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Partial Fulfillment of the Requirements for the Award of

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FACULTY OF SCIENCE,

GEOLGY,

A Project Work Submitted To The Department Of

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ABDEEMI OPEYEMI

BY

PETRITFORMATION: SOUTHERN BIDA BASIN
GEOTECHNICAL INVESTIGATION OF THE SHALE-CLAY MEMBER OF THE
CERTIFICATION

Oye-Ekoh, Ebiyi State, Nigeria

The work has been approved as meeting the required standard for the award of Bachelor of Science (B.Sc) Degree of the Department of Geology, Faculty of Science, Federal University Otuaro.

The research project on the Geotechnical Investigation of the Shale-Chay

Date 18/02/2019

Project Supervisor

Date 18/02/2019

Head of Department

Date 18/02/2019

External Examiner

Date NAME OF EXTERNAL EXAMINER

Signature

Date

Signature
DEDICATION

This report is dedicated to the Lord Almighty who kept me in his abiding mercies throughout the period of the research.
To everyone not mentioned I remember you.

The words may be few but the thanks to you guys.

Her encouragement and advice I must not fail to acknowledge my cohearses who helped during my struggle also goes to my supervisor Prof. O.I. Ojo and assistant supervisor Mrs. Nukwe for my parents Rev. (Dr) A.E. Evans; I owe for the support physically and spiritually.

My thanks go to the Almighty God for the good health, knowledge and intensive memory given.
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Section Two

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Plate I: Global Positioning System
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The samples are the graded making the grain size analysis to have high value of passing them.

Sampled shale is impermeable i.e., it has a low value of 2.16 x 10^{-6} and 2.43 x 10^{-6}. The two (2) permeability connection due to high plasticity index which ranges from 3:1 to 4.6. The two (2)
permeability connection due to high plasticity index which ranges from 3:1 to 4.6. The two (2)
connection makes the shale to have high dry densities which are 1.80 and 1.79.

The shale in the study area is intercalated with limestone and claystone. The shales are dark in

colour. The shales, therefore, limit the grain size. The samples are done on the shale-clay samples are.

Also, the permeability of the shale-clay member of the study is to determine the permeability and

particulate grain size. The samples are done on the shale-clay samples are. Alternate lithology

comparison of the southern Buda Basin. The objective of the study is to determine the permeability and

part of the southern Buda Basin. The objective of the study is to determine the permeability and

ABSTRACT
1.

LOCATION OF THE STUDY AREA

The Bika Basin, located at central Nigeria, is one of the important sedimentary basins in the Northwestern clastic wedge. The thinning and northern transition to the Niger delta is characterized by rapid subsidence and accumulation of fine-grained sediments. The basin is underlain by the sedimentary sequence deposited during the Cretaceous and Palaeocene epochs, which is composed of sandstones, shales, and limestones. The basin is bounded by the Benue Trough to the east and the Jos Basin to the west. The basin is characterized by a series of grabens and half-grabens that have undergone tectonic activity in the past. The basin is divided into two major sedimentary provinces: the Western and Eastern Basins. The Western Basin is characterized by a sequence of sedimentary rocks that are primarily sandstones and siltstones, while the Eastern Basin is characterized by a sequence of sedimentary rocks that are primarily shales and siltstones. The basin is underlain by a series of thrust faults that have controlled the tectonic evolution of the basin. The basin is an important source of oil and gas, with several oil fields located within the basin.

INTRODUCTION
Figure 1.1: Map of Nigeria showing the sedimentary basins in Nigeria (Ogabe et al., 2004)
The type of climate in Lokoja is that of the tropical humid region of Nigeria (Wedeman, 2012). The climate is characterized by two distinct seasons namely the wet season and the dry season. The wet season lasts for seven months from April to October, the dry season lasts for five months from November to March. Average annual precipitation from 2001 - 2010 for the area range from 1,280 to 1,600 mm. The monthly rainfall from April to September is 1,050 mm. The area is typified by the two distinct rainy seasons and the dry season. The wet season is characterized by two distinct rainy seasons namely the short rainy season and the long rainy season. The short rainy season lasts for 4 months from April to July. The long rainy season lasts for 3 months from July to September. The dry season lasts for 4 months from October to March. The dry season is characterized by two distinct dry seasons namely the short dry season and the long dry season. The short dry season lasts for 2 months from October to November. The long dry season lasts for 2 months from December to March. The area is typified by the two distinct dry seasons and the wet season. The wet season is characterized by the two distinct rainy seasons namely the short rainy season and the long rainy season. The short rainy season lasts for 4 months from April to July. The long rainy season lasts for 3 months from July to September. The dry season lasts for 4 months from October to March. The dry season is characterized by the two distinct dry seasons namely the short dry season and the long dry season. The short dry season lasts for 2 months from October to November. The long dry season lasts for 2 months from December to March. The area is typified by the two distinct dry seasons and the wet season. The wet season is characterized by the two distinct rainy seasons namely the short rainy season and the long rainy season. The short rainy season lasts for 4 months from April to July. The long rainy season lasts for 3 months from July to September.
The aims and objectives of the study were to explain the knowledge of the geotechnical characteristics of the shrimp and farming are the main occupation of the people in the area and crops produced include cassava, yam, rice, millet, guinea corn, beans and soya beans etc.

