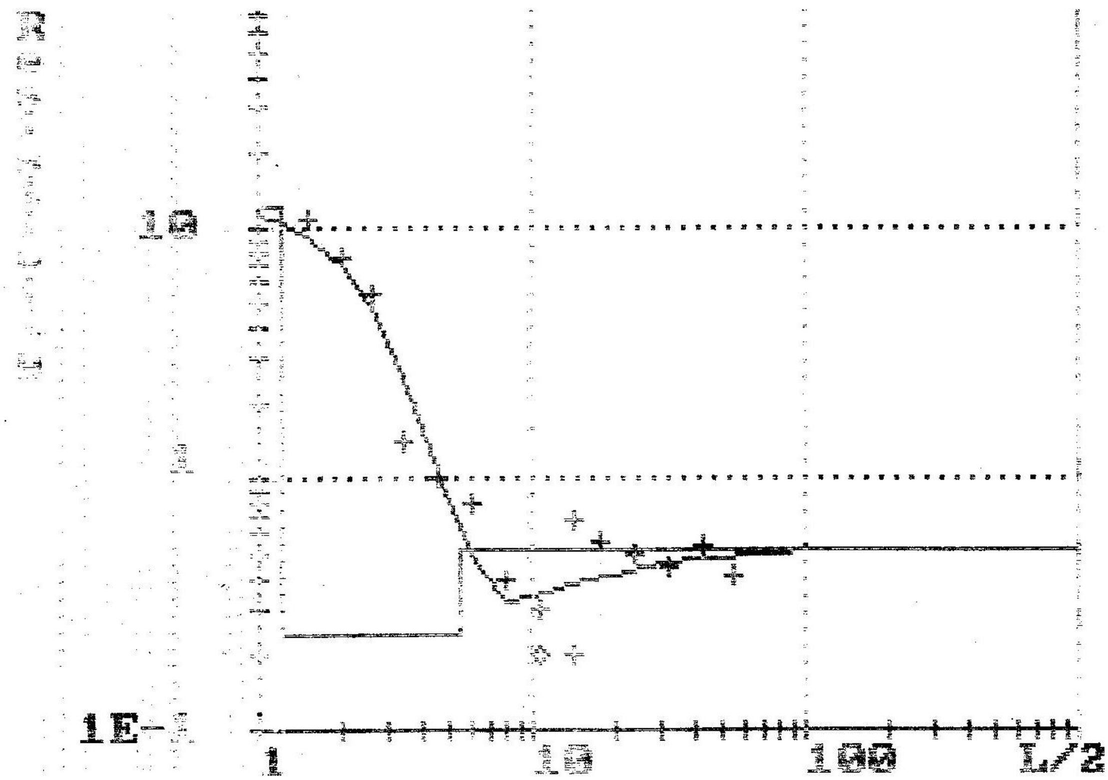
Code name VES P63 Remarks ABIA STATE

Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.

Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	63.4	8.0	46.0	24.0	53.1
2.0	65.9	10.5	48.4	32.0	49.9
2.6	53.2	14.0	43.1	42.0	40.1
3.4	42.6	10.5	49.4	55.0	27.0
4.5	42.7	14.0	53.6		
6.0	41.6	18.0	49.0		

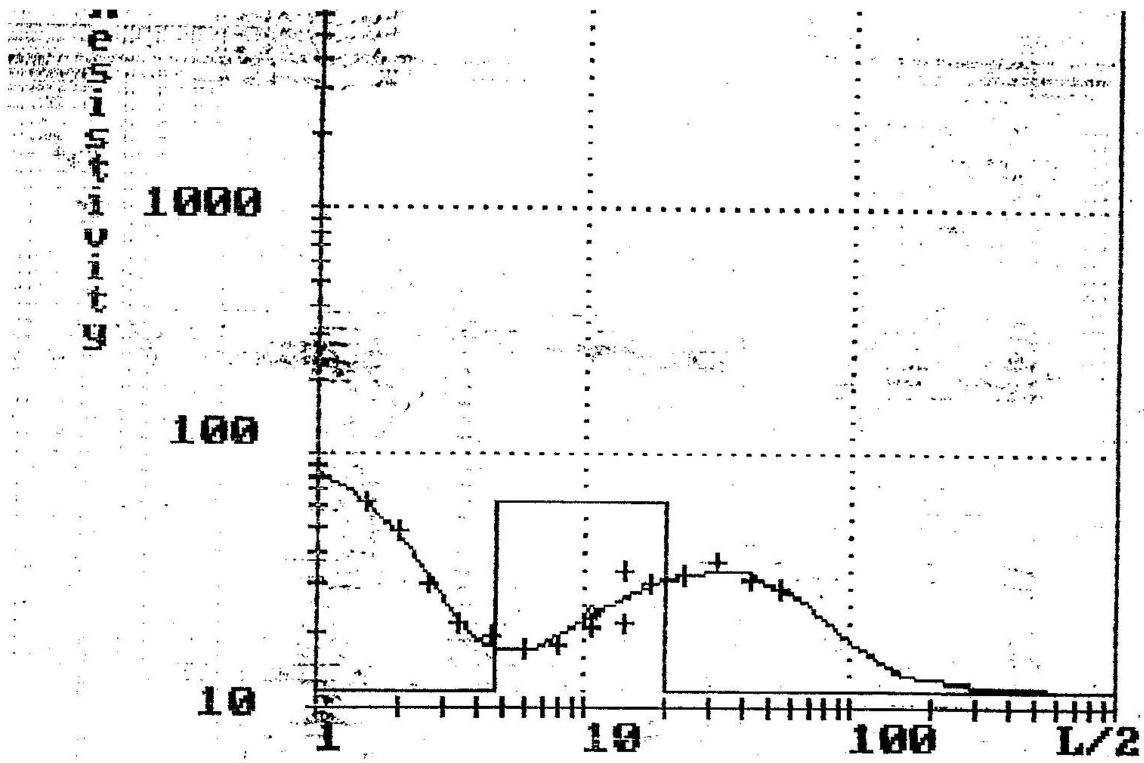
Resistivity (Ohm.m)	Depth (m)
83.0	0.8
36.4	6.0
68.0	18.4
8.6	



Data (File) name	P64	Date	5-12-2014
Project name	QUARRY STUDIES	Direction lay out	
W(271),N5 56.742',E7 25.963',H389ft			
Code name	VES P64	Remarks	ABIA STATE
Coordinates	LOKPAUKWU,UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	10.7	8.0	0.4	24.0	0.5
2.0	7.7	10.5	0.3	32.0	0.4
2.6	5.0	14.0	0.2	42.0	0.6
3.4	1.4	10.5	0.2	55.0	0.4
4.5	1.0	14.0	0.7		
6.0	0.8	18.0	0.6		

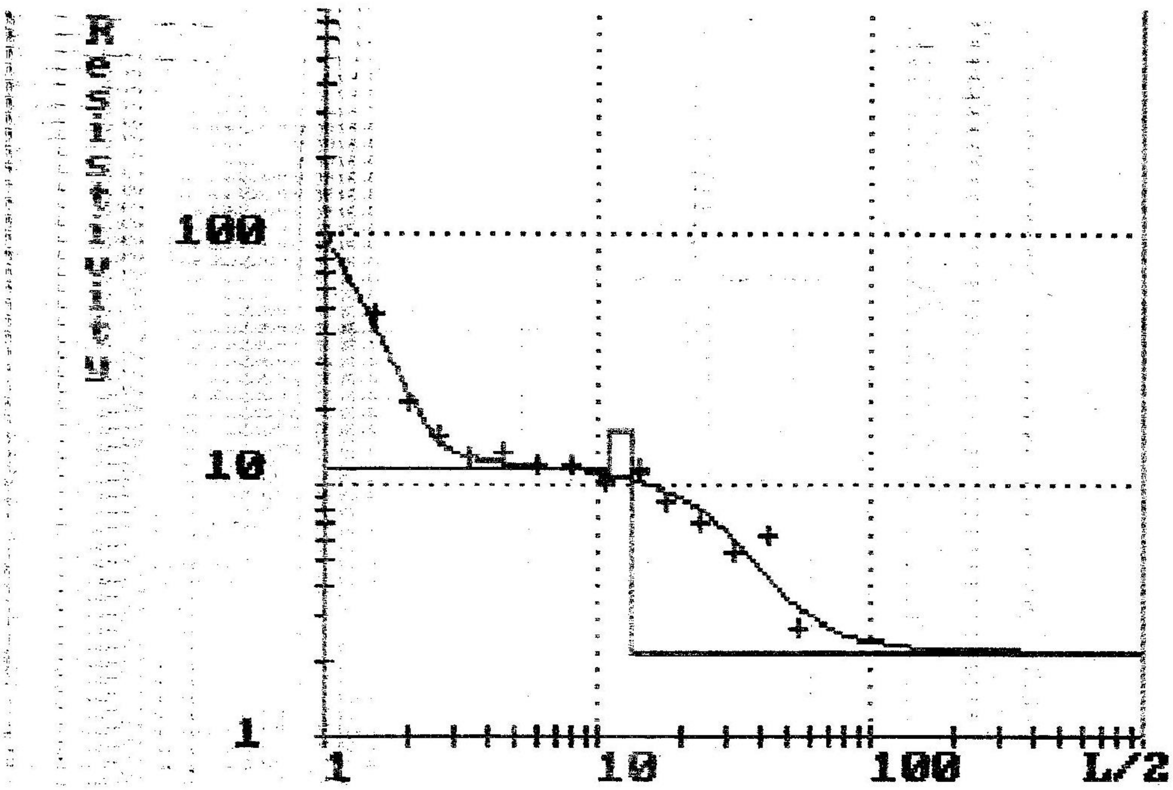
Resistivity (Ohm.m)	Depth (m)
12.3	1.2
0.2	5.4
0.5	



Data (File) name V71 | Date 5-12-2014
Project name QUARRY STUDIES | Direction lay out
W-SE(345),N5 56.582',E7 25.961',H386ft
Code name VES 71 | Remarks ABIA STATE
Coordinates LOKPAUKWU,UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	62.8	8.0	18.0	24.0	32.9
2.0	48.3	10.5	20.8	32.0	36.3
2.6	30.7	14.0	21.5	42.0	31.4
3.4	21.3	10.5	23.3	55.0	29.2
4.5	18.8	14.0	34.6		
6.0	16.9	18.0	30.8		

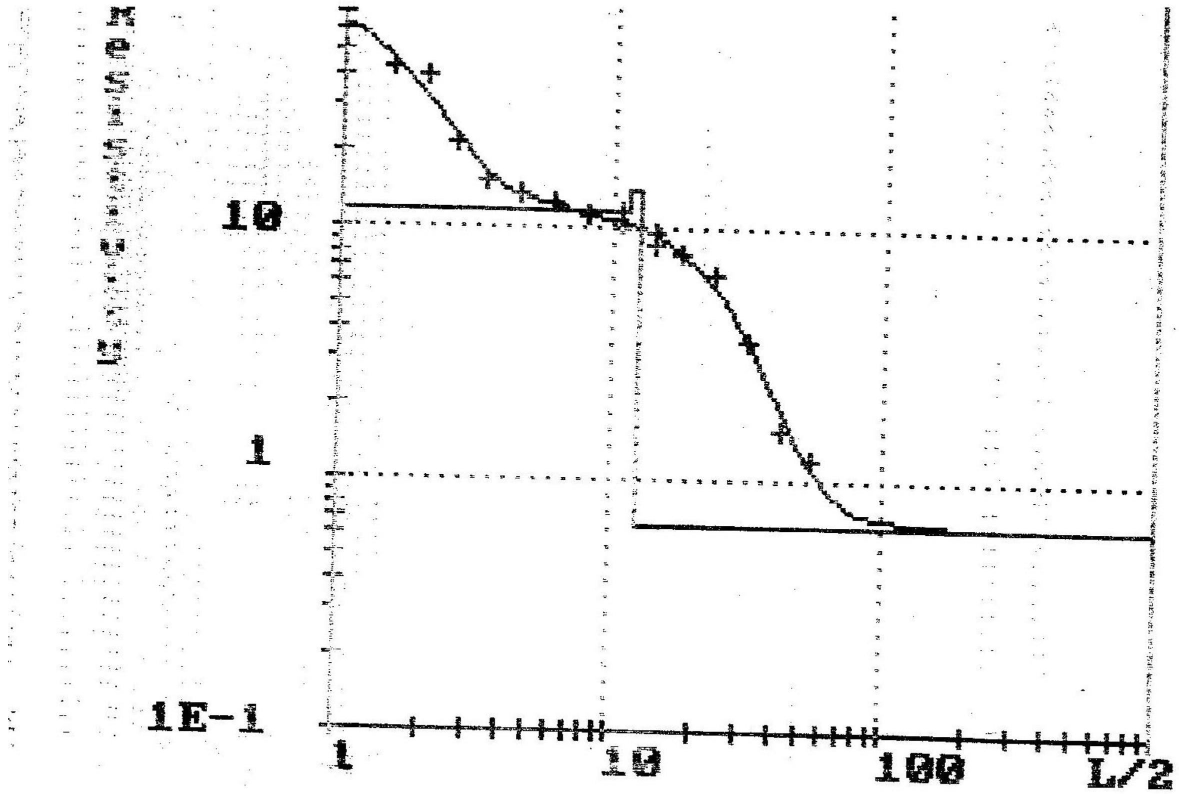
Resistivity (Ohm.m)	Depth (m)
97.0	0.9
11.8	4.7
63.9	20.1
11.8	



