PRELIMINARY STUDY OF ROCKS AND SOILS TYPES IN MANGUN PLATEAU STATE, NORTH CENTRAL NIGERIA.

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ABSTRACT
The geological study involves field mapping of the lithological units and the geological structures of the area of Mangun, Plateau State. The investigation reveals the following rock types: migmatite-gneiss, porphyritic biotite granite, medium – coarse grained biotite granite, older basalt and laterized older basalt. The granites belong to the older granite series. The geological structures include: joints, foliation, quartz veins and quartzo-feldspathic dykes. The rocks are highly fractured while some are foliated due to the tectonic activities that took place after their emplacement. Field observation shows various soil types: clay, saprolite, kaolin and laterites - of varying composition, texture and colours. In order to produce a reviewed geological map of the study area, it is required that a geotechnical analysis of representative samples be carried out in order to determine the properties of soils and rocks in the study area and to delineate same for various engineering and geotechnical purposes.

KEYWORDS: Geological Mapping; Field Mapping; Lithological Units; Representative Samples; geological Structures.

INTRODUCTION
The study area is located in Mangun, Mangu Local Government Area of Plateau state, Fig 1. It is situated in the south western part of the Jos Plateau. It lies between latitudes 9° 48' N - 9° 15'48" N and longitudes 9° 8' 4" E - 9° 14' 4" E, which covers an area of 100km². Figure 1 shows the location of the study area.

Soils are products of weathering of rocks brought about by various agents of denudation. These soils differ in characteristics depending on the mineralogical composition of the parent rock and the condition of weathering. Therefore the knowledge of the rock types from which the soils are derived is very important in geotechnical engineering. The area under study is situated on the basement complex of the Jos Plateau which is characterized by Precambrian basement complex rocks. Wright, (1971; 1976). Since soils are formed from weathering of rocks, the geotechnical investigation of the soils is preceded by geological mapping in order to establish the various lithological units from which the soils are formed.

The soils under study are residual soils. They have wide range of application especially the construction industry. Prominent among them are road construction where they are used as subgrade, sub base and base course materials. Soils have variable engineering properties due to their composition and mode of formation (Amadi, 1988). Soils like any engineering materials distort when placed under load. This distortion paves way for settlement of the structure. The eventual collapse of the structure can be of monumental losses both in terms of economic values and human lives.

In the southern terrain of the study area, there are two portions of the untarred roads that are not accessible to motorists at the peak of rainy seasons. These are Laarpia along Nyemdung-Gung road and Taabel along Mangun Town-Gwakshesh road. These two portions of the roads become so plasticized beyond accessibility during wet seasons.

The question is why do some portions of the roads become plasticized while others do not? For this reason, the research work is aimed at finding the geotechnical problem associated with the areas and proffer possible solution(s) to the problems.
METHODOLOGY

The research methodology involves Literature review, Study and interpretation of satellite image of the study area, Geological and structural investigations of the study of rocks and soils. Equipment/Instruments and Materials Used include Garmin Global positioning system, Clinometer Compass and sundry field/ laboratory instruments.

The use of ILWIS Softwares was effectively deployed, (Lar et al 2011; Mallo et al 2011). For this study, the Landsat 7 ETM + image data was used for the establishment of required Images. The Band 7 deployed in this study has high information content, i.e. there is large variation in the spectral response of materials in the environment. This is because Band 7 is the least affected by atmospheric attenuation compared with the reflected infrared bands.

GEOLOGY

The northern terrain is relatively flat as a result of the the laterised older basalt. The terrain is also characterized by sporadic granitic intrusions. The drainage system is dendretic as this very area is water shed. The southern terrain has a rugged topography and predominated with granitic hills of varying heights. There are also some few older basalt. The area under study is underlain by precambrian basement rocks being part of the Jos plateau, Wright, (1971; 1976). These rocks include; migmatites, gneisses and older granites. The precambrian basement complex is intruded by anorogenic younger granites (granites, porphyries and rhyolites) Falconer, (1911). The younger granites are Jurassic in age. Macleod et al, (1971; 1977). The third group of rocks on the Jos Plateau is the basalts. They are tertiary to quaternary in age. They are mostly olivine basalts and are subdivided into three, namely; Laterized Older Basalts ;(LOB) Older; Basalts (OB) and Newer Basalts (NB). The LOB represents lavas now decomposed to clays and usually overlain by a thick cap of lateritic ironstone. The LOB is found in Bokkos L.G.A. The OB and NB are also decomposed and are usually distinguished by the fact that while the former lacks volcanic foci, the latter has. OB are found in Mangun while NB are found in Ampang West/Kerang.