OCCUPATION OF THE INHABITANTS

The vegetation of the study area is classified as Guinea savanna of Nigeria. It is characterized by the presence of tall grasses and scattered short deciduous trees. A major of rainfall in the area marks the beginning of the growth of grasses in the area. Examples of trees in the study area include Azteca Africana, Lappanecoccasia, Dendrinea obert (sexual bean), and Acacia nilotica. The vegetation of the study area ranges from 940 m to 974 m.

Aims and Objectives of the Study

1. To determine if it will be suitable for engineering purposes or not.
2. To assess the permeability of the shale.
3. To determine the particle grain size.

The objectives are as follows:

- Compressibility, permeability and grain size analysis.
- The study is a member of the Pahul formation of the basin which includes all the formations.

The area of this research was to explain the knowledge of the geotechnical characteristics of the area. During the rainy season, maximum temperatures of about 32°C and a rainfall range from 55% to 65% during the dry season and from 0% during the rainy season. The range from 940 m to 974 m.
made on the hydrocarbon potential of the basin.

E.B. Adevere' (1973), Laderie et al., '1974; Abygula, '1977), only few investigations have been
of the oilfield horizons in the Bida Basin has been a principal subject of several works
in the main marine and marsh environments for the Cretaceous horizons. Whereas the origin
of the sedimentary successions in the southern Bida Basin are ranging from continental to
the shallow marine environment, the interpretation of the facies of the Paleocene formations
of the Lokota and Pool formations. Allover and el. (2002) interpreted the palaeoenvironments
phenomenon-formational associations including the investigation of the palaeoenvironments
morphological-paleoecological studies of Jan du Chatte et al. (1979) which documented the
previous studies on the geology of the Bida Basin were reported in Adevere' (1973) and the

in the Southern Middle Niger Basin and studied the promising systems and sediments. Previous
studies during the late Cretaceous on Building of sedimentary sequences of
formation of various sands, silt, and clay in continental palaeodepositional settings of
amphibians of the Diplodocus sediments from both of the Lokota Formation and the
marginal marine deposits in parts of Southern Middle Niger Basin. These and laboratory
worked was done in the basin to know the sedimentological and palaeodepositional studies

Generation potential

Essential source rocks. The results indicate that the shales are gas prone with minor oil
microscopic evidence for the presence of land derived humic kerogen derived from
range from 0.17 to 4.9% (mean = 2.3%) Rock Eval data for the shale support the
mainly marine kerogens with low values varying mostly from 0.2% to 0.63% TOC values
in-situ and high temperature properties of these kerogens are important to
with some Type II (ilignite) and Type I (humic) Yunique
Type III kerogens (Ozbek, 2002). The results indicate that the kerogen in the Bida Basin is dominantly
investigation of Ozbek (2002) suggested that kerogen in the deeper horizons are in the early-mature stage of gas generation and
may have reached the gas phase in these source rocks is in the early-mature stage of gas generation and
were not detected. These rocks are the principal rocks contained of aromatic, bituminous, vitrinite, and inertinite. The

The Bida Basin has potential source rocks comprised of 18
The stratigraphic framework in this basin has been shown through the geographic subdivision of the

STRATIGRAPHIC FRAMEWORK

framework for the southern Binta basin similar to a pull-apart basin (Biddle, 1992).

From a tectonic and structural standpoint, the basin may be divided along the structural alignments of the southern Binta basin.

The southern Binta basin has been shown to be the result of a pull-apart basin similar in orientation to a pull-apart basin (Biddle, 1992).
strata and igneous intrusions are well developed. The depositional sequence is characterized by a marine transgression that is overlain by a non-marine transgression.

The depositional sequence is characterized by a marine transgression that is overlain by a non-marine transgression. The depositional sequence is characterized by a marine transgression that is overlain by a non-marine transgression. The depositional sequence is characterized by a marine transgression that is overlain by a non-marine transgression.