Data (File) name P-11 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
NE-SSW(10),N5 56.999',E7 28.113',H336ft
Code name P-11 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	48.4	8.0	12.0	24.0	7.1
2.0	21.2	10.5	10.4	32.0	5.5
2.6	15.6	14.0	11.1	42.0	6.3
3.4	12.8	10.5	10.5	55.0	2.7
4.5	13.3	14.0	11.5		
6.0	12.1	18.0	8.5		

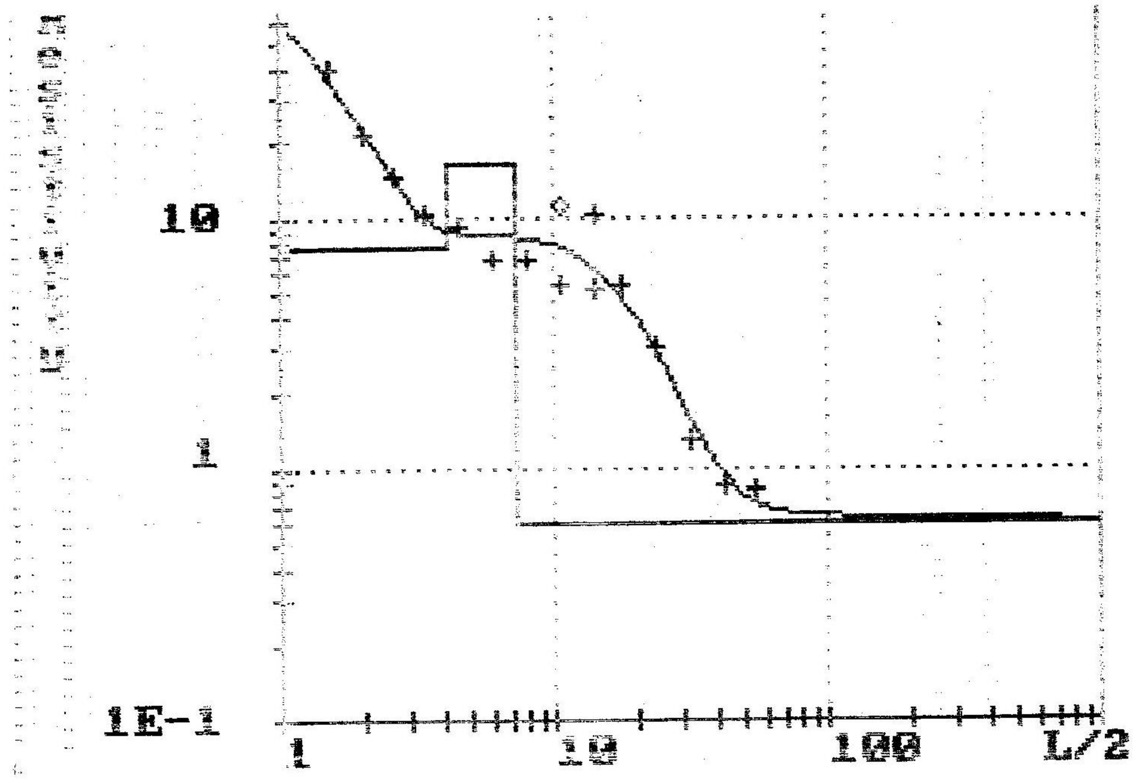
Resistivity (Ohm.m)	Depth (m)
236.0	0.5
11.7	11.1
16.2	13.5
2.2	



Data (File) name	P-12	Date	11-12-2014
Project name	QUARRY STUDIES	Direction lay out	
-S,N5 57.083',E7 28.117',H288ft			
Code name	P-12	Remarks	ABIA STATE
Coordinates	LEKWESI, UMUNNEOCHI L.G.A.	Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	42.7	8.0	11.0	24.0	6.6
2.0	40.1	10.5	11.8	32.0	3.6
2.6	21.3	14.0	8.6	42.0	1.6
3.4	15.3	10.5	10.3	55.0	1.2
4.5	13.3	14.0	7.6		
6.0	12.4	18.0	7.9		

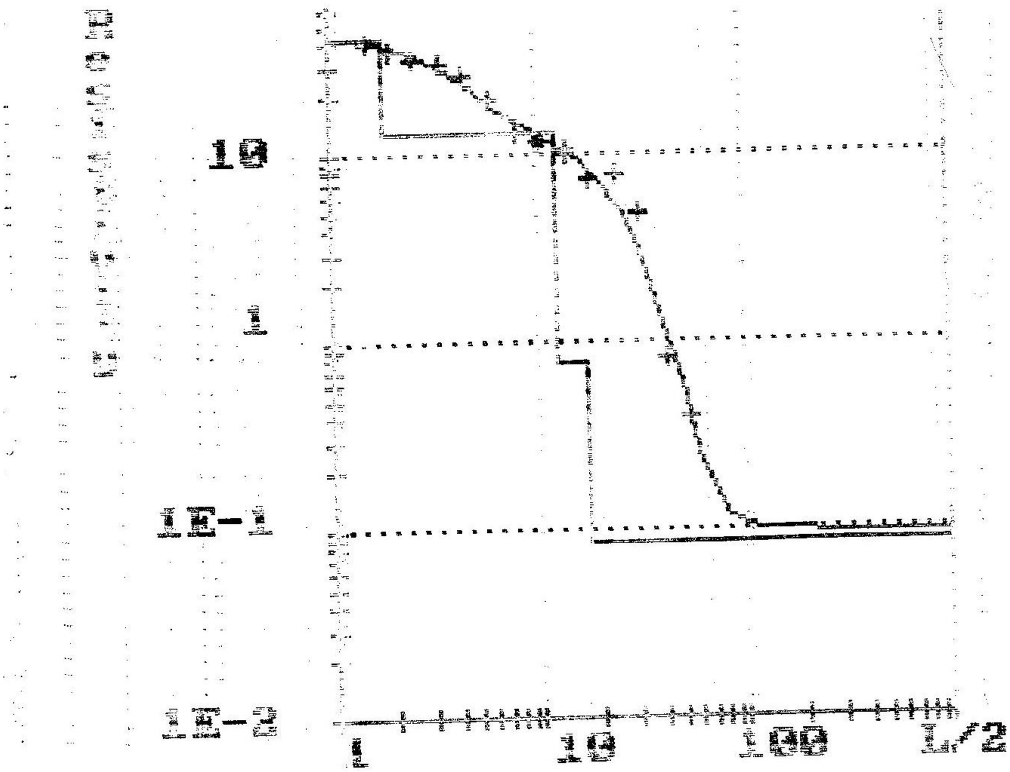
Resistivity (Ohm.m)	Depth (m)
81.0	0.8
11.6	11.5
13.9	12.6
0.6	



Data (File) name P-13 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
NE-SSW(10),N5 57.073',E7 28.120',H350ft
Code name P-13 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	38.9	8.0	6.8	24.0	3.0
2.0	21.2	10.5	5.5	32.0	1.3
2.6	14.7	14.0	5.1	42.0	0.9
3.4	10.4	10.5	11.3	55.0	0.8
4.5	9.4	14.0	10.2		
6.0	6.9	18.0	5.3		

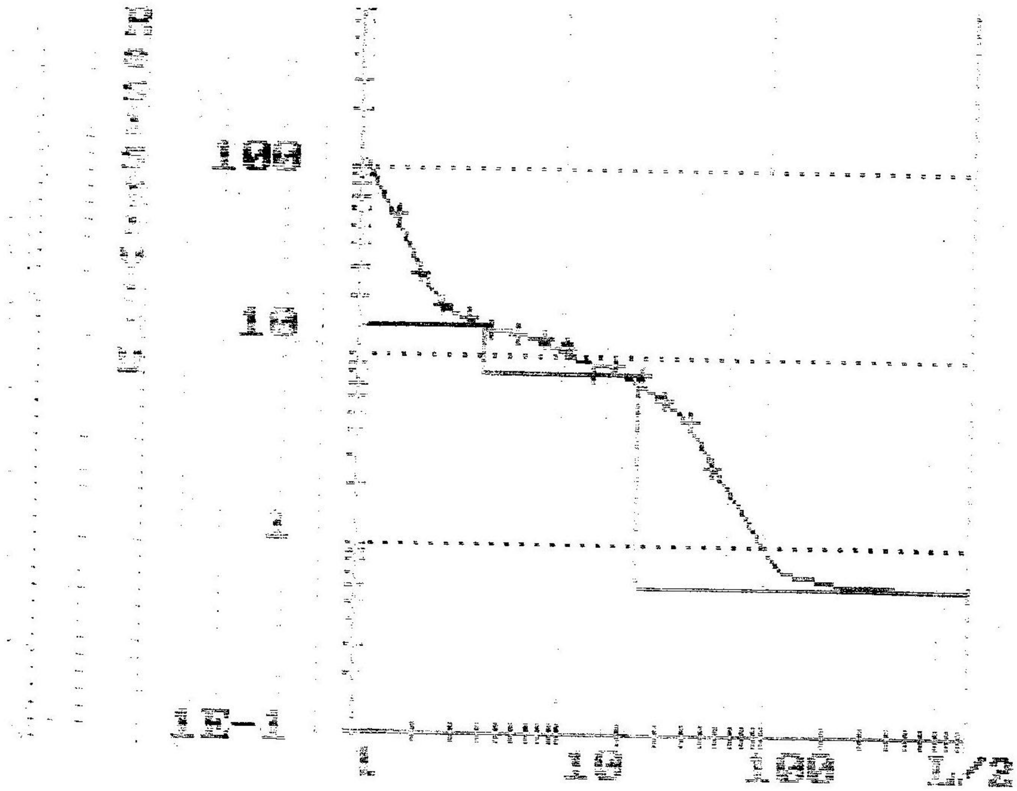
Resistivity (Ohm.m)	Depth (m)
89.0	0.7
7.6	4.1
16.6	7.3
0.6	



Data (File) name	P-21	Date	11-12-2014
Project name	QUARRY STUDIES,	Direction lay out	
E-W(273),N5 56.962',E7 28.169',H330ft			
Code name	P-21	Remarks	ABIA STATE
Coordinates	LEKWESI, UMUNNEOCHI L.G.A.	Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	39.2	8.0	12.6	24.0	7.8
2.0	36.5	10.5	11.4	32.0	4.9
2.6	32.7	14.0	10.3	42.0	0.8
3.4	31.2	10.5	11.8	55.0	0.4
4.5	25.9	14.0	10.2		
6.0	19.1	18.0	7.4		