The purpose of this study is to give a description of the different rock and soil types in the study area. The field and megascopic description are based on field observations and the study of the rocks in hand specimens using aided and unaided eye. The lithological units established are as described below.

Migmatite-Gneiss :The migmatite-gneiss outcrops at the eastern and western portions of the study area. It occupies about 10% of the study area. The outcrops are of low relief compared to the porphyritic and medium-coarse grained

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biotite granites. The migmatite-gneiss is foliated and in some cases the foliations are folded. It also exhibit boudanage structures and is also fractured. It is fine to medium grained in texture. There is alternation of light and dark minerals.

Porphyritic Biotite Granite: The porphyritic biotite granite outcrops at the mid east and north western parts of the study area. Most of the area mapped ranges from granitic to granophyric. It occupies about 15% of the study area. The major constituents of the porphyritic biotite granite are the plagioclase feldspars, which give the rock whitish to gray colour, biotite and quartz. The biotites are dark in colour. The plagioclase feldspars are imbedded in a medium grained granular matrix of quartz, biotite and other accessory minerals. The plagioclase feldspars occur as phenocrysts with some of the crystals measuring 20mm. (Plate 1).

Plate 1: Porphyritic biotite granite at Taabel. (9 11 30.52 N, 9 10 21.72 E).

Medium-Coarse Grained Biotite Granite: This rock occurs at the western, down to the south and extend to the eastern and north central parts of the study area. It is widely distributed among other rock types. It makes up about 55% of the rock type. The major minerals of this rock are plagioclase feldspar, quartz and biotite.

Older basalts: These rocks occur in the north western and south western parts of the study area. They occur as volcanoes and they seem to be structurally controlled because while some of them trend NE-SW, others trend N-S. They occur as boulders. They are highly weathered and lack volcanic foci. They occupy about 2% of the study area. They are quartz free and are grey to dark in colour.

Laterized Older Basalt: They are found mainly in the northern portion of the study area. They occupy about 18% of the study area. They are brownish to dark in colour due to abundant iron oxide left after leaching of the soluble minerals like feldspar. The laterized older basalt undergoes honey comb weathering as can be seen on Plate 2. A reviewed geological map of the study area is presented in Fig. 2 (shown as Fig 11).
Plate 2: Laterized Older Basalt at PRTV, Mangun, (9°14'25" N, 9°08'29" E)

Fig. 3: Satellite image of the study area
Source: National Centre for Remote Sensing

Plate 4: Dyke on migmatite-gneiss at Kaharyam, (9°13'18.55" N, 9°11'57.71" E)
Fig. 3 illustrates the image of this band over the study area. The enhancement of the image was achieved using the image histogram equalization with 10% stretching interval. The stretched image was sharpened through the use of directional filters in order to emphasize the linear features. The enhanced image shows increased contact and sharpness between geologic features and improves the recognition of subtle differences. Four lithological units and the dentritic drainage pattern are recognized on the image. The lithological and structural overlay is then compared with the field results. The analysis of the structures using ILWIS software shows the distribution of lineaments over the study area and it is useful in the sense that it offers a quick glance of the spatial distribution and density of lineaments and so provides a useful database in mineral exploration, geophysics, hydrogeology, water borehole drilling, road and dam location and alignments, environmental planning as well as potential hazard monitoring and control (Ogezi, 2000).

Structural Geology
Geological structures are geological features that can be defined geometrically. That is to say, they have strike and dip in the case of planar structures and trend and plunge in the case of linear structures. In other words, they are imprint of deformation left on the rocks which include: joints, faults, foliations, lineations, folds, dykes, veins etc. These structures are believed to have resulted from the intense regional tectonism that preceded and accompanied the emplacement of the older granite during the pan African orogeny which produced a well define and extensive N-S trend in north central Nigeria of which the study area is part of it. The origin of these structures cannot be totally attributed to only tectonism but they might have been due also to tensional forces developed during cooling.

