# GEOLOGICAL MAPPING OF TEGINA AND ENVIRONS NORTH-CENTRAL NIGERIA

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## ABSTRACT

Tegina and environs is situated within the north-central part of Nigeria. Geological mapping of Tegina and environs was carried out to produce a geological and structural map of the area with a view of updating the existing information on the geology of Nigeria. Lithologies mapped include migmatite-gneiss, schist and medium to coarse-grained granite. The dominant lithology in the area is schist covering more than 50% of the total area. Structures observed in the area are joints, veins, dykes, foliations, faults and folds and are mostly observed on the migmatite-gneiss and granitic rocks only. The NE-SW structures dominate, with minor trends of structures in the NW-SE and E-W directions. The flows of streams in the study area were structurally controlled. From field evidences, the geological and structural map of the area was produced.

**Keywords:** Tegina, North-central Nigeria, Mapping, Lithologies, Structures.

## INTRODUCTION

According to Olayinka (2009), geological field mapping is the process of gathering geological data in the field and adding to a topographic map to create a geological map of our own. The author further showed that the process involves careful observation of exposure, searching for other clues about the hidden geology, interpretation of these data to create the map and often then writing a geologic report. Nwajide, (2002) in his contribution said a field geologist seek to describe and explain the surface and subsurface features of the crust through systematic examination of the rocks of a given region for purely scientific and/or economic purpose. Baba (2009) further said geological field mapping forms the basis for prospecting, exploration and application in many other fields such as Hydro geological, Engineering geology and land use planning. Since geological maps are the visual language of geologist, and geological fieldwork provides the fundamental scientific basis for most geologic map (Rahaman, 2009) therefore, this research work was carried out to add up to the database of the geology of Nigeria.

## MATERIALS AND METHODS

### Study Area

The study area Tegina and environs, located in the present Niger State north-central Nigeria lies between Longitudes $06^0$10' to $06^0$13'E and Latitudes$10^0$03' to $10^0$06'N and covers an area of about 31.36 $km^2$ (Figure 1). The highest topography in the area is about 420 m above mean sea level and is observed at the south-eastern end of the area on Ugu hill. Other places with higher elevations are to the north-western and north-eastern parts of the area. To the central parts, the topography is a near peneplain undulating between 220 m to 280 m above mean sea level. The drainage pattern in the area is dendritic with most of the streams flowing dominantly in the NE-SW direction and

NW-SE, E-W minor directions. Vegetations in the area are mainly shrubs and tall trees with thin leaves typically of the Sudan savannah.

