The Geology Around Kagadama - Dass Area SW Bauchi, Bauchi State, Nigeria

By

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DECEMBER, 1996

THE GEOLOGY AROUND KAGADAMA-DASS AREA SW BAUCHI, BAUCHI STATE, NIGERIA

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A THESIS SUBMITTED TO THE GEOLOGY PROGRAMME, SCHOOL OF SCIENCE, ABUBAKAR TAFAWA BALEAWA UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF TECHNOLOGY (B. TECH) HONOURS IN APPLIED GEOLOGY

DECEMBER, 1996

CERTIFICATION

I certify that this report is an original work done by Aliu A. O., under my supervision and has met the requirement for the award of Bachelor of Technology (Applied Geology) of Abubakar Tafawa Balewa University, Bauchi.

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ACKNOWLEDGEMENT

My greatest thanks goes to the ALMIGHTY ALLAH, whose blessings on me are not quantifiable, I can not but only say thank you my God.

I wish to express my sincere gratitude to my supervisor Dr. S. S. Dada, who has made this work a reality, sir once again I am sincerely grateful.

And to my other lecturers, I want say thank you for imparting this knowledge on me, most especially Mr. C. E. Suh,thank you for your untiring words of encouragement.

My utmost and warmest thanks also goes to all those who have made my acedemic career a worthwhile adventure, I am indebted to you all, may the ALMIGHTY ALLAH Bless, Guide and be with each and everyone of you.

ABSTRACT

Field geological mapping and petrological studies of rock samples, were carried out in Dass Area, South-West of Bauchi, in North-Eastern part of Nigeria. The area lies between longitudes $9^{\circ}30^{1}$E and $9_{o}35^{1}$E and latitudes $10^{\circ}00^{1}$N and $10^{\circ}03^{1}$N covering approximately 81sq km.

The area is underlain mainly by crystalline basement, which can be divided into two major groups:

i. The Gneiss-Complex which consists of Garnet-Gneisses and Granite-Gneisses.

ii. The Older Granite Series comprising mainly of fine-medium grained Biotite granite and charnockitic diorite.

The Gneiss-Migmatite Complex which has originated from regional metamorphism, migmatization, granitisation and metasomatism, is the oldest group of rocks in the area.

The Older Granite rocks were emplaced during the Pan African event (600ma), by Magmatism with a chanockitic diorite core grade.

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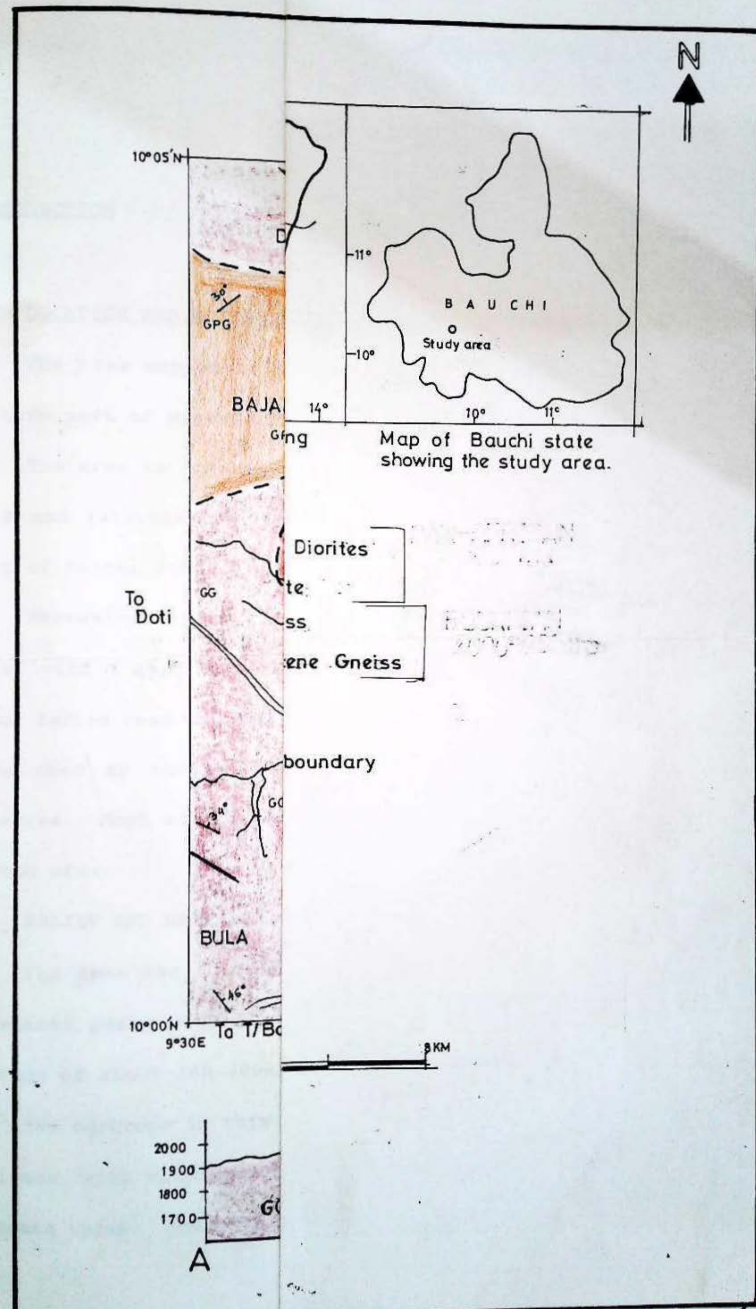
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Study area
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Map of Bauchi state
showing the study area.

CHAPTER ONE

INTRODUCTION

1.1 LOCATION AND ACCESSIBILITY

The area mapped is in Dass South West of Bauchi; in North Eastern part of Nigeria. Fig.1a.

The area is located between Longitude 9° 30^{1}E and 9° 35'E and latitude 10° 00'N and 10 05'N in the South Western part of Bauchi State.

Accessibility in this area can be described as moderately fair, with a good network of foot paths, river channels, and a major tarred road which links Bauchi town with Dass. These roads were used as the main routes throughout the course of the exercise. Most of the footpath link us to scattered settlement in the area.

1.2 RELIEF AND DRAINAGE

The area has a high relief, the Dass hills form the most prominent peaks with elevations of about 1000m, and a general average of about 500-600m. fig.1b.