The structural setting in the study area has greatly controlled the geology, relief and drainage pattern of the area. Generally the nature and extent of rock deformation is a function of the duration of the destructive force(s) in action.

The following structures were observed on the field.

Joints: Joints are fractures developed in rocks during cooling of the magma or during tectonism and do not result in the displacement and offset of one block relative to the other. Joints occur on the migmatite, porphyritic biotite granite, medium - coarse grained biotite granite and the laterized older basalts of the area. The joints and folliages on the rocks were studied for specific areas, these include:

1. Joint on migmatite-gneiss at Kolushik, (9° 13' 8.55" N, 9° 11' 57.71" E).
2. Joint on medium to coarse grained biotite granite at Mangun Old Market Square, (9° 12' 53.28" N, 9° 09' 23.58" E).
3. Joint on medium to coarse grained biotite granite at Mangun Old Market Square, (9° 12' 53.28" N, 9° 09' 23.58" E).
4. Foliation on migmatite-gneiss at Kolushik, (9° 12' 14.76" N, 9° 12' 52.60" E).
5. Dyke on migmatite-gneiss at Kaharyam, (9° 13' 18.55" N, 9° 11' 57.71" E).
6. Quartz veins on migmatite-gneiss at Kolushik, (9° 12' 14.76" N, 9° 12' 52.60" E).

Table 1. Shows the Joint readings of strike on porphyritic biotite granite at Taabel, while Fig. 4 shows the fracture pattern of the study area as digitized.

Foliation: The term foliation is a general term sometimes used as essentially synonymous with cleavage, but is applied most generally to mineral alignment in metamorphic rocks and sometimes in igneous rocks (older granites). Thus, slaty “cleavage” and “schistosity” are special types of metamorphic foliation characterized by the types of fabric or mineral arrangement commonly found in slates and schists. Foliation is mostly used for metamorphic fabric like migmatite-gneiss.

Foliation is formed as a result of static pressure that act on the pre-existing rock changing the platy mineral such as mica and amphiboles contained in the rock structurally to a new form. The presence and degree of foliation in a rock helps in knowing the rock type and condition under which the rock was formed. Some of the foliations are folded.

Dykes: Dykes are rock bodies that cut across another rock type discordantly. In the study area, dykes characterize both the migmatite-gneiss and the older granites. They are quartzo-feldsparitic in composition. They are light coloured and of fine to medium grained in texture. They range in diameter from 15-70 cm on the older granites and 10 -73 cm on the migmatite-gneiss. The dykes in some cases cross cut each other, Plate 4.

Veins: Veins are sheet like or tabular, discordant, mineralized body formed by complete or partial filling of a fracture within a rock, Fig. 4( shown as Fig.12). In the study area, the materials that fed up the joints are quartz.
Figure 12: Fracture pattern of the study area

Fig. 5: Rose Plot of Joints on Porphyritic Biotite Granite

Figure 17: Sample location map of the study area
DATA PRESENTATION AND MEGASCOPIC DESCRIPTION

The joint and foliation readings were taken on the lithologies in the study area, the tabulation and rose diagrams accordingly established for Medium-grained biotite, porpheric biotite granite, and magmatic gneiss (Table 1 and Fig.5). The results of the field studies provide information on megascopic analysis as follows:

a. Plot of Joints on medium coarse-grained granite: Number of lots 44; Dominant trends NW-SE; Minor trends NE-SW, NNW-SSE; Axis Angle 30° and Bin Size 16.

b. Plot Joints on porphyritic biotite granite: Number of Plots 44; Dominant trends NW-SE; Axis Angle 30°; Bin Size 16.

c. Plot of Joints on magmatic Gneiss: Number of Plots 44; Dominant Trends NE-SW, Minor Trends NE-SW, Axis Angle 30°, Bin Size 16 and

d. Foliage plot of magmatic gneiss: Number of plots 44, Dominant trends NE-SW, Minor Trends NW-SW, Axis Angle 30°, Bin Size 16.