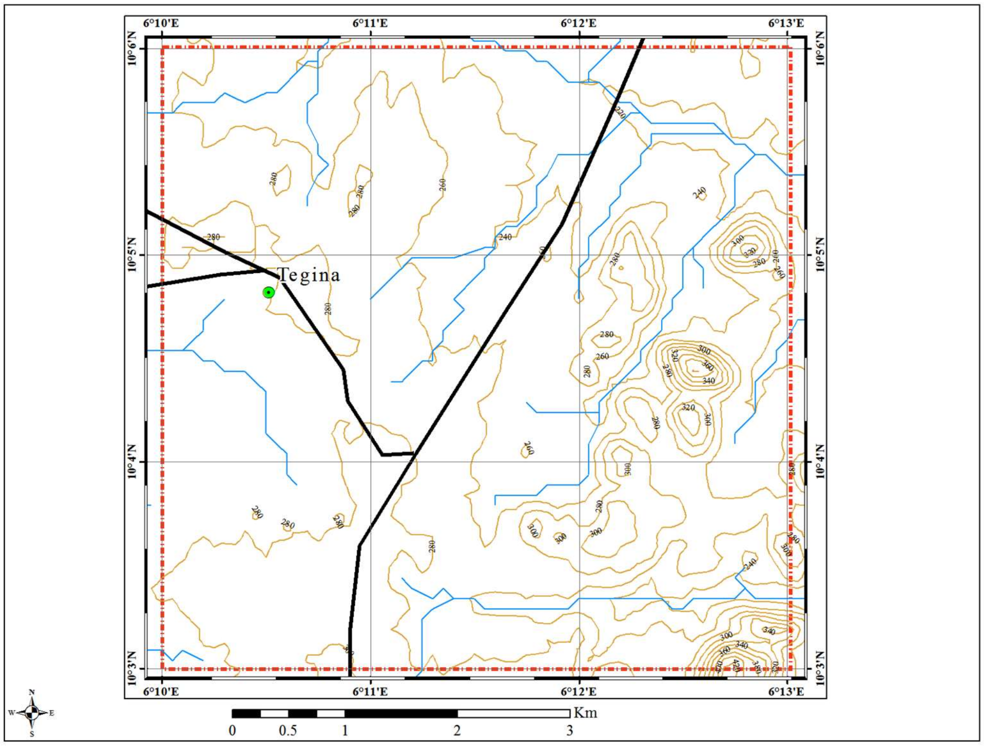


**Figure 1:** Topographic Map of Tegina and Environs (NCRS,2016)

## Methods of Geological Field Mapping

The geological field mapping of Tegina and environs lasted for five days (13 – 17 June 2017). The area mapped was 5.6 by 5.6 km. Equipment and materials that were used to aid geological field mapping include a topographic map of the area, silva compass, Etrex[10] Garmin global positioning system (GPS), Nikon camera, measuring tape, hammer, hand lens, field notebook and writing materials. During the field exercise, principles of geological mapping and field observations were applied, rock specimen samples were collected. Recognition of structures such as fold, fault, joints, veins, dykes, foliations were done following criteria described by Barnes (1981), Gokhale (2007). While mapping Tegina and environs, the topographic map of the area was gridded at fifteen seconds (15’’) intervals for easy plotting of location points and the random traversing method was adopted during the mapping exercise. The strikes measurement of joints, veins and dykes were inputted into computer software (GEOrient version 9.4.4) for statistical analysis and the outcome was a rose diagrams plots which showed the predominant structural trends in the area. The lithogic boundaries mapped on the field and their coordinates plotted directly on the topographic map were later transcended into the geologic map of the area.

# RESULTS

## Mapping of Lithologies

In the mapped area, migmatite-gneiss rock unit occupies the eastern part of the area and is low lying. In the hand specimen, the rock is light gray and composed of quartz, feldspars and mica (biotite) displaying foliations. In some areas, the contact between migmatite-gneiss and the granite plutons is a sharp contact (Figure 2) but in most of the areas mapped it is a transitional contact alternating between migmatite-gneiss and granite.

More than fifty percent (50%) of the area mapped is underlain by schist, and in some areas, it occurs in association with quartzite. To the eastern part of the area, this rock unit was observed to be greenish-black with traces of muscovite and it displayed perfect cleavage. In this area, the observed rock has a width of about 2 - 6 m, extending for a few meters and trends generally in the NNE-SSW direction. The rocks appeared to be infolded within the migmatite-gneiss complex (Figure 3).


**Figure 2:** Migmatite-gneiss contact southeast of Tegina town (Long. $6^0$11'44''E and Lat. $10^0$03'36''N), southeast of Tegina town.


**Figure 3:** Greenish schist rock in between migmatite-gneiss complex (Long. $6^0$12'46''E and Lat. $10^0$03'25''N)

Granite occurs in the area mapped as mountain chains of plutonic rocks intruding the migmatite-gneiss complex and trending generally in the NE-SW direction. The contact between this rock unit and the migmatite-gneiss complex is mostly transitional but sharp in some few instances. In the hand specimen, the rock is light (leucocratic) and is generally medium to coarse-grained exhibiting minerals like Quartz, feldspars and biotite.

**Mapping of structures**

Structures encountered in Tegina and environs include joints, veins, dykes, foliations, exfoliation, faults and folds.

Joints were observed on all the rock units, but the most peculiar ones occurring on the migmatite-gneiss outcrops are set of joints cross-cutting one another at the right angle ($90^0$) trending in the N-S and E-W directions (Figure 4). From the rose plot of joint in the mapped area (Figure 5) the dominant trend is in the NW –SE direction, other minor trends are in the N-S to NE –SW and E – W directions.