The outcrops in this area comprises mostly of granites and Gneisses, with varying shapes and sizes, from domal to oval and elongate types. Seasonal streams dominate the terrain. The main

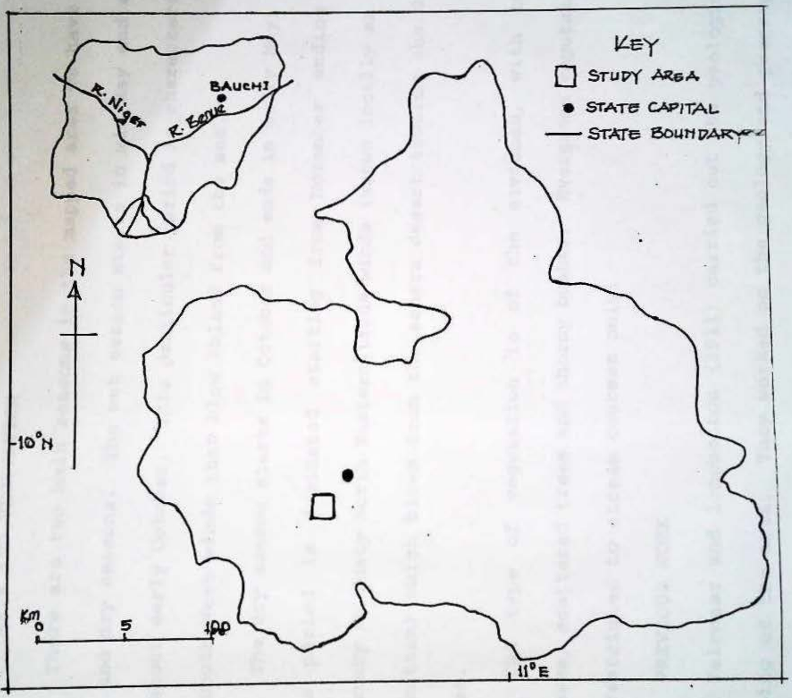

FIG. 1A; LOCATION MAP SHOWING AREA MAPPED river is river Kama which flows from Northeast to south west in the area.

1.3 CLIMATE AND VEGETATION

There are two main seasons in the mapped area we have the wet and dry seasons. The wet season starts in mid-May and ends at about early October. This particular period is characterized by South West winds that blow inland from the sea.

The dry season starts in October and ends in early May, and this period is dominated starting from November ending to February by dusty North-Eastern trade winds (known locally as the harmattan) which blows from the sahara desert towards the Gulf Coast.

The type of vegetation is of the savannah, with tall grasses, scattered trees and thorny bushes. Evergreen vegetation is restricted to stream courses only.

1.4 PREVIOUS WORK

Falconer and longbotton (1911) carried out the geological mapping of the area. They worked on the geology and geography of Northern Nigeria which includes the area studied in their reconnaissance survey.

They recognized the oldest Rocks in the area which are called Basement complex and are made up of mainly migmatites and

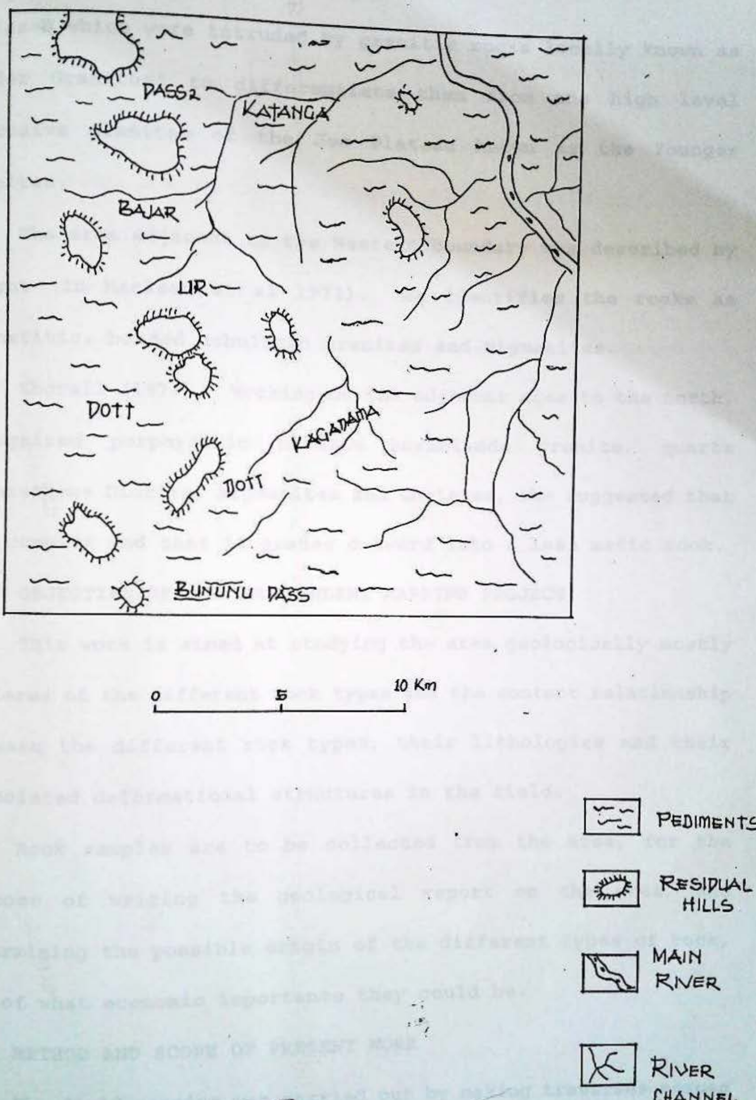

FIG.1B:
PHYSIOGRAPHICAL DIAGRAM OF THE AREA MAPPED

Gneisses which were intruded by granitic rocks locally known as "Older Granites" to differentiate them from the high level intrusive granites of the Jos Plateau known as the Younger Granites.

The area adjacent to the Western boundary was described by Wright (in Maclead et al 1971). He identifies the rocks as Migmatitic, banded nebulitic granites and Migmatites.

Eborall (1976). Working on the adjacent area to the north, recognized porphyritic biotite hornblende granite, quartz Hypersthene Diorite, Migmatites and Gneisses, she suggested that the complex and that it grades outward into a less mafic rock.

1.5 OBJECTIVE OF THE INDEPENDENT MAPPING PROJECT.

This work is aimed at studying the area geologically mostly in terms of the different rock types and the contact relationship between the different rock types, their lithologies and their associated deformational structures in the field.

Rock samples are to be collected from the area, for the purpose of writing the geological report on the area, and determining the possible origin of the different types of rock, and of what economic importance they could be.

1.6. METHOD AND SCOPE OF PRESENT WORK

The field mapping was carried out by making traverses across the area using the topographic map of the as a guide, for about

21 days.

The mapping was done on a scale of 1.50,000 and the different rock type samples were collected during the exercise and observations were made and indicated in the note book and on the base map. Contact zones and other associated geological feature were observed studied and indicated in the notebook.

Thin sections of selected rock samples were prepared for petrological studies of the rock samples with the aim of identifying the different mineral contained in each of the rock samples.

CHAPTER TWO

GENERAL GEOLOGY GEOLOGICAL SETTING

2.1 GENERAL GEOLOGY

The geological set up of Bauchi consists broadly of crystalline rock of the basement complex. The area generally is made up of amphibolite facies basement migmatites and biotite gneisses with ancient metasediment remnants, occasionally of granulite facies, and Older granite complexes of Acid and intermediate rocks.

The unusual Fayalite quartz Monzonite at Bauchi town were first emphasized by Oyawoye (1958, 1961) who named it bauchite (1965). Biotite hornblende granite forms a large part of the complex, and quartz diorites are also common.

Quartz diorites are found in and near to the intrusions or as dykes in the area.

2.2 GEOLOGICAL SETTING

The area mapped is made up mainly of crystalline rock which underlies the whole area. The area consists almost entirely of granites, gneisses, and diorites.