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north of the Locona Formation includes some shallow marine influence.

The first basement, comprising the Early Cretaceous river deposits, is overlain by a thick sequence of fluvial and deltaic sediments. These deposits are characterized by a variety of facies, including fluvial channels, shallow marine deposits, and lagoonal sediments. The formations are assigned to the Late Cretaceous and Paleocene epochs, with the underlying deposits representing a more continental setting.

The location of the Locona Formation is in the Southern Bida Basin.

The Southern part is divided into three formations: the Paleozoic, the Cretaceous, and the Tertiary. These formations are characterized by a variety of sediments, including sandstones, shales, and volcanic rocks. The Paleozoic formations are mainly characterized by carbonate deposits, while the Cretaceous and Tertiary formations include clastic sediments.

The Bida Basin is divided into two categories: southern and northern. The northern part is divided into the Paleozoic, Cretaceous, and Tertiary formations.
and Fossil Formations in the Anahuma Basin (Creston, 1986; Vardenbo, 1997). Ndellite and
and Fossil Formations in the Anahuma Basin. Depositional environments of similar lithologic units of the Main
therefore appears to have been deposited in marginal shallow marine to brackish water
environments for the1/Mass Formation sedimentary of the Anahuma Basin. The Main Formation
hence provided strong evidence for shallow marine, deltaic to intertidal depositional
sandstones of the Main Formation (Middle Transition) in the northern flanks of the basin
(Albrecht et al., 1997). This sequence is overlain by neighboring easterly marine
sandstones and coal units in concert with terrestrial coal beds, coal-derived organic matter, sandstone fossils, and
commonly interbedded with terrestrial coal beds, coal-derived organic matter, and sandstone fossils, are
(Creston, 1986). Shells of the Main Formation on the south side of the Anahuma Basin are
western margins of Anahuma Basin (the Basal conglomerate) in the adjacent Anahuma Basin
essentially composed of nanofossils, Alkali-Madana, Toflah, and Tohlama which are
an assemblage of Alkali-Madana, Alkali-Madana, Toflah, and Tohlama which are
revealed the occurrence of Archean formations in the whirling of the Main Formation with
western conditions. However, this area and its depositional setting have not yet been
and plant material comprising mostly land-derived organic matter, suggest terrestrial
region of the study area. The entire thickness of the Main Formation consists of a single, large body of water
formation contains a variety of conditions and settings, including both freshwater and
contact of the Anahuma Formation with the Lower Mass Formation. The
predominance of Archean rocks, especially silicified, shales, and silicified, is the Main
more eukaryotic and microfossilically unique compared with the Lower Mass Formation. The
shales are frequently carbonaceous. The subjacent shales, which are the Main Formation are
interbedded. Depositional are generally massive and dolomitic, whereas the interbedded gray
l lagen stromata. Trace fossils (especially Stromatolites) are frequently preserved,
and older shales with wave ripples, convolute laminations, and other silicified units. The Main Formation is
interbedded with the Lower Mass Formation. The silicified shales are interbedded with the Main
overlying the Main Formation occur between Kookan-Karli and Aqat. The Main Formation
have provided much more.

The Main Formation

The Main Formation is...
Deposition of the Aghapa formations in the southern Bika Basin (Ladipo et al., 1994). The marine inundations appear to have continued throughout the period of Oligocene (1996). The marine inundations and the Rand Formation (Brede, 1992; Ouma et al., 1994). The marine inundations were also reported to have inundated the initial continental environment of the Njoro Marine. Massive conglomerates and oolite formations observed (Ladipo et al., 1994). Massive conglomerates formed in this region. The sands and clays are intercalated, and the basement of the Bika Basin in a more or less continuous and at a depth of the southern Bika Basin is a basement equivalent of the Bika Formation on the northern side of the Njoro Marine. Massimatosed sediments in the southern Bika Basin (Ladipo et al., 1994). The marine influence in the adjacent Amana Basin is probably related to the presence of the basin to the Cretaceous Atlantic Ocean prior to the growth of the Nyanza Delta.
6. Hammer and Chisel: These were used to break samples in a moderate size to get the
laboratory for analysis.
5. Sample bag: The sample bag is normally used in the field to store any collected rock
The paper tape and marker pen was used to label the sample in the location of collection.
4. Paper tape and marker pen: Both were used together to label each rock sample collected.

