PDF - A GEOPHYSICAL INVESTIGATION USING SEISMIC REFRACTION METHOD TO DETERMINE THE CAUSE(S) OF ROAD FAILURE - researchcub.info**ABSTRACT**

This project work was carried out at Ireukpen-Ozalla Road Axis Ekpoma, Esan-West Local Government Area Edo State. Using seismic refraction prospecting method to examine the cause(s) of the persistent failure of the road. An ABEM TERRALOC MARK-6 Seismometer was used as the recording instrument and twelve geophones as wave detectors in series with one another. The geophones were spread at predetermined distances and the impact of a sledge hammer on a flat plate served as the source of generating seismic waves. The “SERCOM1” software was employed in the interpretation of the field result for the forward and reversed shooting respectively. From which the subsurface reveals two layers of velocities, which are 980ms-1 and 1283ms-1 for the forward shooting, 851ms-1 and 1276ms-1 for the reversed shooting respectively. The investigation also shows that at twenty three metres (23 m) from the surface of the forward shooting, clay deposit could be discovered. And even at thirteen metres (13 m) from the surface of the reversed shooting clay deposit could also be encountered. The form of road failure identified in this study is due to subsidence associated with clayey material and the delineated clayey water absorbing sections which are major geologic factors responsible for road failure in the area.

CHAPTER ONE

MEANING AND BASIC APPLICATION OF GEOPHYSICS

1.1 INTRODUCTION

It is to be noted that the geophysical method of prospecting and delineation of anomalous zone in the subsurface extend its wide application to buried material (both of economic and non economic values) (Ozegin, K.O. et al., 2007). Also geological factors are not often considered as precipitators of road failure even though the highway pavement is founded on the geology (Momoh et al., 2008).

Seismic method has successfully help in the search and exploitation of the subsurface. In particular, seismic refraction method is commonly used to get detailed information of the subsurface lithology, geologic setting (mapping), locating refracting interfaces separating layers of different seismic velocity, subsurface mapping, lithological boundary differentiation, engineering geophysics and static correction.

It is sad to note, that, the perennial or incessant failure and poor rehabilitation work on these roads has become a very common phenomena and a source of concern. Generally, in seismic refraction surveying technique, the method uses seismic energy that returns to the surface of the Earth after travelling through the ground along refracted ray paths. The vast majority of refraction surveying is carried out along profile lines which are arranged to be sufficiently long to ensure that refracted arrivals from target layers are recorded as first arrivals for at least half the length of the line. It involves putting the first geophone relatively far away from the shot point, and the shot and detector are on the same line. Consequently, the ABEM TERRALOC MARK-6 were used. And a hand held hammer was used to generate the source energy.

Many factors causes road failure, these include;

Geogical, geomophological/geotechnical, road usage, poor or bad construction practices and maintenances. The influence of geology and geomorphology in the design and construction phases may not have been adequately considered. The problem could also be as a result of inadequate knowledge of the characteristics and behavior of residual soils and not putting the bearing capacity of rocks in relation to vehicular traffic into consideration. Furthermore, the geological factors in road failure covers the nature of soils (i.e. laterite) the near surface geological sequence, existence of geological structure like cavities,

ancient stress, channels and shear zones, near surface geological sequence. Sometimes there is the presence of some concealed subsurface geological structure as well as rock weakness or deficiency. One or more of the aforementioned factors has been noticed to have contributed in some of our highway and rail track
failure. For the purpose of information, geomorphological factors are concerned or related to topography and surface/subsurface drainage systems. Also, subsurface geologic sequence and concealed geological structure can be mapped by geophysical method, hence its relevance (Ozegin et al., 2007).

LOCATION OF STUDY AREA

The study area lies along the Iruekpen-Ozalla Road, in Esan-West Local Government Area, Ekpoma, Edo State, Nigeria. It has its headquarters in the town of Ekpoma, with an area of 502km2 and a population of 125,842 people, according to the 2006 national census. The study area is located on 614411211N, 60813611E as obtained from a reliable geographical positioning system (GPS) meter. The Local Government Area is bounded on the South by Orhionmwon Local Government Area, on the East, by Esan Central Local Government Area (L.G.A), on the West by Uhumwonde and on the North by Owan West L.G.A. The people of the local government are basically subsistent farmers and petty traders.
It is thickly forested with a moderate temperature between 200C to 300C and a climate which is predominately rainforest characteristics by two seasons, that is, dry and wet season. Its topography is generally undulating (Ewanlen, T.A., 2010).