The oldest rocks of the area are the gneisses, which through the processes of metamorphism, migmatization and granitization have been largely converted into migmatites with relics of the original gneisses remaining as resisters to the Migmatization and the granitization processes (Mccurry, 1970). fig.1

In South west Nigeria grant (1979) suggested two events for the evolution of these gneisses and migmatites. The older event considered as liberian (in excess of 2750ma), and the younger which is Eburnian (about 2100ma). However, Rahaman (1988) doubted the presence of the liberian event.

The older granites including the diorites found at the eastern edge of the older granite rocks, which consists of various types of biotite granite and biotite hornblende granite. The main diorite in the area has field relationship with the surrounding rocks in some ways similar to those of bauchite with biotite hornblende granite.

The diorite is the more basic of the complex and grades outward into a less mafic rock. The most youngest rock types are the Pegmatites and quartz veins intruding nearly all the rock types in the area. Recent alluvium, resulting from weathering and erosion of hills is developed insitu on the basement rocks forming Pediments. fig.

2.3 GNEISSES

The gneisses covers up to about 60% of the mapped area (fig.1a). They commonly outcrop fairly well as lowlying hills, with a few of them appearing as prominent hills. They can be observed to be highly fractured with most begin foliated as well.

Large areas of the Basement complex have been converted to granite gneisses and many of the features in the original gneisses have been obscured. Changes from gneisses into Migmatite terrain are subtle and gradual and are not easily seperable. The granite gneiss are mostly heterogeneous group of rocks, predominantly of granodioritic composition in which variable amount of remnant streaks and larger relict bodies of original gneiss are recognizable.

Many of the gneisses are believed to be of a sedimentary origin and it is also believed that an ancient sedimentary sequence has been metamorphosed and granitised to form gneisses, the sedimentary sequence are believes to belong to an extensive supracrustal cover of probable Birimian age, which has been extensively modified through at least two tectonometamorphic events. The migmatites include rocks of varying lithology texture and structure, showing differing degrees of granitization and migmatisation. They are composite rocks consisting of metamorphic host rock and acid injection which may be Pegmatitic, feldspathic or granitic material. (Truswell and Cope 1963). The migmatisation is believed to represent an early phase in the emplacement of the older granite series. In general original biotite and hornblende gneisses grades through banded gneisses to anatectic migmatites and granite (Mc ccurry 1973, Macleod, et al 1971, Carter et al 1963)

2.4 OLDER GRANITES

The older granites occupy about 30% of the area mapped, with various types of biotite granite of fine to medium grained varieties, where the granites are foliated, the foliation is usually parallel to the regional foliation and are defined by the parallel alignment of feldsper megacryst and Biotite. The rocks are mostly slightly fractured and in some places fractures can be observed running parallel to each other. Another rock type in these area is diorite which are mostly outcroping as a low lying hills, dark with whitish specs colour kind of rock, generally unfoliated and showing a week contact with the surrounding rock and they are the more basic core of the complex and grades outward into a less mafic rock.

2.5 PEGMATITES AND VEINS

Pegmatite occur mostly as dykes intruding nearly all the rock types in the area, they are mostly simple pegmatite ranging from about 80cm to 50cm in width and can be traced in terms of length for several meters.

Quartz vein are the most dominant of the intrusive rock types in the mapped area. In most places they are found crisscutting each other and ranges from about 20cm to 50cm in width in most places but could be several meters long.

CHAPTER THREE

3.0 INTERPRETATIVE GEOLOGY; FIELD OCCURRENCE AND PETROLOGY

3.1 INTRODUCTION

The area in which the mapping was carried out is underlain by basement rocks of the gneiss complex which consists of Garnet gneisses and granite gneisses. The older granites rocks consists of fine-medium grained granites, and quartz hypersthene/ hornblende diorite. Other rock types include quartz veins and pegmatite vein.

3.2 GNEISS COMPLEX

3.2.1 GARNET GNEISS

FIELD OCCURRENCE

It occurs mostly as a slightly massive outcrop in the N-W part of the mapped area and it is migmatised in place. The rock is well foliated with foliation defined by the parallel alignment of biotite minerals. Changes from the garnet gneiss to the granite gneiss is gradational, hence making separation between them difficult.

In hand specimen the rock is light coloured, medium grained and comprises mostly of conspicuous minerals like garnet, biotite, quartz and feldspars.

PETROLOGY

The rock in thin section is made up of mainly biotite,

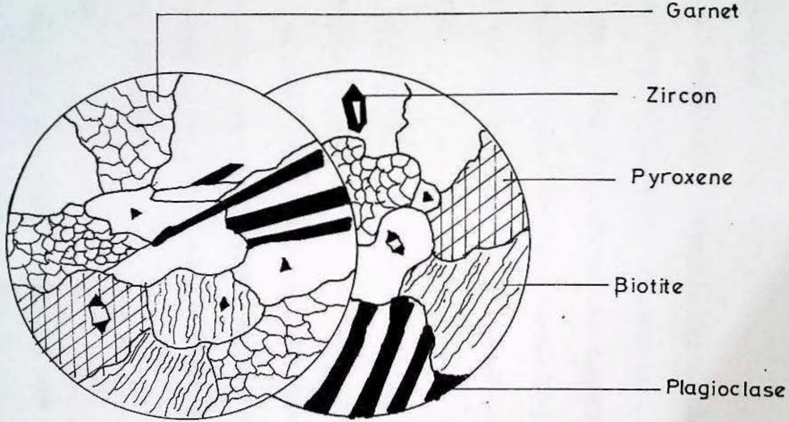

Fig. 3 A THIN SECTION OF GARNET PYROXENE - GNEISS SHOWING ITS MINERALOGY. Mg x 80

quartz, garnet, plagioclase, hypersthene with some accessory minerals like zircon and chlorite. fig.3a.

PLAGIOCLASE:

The plagioclase crystals are subhedral to anhedral in shape, with an extinction angle of about 31° , and ranges in composition from $(An_{48} - An)_{54}$ belongs to the labradorite type. Twinning is predominantly polysynthetic, with inclusions of opaque minerals which are quite common in the plagioclase crystals.

BIOTITE

Biotite make up about 30% of the minerals in the rock, it appears brown to brownish red, and occurs with various shapes and with varying sizes, with most of the crystals being aligned, while others are scattered. Some of the biotite crystals have been altered to some greenish coloured minerals which are most likely chlorite.

QUARTZ

Most of the quartz crystals are anhedral to subhedral in shape and appears colourless to grey coloured. Inclusions of opaque minerals are found in the quartz crystals. Extinction in most of the crystals is wavy, and it accounts for almost about 20% of the modal composition of the rock.

GARNET

The garnet crystal has inclusion of biotite and quartz in it giving it a poikiloblastic texture. It is dark brown in colour and have a very high relief, they are of the almandine type. They account for about 7% of the modal composition of the total minerals in the rock.

PYROXENE

The pyroxene crystals are pale green coloured and are plaeochroic from greenish to pale redish, they are recognized with its characteristic cleavage (88° to 92), they have inclusions of opaque minerals. Hypersthene is the most likely type of the pyroxene, and constitute about 8% in modal analysis.

ZIRCON

Zircon is present mostly as a secondary mineral, it has a high relief and in most cases it occurs as inclusions in a main mineral giving it a Zenoblastic texture. The mineral accounts for about 2% of minerals in the rock.