Note: (check page 11)

2. Field notebook: The field notebook was used to record all the information on the field
amount and direction of inclination on necessary geological features observed (check page 11)
1. Compass/Clinometer: The compass was used in the field for accurately determining the
another (check page 1.)

These will allow the geologist to know the exact distance from one sampling point to
GPS can enable the geologist to lock down the navigation patterns adopted in a particular
basically used in determining the exact position of any sampling point on the map. Hodem
is a sophisticated technology which is
determine the ground position of an object. The GPS is a sophisticated technology which is

3. MATERIALS AND METHODS

CHAPTER THREE
SAMPLE COLLECTION

Representative samples are collected from the outcrop. Measurement of the thickness of each bed in the particular outcrop. Finally, a very good measurement may include description of the outcrop, description of the lithology, and information about the thickness of the beds. Necessity is necessary to collect in any outcrop encountered such across the field, necessary for the accurate determination of height may within such grid. When making the exact position on the field map, during traversing every grid on the map is being marked with all observed geological structure, such as contour or profile. The GPS is used essentially to know the exact position on another with the aid of the geographical positioning system (GPS). The field mapping was done by navigating through a system of grid patterns which is basically known as traversing. Here, movement around various contours is done by Permeability, green, size, and color. The Bearline method (CBR) and Virginia methods employed in this study include field mapping, sample collection, and laboratory analysis. The importance and analysis that is geographical maps is indicated. Another limit.
soil sample can be rolled by hand into a thread of 3.2 mm diameter without breaking.

Plastic limit is the water content at which a soil will pass from plastic stage to semi-solid stage. Soil can no longer be rolled or shaped and when crushed will crumble to show visible cracks. Plastic limit is the soil water content at the boundary between the semi-solid stage and plastic stage. Plastic limit is known as Atterberg limit. The Atterberg limits between the solid and semi-solid stages are known as Atterberg limits. Between the solid and semi-solid stages of plasticity, the water content at the boundary of semi-solid stage and plastic stage and to liquid stage. The water contents at the boundary of semi-solid stage to plastic state and to liquid state, the water contents at the boundary of semi-solid stage to plastic state and to liquid state.

Wash the bowl filled with distilled water, dry the oven at 105°C.

Wet the bowl filled with distilled water, dry the oven at 105°C.

Atterberg limit is the water content at which a soil will pass from plastic state to semi-solid state.

Atterberg limit is the water content at which a soil will pass from plastic stage to semi-solid stage. Soil can no longer be rolled or shaped when crushed will crumble to show visible cracks. Plastic limit is the soil water content at the boundary between the semi-solid stage and plastic stage. Plastic limit is also known as Atterberg limit. The Atterberg limits between the solid and semi-solid stages are known as Atterberg limits. Between the solid and semi-solid stages of plasticity, the water content at the boundary of semi-solid stage to plastic state and to liquid state, the water contents at the boundary of semi-solid stage to plastic state and to liquid state, the water contents at the boundary of semi-solid stage to plastic state and to liquid state.

Atterberg limit is done to measure the water content of the sample.

The analyzed sample is sterile which is a fine-grained soil. There are nine (9) samples.
Liquefied Limit

1. Take a soil sample from a depth of 3-2 in (75 mm) into a clean, dry, 2 in (50 mm) diameter mould.

2. Take the remaining sample and add distilled water until the soil is saturated and can be pulled without sticking to the hands.

3. Form the soil into an ellipsoidal mass. Roll the mass into a thread of uniform diameter by hand to the starting position. The thread shall be deformed so that its diameter reaches 1/4 in (6 mm) when about 90 strokes per minute, a stroke is one complete motion of the hand forward and back in the plane of the thread.

4. When the thread of the ellipsoidal mass is about 4 mm (1/8 in), take no more than two minutes.

5. Grind the rough edges of the mould together and place the soil into a moulding can.

6. Remove the lid, and place the can into the oven. Leave the moulding can in the oven for at least 16 hours.

7. Remove the moulding can from the oven. Leave the moulding can on the soil, record the mass, immediately weigh the moulding can containing the soil, record its mass, and then cover it. If the can does not contain at least 6 grams of soil, add soil to the can from the top cover.

8. Weigh the remaining sample with their lids and record the respective weights and can numbers on the data sheet.

Test Procedure:

Liquefied Limit

Same balance for all weighing

From each soil by using the same method used in the first laboratory. Remember to use the
(6) Repeat steps twice, four, and five at least two more times. Determine the water content
least 16 hours.

Remove the lid, and place the can into the oven. Leave the moulding can in the oven for at
next that (see step) immediately weigh the moulding can containing the soil, record its mass,
then cover it. If the can does not contain at least 6 grams of soil, add soil to the can from the
top cover.

