THE GEOLOGY OF THE KALTUNGO INLIER UPPER BENUE TROUGH, NORTHEAST NIGERIA

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ABSTRACT

Field mapping of the Kaltungo inlier showed disposition of the rock units outcropped as stocks, plugs and intrusions were characteristic of a rocky outcrop. The litho logic units delineated in the study area consist of porphyritic biotite granite, biotite granite, medium grained granite, micro granite, pegmatite, diorite, protocataclasite, trachyte, trachy-andesite and basalt while the oldest sedimentary unit in the Upper Benue Trough, the Cretaceous Bima Sandstone Formation surrounds the inlier. Major strike-slip fault cross-cut the inlier from Labeke to Ture Pandi trending N60^{0}E into the western block around Kufai, Billiri, Kalmai, Banganje, Tanglang and Tal and the eastern block around Kaltungo, Okra, Poshereng, Popandi, Lapan, Karel, Labeke Kulishin and Ture Pandi. The inlier is intensely sheared and faulted, trending dominantly NE-SW and NW-SE direction is in agreement with the general structural trend of the Nigerian Basement Complex.

Keywords: Lithology, Strike-slip fault, Kaltungo Inlier, Nigeria.

INTRODUCTION

The Kaltungo inlier is a Precambrian Basement located within the Gongola arm of the Upper Benue Trough northeast Nigeria, and falls within the Kaltungo topographic sheets 173NE and 173NW (Fig 1). The inlier has been described as undifferentiated granitic rock units that display topographic highs trending dominantly northeast-southwest to north-south. Geologic information on litho logy, petrogenesis, tectonic setting and age of rocks in the inlier is scarce in comparison to other Basements complexes of Nigeria. Various workers (Falconer., 1911; Van Coppenhagen., 1948; Carter et al., 1963, Mc Curry., 1971; Maurine et al., 1985, Garba., 1988; Maurine et al., 1986, Burke 1992, Islam et al., 1992,

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Baba et al., 1996, Baba et al., 2006, Obaje 2009, Bassey., 2007, Adeyinka et al., 2013, Mboringong et al., 2013 and Barka 2013) submit that the northeastern Nigerian Basement Complex is characterized by tectonic and structural elements such as the Hawal massive, Adamawa Massive, Kaltungo inlier, Gombe inlier, Burashika inlier Therefore, this work is an attempt to elucidate and update the different litho logic units and structures of the inlier, to serve as a baseline for future researchers.

GEOLOGIC SETTING

The Kaltungo inlier consists of rocks of the Pan-African granitoids which form part of the Nigerian Basement Complex. Carter et al (1963); Van Breemen et al (1977) and Tubosun (1983) reported that the rocks of the Kaltungo inlier are dominantly the Older Granites series, surrounded by the outcrop of the Cretaceous Bima Formation. Maurine et al, (1986) delineated four different granitic rocks; comprising granitic orthogneiss; porphyritic biotite granite, equigranular, biotite granite and alkaline granite that are intruded by micrograniti c dykes and exhibit poorly express foliation.

A major NE-SW trending N50E fault zone, of about 1km wide cross-cut the inlier displaying an anastomosing network of both ductile shear zone expressed by mylonitic bands generated by dextral wrenching during the Pan African orogenic activity and brittle shear zones represented by cataclasite series related to a sinistral wrenching (Maurine et al., 1986).

METHODOLOGY

Geologic field mapping of the area was undertaken and samples collected. The sample localities were selected based on access to the site, rather than any statistical pattern or method and sampling procedure involved collection of at least three individual fresh samples from each outcrop. During the field mapping numerous structures including shear zones, foliation veins, dykes and faults were mapped, and a generalized geologic map of the study area was produced based on the different lithologic units and contacts.

FIELD RELATIONSHIPS AND DESCRIPTION OF ROCK UNITS

Litho logic units of the Kaltungo inlier consists of porphyritic biotite granite, porphyritic granite, medium grained granite, micro granite, diorite, trachyte and trachy-andesite, basalt and several intrusive bodies (comprising acid and basic dykes and veins) cross-cut the rock units. The rocks are exposed as stock, plugs, oval or dome-shaped bodies sporadically distributed within the area.

PORPHYRITIC BIOTITE GRANITE: This is a coarse grained porphyritic igneous rock dominated by phenocrysts of orthoclase feldspar in a fine grained ground mass of quartz, and biotite (Plate 1). The orthoclase phenocrysts are tabular to euhedral crystals ranging from 2 - 5 cm in length. Some phenocrysts show simple twinning and zoning in hand specimen with visible exsolution lamellae of microperthite. Biotite mineral commonly align in the intergranular space along the boundaries of the orthoclase feldspar phenocrysts. The porphyritic biotite granite covers most part of the inlier around Kaltungo (Fig: 1).