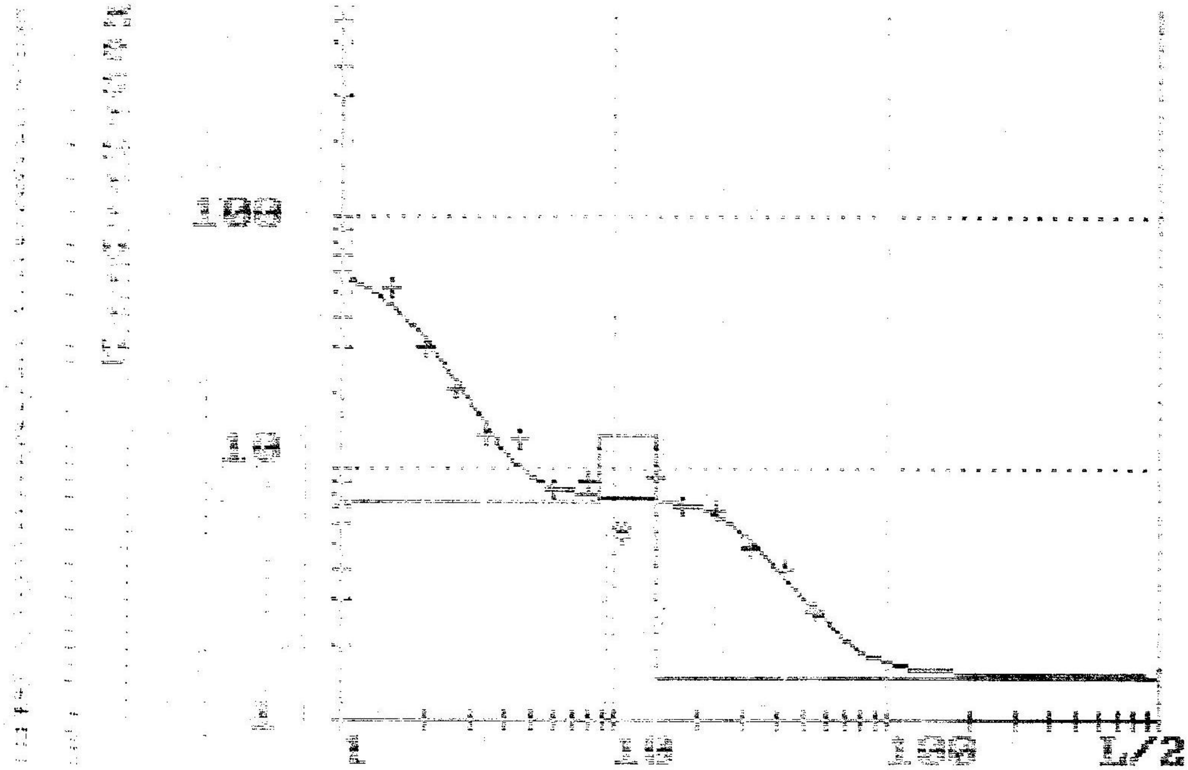
Resistivity (Ohm.m)	Depth (m)
42.9	1.6
12.9	12.6
0.8	17.4
0.1	



Data (File) name	F-22	Date	11-12-2014
Project name	QUARRY STUDIES	Direction lay out	
NE-SW(310),N5 57.006',E7 26.181',H336ft			
Code name	F-22	Remarks	ABIA STATE
Coordinates	LEKWESI, UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	55.9	8.0	12.4	24.0	8.1
2.0	77.1	10.5	11.1	32.0	5.9
2.6	18.2	14.0	5.6	42.0	4.7
3.4	10.6	[illegible]	11.2	55.0	2.7
4.5	13.5	[illegible]	6.1		
6.0	12.7	[illegible]	8.8		

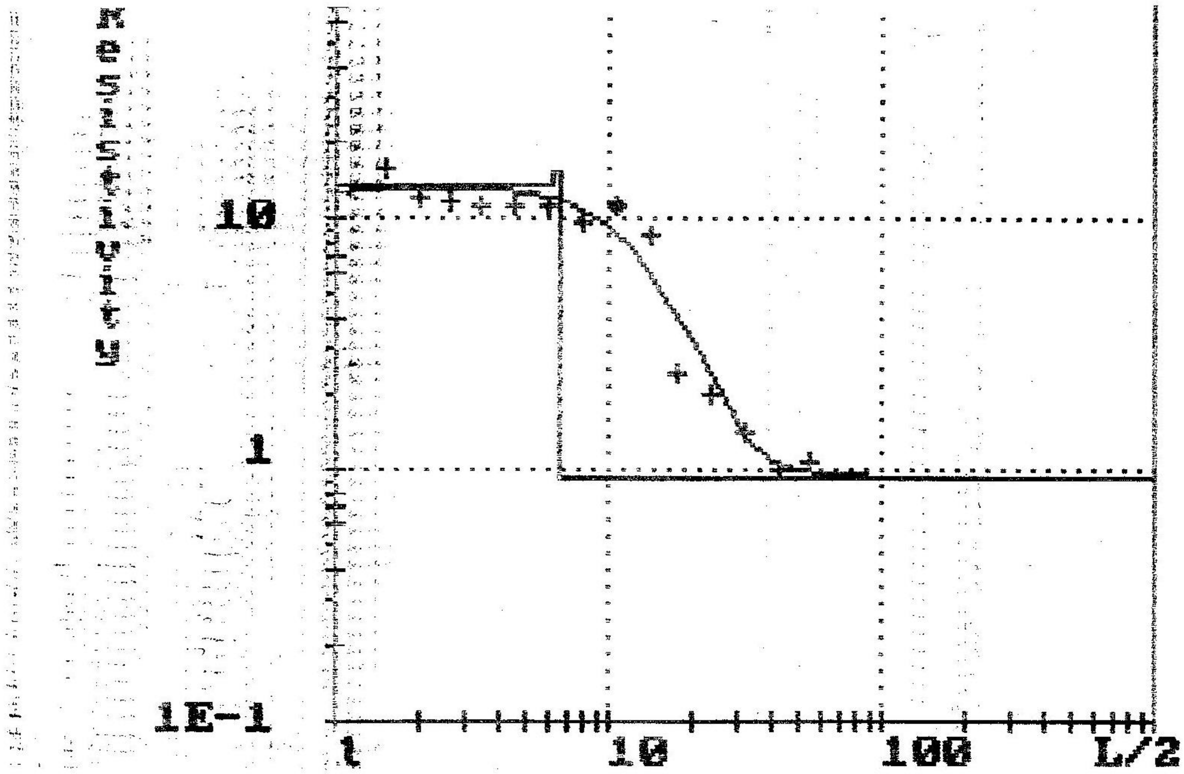
Resistivity (Ohm.m)	Depth (m)
299.0	[illegible]
14.5	[illegible]
6.3	23.3
0.6	



Data (File) name P-23 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
NE-SW(200),N5 57.030',E7 28.190',H234m
Code name P-23 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger 01Nal11

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	50.9	8.0	8.8	24.0	6.8
2.0	30.6	10.0	8.5	32.0	4.9
2.6	20.5	14.0	7.2	42.0	3.9
3.4	13.6	[illegible]	7.9	55.0	2.7
4.5	12.8	[illegible]	7.2		
6.0	8.3	18.0	7.1		

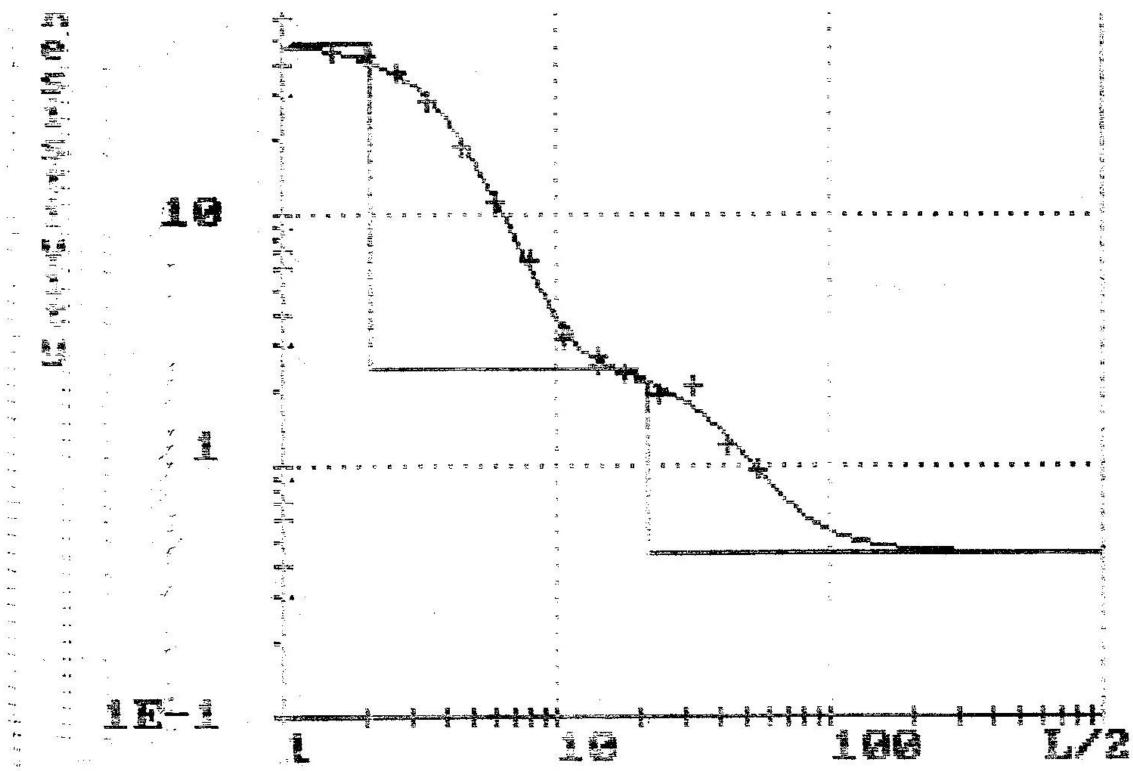
Resistivity (Ohm.m)	Depth (m)
67.7	1.0
7.3	1.9
13.8	14.3
1.5	



Data (File) name P-24 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
NE-SW(210),N5 57.063',E7 28.201',H322ft
Code name P-24 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	15.9	8.0	9.6	24.0	2.0
2.0	12.3	10.5	11.1	32.0	1.4
2.6	11.5	14.0	8.6	42.0	1.0
3.4	11.1	10.5	11.3	55.0	1.1
4.5	11.4	14.0	8.4		
6.0	11.2	18.0	2.4		

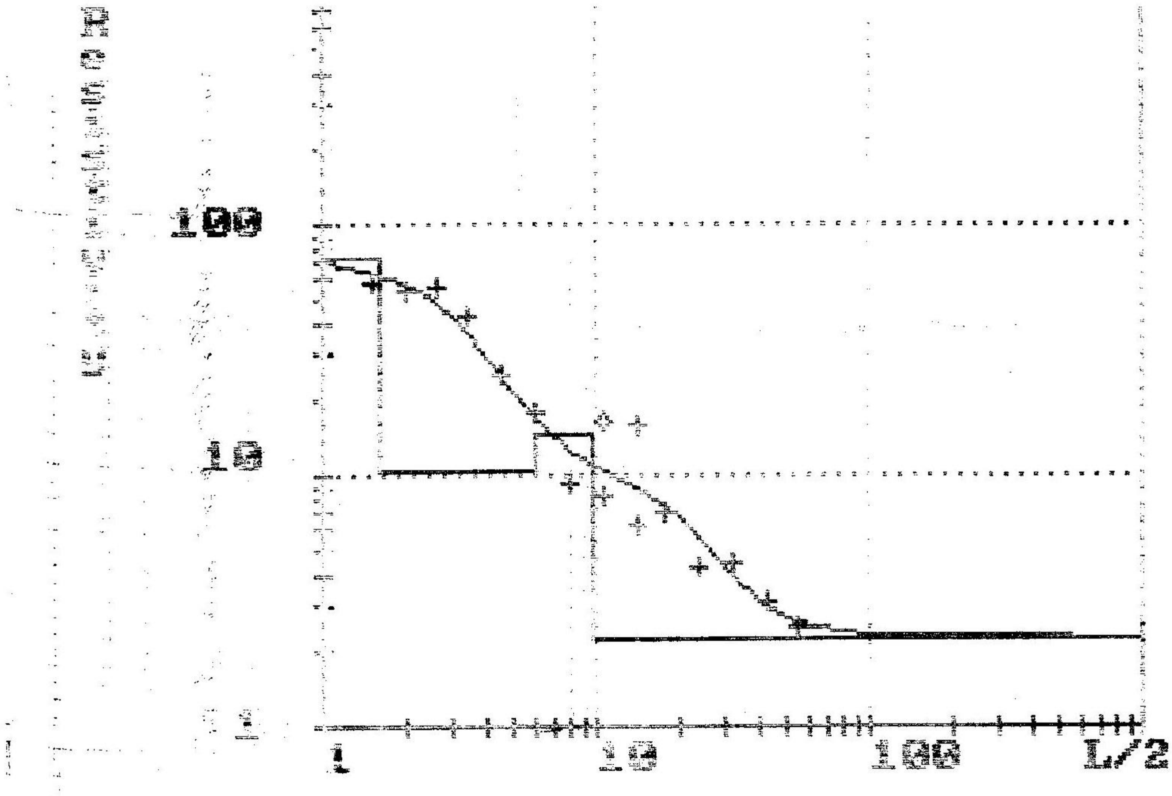
Resistivity (Ohm.m)	Depth (m)
12.6	0.7
13.8	6.1
15.5	6.6
0.9	