PARAGENESIS

From the minerological composition and textural characteristic of the garnet gneiss the following inferences can be drawn.

a) The gneissic texture of the rock suggests that it is of regional metemorphism

b) Medium to high grade characteristic of high pressured areas, metamorphism is suggested with the presence of garnet and the plagioclase compositional range.

c) High grade metamorphism is also suggested with the poikiloblastic texture of the plagioclase based on the assumption that in high grade gneisses calcic plagioclase are notably poiklioblastic (Moor house 1959).

d) The rock can be grouped in the amphibolite facies and further into pyroxene-hornfels subfacies because of the presence of pyroxene.

e) The zircon have inherited cores pointing to a metamorphic origin, possibly with arenaceous sediments as protolith.

From the above deductions, it can be said that the garnet gneiss are of medium grade metamorphic rocks of amphibolite facies.

3.3 GRANITE -GNEISS

FIELD OCCURRENCE

The rock type outcrops fairly well as a low lying small hill such as in the north central path of the mapped area, and in

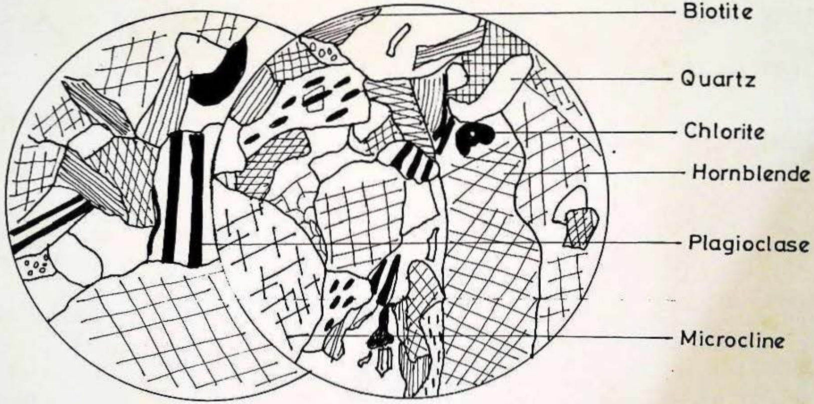

Fig. 3Bi THIN SECTION OF GRANITE GNEISS
Mg x 80

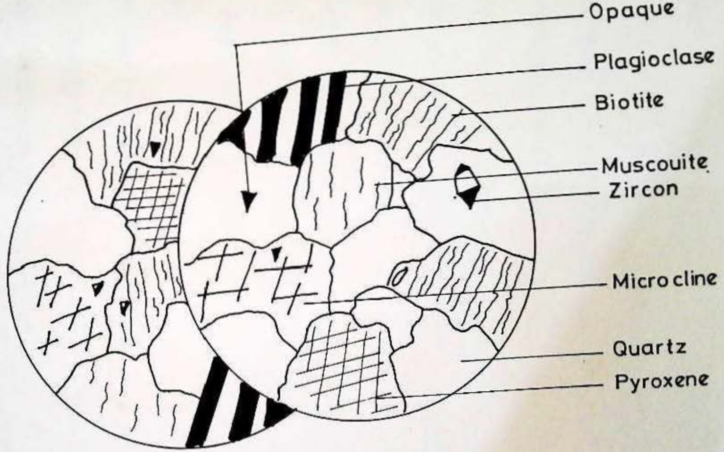

Fig3aii THIN SECTION OF GRANITE GNEISS
Mg x 80

other areas such as the north eastern path of the area it occurs predominantly as a low-lying poorly outcroping almost homogeneous masses. The rocks are banded and recognized by the alignment of feldspars parallel with biotite which can be clearly seen.

Foliations are common in some of the outcrops, but on other rocks such as in the north-east, are not conspicuous. We have quartz veins running across most of the outcrops, though in width the veins are not extensive.

In hand specimen the rock is pink to dark in colour and is medium to coarse grained, comprising mainly of quartz, feldspar, biotite and tiny flakes of mica.

PETROLOGY

The rock in thin section consists of minerals like, quartz, biotite, hornblende, pyroxene, muscvite, plagioclase feldspar, Potassium feldspar, with zircon, chlorite and opaques as accessory minerals. (figs.3bi & 3bii)

PLAGIOCLASE

The plagioclase crystals are semi-rectangular shaped and have extinction angle of 26° and is of the Andesine variety, it ranges in composition from (An_{30} to An_{48}). It has a modal composition of about 30-40% and appears with different shapes and sizes, with majority being small in size.

Some of the plagioclase crystals are of the Labradorite

(An_{43} -An_{54} fig.3bii) type with extinction angle of between 31° and 33° crystals exhibit polysynthetic twinning, with a few exhibiting carlsbad twinning, inclusions of quartz, opaque and zircon are common, and there seems to be intergrowth between some of the plagioclase crystals with biotite and quartz, and they appear to be aligned. Some of the plagioclase crystals can be observed to be on the verge of altering thereby making it difficult to estimate there maximum extinction. Some of the plagioclase crystals in some places are found joined with pyroxene, fig. where as others are mostly fractured and the rest are zoned.

BIOTITE

Biotite is very prominent in thin section and most are brown in colour and seem to align with each other. Some of the biotite crystals can be seen, getting altered to the greenish coloures chlorite mineral, and are found to be wedged between chlorite in some places. In other instances the biotite can be observed to be intergrowing or aligning with pyroxene and or hornblende and occur mostly interstitially as elongated tabular crystals. (fig.3bi). In some other instances some of the crystals possess a definite prefered orientation. Inclusion of quartz, zircon and opague crystals are common (fig.3ii); Biotite accounts for about 30% of total minerals in the rock.

PYROXENE

The pyroxene crystal in the rock sample is pale green in colour and plaeochroic from greenish to pale redish and recognised with its cleavage of about 93° to 87° it is of the hypersthene variety. it consists of inclusions of opaque minerals and quartz crystal giving the hypersthene a poikiloblastic texture. Pyroxene constitutes about 8% of the minerals in thin section.

HORNBLENDE

The hornblende crystals on the slide looks almost like biotite in terms of colour but it is distinguished with its characteristics cleavage [58° and 122°], it is plaeochroic and has an extinction angle of about 21°; some of the crystals are on the verge of being altered.and has a modal composition of about 5%.

POTASSIUM FEILDSPAR

Microcline is prominent over orthoclase. It appears cloudy which may due to alteration processes. some have inclusions of chlorite and quartz. Polysynthetic twinning are common within the crystals. Microccline accounts for about 12% of the total minerals in the rock while orthoclase accounts for about 3% of the total minerals in the rock.

QUARTZ

The quartz crystals appears as granular masses and are slightly fractured and constitute about 15% of the minerals in the rock, some are strained and others occurs as inclusions in biotite and pyroxene crystals giving quartz a zenoblastic texture. In some cases they are observed to be encroaching into other minerals like biotite, and they have an undulatory extinction.

CHLORITE

Chlorite appears mostly as greenish coloured crystal, and are found in between the biotite crystals as such could be alteration products of biotite. They have a modal composition of about 2%.