Grind the rough edges of the mould together and place the soil into a moulding can.

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back in the plane of the thread.

Form the soil into an ellipsoidal mass. Roll the mass into a thread of uniform diameter by
hand to the starting position. The thread shall be deformed so that its diameter reaches 1/4 in (6 mm) when about 90 strokes per minute, a stroke is one complete motion of the hand forward and
back in the plane of the thread.

To the remaining ellipsoidal mass, roll the mass between the palm of the fingers and
a consistency where it can be pulled without sticking to the hands.

Weight the remaining sample with their lids and record the respective

plastic. Liquefied Limit is the soil water content where the soil changes from a plastic to a
(6) Where sure that the base of the apparatus below the cup and the undersides of the cups is clean of soil. Turn the crank of the apparatus at a rate of approximately two drops per second.

(5) Use the grooving tool carefully on a clean straight groove down the center of the cups.

(4) Place a portion of the previously mixed soil into the cup or the humidifier apparatus at least six per second.

(3) Adjust the humidifier apparatus by checking the heighth of drop of the cup. The point on and near numbers on the data sheet.

(2) Withdraw from the cup or moisture gage the liquid lid and record the respective weights.

(1) Take the following steps:

1. Cover the soil with a smooth uniform layer of soil. Place a small amount of distilled water until it appears as a smooth uniform layer. Cover previously passed through a No. 40 sieve, air-dried, and then pulverized. Thoroughly mix the soil with a small amount of distilled water until it appears as a smooth uniform layer. Cover previously passed through a No. 40 sieve, air-dried, and then pulverized. Thoroughly mix the

Test Procedure:

Together a 15 mm section of the groover cuts into the soil sample.

Find the soil water content that corresponds to the number of drops (47) needed to bring

viscous (hydrated) state. Liquid limit is determined using the Casagrande cup. This involves
per second. Shade has low permeability, this makes it a good trap for percolation, insurances
degree of incroachment, Permeability is measured in units of velocity, such as centimeters
low value of permeability, with in case of higher, it transmits water poorly and always has
Permeability is a measure of how a material can transmit water or other fluid. Materials like
sample is permeable or not.

3.5.2 PERMEABILITY

This is the point in which soil will pass from semi-solid to solid state.

Shrinkage Limit, SL

in this method, two (2) shale samples were analyzed. This test was done to determine if the

SL

Shrinkage Limit, SL

decrease.

(8) Remix the entire soil specimen in the portioning dish, add a small amount of distilled

cups on the appearance and the grooving tool.

at least 16 hours. Place the soil remaining in the can into the portioning dish. Clean and dry the
mass. Remove the lid and place the into the oven. Leave the moisture can in the oven for
moisture can cover it immediately. When the moisture can commence the soil, record its
include the soil in both sides of where the groove came into contact. Place the soil into a

(7) Take a sample, using the spatula, from edge to edge of the soil part the sample should

(6) Repeat steps six, seven, and eight for at least two additional lid's producing successfully

25 to 35 drops, one for distance between 20 and 25 drops, and one trial for a close reading

Determining the water content from each trial by using the same method used in

15 to 25 drops. Determine the water content from each trial by using the same method used in

the first laboratory. Remember to use the same balance for all weighing.

(9) Repeat steps six, seven, and eight for at least two additional lid's producing successfully
18
(10) Keep the pan with remaining soil in the drying oven.

(9) Measure the sample length at four locations around the circumference of the calomel electrode

(8) Place the compression spring on the porous stone and replace the chamber cap and the
upper porous stone on the upper chamber. Level the top surface of the soil and place a filter paper and then the

(7) Replace the upper chamber section, and don't forget the rubber gasket that goes between

(6) Use the sampling device to collect the layer of soil. Use approximately 1 cm of the

(5) Using a scoop, pour the prepared soil into the lower chamber using a circular motion to

(4) Mix the soil with a sufficient quantity of distilled water to prevent the segregation of

(3) Place one porous stone on the upper support ring in the base of the chamber then place a

(2) Remove the cap and upper chamber of the permeameter by unscrewing the knurled cap

(1) Measure the initial mass of the pan along with the dry soil (M1).

Test Procedure:

Stopwatch, Thermometer, Filter paper
Include Permeameter, Tamper, Balance. Scoop, 1000 ml Graduated cylinders, Watch (or

(10) Keep the pan with remaining soil in the drying oven.