Data (File) name P-31 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
W(270),N5 56.959',E7 28.225',H349ft
Code name P-31 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	44.6	8.0	6.6	24.0	1.9
2.0	42.4	10.5	3.1	32.0	2.1
2.6	36.8	14.0	2.7	42.0	1.2
3.4	22.4	10.5	3.4	55.0	0.9
4.5	18.2	14.0	2.5		
6.0	11.0	18.0	2.3		

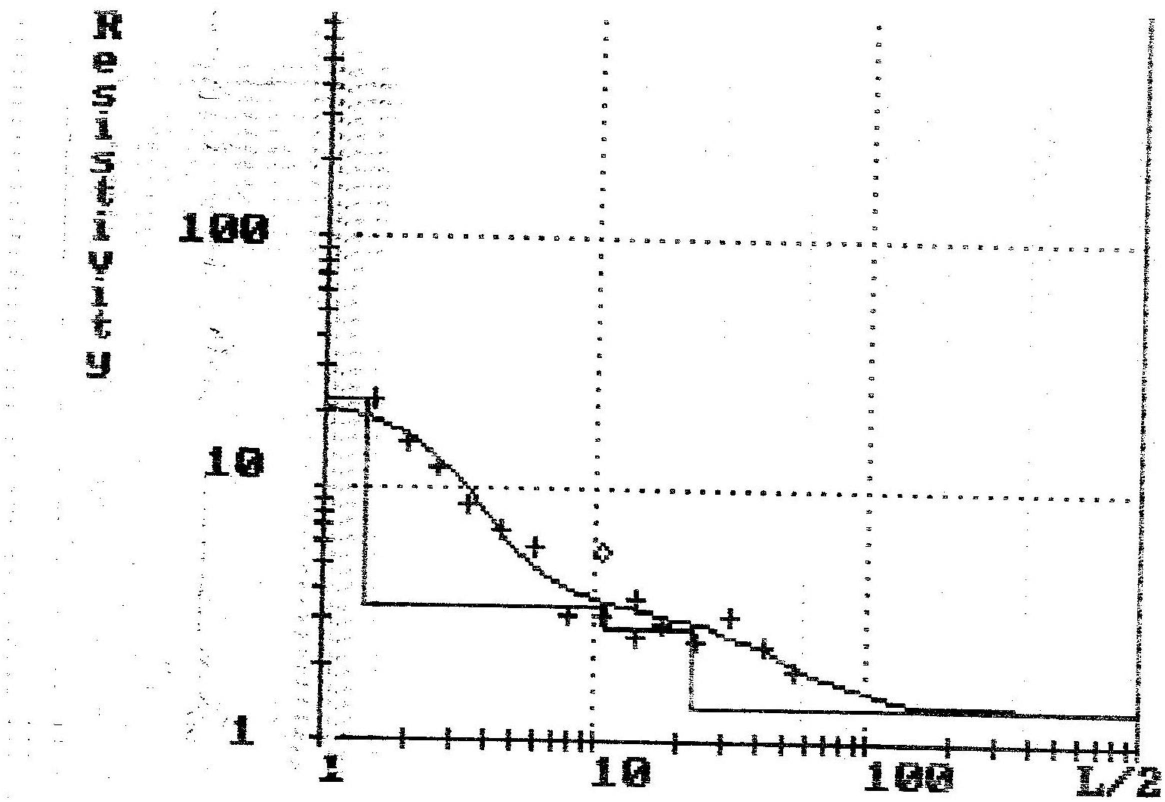
Resistivity (Ohm.m)	Depth (m)
47.6	2.1
2.5	19.3
2.2	21.3
0.4	



Data (File) name P-32 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
NE-SW(210),N5 57.001',E7 28.233',H348ft
Code name P-32 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	58.4	8.0	9.4	24.0	4.3
2.0	53.0	10.5	8.3	32.0	4.5
2.6	55.2	14.0	6.2	42.0	3.1
3.4	42.6	10.5	16.7	55.0	2.5
4.5	25.1	14.0	15.7		
6.0	17.9	18.0	7.2		

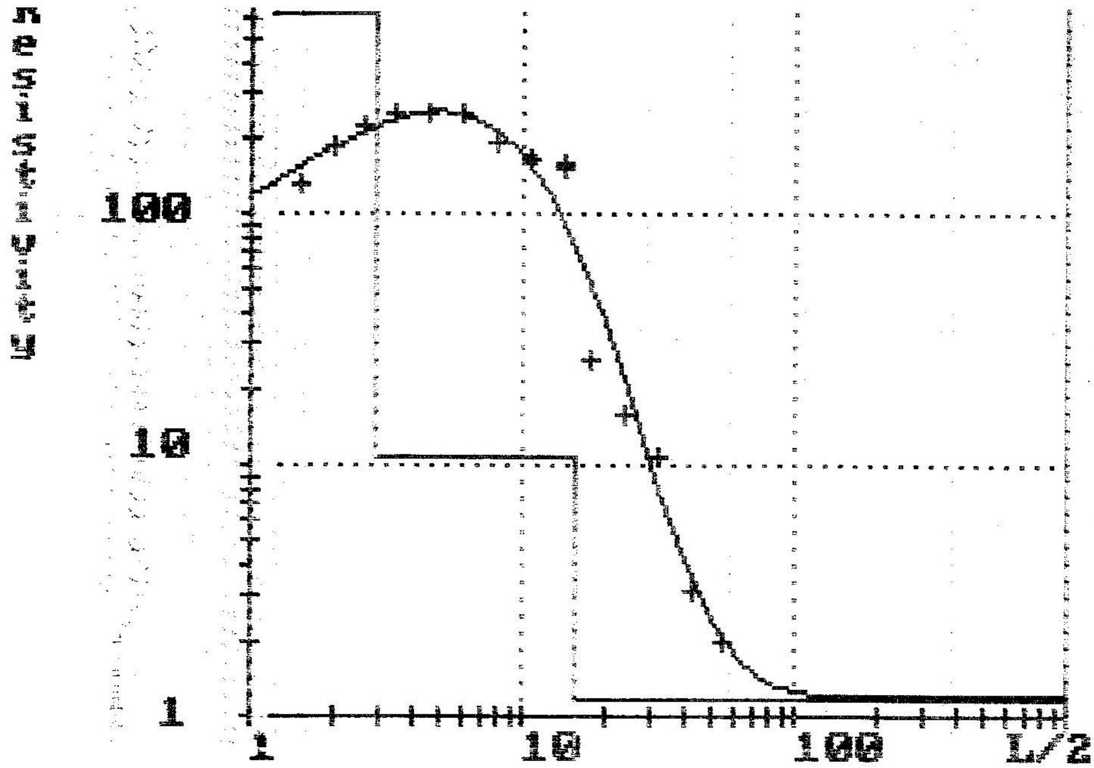
Resistivity (Ohm.m)	Depth (m)
72.2	1.6
10.2	6.0
14.9	9.7
2.3	



Data (File) name P-33
Project name QUARRY STUDIES
-S(0),N5 57.044',E7°28.231',H271ft
Code name P-33
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Date 11-12-2014
Direction lay out
Remarks ABIA STATE
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	21.9	8.0	3.2	24.0	2.5
2.0	15.3	10.5	3.1	32.0	3.2
2.6	12.3	14.0	3.7	42.0	2.4
3.4	8.5	10.5	5.7	55.0	1.9
4.5	6.9	14.0	2.6		
6.0	5.8	18.0	2.9		

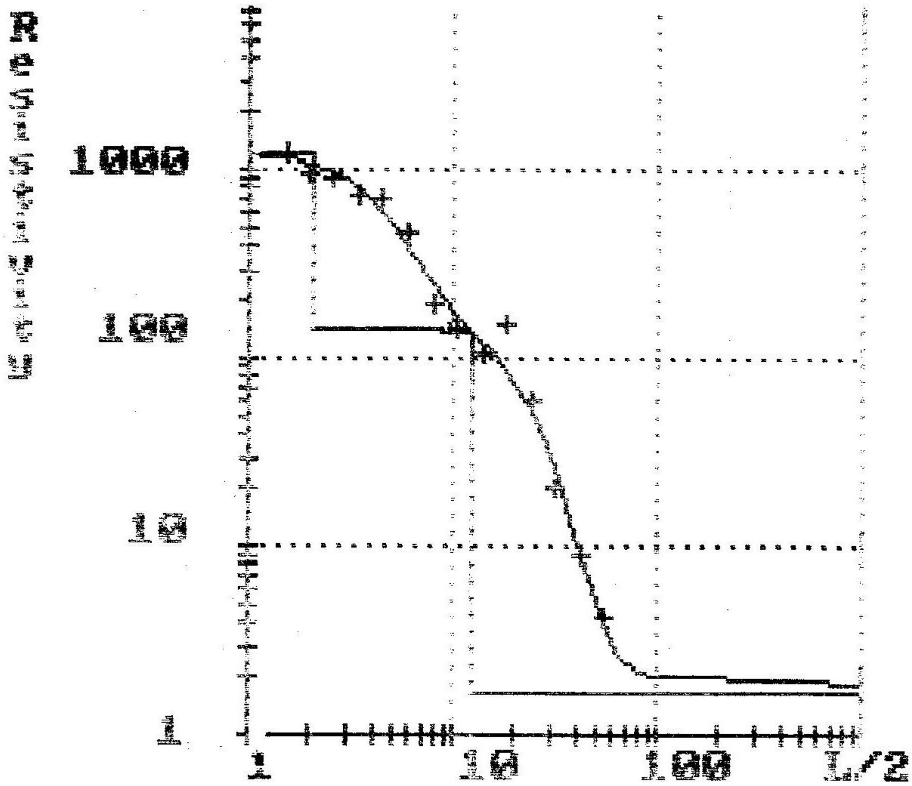
Resistivity (Ohm.m)	Depth (m)
22.0	1.4
3.5	10.9
2.8	23.2
1.4	



Data (File) name	P-41	Date	11-12-2014
Project name	QUARRY STUDIES	Direction lay out	
:-W(270),N5 56.959',E7 28.087',H368ft			
Code name	P-41	Remarks	ABIA STATE
Coordinates	LEKWESI, UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	130.0	8.0	192.0	24.0	15.7
2.0	186.1	10.5	166.0	32.0	10.9
2.6	218.8	14.0	156.2	42.0	3.1
3.4	244.9	10.5	165.1	55.0	2.0
4.5	244.9	14.0	154.0		
6.0	247.1	18.0	26.2		