STATEMENT OF THE PROBLEM

The perennial road failure experience at Iruekpen-Ozalla Road Axis Ekpoma, Easn West L.G.A has been characterised by different problems, these include; loss of precious lives, properties, transportation challenges and environmental degradation. Similarly, there has be several cases of gully erosion in the neighboring communities and its environs. Therefore finding the cause(s) why this road is constantly failing is the focus of this study.

AIM AND OBJECTIVES OF THE STUDY

1.4.1 Aim

The aim of this study is to investigate the causes (s) of the failure of this Iruekpen-Ozalla road axis in Easn-West L.G.A Ekpoma.

1.4.2 Objectives

To obtain data from survey using seismic refraction 2-D array in all parts of the study area.
To quantitatively analyze the data obtained
To determine the presence of clay deposits within the study area.
To determine the thickness of clay deposit using seismic refraction method.
To identify zones of weakness.

SIGNIFICANCE OF THE STUDY

It is hoped that a research work like this type can provide useful information for best policies and solutions, aim at minimizing the loss of lives and properties, help fast track economic development in Iruekpen and environs. Which can also be replicated in other parts of the country that possibly share similar problem?

MEANING OF GEOPHYSICS

Geophysics is the science which deals with investigating the Earth, using the method and techniques of physic. The physical properties of the Earth materials (rock, air, and water masses) such as density,

elasticity, magnetization, and electrical conductivity all allow inference about those materials to be made from measurement of corresponding physical field-gravity, seismic waves, magnetic fields, and various kinds of electrical fields (Encarta 2008).

In a more robust definition, geophysics is a non-destructive and non-invasive Earth science (that is, the study of the Earth and one or more of its part) that uses the very latest science and technology in instrument, data acquisition and advanced computer modeling and interpretation in subsurface exploration. We use seismic, magnetic, electromagnetic, radiometric and gravitational technologies and techniques to determine the structure and composition of natural (and sometimes artificial) material below the Earth's surface without the need for drill or excavation.

1.6.1 Division of Geophysics

The two great division of geophysics conventionally are labelled as; Global Geophysics and Exploration Geophysics.

Global Geophysics

In global geophysics, we find studies of; Earthquakes, physical oceanography, the main magnetic field, studies of the Earth's thermal state, meteorology amongst others.

2. Exploration Geophysics

In exploration geophysics, we find the same physical studies applied, usually to the search for resources such as oil, gas, minerals, water and building stone. Seismic prospecting method is the most common geophysical survey method used.

1.6.2 Uses of Geophysics

Geophysics can be used in many diverse situations such as: Hydrocarbon, mineral and underground water exploration, Archaeology, Oceanography, Atmospherics, Planetary science, Astronomy and Astrophysics, Geohazards, such as volcanoes and earthquakes as well as urban utility mapping etc.

GEOPHYSICAL TECHNIQUES

Geophysicist uses a variety of scientific techniques to determine subsurface structure of the Earth and other bodies.

The main geophysical techniques used are:

Seismic (reflection and refraction)
Radiometric and ground penetrating radar (GPR)
Electrical
Magnetism and electromagnetism
Gravity

1.7.1 Data Acquisition

Methods such as seismic, sonar and GPR can be classified as active where a signal is generated into the medium being analyzed. Because the different layers within the medium have different density, part of the signal is reflected back to its surface as the signal passes through the layers. Other equipment and instrumentation (geophones or hydrophones) is then used to detect the signal and record its new properties.

Other methods such as magnetism, electromagnetism (induce polarization) and gravity are passive in that instrumentation is used to detect changes in the medium properties due to variation in its density and content. For example, a body of iron-ore will have much higher magnetic and gravitational properties than the Earth surrounding it.

1.7.2 Interpretation

Once the data has been collected in the field it can then be analyzed using powerful computer and sophisticated software applications. After analysis, 2D and 3D maps of the subsurface, magnetic or gravitational structure of the test area are generated. In the case of resources exploration, based on the results of the data analysis, the exploration team (made up of geophysicist, geologist, petroleum, drilling, production and reservoir engineers) will determines the most promising sites to continues with further exploration.

1.8 GENERAL GEOLOGY OF STUDY AREA

1.8.1 Regional Setting

The Niger Delta is situated on the gulf of Guinea on the West of Central Africa. It built out into the Altantic Ocean of the mouth of the Niger-Benue River system. The Delta's is one of the world largest with the sub-aerial portion covering about 75,000km and extending more than 300km from the apex to mouth (short, K.G. and stable, A.J.I., 1967). Accumulating of marine sediments in the basin probably commenced in Albian time, after the opening of the South Atlantic Ocean between Africa and South America continents through delta. Its structure and stratigraphy have been controlled by the interplay between rates of sediments supply and subsidence. It is a typical wave and tidal dominated Delta. One of the most striking features of the Delta is the sandy nature of the sediments.