Table 1. Joint Readings of Strike on Porphyritic biotite granite at Taabel

| S/NO | STRIKE (°) | DIP (°) | S/NO | STRIKE (°) | DIP (°) |
|------|------------|---------|------|------------|---------|
| 1    | 114        | 84S     | 23   | 104        | 52S     |
| 2    | 52         | 78SE    | 24   | 160        | 90      |
| 3    | 150        | 56SW    | 25   | 160        | 90      |
| 4    | 80         | 90      | 26   | 76         | 30S     |
| 5    | 172        | 90      | 27   | 120        | 90      |
| 6    | 106        | 90      | 28   | 166        | 90      |
| 7    | 44         | 90      | 29   | 154        | 42W     |
| 8    | 134        | 90      | 30   | 110        | 50SW    |
| 9    | 26         | 90      | 31   | 112        | 90      |
| 10   | 26         | 90      | 32   | 112        | 90      |
| 11   | 160        | 90      | 33   | 112        | 90      |
| 12   | 160        | 90      | 34   | 116        | 90      |
| 13   | 178        | 90      | 35   | 116        | 90      |
| 14   | 164        | 90      | 36   | 156        | 52SW    |
| 15   | 26         | 90      | 37   | 152        | 46SW    |
| 16   | 142        | 90      | 38   | 152        | 46SW    |
| 17   | 174        | 90      | 38   | 88         | 90      |
| 18   | 166        | 90      | 40   | 140        | 70SW    |
| 19   | 38         | 90      | 41   | 106        | 90      |
| 20   | 88         | 90      | 42   | 106        | 90      |
| 21   | 10         | 90      | 43   | 106        | 90      |
| 22   | 46         | 90      | 44   | 106        | 90      |

Source: Yarekes Field Data 2010

The dominant trends of NW-SE and NE-SW respectively correspond to the general trend of Precambrian to Cambrian rocks in Nigeria, including rocks of the Basement Complex, as a result all the rock types are said to be Pan-African in age.

These structural features could have different relative periods of tectonics and metamorphism in the study area. The rock structures exert important influence upon the activities and pattern of rivers. This could be related to the courses of river channels in the study area.

The structural setting in the study area has greatly controlled the geological setting, relief and drainage, geological boundaries and trend of younger rocks. Generally, the nature and extent of structures depend on the duration and intensity of deformation.

The trends of the field observation also confirm what is obtainable on the Landsat Image. For the NW-SE, trends on the granites, it was most likely that the deformational stress acted in a NE-SW direction, while the NE-SW trends on the migmatite-gneiss were most likely acted upon by a NW-SE stress.
The geological structures may affect roads and or foundation negatively especially at geological contacts, crushed or fault zones. The presence of tectonic structures is an indication of deformative stresses, both on regional and local scales. The geological structures were investigated as lineaments. Generally, regional linear or curve-linear features expressing deep-seated geological structures are usually visible on remote sensing image such as aerial photographs or satellite imageries. Therefore, structural features, mainly in the form of lineaments, were extracted for this work from the satellite image covering the study area.

SELECTION OF SAMPLE SITES AND PROCEDURE
The map of the study area was first of all gridded and representative soil samples were collected systematically based on the gridded map at an average distance of 2 km. Fig. 6 (shown as Fig.17). Table 2 shows the tabulated locations, coordinates and description of the soil samples.

Disturbed samples were collected at each sampling point at an average depth of 0.5m using pix axe. Thereafter, undisturbed samples were collected on the same floor using metallic sampling tubes. The sampling tubes have an average length of 13.2cm and an average internal diameter of 4.2cm. A total of forty samples of disturbed and undisturbed samples were collected within the study area.