PORPHYRITIC GRANITE: This granite consists of a lot of pink orthoclase feldspar, whitish to grey quartz and biotite. The rock has large and well developed crystal of feldspar in a ground mass of quartz, and biotite (Plate 2). This indicates two phases of crystallization where early formed crystals developed into large grain over a long quiet period before the magma was emplaced followed by a more rapid cooling, resulting into coarse and fine crystal occurring together at shallow depth. This lithologic unit covers most of the adjoining western part of the inlier (Fig: 1).

MEDIUM GRAINED GRANITE: This rock unit is granular in nature and distinctively pinkish in color indicative of preponderance of orthoclase feldspar (Plate 3). Mineralogically it consists of quartz, feldspar and minor amount of biotite. This granite is more predominantly found in the western part of the inlier and around Boh in the eastern portion of the inlier (Fig: 1).

MICROGRANITE: The rock consists of whitish quartz, pinkish feldspar and some small specks of biotite (Plate 4). It occurs mainly as intrusions in the study area, outcroping in both the eastern part of the inlier around Kaltungo and the western part of the inlier around Kufai (Fig 1).

PEGMATITE: The pegmatite contains unusually large feldspar grains greater than 2.5cm in size, dominantly orthoclase and quartz, with minor biotite. Outcrops of the rock with distict perthitic texture (Plate 5) occur within porphyritic biotite granite around Kaltungo.

DIORITE: The rock appears grey or dark-grey with some greenish cast and is granular in texture with principal minerals consisting of Na-plagioclase feldspar (oligoclase or andesine), hornblende, biotite, and pyroxene, with small amount of quartz (Plate 6). Diorites in the study area commonly occur as an intrusion within the granite, especially within the porphyritic granite around Kufai Tal and Labeke area (Fig: 1)

PROTOCATACLASITE: The feldspar phenocrysts in the rock were broken down into rounded to surrounded and angular crystals due to brittle deformation. Thus the rock unit became altered to protocataclasite (Plate 7). The porphyritic biotite granite was deformed in the vicinity of the strike slip fault around Ture Pandi in the northeastern part of the inlier occasioned by intense localized stress which caused incipient crushing and grinding of the mineral grains especially the feldspars crystals (Fig: 1).

TRACHYTE: Trachyte outcrop in the western part of the inlier around Kalmai, Lakarai and Tanglang (Fig: 1) and displays typical trachytic texture where acicular to tabular feldspar phenocrysts align in one direction indicating flow prior to cooling (Plate 8a). Most of the outcrops are domed, depicting that the lava was of moderate viscosity. Plate 8b shows sharp boundary between trachyte and trachy-andesite

The rock has fine to porphyritic texture with large crystal of sanidine alkali feldspar aligned parallel to sub parallel within the ground mass. The mineralogy consists essentially of alkali feldspar (sanidine), minor plagioclase and quartz. Sanidine feldspar occurs in two generations, both as large well shaped porphyritic crystal and in smaller imperfect rods or laths forming a fine crystalline groundmass.

TRACHY-ANDESITE: This rock unit is of intermediate composition between trachyte and andesite. Mineralogically, it consists of alkali feldspar, calcic plagioclase, olivine and pyroxene. The trachy-andesite is found within the trachyte around Kalmai and Lakarai (Fig: 1). Plate 9 shows a hand specimen sample of trachy-andesite.

BASALT: The basalt in the study area occurs as columnar jointed outcrops (Fig 10b) adjoining the trachyte and porphyritic granite around Kufai, in the western part of the inlier (Fig: 1). The rock appears dark, dark grey to black in color and has high calcic plagioclase feldspar (usually labradorite) and pyroxene content, which are mostly indistinguishable to the naked eye (Fig 10b). Minor rocks, including quartz vein and aplitic veins criss-cross the major rock units in various places within the study area. A prominent quartz vein within the micro granite around Kufai is between 5–15cm thick (Plate 11). The observed aplite is fine sugary grained rock associated with pegmatite and granite. The observed minerals in aplite are quartz and alkali feldspar. The quartzo-feldspatic aggregate tends to fill up the interspaces between the early minerals in the main rock body. Plate 12 shows an aplitic vein within porphyritic granite along a sinistral micro fault around Kufai

STRUCTURES OF THE KALTUNGO INLIER

Fault

A major N60^{0}E trending strike-slip fault, of about 5 to 7 km wide criss-cross the inlier from Labeke in the south-western part through Boh to Ture Pandi in the northeastern part. Horizontal shear movement associated with the fault movement shattered and consumed the plane of the fault completely with little or no evidence of outcrop except for the resistant quartzitic materials along the fault plane (Plate 13a). Plate 13b show remnant of quartz left behind along the fault plane around Boh area. A sinistral strike-slip fault trending almost N-S, cuts across the major strike-slip fault around Boh displacing the blocks to about 20m wide, with each block trending N70^{0}E around Boh area (Plate 14).