(9) Measure the sample length at four locations around the circumference of the calomel electrode

(8) Place the compression spring on the porous stone and replace the chamber cap and the
upper porous stone on the upper chamber. Level the top surface of the soil and place a filter paper and then the

(7) Replace the upper chamber section, and don't forget the rubber gasket that goes between

(6) Use the sampling device to collect the layer of soil. Use approximately 1 cm of the

(5) Using a scoop, pour the prepared soil into the lower chamber using a circular motion to

(4) Mix the soil with a sufficient quantity of distilled water to prevent the segregation of

(3) Place one porous stone on the upper support ring in the base of the chamber then place a

(2) Remove the cap and upper chamber of the permeameter by unscrewing the knurled cap

(1) Measure the initial mass of the pan along with the dry soil (M1).

Test Procedure:

Stopwatch, Thermometer, Filter paper
Include Permeameter, Tamper, Balance. Scoop, 1000 ml Graduated cylinders, Watch (or
determine the distribution of the coarse, larger-sized particles, and the hydrometer method is
soil. Nine (9) samples were analyzed. The mechanics of these analyses is performed in
This test is performed to determine the percentage of different grain sizes contained within a

3.4.3 GRAIN SIZE ANALYSIS

Place the dry soil (A12).

22) Remove the pan from the drying oven and measure the final mass of the pan along with

21) Repeat Step 17 and 18 with different vertical distances.

19) Measure the vertical distance between the funnel head level and the chamber overflow

respectively.

18) Allow adequate time for the flow pattern to stabilize.

17) Open the bottom outlet valve and raise the funnel to a convenient height to get a

reasonable steady flow of water.

16) Close the bottom outlet valve and disconnect the tubing at the bottom. Connect the

control valve. Letting water flow out of the outlet for some time.

15) As soon as the water begins to flow out of the top control (dialing) valve, close the

control valve. Letting water flow out of the top control. Open the bottom outlet valve and

14) Open the bottom outlet valve and allow the water to flow into the permeameter.

13) Place tubing from the top outlet to the sink to collect any water that may come out.

12) Connect the permeameter to the funnel until the funnel to the bottom outlet of the

11) Adjust the level of the funnel to allow the constant water level in it to remain a few

Several different methods are used to compact soil in the field, and some examples
mass. The compaction effort is the amount of mechanical energy that is applied to the soil
analyzed. Two (2) samples were weighed and the dry density of a soil for a specified compactive effort. This laboratory test is performed to determine the relationship between the moisture content

**3.14 COMPACTATION TEST**

**Procedure:**

1. Weigh the dry soil sample. A loss of more than two percent is unsatisfactory.
2. Calculate the percent retained on each sieve by dividing the weight retained on each
   mass of the soil sample by the original sample mass. (c) Calculate the percent passing (or percent finer) by
   sieve by the original sample mass. (d) Calculate the percent retained on each sieve by subtracting the weight retained on each

**Data analysis:**

(1) Subtract the weight of soil retained on each sieve from the weight of the aggregate, and record the weight of the
(2) Remove the stack from the shaker and carefully weigh and record the weight of each
(3) Place the sieve stack in the mechanical shaker and shake for 10 minutes.
(4) Carefully pour the soil sample into the top sieve and place the cap over it.
(5) Ensure that all the sieves are clean and assemble them in the ascending order of sieve
(2) Record the weight of the given dry soil sample.
(1) Write the weight of each sieve as well as the bottom pan to be used in the analyses.

The test procedure is as follows:

Distribution, and is required in classifying the soil
sizes affect the engineering properties of soil. Grain size analysis provides the grain size
used to determine the distribution of the finer particles. The distribution of different grain
(g) The soil should completely fill the cylinder and the last compressed layer must extend slightly above the collar joint. If the soil is below the collar joint at the completion of the drop, the test point must be repeated. (Note: For the last layer, match carefully and add more drops if it appears that the soil will be compressed below the collar joint.

(6) The soil should completely fill the cylinder until the top of the guide sleeve, drop, and the collar should provide uniform contact of the specimen surface. Try to avoid the number of drops of the specimen per layer is also dependent upon the type of mold used.

(7) Assemble the compression mold to the base plate, place some soil in the mold, and compress the soil until the top fills a uniform color.

(4) Measure out the water, add it to the soil, and then mix thoroughly into the soil using the equivalent of approximately one milliliter of water.

Where "water to add" and "soil mass are in grams. Remember that a gram of water is 0.0018 liters, so water to add is 0.0018 liters.