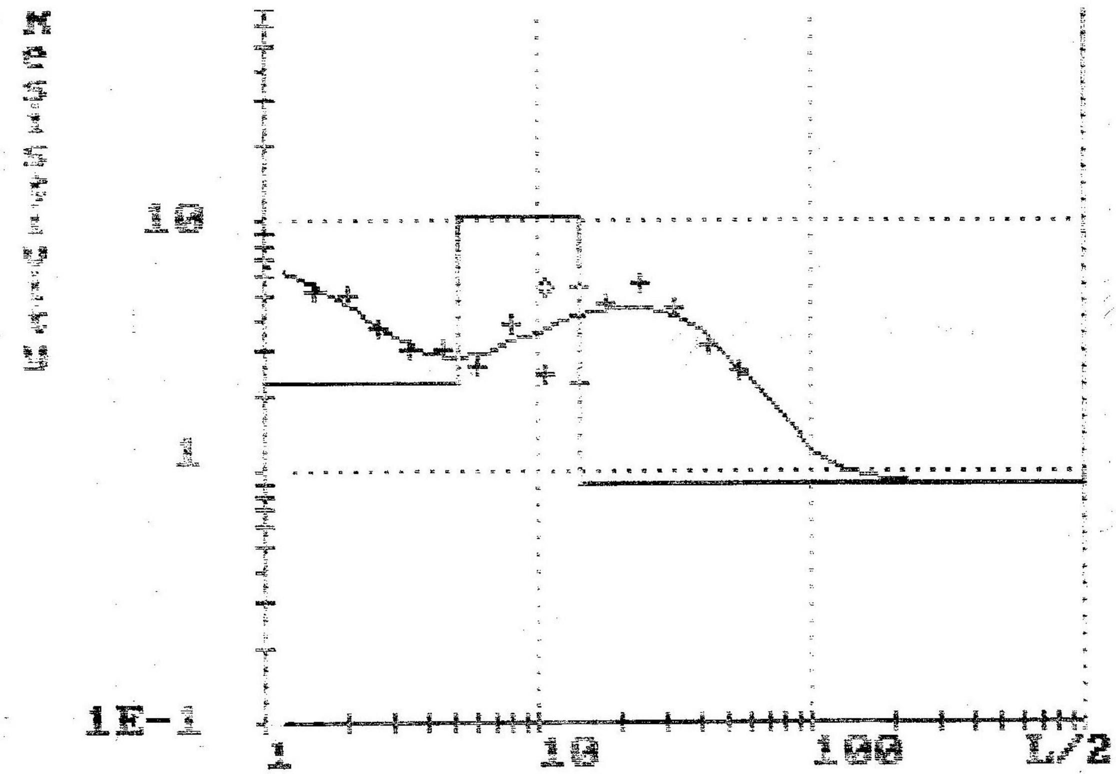
Resistivity (Ohm.m)	Depth (m)
79.0	0.6
627.0	2.9
10.8	15.7
1.1	



Data (File) name	P-42	Date	11-12-2014
Project name	QUARRY STUDIES	Direction lay out	
W-SE(125),N5 57.080',E7 28.034',H374ft			
Code name	P-42	Remarks	ABIA STATE
Coordinates	LEKWESI, UMUNNEOCHI L.G.A.		
		Schlumberger	O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	1236.5	8.0	192.4	24.0	59.3
2.0	951.8	10.5	145.1	32.0	20.5
2.6	885.5	14.0	103.9	42.0	9.2
3.4	731.3	10.5	146.3	55.0	4.2
4.5	684.5	14.0	104.2		
6.0	460.4	18.0	147.5		

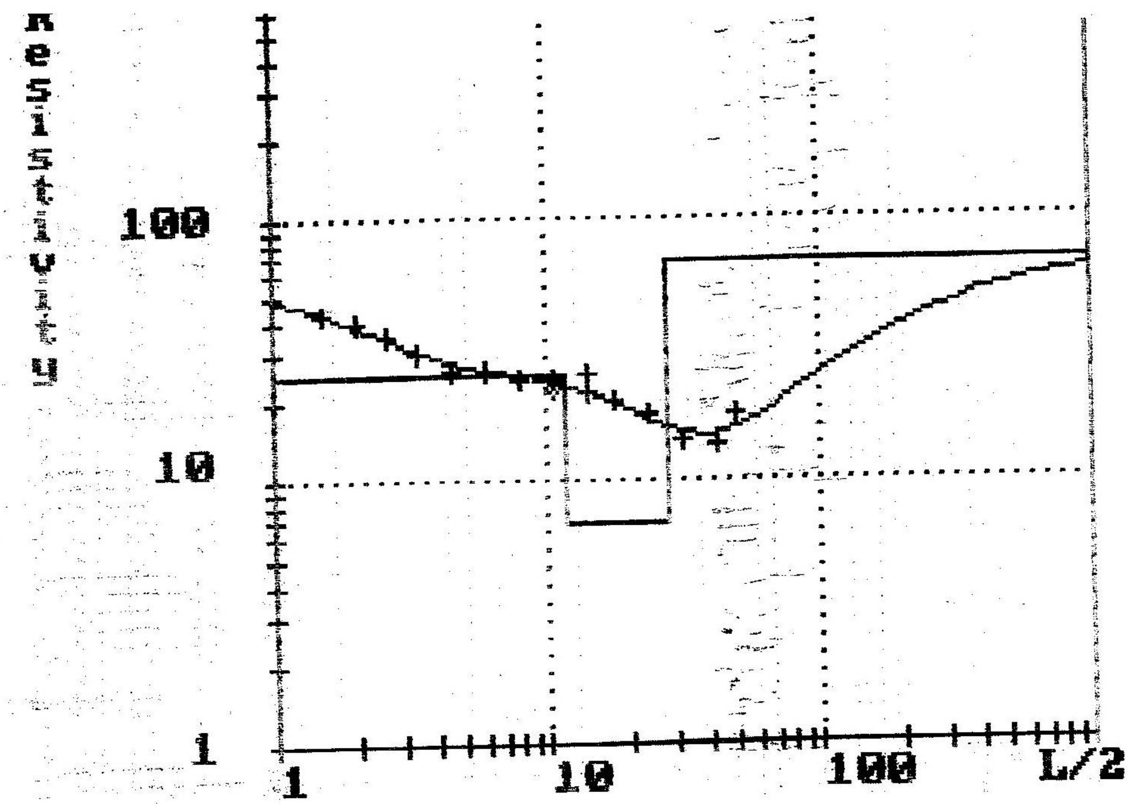
Resistivity (Ohm.m)	Depth (m)
1220.0	2.1
146.0	8.9
136.0	12.4
1.7	



Data (File) name P-43 Date 11-12-2014
Project name QUARRY STUDIES Direction lay out
N130E,N5 57.065',E7 28.290',H298ft
Code name P-43 Remarks ABIA STATE
Coordinates LEKWESI, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	5.3	8.0	3.9	24.0	5.6
2.0	3.0	10.5	2.4	32.0	4.5
2.6	3.7	14.0	2.2	42.0	3.1
3.4	3.0	10.0	5.3	55.0	2.5
4.5	3.0	14.0	5.5		
6.0	2.6	18.0	4.6		

Resistivity (Ohm.m)	Depth (m)
7.4	0.9
2.2	5.1
10.5	14.1
0.9	

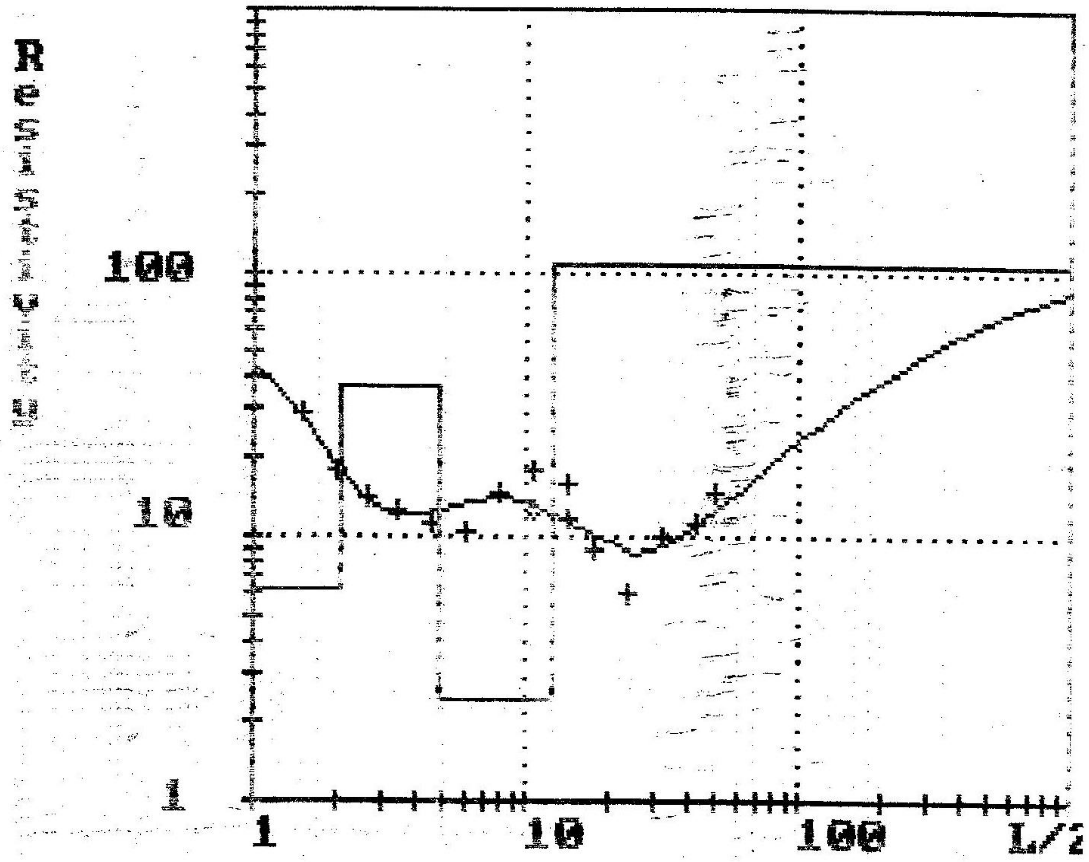


Data (File) name P11
Project name QUARRY STUDIES
-SW(40),N5 54.873',E7 27.028',H302ft
Code name VES 11
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.

Date 16-01-2015
Direction lay out
Remarks ABIA STATE
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	42.7	8.0	24.0	24.0	17.7
2.0	40.1	10.5	24.2	32.0	14.1
2.6	34.8	14.0	24.6	42.0	13.4
3.4	30.9	10.5	22.0	50.0	17.6
4.5	26.4	14.0	21.5		
6.0	25.8	18.0	19.6		

Resistivity (Ohm.m)	Depth (m)
52.8	0.9
24.9	11.8
6.8	27.7
68.3	



Data (File) name P12 Date 16-01-2015

Project name QUARRY STUDIES Direction lay out

INE-SSW(10),N5 54.877´,E7 27.048´,H302ft

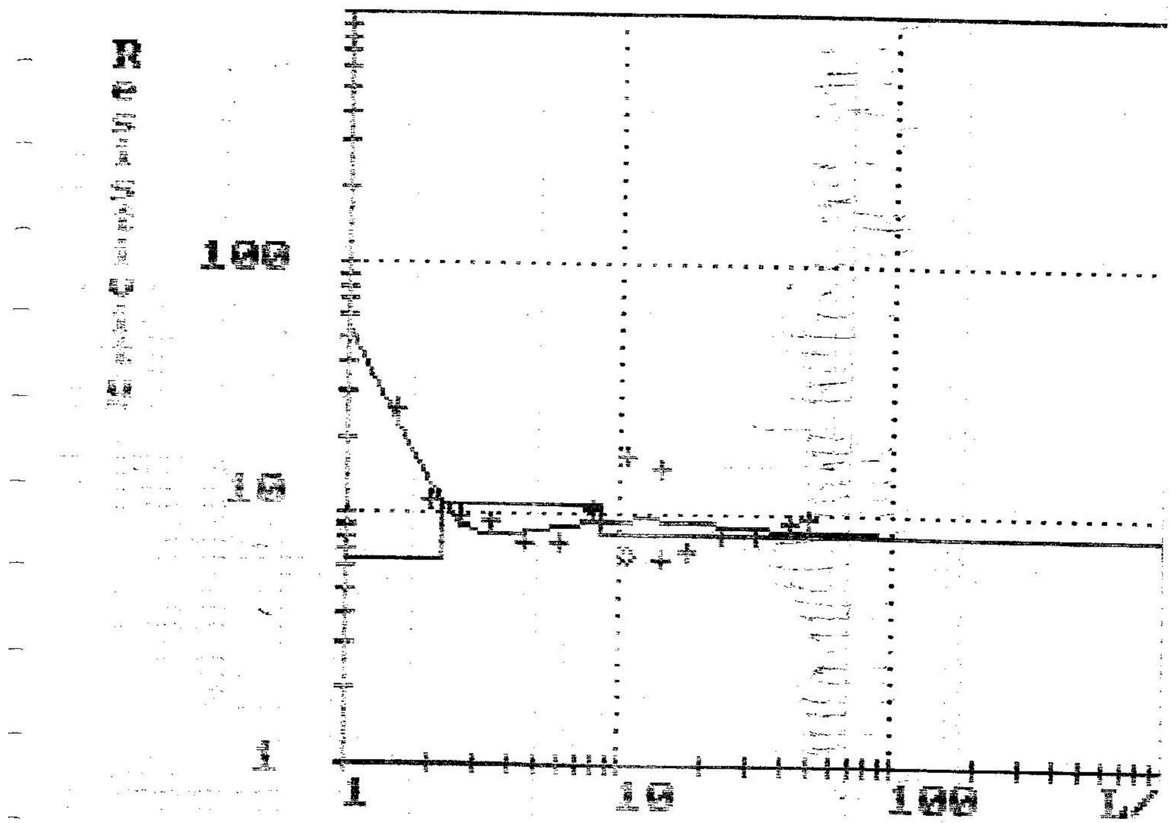
Code name VES 12 Remarks ABIA STATE

Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.