A major shear zone with the same remnant of quartz trending N340^{0}S was observed around Kalmai area in the north western part of the inlier (Plate 15a). This major shearing might have intensely deformed the boundary of the porphyritic biotite granite around Boh and likely initiated the N-S trending sinistral strike-slip fault that cuts across the major strike-slip fault around Boh. Other shear blocks of deformations were observed in several locations within the inlier trending between N50^{0}E to N70^{0}E and dipping between 68^0 -72^0. A good example the deformation at Labeke (Plate 15b). However, the intensity of the deformation decreases as one move further away from the boundary of the major strike-slip fault plane. The shear deformational cones at Ture Pandi, Kufai trend and dip in the same as the major strike-slip fault.

ROSSETTE DIAGRAMS FOR JOINTS AND VEINS

Field data was used for plotting rosette diagrams with the aim of determining the direction of dominant tectonic force responsible for the deformation on the outcrops. The joints attribute in the rosette diagram shows dominant trending in NW-SE and E-W and less minor trends in NE-SW direction (Fig 2) which coincides with the trends of the deformational shear activities. Preponderance of the joints on the granites, diorites, protocataclasite and trachyte, which were variedly deformed, is a likely evidence that the joints were initiated by shearing on the outcrop.

Conversely, dykes and veins, also common especially on the granite rocks trend dominantly in a NE-SW and E-W direction and with minor NW-SE direction (Fig: 3).

DISCUSSION OF RESULTS

Field evidence reveals that a major strike-slip fault divided the Kaltungo inlier into two, comprising a western block around Kufai, Billiri, Kalmai, Tanglang, Lakarai and Tal and an eastern block around Kaltungo Kulishin, Boh, Karel, Lapan, Popandi, Poshereng, Kale and Okra that is surrounded by Bima Formation. Carter et al (1963) described the inlier as hills around Kaltungo and Billiri, and the present detailed field observation reveals that the inlier consists of porphyritic biotite granite, porphyritic granite, medium grained granite, micro granite, pegmatite, diorite, protocataclasite, trachyte, trachy-andesite and basalt (Fig 1). Gradational contact relationship were observed between trachy-andesite and andesite, intrusive diorite and porphyritic granite, basalt and porphyritic biotite granite, while the boundary between porphyritic biotite granite and porphyritic granite, medium grained granite, protototocataclasite are transitional. Gradational to transitional boundary with each rock units indicate an igneous evolutionary process for the entire rock suite (Adekeye and Ntekim, 2004).

The fault and shear zones in the study area were seen to be genetically related. The faults were product of tectonic activities where shear stress exceeded the shear strength within the rock along the plane harboring the fault (Bruce et al., 1976). Trends of the faults and outcrops in the studied area are similar to those of stream channels suggesting that the stream channels were structurally controlled by the fault. The dominance of NE-SW, NW-SE with minor N-S and E-W accentuate the general structural trend of the Nigerian Basement Complex.

CONCLUSSION

Field mapping of the Kaltungo inlier has revealed the major strike-slip fault that divides the inlier into two: the western block and the eastern block, both adjoined by the Cretaceous Bima Sandstone. The lithologic units consist of porphyritic biotite granite, biotite granite, medium grained granite, microgranite, pegmatite, diorite, protocataclasite, trachyte, trachy-andesite and basalt. The inlier is intensely sheared and faulted, trending dominantly in the NE-SW and NW-SE directions.