1.9 STRATIGRAPHIC NOMENCLATURE

As in many deltaic areas, it is extremely difficult to define a satisfactory stratigraphic nomenclature. However, three formation names are in wide spread use. They are;
Akata formation, Agbada formation and Benin formation (Marron, P. 1967).

Akata Formation (Marine Shale's)

This lithofacies is composed of shales, clays and silts at the box of the known Delta sequence. They contain a few streaks of sand, possibly of turbiditic origin and were deposited holomarine (Delta front to deeper marine) environment. The thickness of this sequence is not known for certain but many reads 7000m in the central part of the Delta. They crop at offshore along the continental slope and onshore in the north Easthern parts of the Delta. The marine shale forms the base of the sequence in each deposit belt and range from Paleocene to Holocene age.

Agbada Formation (Paralic Clastics)

It is represented by an alteration of sands, silts and clay in various proportions and thickness, representing cyclic sequence of off lap units.

The paralic clastics are the truly deltaic portion of the sequence and were deposited in a number of Delta front, Delta topset and fluvio-deltaic environments. The paralic sequence is present in all deposit belt and ranges in age from Eocene to Pleistocene. A maximum thickness of more than 300m, under this formation Edo State lies.

Benin Formation (**Continental Sand**)

The shallowest part of the sequence is composed almost entirely of non-marine sand. It was deposited in alluvial or upper coastal environments following a Southward sloft of deltaic deposition into a new deposit belt. The oldest continental sands are probably Oligocene, although they lack fauna and are impossible to date directly.

1.10 CLAY AND ITS MINERAL DEPOSIT

Clay is a naturally occurring material composed primary of fine-grained minerals and part of the sedimentary rock formation. It show plasticity through a variable range of water content and can be hardened when dried or fired. The mineral, phyllosilicate, is found in clay deposit. It can be differentiated from other fine-grained soils by differences in size or mineralogy for example silts soil, which has larger particle size than clays.

1.10.1 Properties of Clay

The advancement in technology like the x-ray diffraction technology has helped in analyzing the molecular particles of clay. Hence, the term clay is applied both to materials having a particles size of less than two micrometers and the family of minerals that has similar chemical compositions and common crystal structural characteristic. However, clay sized crystals of other minerals such as quartz; carbonated metal oxides are also constituents of clay. Its colour may range from dull grey to deep orange-red depending on the soil content.

Clay properties include: plasticity, shrinkage under firing and air drying, fineness of grain, colour after firing, hardness, cohesion, and capacity of the surface to take decoration.

Clay minerals have strong affinity for water. That is water molecules are attracted to clay mineral surface, because when a little clay is added to water, a slurry forms. Because the clay distributes itself evenly throughout the water. Hence, it is properly utilized by the paint industry to dispense pigment evenly throughout paint.

Another important property of clay minerals is their ability to exchange ions relatively to the charged surface of clay mineral. Hence, clay can be an important vehicle for transporting and widely dispersing contaminant from one area to another.

1.10.2 Formation of Clay

The geological condition which clay and its minerals occur include: continental and marine sediments, soil horizons, volcanic deposits, geothermal fields, weathering rock formations. Most clay minerals form where rock are in contact with water, air or steam. Also extensive alteration of rocks of clay minerals can produce relatively pure clay deposits that are of economic interest for example drilling mud and ceramic (Hillier, S. 1995).

Furthermore, it is also to be noted that some of the factors that causes clay formation are; erosion, Diagenesis and weathering.

Erosion:

The transport and deposition of clay and its minerals produce by eroding older continental and marine rocks and soils are important parts of the cycle that form sedimentary rock. The ancient sedimentary rock record is composed of about 70 percent mudstone (containing 50% clay-sized and shale which are coarser than mudstone and may contain clay sized particles).

Today, sedimentary environment that contain muds cover 60% of marine continental shelves and 40% of deep ocean basins. Therefore, clay is a critical component of both ancient and modern sedimentary environment.

Diagenesis:

It is the in- place alteration of mineral to more stable forms, excluding surfical alteration (which is weathering). It occurs, for example, when minerals stable in one depositional environment are exposed to another by burial and compaction. For example, silicate minerals like, quartz, feldspars are transformed

during diagensis to more stable clay mineral by dissolution and re-crystallization.

Weathering:

The primary way that clay and its minerals form at the Earth surface today, is the weathering of rock and soil. Hence, weathering is the process that involves physical disaggregation and chemical decomposition that change original mineral to clay minerals. Weathering is uneven and many stage of breakdown may be found in the same clay sample.

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