MUSCOVITE

The muscovite crystal appears pale green in thin section, with a moderate relief and occurs mostly as tabular crystals and are found associated with biotite and feldspers in most cases.

ZIRCON

They are appear scattered on the slide mainly as inclusions in quartz and biotite. Constitute about 1% of total minerals on the slide.

OPAQUE

Opaque minerals are present on the slide and appears mainly as a dark nonplaechroic crystals they are minutely scattered in the rock.

PARAGENESIS

i. The gneissic texture of the rock suggests it to be of regional metamorphism

ii. The presence of inclusions in plagioclase, there by giving it a poikiloblastic texture suggest high grade metamorphism based on the assumption that in high grade gneisses calcic plagioclase contain inclusion. (Moorhouse 1959)

iii. The presence of Zircon with inherited cores suggests the rock to be derived from arenaceous sediments.

iv. The rock can be placed in the amphibolite facies because of the association of hornblende and plagioclase.

From the above deductions, it can be said that these group of gneisses are medium grade metamorphic rocks of amphibolite facies and originated from the regional metamorphism of arenaceous sediments.

3.4 OLDER GRANITE

Two main varieties of rock of the older granite group are recognized

a) Biotite Granite

b) Charnockitic Diorite .

3.4.1 BIOTITE GRANITE

FIELD OCCURRENCE

The rock types are found mostly at the south western part of the mapped area, and its boundary with other rock types is gradational and mostly obscure. The granites are slightly foliated as can be seen at the central part of the south western part of the mapped area.

Majority of the outcrops, which occurs as slightly elevated hills are fractured somehow.

In hand specimen the rocks are fine to medium grained texture wise and leucocratic to mesocratic in colour, minerology from hand specimen consists of quartz, biotite and feldspar, and in some cases with Muscovite flakes which are all identifiable.

PETROLOGY

The rock in thin section is composed mainly of, quartz, Biotite, Plagioclase, microcline, and Muscovite. fig.3c.

QUARTZ

The quartz crystals are mostly clear but few have yellow tint in them. Majority of the crystals are irregularly shaped and are slightly fractured, while others are strained (fig. 3c), and they constitute about 10-15% of the total minerals on the

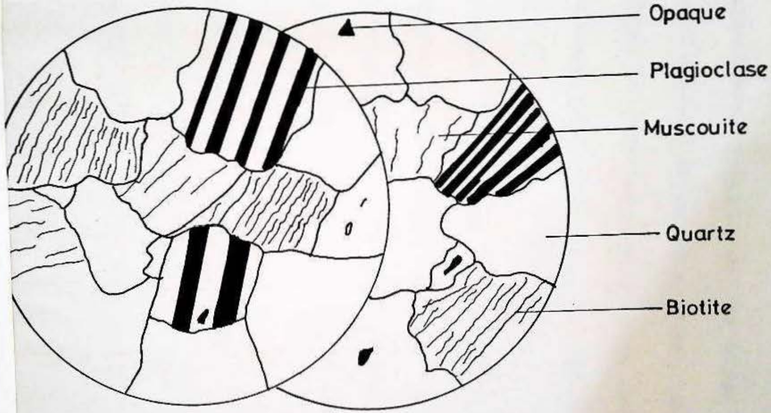

Fig. 3C FINE MEDIUM GRAINED BIOTITE GRANITE Mg x 80 slide.

PLAGIOCLASE

The plagioclase crystals on the slide appears prominent, with a few on the verge of being altered. Most of the crystals appears smallish in size and coupled with the alteration. It is becoming increasingly difficult to estimate their maximum extinction.

Extinction angle is between 42°and 45°and belongs to the Bytownite variety with a compositional range of (An_{68}- An_{74}). Twinning is polysynthetic. The plagioclase crystals constitute about 12% of the total minerals in the rock.

MICROCLINE

Few crystals of microcline are present in the rock and have extinction angle of 11° twinning is polysynthetic, and some of the crystals have inclusion of opaques. Their modal composition is about 2%.

BIOTITE:

Biotite crystals are quite abundant in the rock and they constitute about 20-23% of the total minerals in the rock, and can be seen in thin section with its characteristic brownish colour, with a few almost being altered to the greenish chlorite.

Majority of the crystals are observed clustered together and also appear foliated in some places and appears to be intergrown with quartz, in other places, almost forming a chain.fig.3c.

MUSCOVITE

Muscovite crystals appears tabular in section, with the minutely crystalline varieties refered to as Sericite being most dominant. They constitute about 7% of the minerals in the rock and have a slightly high relief in section.

3.4.2 CHARNOCKITIC DIORITE

The diorites mapped in the area occurs as lowlying outcrops, outcroping close to Dass town, and its boundary with the granites are gradational and almost obscure. Though the outcrop is slightly foliated, they appear to be highly weathered.

In hand specimen minerals that are observable include quartz, feldspar, and biotite, with most of the minerals appearing with a medium grained texture.

PETROLOGY

The observable minerals in thin section are Biotite, Pyroxene, Hornblende, Quartz, Plagioclase, Microcline, Zircon and accessory minerals like opaques (fig.3Di & Dii).

BIOTITE

The Biotite crystals occurs mostly as brown to redish brown coloured minerals, with a few crystals being altered. They exhibit a parallel extinction and are slightly pleochroic. Few

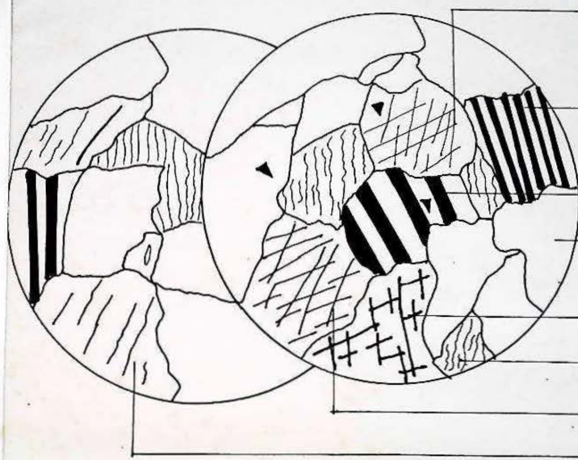

Fig. 3Di THIN SECTION OF CHARNOCKITIC DIORITE Mg x 80

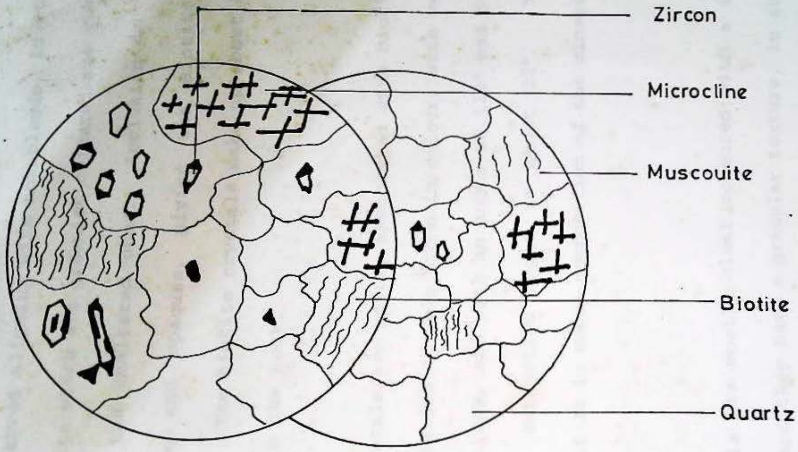

Fig. 3Dii THIN SECTION OF DIORITE Mg x 80 of the crystals are observed aligning with hornblende, in other places the altered Biotite which are greenish coloured are always found associated with the unaltered ones. Inclusion in the Biotite include Zircon and opaques, giving the Biotite a poikiloblastic texture. The Biotite crystals make up about 20% of the total minerals in the rock.