Table 2: Sample Locations and Soil Description

| S/no | Location | Abbreviation | Coordinate            | Elevation (m) | Soil Description                      |
|------|----------|--------------|-----------------------|---------------|---------------------------------------|
| 1    | BOHONZU R| BHZ          | N⁰ 10° 27.96', E⁰ 9° 33.54' | 1198          | Whitish Sandy Clayey Soil             |
| 2    | LAARPIA  | LRP          | N⁰ 11° 11' 05.64', E⁰ 9° 33.18' | 1227          | Brownish Clayey Laterite              |
| 3    | YILPIA   | YLP          | N⁰ 11° 52.38', E⁰ 9° 08.26.94' | 1269          | Brownish Sandy Laterite               |
| 4    | KONGNDE P| KGN          | N⁰ 12° 36.72', E⁰ 9° 14.22' | 1338          | Brownish Sandy Laterite               |
| 5    | KOOBIRI NG| KBG         | N⁰ 15° 29.53', E⁰ 9° 10.98' | 1370          | Clayey Soil, Ash in Colour            |
| 6    | DEERTUH UN| DTH        | N⁰ 15° 05.64', E⁰ 9° 53.76' | 1365          | Kaolin, White-Purple in Colour        |
| 7    | YILPANG  | YPG          | N⁰ 14° 31.77', E⁰ 9° 18.52' | 1395          | Brownish Laterite                     |
| 8    | DUNGOHO R| DGH         | N⁰ 13° 36.72', E⁰ 9° 05.48' | 1392          | Reddish Laterite                     |
| 9    | TAABEL   | TBL          | N⁰ 11° 24.60', E⁰ 10° 24.15' | 1277          | Brownish Clayey Laterite             |
| 10   | KOPKULI  | KPK          | N⁰ 12° 32.88', E⁰ 10° 02.29' | 1333          | Clayey Sandy Soil                    |
| 11   | KOLUSHIK | KSK          | N⁰ 10° 56.77', E⁰ 12° 35.49' | 1180          | Brownish Laterite                     |
| No. | Location       | Soil Profile                        | Coordinates                  | Depth | Notes                  |
|-----|----------------|-------------------------------------|------------------------------|-------|------------------------|
| 12  | KOLUSHIK       | KSK1                                | N9°12' 12.52, E9°13' 25.35"  | 1199  | Whitish Clayey Sandy Soil |
| 13  | KOLUSHIK       | KSK2                                | N9°12' 18.17, E9°11' 43.45"  | 1203  | Ash Clay Soil          |
| 14  | NGIHIKUTUP     | NKT                                | N9°12' 52.14, E9°12' 14.82"  | 1250  | Brownish Laterite      |
| 15  | KAHARYAM       | KHY                                | N9°13' 02.10, E9°11' 17.72"  | 1296  | Whitish Laterite      |
| 16  | KAHARYAM       | KHY1                               | N9°14' 14.34, E9°10' 46.08"  | 1314  | Whitish Powdered Clay |
| 17  | KAHARYAM       | KHY2                               | N9°14' 08.85, E9°12' 05.41"  | 1328  | White Clayey Sandy Soil |
| 18  | DUSEWARI       | DWR                                | N9°14' 53.87, E9°11' 39.00"  | 1360  | Orange Sandy Clayey Soil |
| 19  | TOOKSHAAR      | TSH                                | N9°13' 30.48, E9°10' 48.32"  | 1351  | Brownish Laterite      |
| 20  | TINGKUM        | TKM                                | N9°10' 48.23, E9°08' 41.44"  | 1196  | Brownish Laterite      |

The geotechnical investigation involves field and laboratory analysis of the soil samples. In the field, visual inspection of each sample was carried out followed by collection of the samples. Plate 5 shows a typical soil profile in the south western part of the study area. The laterite is reddish brown and about 1.6m while the clay which is whitish in colour begins from this depth. Soil profiles in the southern terrain reveal that the brownish laterite is underlain by thick clay (saprolite). See Plate 5 below.

Plate 5. A typical soil profile of a gulley at Dungkool, SW of the study area, N09°10.721, E009°09.397
CONCLUSION
Geological mapping was and sundry field investigation was carried out over an area covering 100km² bound by latitudes 9° 48’ N - 9° 15 48’ N and longitudes 9° 8 4’ E - 9° 14 4’ E. The study area is located in Mangun, Mangu LGA of Plateau State north Central Nigeria.

The geological mapping reveals that the study area is underlain by the Precambrian basement rocks which include: migmatites, gneisses and older granites. Other rocks found in the area are older basalts and laterized older basalts. Structurally, the migmatite-gneiss has a NE-SW major structural trend of joints and foliations, whereas the older granite series have a NW-SE major structural trend of joints.

The study reveals three types of clays viz: children clay, saprolite and kaolin. A study of the soil profile at the south western part of the study area reveals that the lateritic cap is underlain by thick saprolite.

The study was more of an area extent. Therefore another study can be made so that the soils can be sampled with depth in order to have a vertical geotechnical data of the area as well. A further investigation is required on the representative soils and rocks samples taken from the study area for the purpose of their geotechnical characterizations and delineation for industrial applications. The kaolin deposit sample (DTH) from Deertuhun should generate interest for investors and therefore requires further investigation for possible exploitation or otherwise.

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