**Figure 4:** Set of Joints cross-cutting one another at $90^0$east of Tegina town (Long. $6^0$12'21''E and Lat. $10^0$03'53''N).

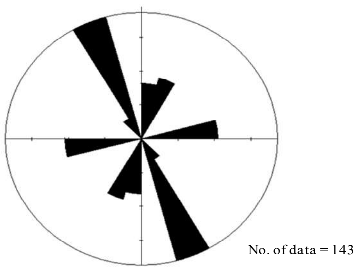


**Figure 5:** Rose plot of Joints in Tegina and Environs

Veins observed in the area are quartz veins (Figure 6) ranging in width from less than 1 cm to about 4 cm and were observed to occur mostly on the migmatite-gneiss and granitic outcrops. Rose plot of vein structures in the area (Figure 7) showed dominant trends in the N-S to NE-SW directions and minor trends are the NW- SE and E-W directions.


**Figure 6:** A Sinistral Strike-slip Quartz Vein northeast of Tegina town. (Long. $6^0$12'52''E and Lat. $10^0$05'46''N)

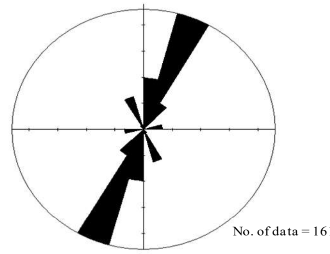


**Figure 7:** Rose Plot of Veins in Tegina and Environs

Dykes observed on the migmatite-gneiss complex and granite outcrops are quartzo-feldspathic to aplite dykes (Figure 8 and 9). The aplite dykes exhibits a sugary texture. The dykes observed range in thickness from 20 cm to 36 cm trends generally in the NE-SW (20 - $30^0$) directions.


**Figure 8:** A NE-SW trending Quartzo-feldspathic dyke southeast. (Long. $6^0$12'43''E and Lat. $10^0$03'41''N)


**Figure 9:** A NE-SW trending Aplite dyke southeast of Tegina town of Tegina town. (Long. $6^0$11'43''E and Lat. $10^0$03'26''N)

Foliations are observed on the migmatite-gneiss outcrops only. This structure was exhibited on the outcrop as an alteration of light and dark bands composing of quartz and biotite minerals respectively (Figure 10). The foliation trends dominantly in the NE-SW (10 - $30^{0}$) directions and dips between $40^{0}$- $60^{0}$ NW or SE.

Exfoliation which could have resulted from unequal contraction and expansion of rock during the night when there is a fall in temperature and in the day time when there is a rise in atmospheric temperature and pressure. This structure was observed to occur as degradation of boulders by spilling of surface layers (Figure 11).


**Figure 10:** A trend of NE-SW Foliation on migmatite-gneiss rock (Long. $6^{0}$11'39''E and Lat. $10^{0}$03'36''N)

**Figure 11:** Exfoliation on Granite east-southeast of Tegina town Southeast of Tegina town (Long. $6^{0}$12'36''E and Lat. $10^{0}$04'19''N)

Fault structures observed on migmatite-gneiss and granitic outcrops are mostly strike-slip faults. The strike-slip fault exhibits sinistral sense of movements (Figure 12). Folds observed during the field mapping exercise, occurs on migmatite-gneiss outcrops. Two types of folding observed are symmetrical and asymmetrical folds (Figure 13 and 14).