HORNBLENDE

The hornblende crystals are mostly associated with biotite (fig.3Di) and appear greenish to Pale brown in colour, with well defined cleavage directions, and with an angle of 122° and 58°. Texture is cullumnar, extinction angle is about 23°. The crystals constitute about 3% in modal composition of the minerals in the rock.

QUARTZ

The quartz crystals are mostly clear coloured with a few showing a yellow tint, and they have a granular texture, in some places, they are found interlocking with microcline (fig.3Dii) and have inclusions of zircon, giving it a poikiloblastic texture. The crystals of quartz comprises of about 15% in modal composition.

PLAGIOCLASE

The plagioclase crystals are abundant in the rock, and have an extinction angle of between 32° and 33°, it is of the labradorite variety with a compositional range of (An_{54} - An_{58}). They occur mostly as phenocryst. Polysynthetic twinning are more dominant over carlsbard twinning, intergrowth of plagioclase with biotite is common in the slide.

MICROLINE

Microline crystals seems to be prominent, with a polysynthetic twinning, some have an intergrowth of albite forming a perthite structure and have inclusions of zircon, which translates to the crystals having a poikiloblastic texture. The crystals make up about 10% of minerals in section.

PYROXENE

Pyroxene crystals are pale green to pale red colour, they are pleochroic from greenish to pale redish brown. They cleavage direction are well defined (83°-96^0).

The crystals are most likely of the hypersthene variety, and some have inclusions of opaques minerals in them. The crystals constitute about 3% in modal composition.

ZIRCON

Zircon of various shapes and sizes, surrounded by pleochroic halos are abundant in thin section, and they occur mostly as inclusion in quartz, biotite and even microcline. They have a characteristic high relief, no cleavage and are mostly rounded, with most of the grains. Occurring as equant grains. They have a zenoblastic texture, and constitute about 5% in modal composition. (fig.3Dii).

OPAQUE

Opaque minerals in the rocks occurs mostly as inclusions in the biotite crystals and a few are scattered in the rock, they are mostly rounded to angular in shape and constitute about 1% of total minerals in the rock.

CHLORITE

Presence of chlorite in the rock are mostly due to the alteration of biotite to chlorite, the chlorite crystals appears greenish in colour and have inclusions of opaque minerals, thereby giving it a poikiloblastic texture.

PARAGENESIS

There has been varied opinions about the origin of the granites. The older granites represents a cycle of granite evolution resulting from anatexis, granitisation and magmatism (Carter et al 1963). The older granites are the most obvious manifestation of the Pan-African orogeny and represent a significant addition of materials to the crust. (RAHAMAN). Geochronological (Tubosun et al 1984) and structural evidence's (Annor and Freeth, 1985). From the granites of South Western Nigeria, linked their emplacement within gneisses and migmitites to the last tectonic phase within the basement of Nigeria during thePan African orogeny.

(Olanrewaju and Rahaman 1982) suggested that metasomatism may have modified the initial composition of the granites produced from the anactectic melting with the metasomatic effect being most marked in the immediate vicinity of the porphyritic granites. This would suggest that anatexis has played a major role in the formation of the granites.

The presence of pegmatites and quartz veins suggests that they are intrusive. This postulations are consistent with the view of Mc curry (1976) and Olanreweju and Rahaman (1982) on the origin of granites.

CHAPTER FOUR

4.0 STRUCTURES

4.1 INTRODUCTION

The area mapped is included as part of the area affected by tectonic activity of the Pan-African Orogeny (600+ma). This tectonism is believed to have deformed pre-existing rocks of the Gneiss complex. The Pan African tectonism imposed a general NE - SW structural trends on the region and its magmatism led to wide spread emplacement of granites and other rock types

From field observation the geological structures observed in the area mapped are mainly foliations, lineations, joints minor faults, dykes, and veins.

4.2 JOINTS

Joints are the most prominent of structural trends in the mapped area, and occurs almost in every rock types (Plate 1 & 2) Most of the joints are tight fractures but in some places they are found as open fissures due to weathering. Some of the joints in the Rocks of the Older granite series are intruded by quartz veins and in other areas the joints can be seen criss-cutting one another and are referred to as a joint set.

The tectonic phase of the Pan African Orogeny left imprints of N-S, NE-SW structural trends in the entire basement complex rocks of Nigeria (Wright, 1985) of which the mapped area is included: joint pattern obtained from the rose diagrames plotted indicate these structural trends, though E-W trends seems to be an exception.

4.2.1 JOINTS IN GRANITES

Rose diagram plot for the recorded values of various joints in granites shows the SW-NE trends to be more prominent. fig.4A.

4.2.2 JOINTS IN GRANITE GNEISS COMPLEX

Rose diagram plot for the recorded values of various joints in the gneiss- complex shows a predominant NE-SE trend. The NW-SE trend though present, are not prominent. fig.4B.

4.2.3 JOINTS IN DIORITE (fig.4c)

Joint trends in the diorite rocks of the area are predominantly trending NE-SE, though the NW-SE trend is present. It is not a prominent trend, we have an E - W trend which is an exception.

4.2.4 TRENDS OF FRACTURE DIRECTION (fig.4D)

Rose diagram plotted to observe the trends in fracture direction shows a dominant and prominent NE-SW trending with a less prominent SE-NW trend.

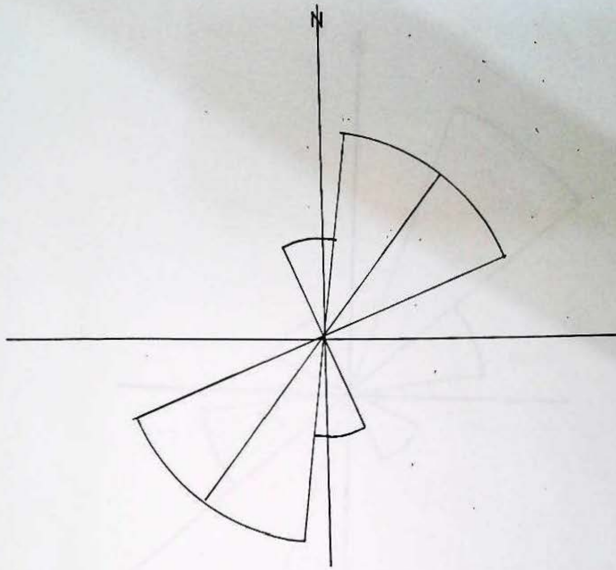

Fig. 4A ROSE DIAGRAM OF JOINT READING IN GRANITES SHOWING A DORMINANT SW-NE TREND.