Schlumberger O´Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	29.0	8.0	14.8	24.0	6.1
2.0	17.7	10.5	18.0	32.0	9.9
2.6	14.1	14.0	16.0	42.0	11.0
3.4	12.4	10.5	12.7	50.0	14.7
4.5	11.3	14.0	11.7		
6.0	10.3	18.0	6.9		

Resistivity (Ohm.m)	Depth (m)
64.9	0.7
6.3	2.1
36.8	4.8
2.4	12.6
107.0	

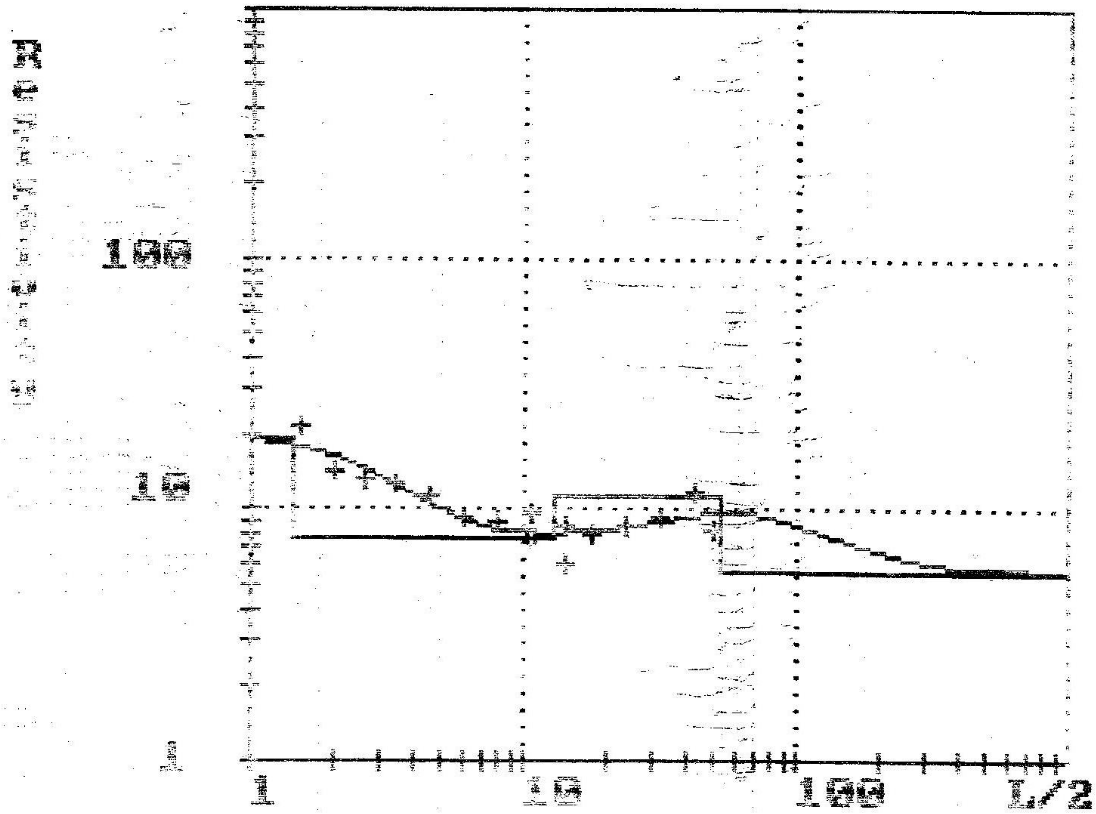


Data (File) name	P13	Date	16-01-2015
Project name	QUARRY STUDISS	Direction lay out	
Code name	VES 13	Remarks	ABIA STATE
Coordinates	LOKPAUKWU, UMUNNEOCHI L.G.A.	Schlumberger	O'Neill

130E,N5 31.924',E7 27.054',H250ft

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	26.0	8.0	10.4	24.0	8.1
2.0	11.0	10.0	16.7	32.0	8.2
2.4	9.6	14.0	15.4	42.0	9.4
3.4	9.2	10.0	6.7	50.0	9.5
4.5	7.5	14.0	6.5		
6.0	7.5	18.0	7.0		

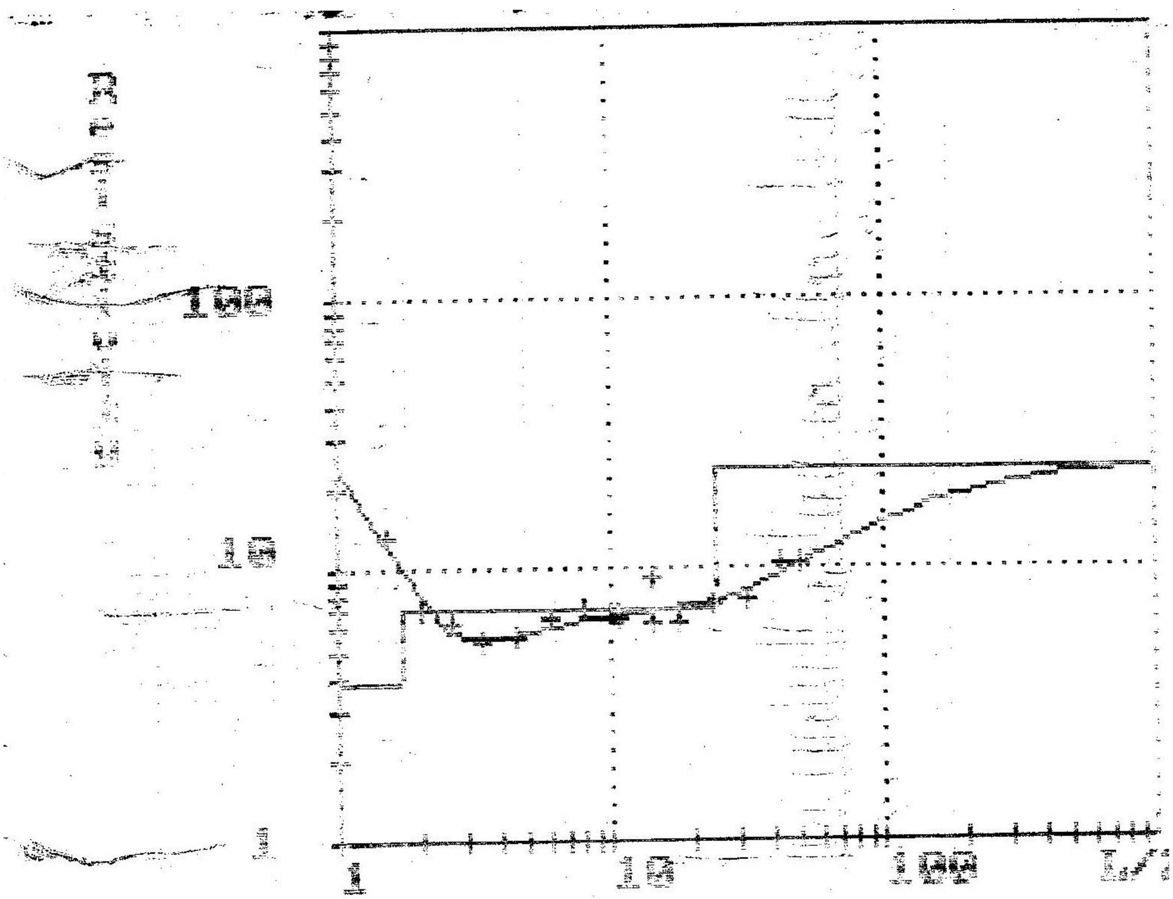
Resistivity (Ohm.m)	Depth (m)
125.0	0.5
6.6	2.2
10.6	[illegible]
8.3	



Data (File) name P14 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
N40E,N5 54.949',E7 27.078',H300ft
Code name VES 14 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	21.4	8.0	9.0	24.0	8.4
2.0	14.1	10.0	9.2	32.0	9.1
2.4	13.1	14.0	8.6	42.0	11.8
3.4	12.4	10.0	7.6	50.0	[illegible]
4.5	11.3	14.0	4.1		
6.0	9.4	8.0	[illegible]		

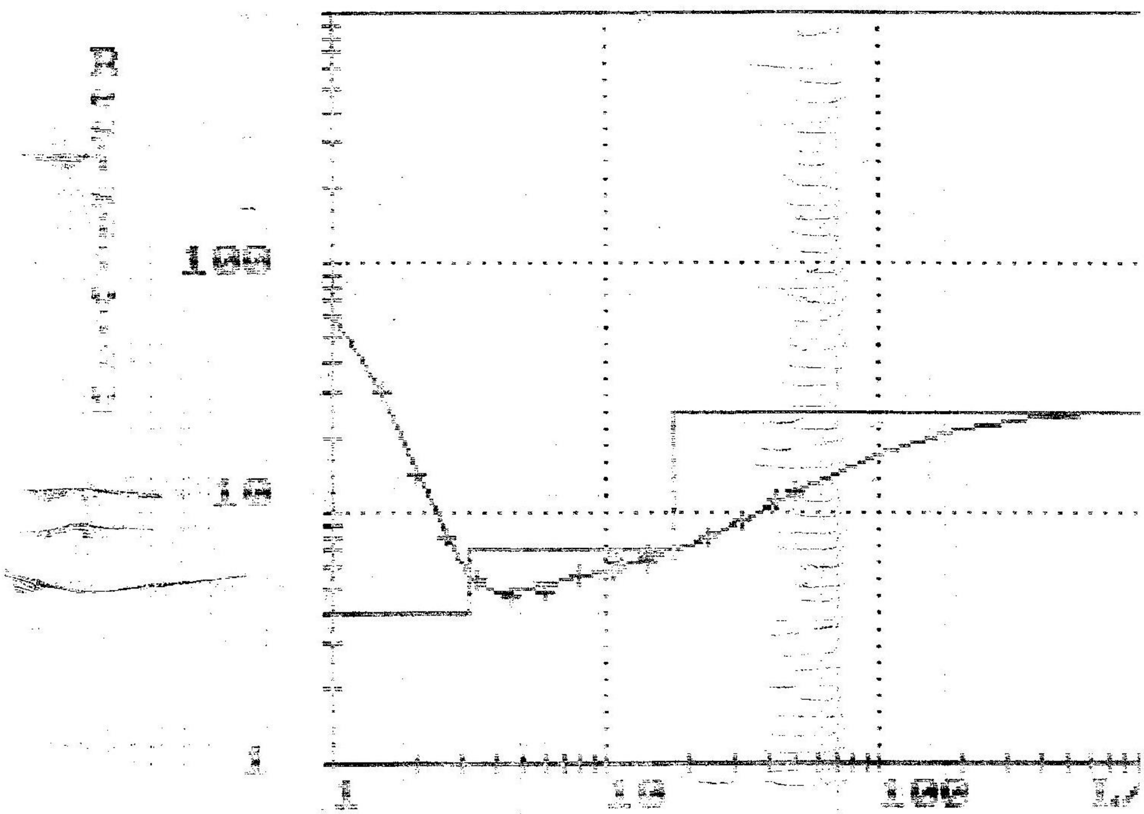
Resistivity (Ohm.m)	Depth (m)
19.5	1.7
7.5	12.9
11.3	31.9
5.4	



Data (File) name P15 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
N50E,N5 54.971',E7 27.070',H309ft
Code name VES 15 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	13.2	8.0	7.0	24.0	7.3
2.0	7.1	10.0	5.9	32.0	7.7
2.4	6.3	14.0	9.2	42.0	10.2
3.4	5.3	[illegible]	6.6	50.0	10.5
4.5	5.6	14.0	6.2		
6.0	6.5	[illegible]	7.0		