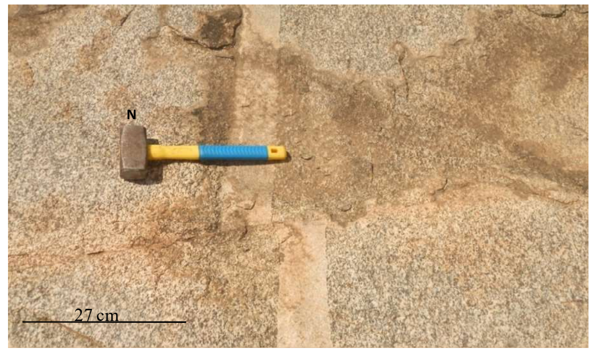


**Figure 12:** A Sinistral Strike-slip Aplite dyke southeast of Tegina (Long. $6^{0}$11'44''E and Lat. $10^{0}$03'27''N) southeast of Tegina town


**Figure 13:** Symmetrical Fold on migmatite-gneiss rock Town (Long. $6^{0}$11'33''E and Lat. $10^{0}$03'38''N)


**Figure 14:** Asymmetrical Fold on migmatite-gneiss rocksoutheast of Tegina town (Long. $6^{0}$11'32''E and Lat. $10^{0}$03'38''N)

The geologic map which showed distributions of rock units and structures in the area is presented as (Figure 15).

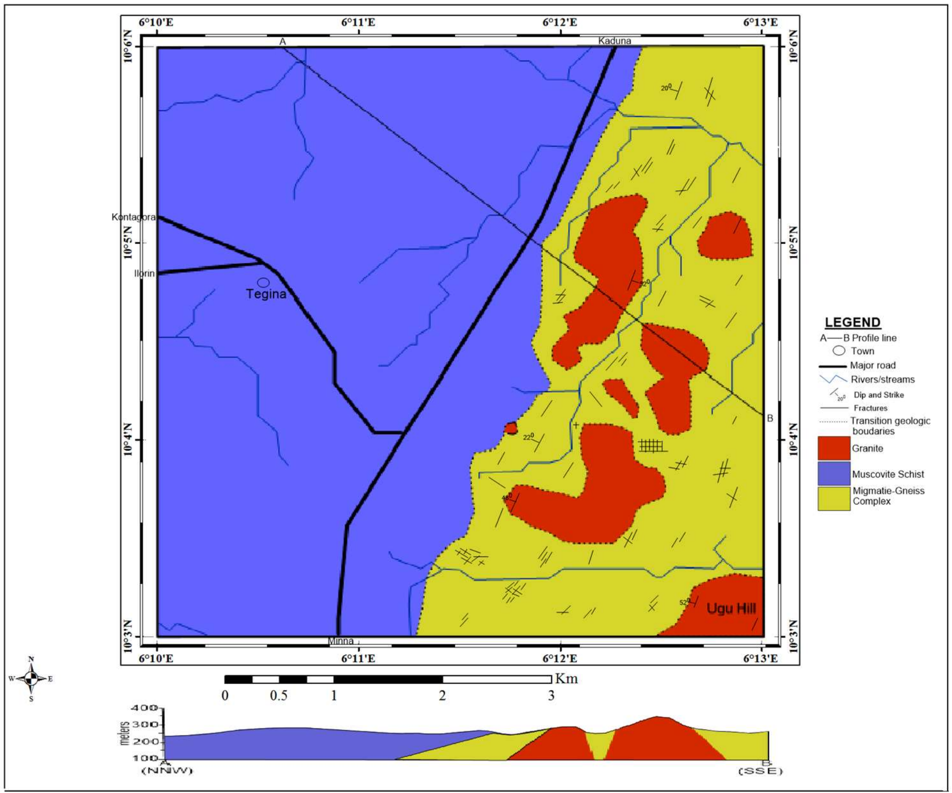


**Figure 15:** Geologic Map of Tegina and Environs/cross-section along line A-B

## DISCUSSION

Field studies in Tegina and environs revealed that the four lithologic groups associated with the Basement Complex rocks of Nigeria are well represented in the area. The migmatite-gneiss which is believed to be the oldest lithologic unit of the Nigerian Basement Complex rocks (Obaje, 2009; Haruna, 2017) outcropped in the area as a low lying rock unit undulating between 220 m to 260 m above mean sea level. This rock unit is made up of quartz, feldspar and biotite and is medium to coarse-grained displaying a NE –SW (10 - $30^0$) foliation trends; with dip varying from 40- $60^0$ NW. Exposures of this rock unit are restricted to the eastern part of Tegina town. Most exposures of schist in the mapped area are dark brownish with minor greenish lenticular exposures within the migmatite-gneiss complex trending in the NNE-SSW direction. The dark brown schist rock unit is fine to medium grained and is dominated by quartzo-feldspathic rocks. More than 50% of the mapped area is dominated by this rock unit and it exhibits a transitional contact with the migmatite-gneiss rock units.