n= 12

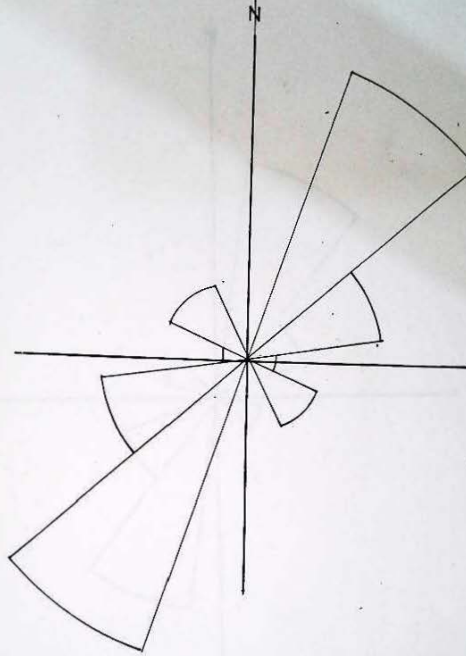

Fig. 4 B ; A ROSE DIAGRAM OF JOINT READINGS IN GRANITE GNEISS SHOWING A DORMINANT NE- SW TREND.

$n = 12$

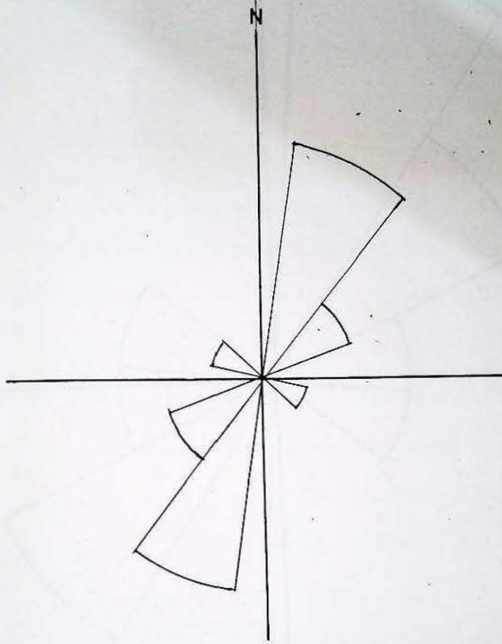

Fig. 4C; ROSE DIAGRAM OF JOINT READINGS IN DIORITE SHOWING A DORMINANT NE.-SW TREND.

n = 10

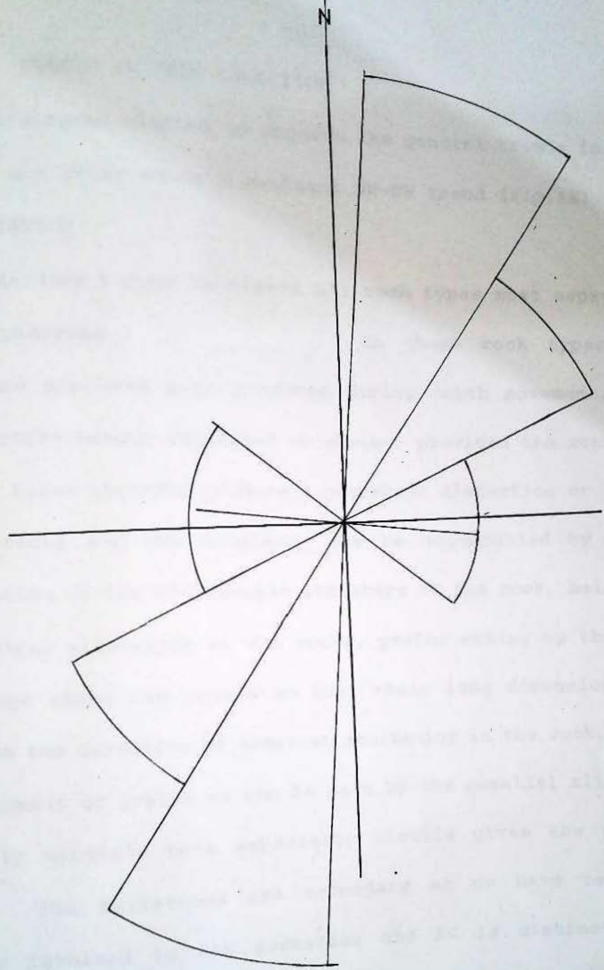

Fig. 4D; A ROSE DIAGRAM OF FRACTURE DIRECTIONS SHOWING A DORMINANT NE-SW TREND. n = 15

4.2.5 TRENDS IN VEIN DIRECTION

Rose diagram plotted to observe the general trends in which the vein are going shows a dominant NE-SW trend (fig.4E)

4.3 FOLIATION

Foliations occurs in almost all rock types most especially in the gneisses. In these rock types, the foliations may have been produced during earth movement, when crustal rocks become subjected to stress, provided the rocks are ductile, these stresses produce a permanent distortion or strain in the rocks and the straining may be accompanied by a re-organization of the microscopic structure of the rock, helped by the chemical alteration of the rocks, grains making up the rock may change shape and rotate so that their long dimension turn away from the direction of greatest shortening in the rock. These new alignment of grains as can be seen by the parallel alignment of platty minerals more especially biotite gives the rock a fabric. The foliations are secondary as we have tectonic activity involved in its formation and it is distinct from primary foliation which is normally associated with sediments. (plate 3:)

Foliations in the Basement rocks are widespread and trends mainly between N-S and NE-SW (Oyawoye, 1970).

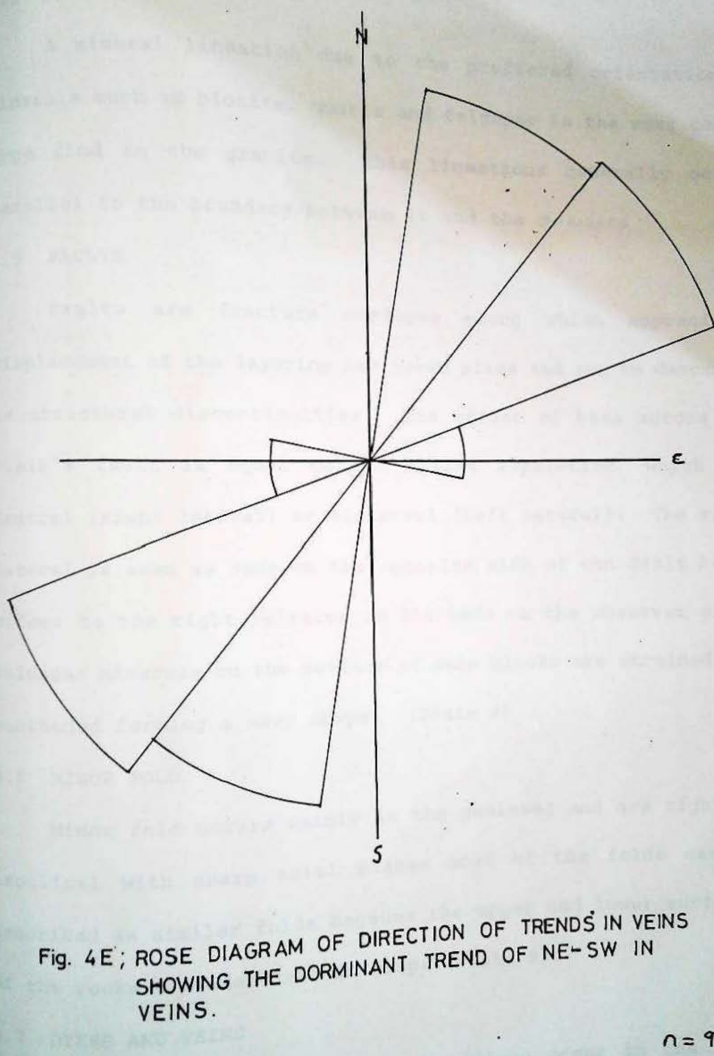

Fig. 4E; ROSE DIAGRAM OF DIRECTION OF TRENDS IN VEINS SHOWING THE DORMINANT TREND OF NE-SW IN VEINS.