(b) Compute water to add from the following equation:

\[ \text{Water to add} = \frac{\text{Soil mass}}{\text{Dense of water}} \]

(a) Assume water content for the first test to be 2 percent.

(3) Compute the amount of initial water to add by the following method:

(2) Determine the weight of the soil sample as well as the weight of the compression mold with its base (without the collar) by using the balance and record the weight.

(1) Depending on the type of mold you are using obtain a sufficient quantity of air-dried soil, and for the 4-inch mold a flake filter over the 10 mesh screen. For the 6-inch mold, use a flake filter over the 8 mesh screen. For the 10-inch mold, use a flake filter over the 4 mesh screen.

Test Procedure:

The Process:

Include lamping, kneading, vibration, and static load compression. The test is also known as
By two slightly lessen compacted soil masses.

Step 4. Repeat steps 5 through 9 until based on wet mass a peak value is reached, followed

mass and re-mix as in

If it will still pass through the #4 sieve, add 2 percent more water based on the original sample

(10) Place the soil specimen in the large tray and break up the soil until it appears visually as

determine the water content

govern samples from the top and bottom of the specimen. Fill the moisture cells with soil and

(9) Remove the soil from the mold using a mechanical extractor and take soil moisture

Determine the wet mass of the soil by subtracting the weight of the mold and base.

(8) Weigh the compacted soil while it's in the mold and to the base, and record the mass.

the trimming process.

With the top of the mold using the towel, replace small bits of soil that may fall on trimming

(7) Carefully remove the collar and trim off the compacted soil so that it is completely even

mass, and re-mix as in
the beds to be obvious.

Summary: The beds of Anhoko are a unique feature of the site, which makes them stand out in color. Overlying this layer is a claystone layer (AY10), above this bed is massive brown in color. Overlying this layer is an association of shale and cemented limestone. It is interpreted from the association of these layers to be the base of the section. The shale is composed of more color greenish and the limestone is of two types: limestone and limestone. This area is composed of shale and limestone with an association of claystone and limestone, the bed within the Luka Formation which consists of shale, claystone and limestone has the elevation of 85m at the base with the elevation of 88.1 14.9 m and the limestone formation (Abdelfat, el al: 2015).

**Chapter 4**

**4.1 Lithology Description of Anhoko**

**Results and Discussion**

**Chapter 4**
Figure 4.1: Field photograph of a section showing the lithology of a soil formation.
<table>
<thead>
<tr>
<th>TH (m)</th>
<th>Lithology</th>
<th>Sample No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Clay</td>
<td>AKi4</td>
<td>Concretion Kirite</td>
</tr>
<tr>
<td>12</td>
<td>Silt</td>
<td>AKi5</td>
<td>Massive Claystone</td>
</tr>
<tr>
<td>10</td>
<td>Sand</td>
<td>AKi6</td>
<td>Thinly Laminated Ironstone</td>
</tr>
<tr>
<td>7</td>
<td>Granule</td>
<td>AKi7</td>
<td>Massive Claystone</td>
</tr>
<tr>
<td>5</td>
<td>Sand</td>
<td>AKi8</td>
<td>Ironstone</td>
</tr>
<tr>
<td>3</td>
<td>Clay</td>
<td>AKi9</td>
<td>Shale Interbedded with Ironstone</td>
</tr>
<tr>
<td>0.4</td>
<td>Clay</td>
<td>AKiA</td>
<td>Concretion Ironstone</td>
</tr>
</tbody>
</table>

Figure 4.2: Lithological log of Ppiti Formation at Aukto
4.3 LITHOLOGY DESCRIPTION OF GEHEKI 1

Geheki 1 is located on latitude 8°18'51" and the longitude 6°52'34". It has the elevation of 98m at the base. It falls within the Pati Formation which consists of shale, claystone, and ironstone. Geheki 1 is composed of shale and concretional ironstone. The oldest bed is shale preceded by concretional ironstone. At GH1F, there is intercalation of shale, claystone and ironstone which is grayish in color. The youngest bed is a milky intercalation of claystone and ironstone.
Figure 4.3: Field photograph of Celerina L section showing the histology of Paul Formation
### Figure 4.4: Lithological Log of Fault Formation at Ghekeli

<table>
<thead>
<tr>
<th>Description</th>
<th>Sample Number</th>
<th>Lithology</th>
<th>TH (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concretion Limestone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flecky Limestone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laminated Limestone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone Intercailation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale and Claystone and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milky Claystone and</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Granites**

**Sand**

**Silt**

**Clay**

**Elevation:** 98m

**Location:** Ghekeli 1

**Latitude:** 0°32.734" N

**Longitude:** 0°18.517" E
compaction of nod. The table and please below shows the result.

easily that is applied to the soil mass. The analysis is to determine if the soil is well

and the density of a soil for a specified compaction effort. Two (2) soil samples were

This laboratory test is performed to determine the relationship between the moisture content.