Granite outcrops occurs as a large uplifted bodies rising up to 420 m above mean sea level at Ugu hill southeast of Tegina town. This rock, unit believed to be Pan-African of age intruded the migmatite-gneiss complex with a general orientation in the NE-SW direction. The rock unit is light and is made up of coarse to medium grained non-foliated material composing of quartz, feldspar and biotite minerals. The granitic rock in some outcrops was subjected to exfoliation processes of weathering. Structures observed in the area are joints, veins, foliations, dykes, faults and folds and are mostly observed on the migmatie-gneiss and granitic rocks only.

Joints appear as fractures on the migmatite-gneiss and granite rock units. The most conspicuous occurrence on the migmatite-gneiss is a set of joints cross-cutting each other at right angles trending in the N-S and E-W directions. Statistical analysis of joints in the area, showed a dominant trend in the NW-SE while minor trends are in the N-S, NE-SW and E-W directions. Veins were observed on migmatite-gneiss and granite rock units, quartz filled veins dominated the lithologies with minor appearance of quartzo-feldspathic filled veins. They range in width from less than 1cm to about 3 cm and runs for several meters. Another obvious structural display by some of these veins are strike-slip faulting with sinistral sense of movement, where the displacements varies from 2 to 6 cm. Rose plot of veins from the study area showed a dominant NE-SW trend and minor NW-SE and E-W trends.

Foliations are noticeable on migmatite-gneiss outcrops as an alteration of light and dark bands of quartzo-feldspathic and biotite minerals respectively; the quartzo-feldspathic bands varies in width from few centimetres to about 15 cm while the biotite bands are up to 140 cm in width. The foliation trends in the NE-SW direction. Exfoliation was observed to occur on granite rocks as degradation of boulders by spilling of surface layers. This phenomenon resulted from temperature variations during the night and in the day time given rise to unequal contraction and expansion of rock unit. Dykes are vertical or near vertical intrusions that are discordant with the layering of the horst rock. These structures observed on migmatite-gneiss and granite outcrops, varies from coarse-grained quartzo-feldspathic to aplite dykes. The aplite dykes are light coloured composing of quartz, feldspar and minor amount of biotite minerals. They are fine to medium grained exhibiting a sugary texture. The dykes range in thickness from 20 cm to 36 cm and trends in the NE-SW (20 - 30$^0$) direction. Some of these dykes were seen to display a strike-slip faulting with sinistral sense of movement.

Symmetrical and asymmetrical folds occur in the migmatite-gneiss rock southeast of Tegina town. These folds have axes trending in the NE-SW direction with a gentle plunge of about 20$^0$ to 30$^0$. The NE-SW, NW-SE and E-W structural trends observed on the field correlates well with the structural trends on the Nigerian Basement Complex rocks (Ekwueme, 1994; Obaje, 2009). With these structural trends it can be postulated that three major tectonic events affected the Basement Complex rock in this region just as in any part of the Nigerian Basement Complex. Ekwueme (1994) relates the NE-SW structural imprints to the last thermo-tectonic activities that affected the Nigerian Basement Complex rock referred to as the Pan-African orogeny. He also relates the NW-SE and E-W structural trends to the orogenies that pre-dated the Pan-African. Faulting and folding structures observed on the field are additional evidences that support the Pan-African orogeny.

## CONCLUSION

Lithologies mapped in Tegina and environs include migmatite gneiss, medium to coarse-grained granite and schist, with schist outcrops dominating by more than 50% of the total area. Structures observed in the study area are joints, veins, foliations, exfoliation, faults and folds and are mostly observed on the migmatie-gneiss and granitic rocks only. The NE-SW structures dominate, with minor trends of structures in the NW-SE and E-W directions. The flows of streams in the study area are structurally controlled.

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