Resistivity (Ohm.m)	Depth (m)
16.7	0.5
3.0	1.7
7.1	21.4
23.6	



Data (File) name CP16 Date 16-01-2015

Project name QUARRY STUDIES Direction lay out

N50E,N5 54.991',E7 37.117',W272FL

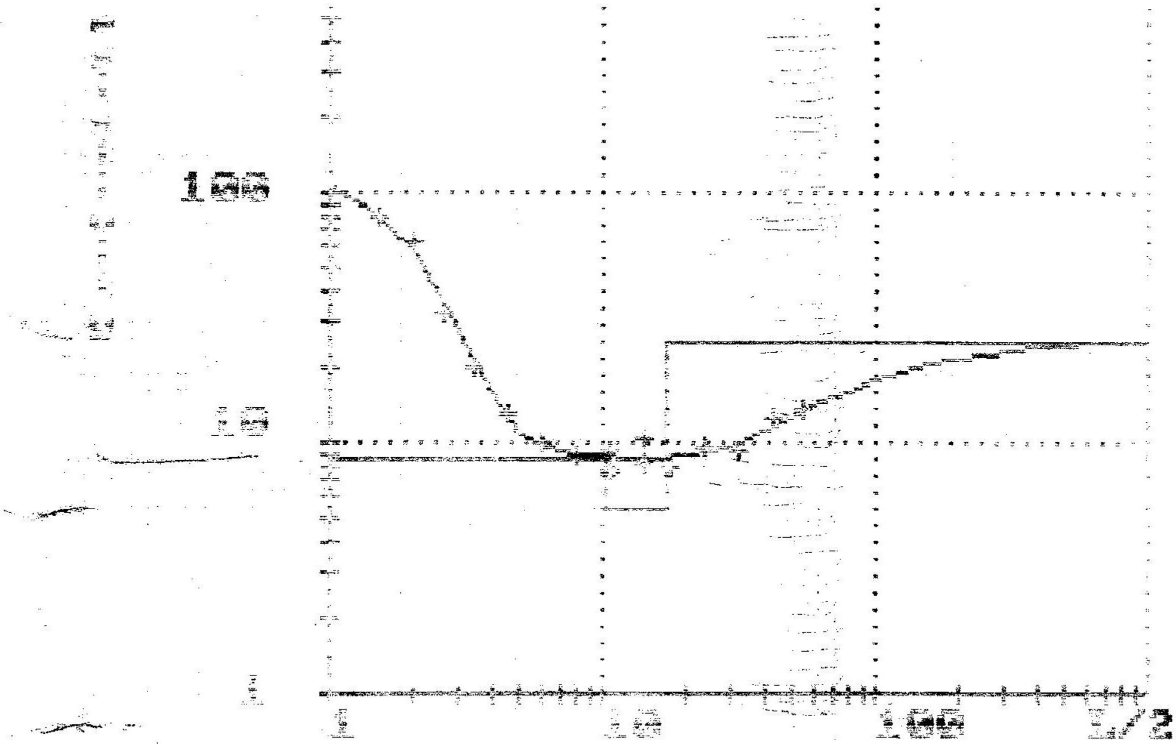
Code name VES 16 Remarks ABIA STATE

Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.

Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	30.1	8.0	5.6	24.0	7.8
2.0	[illegible]	10.0	5.9	32.0	[illegible]
[illegible]	7.9	[illegible]	[illegible]	42.0	11.0
3.4	7.3	[illegible]	6.6	50.0	[illegible]
[illegible]	4.7	[illegible]	[illegible]		
6.0	[illegible]	[illegible]	[illegible]		

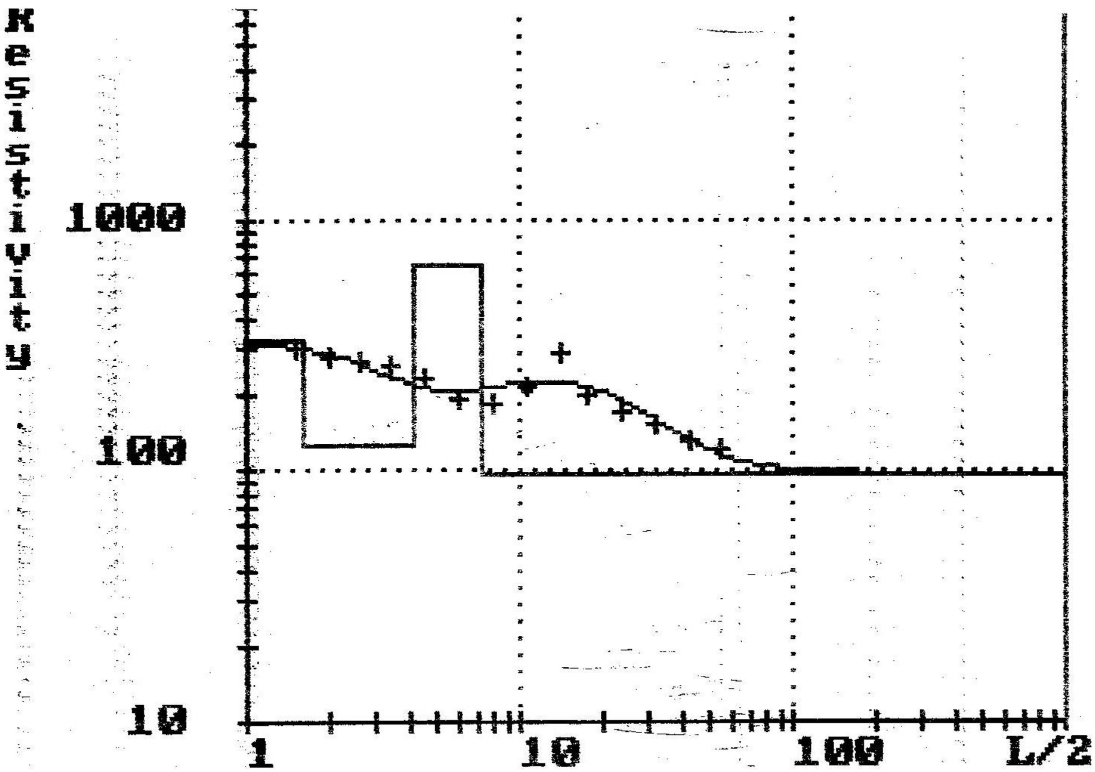
Resistivity (Ohm.m)	Depth (m)
[illegible]	[illegible]
4.0	[illegible]
7	[illegible]
25.5	



Data (File) name P17 Date 16-01-2018
Project name QUARRY STUDIES Direction lay out
N40E, N5 55.019', E7 27.147', H238[illegible]
Code name VES 17 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	77.9	8.0	7.0	24.0	9.6
2.0	62.4	10.0	9.3	32.0	9.1
2.4	32.7	14.0	10.3	42.0	12.6
3.4	20.7	[illegible]	7.8	58.0	10.3
4.9	13.2	[illegible]	[illegible]		
6.0	8.2	[illegible]	[illegible]		

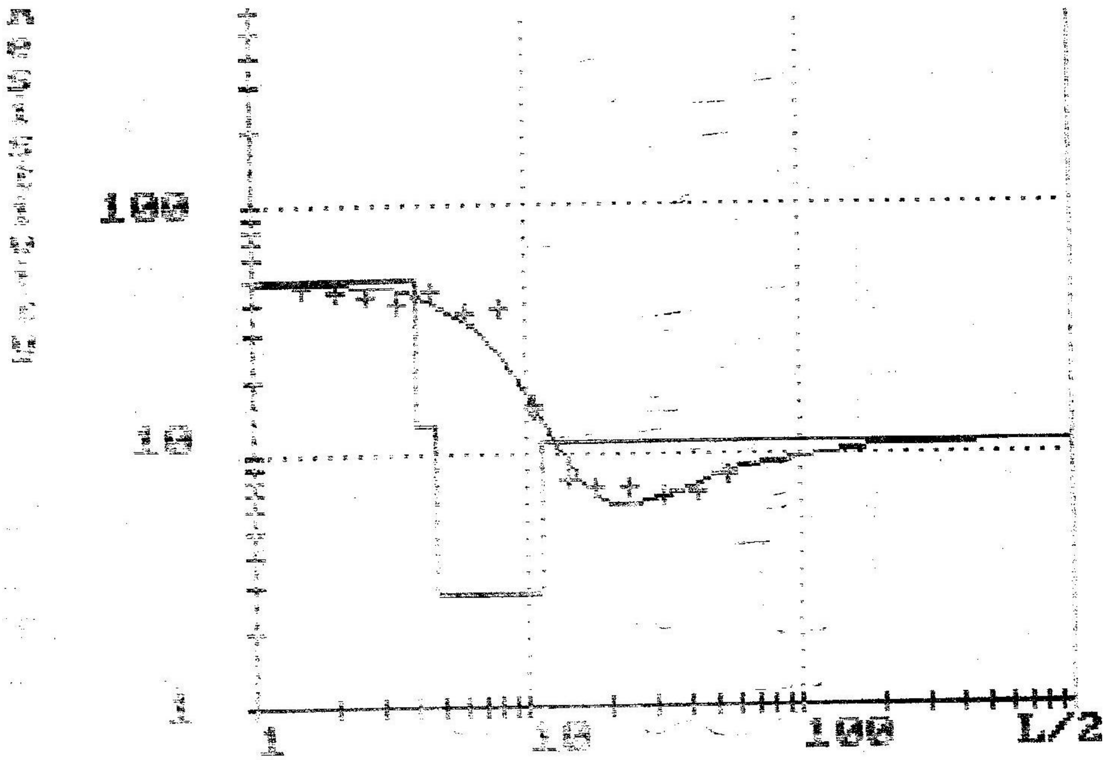
Resistivity (Ohm.m)	Depth (m)
425.0	[illegible]
8.4	[illegible]
[illegible]	[illegible]
25.7	



Data (File) name P18 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
55E,N5 55.033',E7 27.160',H274ft
Code name VES 18 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	298.3	8.0	186.0	24.0	170.0
2.0	278.0	10.5	218.0	32.0	150.0
2.6	274.0	14.0	295.0	42.0	132.0
3.4	262.7	10.5	217.0	55.0	120.0
4.5	232.4	14.0	290.0		
6.0	190.9	18.0	200.0		

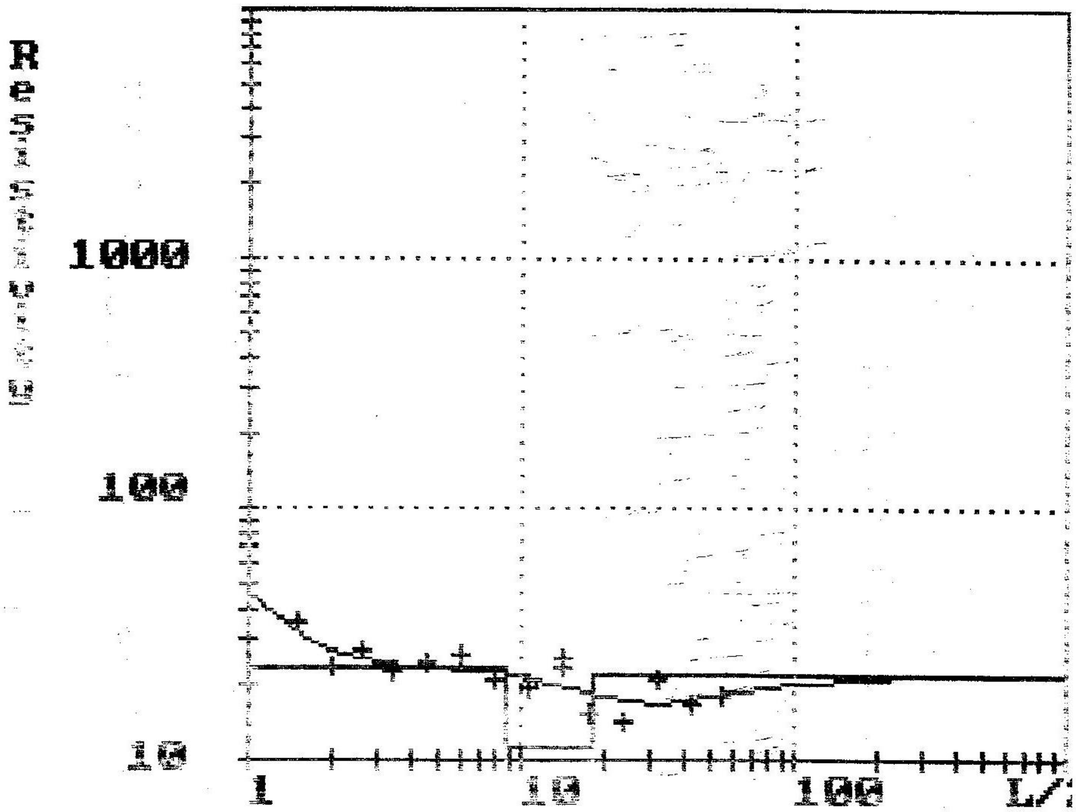
Resistivity (Ohm.m)	Depth (m)
324.0	1.6
127.0	4.1
667.0	7.2
97.0	