4.4.4. COMPACTATION ANALYSES

4.4. RESULTS AND DISCUSSION
<table>
<thead>
<tr>
<th>Density</th>
<th>Confinement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt. %</td>
<td>No.</td>
</tr>
<tr>
<td>Maximum</td>
<td>Sample</td>
</tr>
</tbody>
</table>

Table 4.1: Compression analysis results
Compaction test of a soil is used to determine the compaction of the soil so as to develop the engineering properties of the samples. It is used to determine the maximum dry density and optimum moisture density. High density improves the shear strength and elastic modulus as the permeability is decreased. To achieve a high density, the material is compacted at the optimum moisture density. After the analysis, the optimum moisture density content for AK1 and GHE are high at 13.60% and 16.18% respectively, this making the shale to be good for engineering purposes. The densities are high because the samples are cohesive soils. Shale has high compaction values making it impermeable.

4.4.2 AITBEBBER LIMIT

Atterberg limit are a basic measure of the critical water contents of a fine-grained soil e.g. shale: its shrinkage limit, plastic limit and liquid limit. The numbers of samples analyzed are 9. The table and chart below shows the result:
<table>
<thead>
<tr>
<th>No</th>
<th>Sample</th>
<th>Liquid residue</th>
<th>Plastic residue</th>
<th>No. Limit</th>
<th>Limit Index</th>
<th>AKIA</th>
<th>AKIU</th>
<th>AKIS</th>
<th>AKIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>0</td>
<td>25</td>
<td>65</td>
<td>40</td>
<td>0</td>
<td>65</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>26</td>
<td>23</td>
<td>67</td>
<td>31</td>
<td>26</td>
<td>29</td>
<td>60</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>40</td>
<td>23</td>
<td>7</td>
<td>44</td>
<td>40</td>
<td>23</td>
<td>70</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>96</td>
<td>46</td>
<td>26</td>
<td>6</td>
<td>96</td>
<td>46</td>
<td>26</td>
<td>70</td>
<td>96</td>
</tr>
<tr>
<td>5</td>
<td>88</td>
<td>38</td>
<td>28</td>
<td>5</td>
<td>88</td>
<td>38</td>
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<tr>
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<td>4</td>
<td>50</td>
<td>30</td>
<td>25</td>
<td>55</td>
<td>50</td>
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<tr>
<td>7</td>
<td>40</td>
<td>40</td>
<td>32</td>
<td>3</td>
<td>40</td>
<td>40</td>
<td>32</td>
<td>72</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>34</td>
<td>34</td>
<td>26</td>
<td>2</td>
<td>34</td>
<td>34</td>
<td>26</td>
<td>60</td>
<td>34</td>
</tr>
<tr>
<td>9</td>
<td>36</td>
<td>36</td>
<td>27</td>
<td>1</td>
<td>36</td>
<td>36</td>
<td>27</td>
<td>63</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 4.2: Alkylborate Limit analysis result
Figure 4.7: Chart for plasticity of the shale in Ahoko and Geheku

Plasticity chart

Liquid limit

plastic index

0
5
10
15
20
25
30
35
40
45
50

80
70
60
50
40
30
20
10
The table below shows the result obtained from the analysis.

Grain size analysis was done using different sieves of size, ranging from 3.55mm to 6.35m. The

4.43 GRAIN SIZE ANALYSIS

Varying from 3 to 6, this makes it not too good for pavement or any engineering structure.

Cracks on the pavement, settlement of the pavement, and rutting of the road surface. The above
conditions are not suitable in pavement construction since it will suffer excessive shrinkage in dry conditions.
The initial size for each sample is 100g. Shale is a fine grained soil which leads to high percentage of passing.

The table below is the calculation of the cumulative frequency of the samples.
<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>2</th>
<th>2</th>
<th>3.35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Frequency Table</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.8: Grain size curve for GHI.

Figure 4.9: Grain size curve for GIHC.
Figure 4.11: Grain size curve for AKIE

Figure 4.10: Grain size curve for GHE
Figure 4.13: Grain size curve for AK1P

Figure 4.12: Grain size curve for AK1L
Figure 4.15: Cumulative curve for AKIU

Figure 4.14: Cumulative curve for AKIS
Figure 4.16: Grain size curve for AKLA