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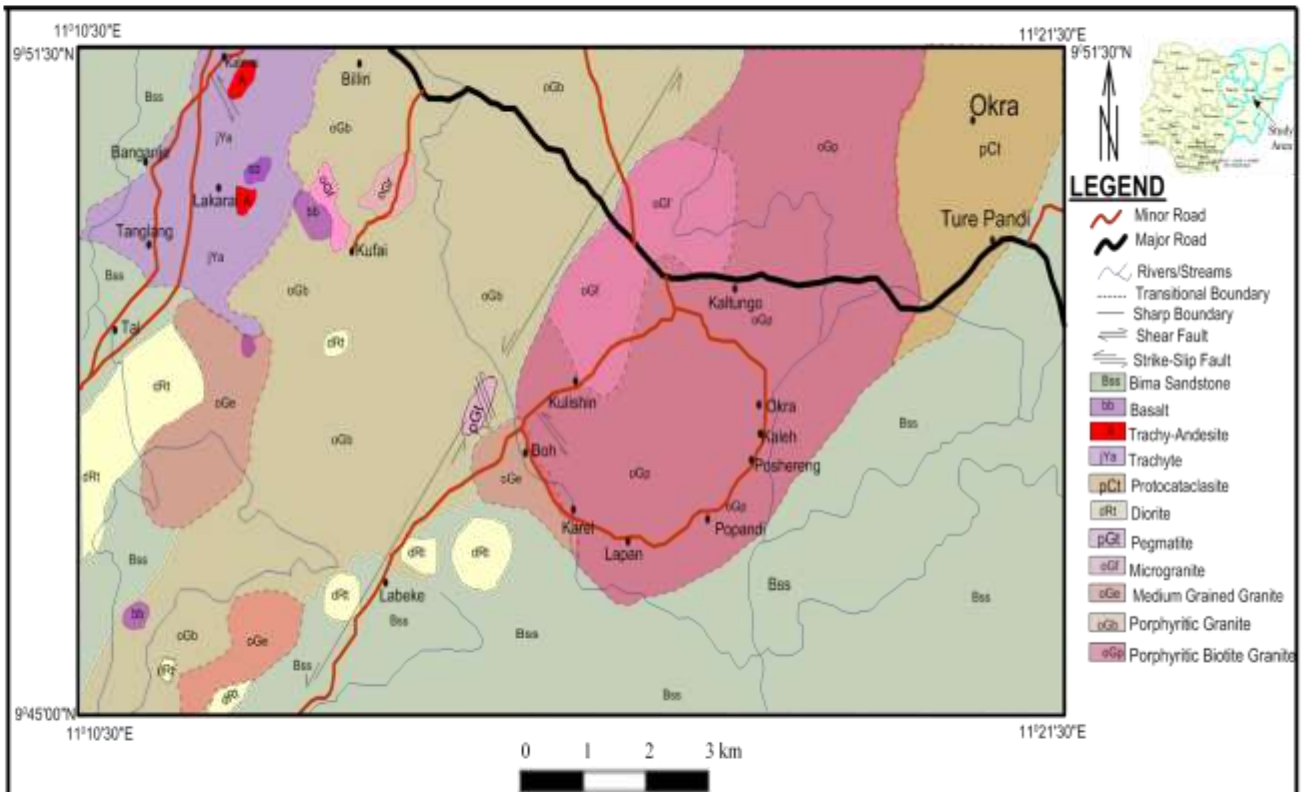

Figure 1: Simplified Geologic Map of Kaltungo and Environs

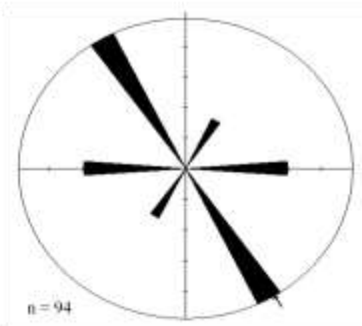

Figure 2: Rose plot for joints in the study area.

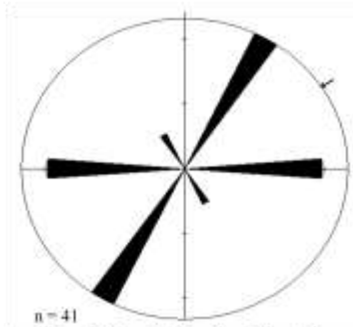

Figure 3: Rose plot for veins in the study area.

Plate 1: Porphyritic biotie granite

Plate 2: Porphyritic granite

Plate 3: Medium Grained Granite

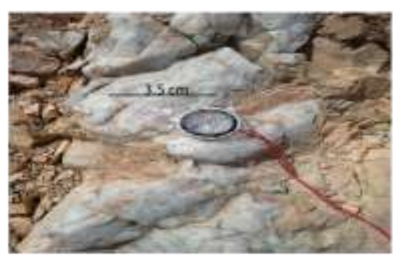

Plate 5: Pegmatite

Plate 4: Microgranite

Plate 6: Diorite

Plate 7: Protocataclasite

Plate 8: Trachyte

Plate 9: Trachy-andesite

Plate 8b: Sharp boundary between trachyte and trachy-andesite

a

Plate 10a: Basaltic Columnar joints

Plate 11: Quartz vein

b

Plate 10b: Basalt

Plate 12: Aplite showing sinistral microfault

a

b

Plate 13a and b shows fault plane and remnant of quartz around Boh

Plate 14: Showing sinistral strike-slip fault cutting across major strike slip fault around Boh

Plate 15a: Showing shear deformation around Kalmai area

Plate 15b: Showing shear deformation around Boh area.

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