Data (File) name P23 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
O(N5OE1,N5 55.076',E7 27.094',H303ft
Code name VES 23 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	47.1	8.0	33.0	24.0	7.4
2.0	44.8	10.5	15.6	32.0	6.9
[illegible]	42.9	14.0	7.8	42.0	7.2
3.4	39.1	10.5	15.4	55.0	8.2
[illegible]	44.9	14.0	7.6		
6.0	36.1	18.0	[illegible]		

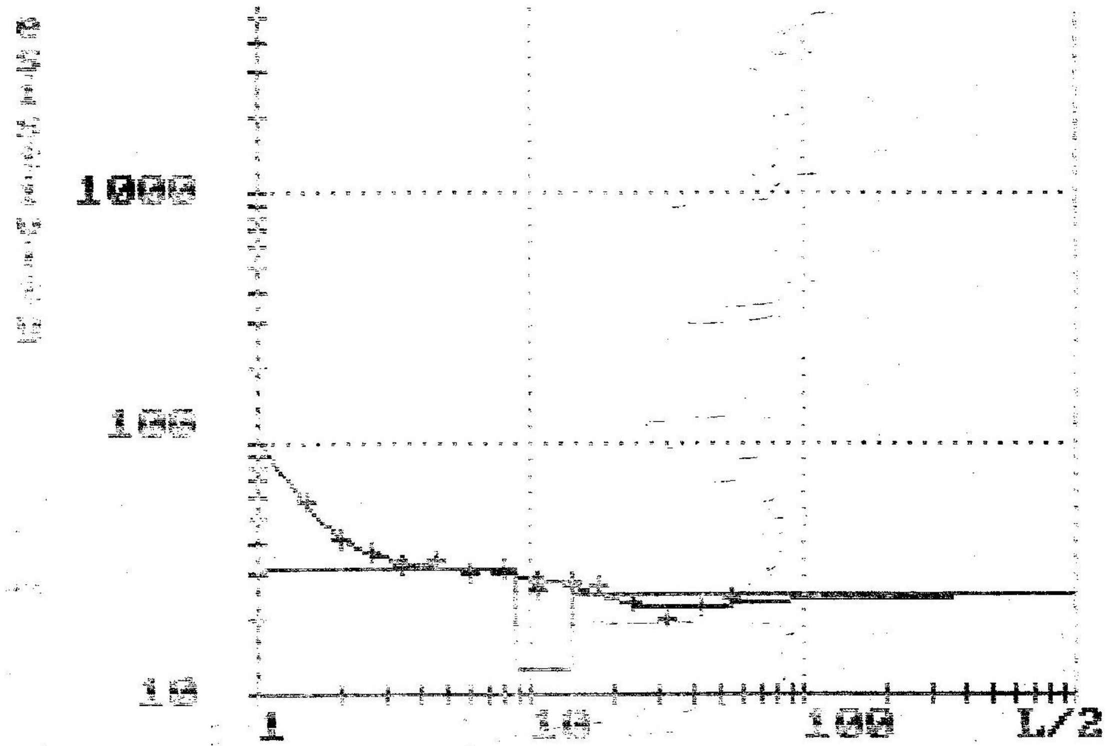
Resistivity (Ohm.m)	Depth (m)
49.3	4.9
13.2	[illegible]
2.8	11.3
11.1	



Data (File) name P22 | Date 16-01-2015
Project name QUARRY STUDIES | Direction lay out
N50E,N5 55.084',E7 27.101',H342ft
Code name VES22 | Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	35.8	8.0	20.4	24.0	13.9
2.0	23.6	10.5	19.0	32.0	20.4
2.5	26.6	14.0	23.4	42.0	16.5
3.4	22.4	10.5	20.1	55.0	17.4
4.5	23.9	14.0	24.8		
6.0	25.8	18.0	15.4		

Resistivity (Ohm.m)	Depth (m)
91.0	0.4
23.0	8.7
11.2	18.4
21.4	



Data (File) name [illegible] Date 16-01-2015

Project name QUARRY STUDIES Direction lay out

N-S(18[illegible]),N5 55.034',E7 27.073',[illegible]

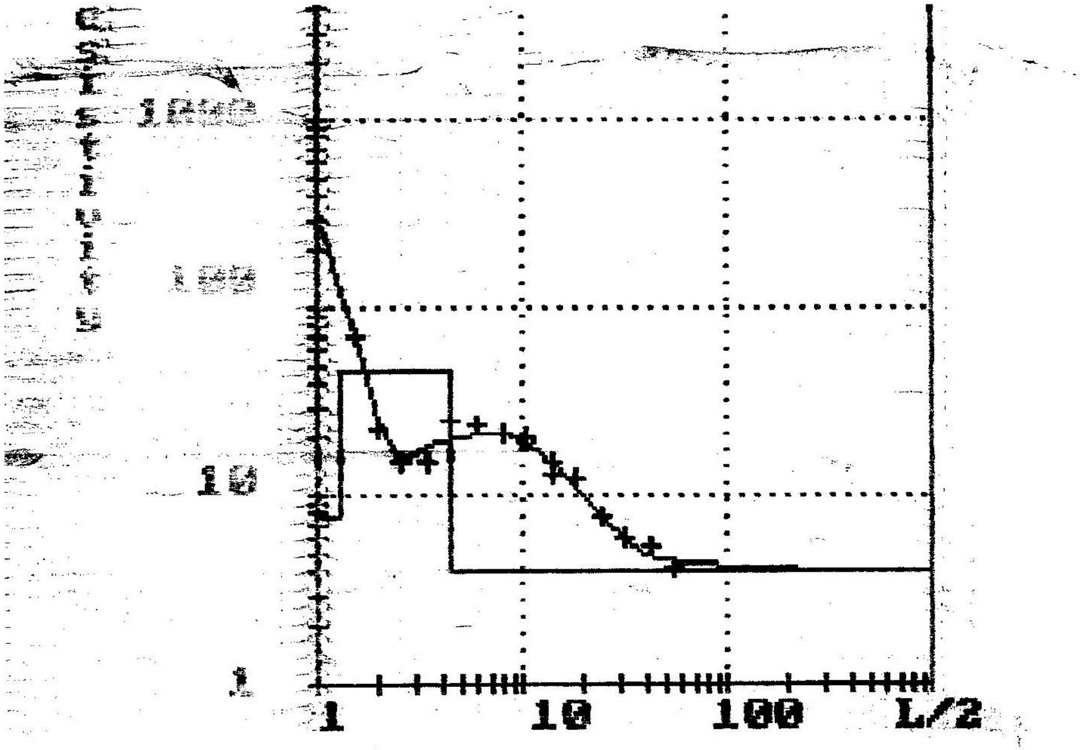
Code name VES 24 Remarks ABIA STATE

Coordinates LUKPAUKWU, UMUNNEOCHI L.G.A.

Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	58.4	8.0	[illegible]	24.0	23.5
2.0	41.2	[illegible]	25.6	32.0	20.0
[illegible]	36.8	14.0	25.3	[illegible]	22.0
3.4	[illegible]	[illegible]	28.6	55.0	[illegible]
[illegible]	33.9	[illegible]	27.2		
5.0	[illegible]	[illegible]	[illegible]		

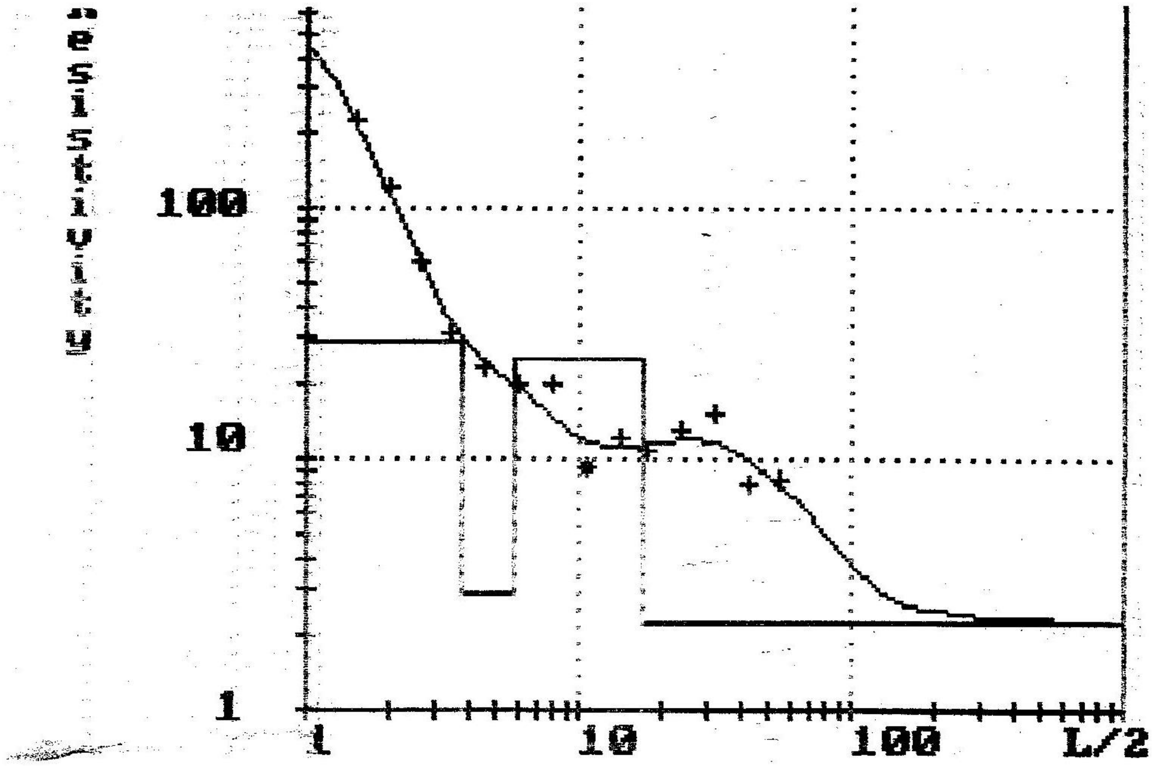
Resistivity (Ohm.m)	Depth (m)
216.0	[illegible]
31.8	[illegible]
[illegible]	[illegible]
24.7	



Data (File) name F25 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
E-SW(250),N5 54.978',E7 27.038',H321ft
Code name VES 25 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	70.0	8.0	21.6	24.0	7.8
2.0	22.5	10.5	20.1	32.0	5.9
2.6	14.7	14.0	14.8	42.0	5.5
3.4	14.7	10.5	18.9	55.0	4.1
4.5	24.5	14.0	13.2		
6.0	24.2	18.0	12.4		

Resistivity (Ohm.m)	Depth (m)
1990.0	0.3
7.7	1.3
45.3	4.4
4.0	



Data (File) name P26 Date 16-01-2015
Project name QUARRY STUDIES Direction lay out
5E,N5 54.943',E7 26.982',H291ft
Code name VES 26 Remarks ABIA STATE
Coordinates LOKPAUKWU, UMUNNEOCHI L.G.A.
Schlumberger O'Neill

L/2 (m)	Rho (Ohm.m)	L/2 (m)	Rho_(Ohm.m)	L/2 (m)	Rho (Ohm.m)
1.5	223.6	8.0	20.0	24.0	13.2
2.0	120.2	10.5	9.4	32.0	15.1
2.6	59.3	14.0	12.3	42.0	7.9
3.4	31.6	10.5	9.1	55.0	8.1
4.5	23.2	14.0	12.1		
6.0	20.2	18.0	10.8		

Resistivity (Ohm.m)	Depth (m)
775.0	0.6
29.8	3.7
2.9	5.8
25.1	17.4
2.2	