n = 9

4.4 LINEATION

A mineral lineation due to the preffered orientation of minerals such as biotite, quartz and feldspar is the most common type find in the granite. This lineations generally occurs parallel to the boundary between it and the gneisses.

4.5 FAULTS

Faults are fracture surfaces along which appreciable displacement of the layering has taken place and can be described as structural discontinuities. The offset of beds across the visible fault is equal to the strike separation, which are dextral (right lateral) or sinistral (left lateral). The right lateral is seen as beds on the opposite side of the fault being offset to the right relative to the beds on the observer side. Feldspar minerals on the surface of some blocks are strained and smothened forming a wavy shape. (Plate 8)

4.6 MINOR FOLD

Minor fold occurs mainly in the gneisses and are tight to isoclinal with sharp axial planes most of the folds can be described as similar folds because the upper and lower surfaces of the rocks are identical in shape (Plate 9)

4.7 DYKES AND VEINS

Pegmatite veins of various dimensions occur in the area mapped but are much more abundant within the granites. The

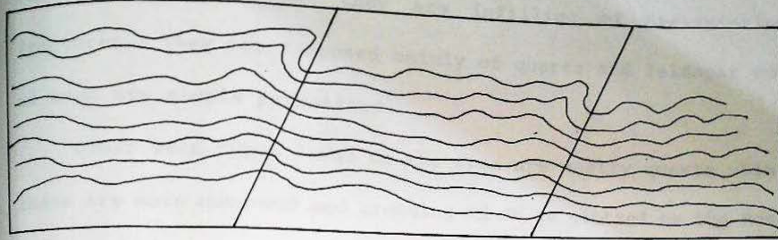

Plate 8; SHOWING OFFSETS OF BEDS ACROSS THE VISIBLE FAULT IN BANDED GNEISS (Sinistral (left lateral).

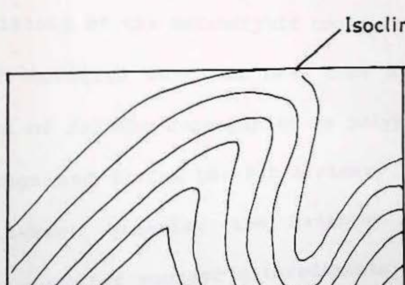

Plate 9; SHOWING AN ISOCLINAL FOID IN GNEISSES contact between the veins and their lost rock are observed to be sharp, suggesting that they are infilling of pre-existing fractures. They are composed mainly of quartz and feldspar and as such are simple pegmetites.

Other vein types found in the area are mostly quartz vein, these are more numerous and trending NE-SW as plotted on the Rose diagram and they are much more abundant than the pegmatites. (Plate [illegible]).

4.8 CONCLUSION

Little work has been done in elucidating the structural and metamorphic history of the metamorphic rocks in Northern Nigeria.

The most detailed work has been done by (Mccurry 1971), where 2 phases of folding accompanied by polyphase metamorphism have been recognized during the Pan-African.

In North-West Nigeria, the Basement complex and its supractrustal cover of younger matasediments were subjected to two phases of tight isoclinal folding during the Pan-African, described as earlier deformation and later deformation.

During the earlier episode, a East-North east to West-Southwest trending structures predominated, with the later deformation has produced the dominant North-South trending, steeply dipping structures common over much of Nigeria.

PLATE I: SHOWING JOINTS IN GNEISSES

In the North east of which the mapped area belongs and as seen from the various plots of Rose diagrams plotted for various structures ranging from joints veins, the general North-South trends swing round to follow North-East, South West direction are recorded in the Basement complex, due to the rotation through 70° early deformation fold giving rise to variable trends within the parallel to sub-parallel later deformation fold axial planes.

CHAPTER FIVE

ECONOMIC GEOLOGY AND HYDROGEOLOGY

5.1 ECONOMIC GEOLOGY

No economic mineral deposit was discovered in the cause of the mapping exercise in the area but will be too early to conclude that the basement rock of the mapped area are unmineralized, further work will reveal this. The crystalline rocks found in the area are quarried to various sizes as observed along Dass-Tafawa-Balewa road for constructional proposes, such as concrete building, Dam construction and building construction.

The pegmatite and quartz veins are simple types coupled with their small sizes and width, brings in doubt of the possibility of being of ore - bearing potential.

However they could be used economically also as construction materials, polished wall and floor tiles.

The veins are very numerous and are found crisscutting one another all through the rock types.

Based on personal discussion with some of the locals in the area, there is an indication of local mining of gemstone such as amethyst most probably from the few quartz veins found in the area.

5.2 CONSTRUCTION MATERIALS

The granites of the area especially the fine-medium grained granite could be quarried and used as construction materials for roads and building construction purposes, also the diorite found in the south-western part of the area are also useful as construction materials could be polished and used for decorative purposes.

5.3 HYDROGEOLOGY

As in all crystalline basement complex region of which the mapped area is a part of the rocks are hard with very low permeabilites, unless if they are highly weathered and or fractured.

Though the area have been described by Dupreeze and Barbe (1965) as poor groundwater regions with recorded average yield of 3960 liters/hour, and average depth of 37.3m and over 30% borehole drilling for water were failures. This assumption have been found not to be true now.

Schroeter (1974) discussed the hydrogeological conditions of Bauchi and its immediate environs and concluded that groundwater is stored in the superficial weathered mantle derived from crystaline rocks of the basement complex.

The rocks of the mapped area are mainly Gneisses and the Older Granite. The rocks have different textures, in granites for example we have from coarse to fine grain's consisting essentially of biotite, feldspar and quartz. The dominance of either the feldspar or quartz is an indication of hydrogeological characteristics.

Generally only small amount of water can be obtained in the freshly unweathered bedrock below the weathered layers. Even when fractured the clayey materials tend to seal the openings of the fractures and prevent water from being transmitted into the borehole.

Although ground water resource is known to occur more widely than surface waters, the ratio of surface water to groundwater is put at 1.3 (Walton 1970)

But unfortunately, groundwater availability is limited by so many factors. It is available only when the rocks in the zone of saturation are permeable enough to transmit sufficient water to wells, springs or streams. In the mapped area which is located in a high relief, run-off water is high and infiltration rates are low, these adverse climatic conditions affects ground water storage.

The granitic areas in Dass often coincide with broad depression or valleys separating the areas of high relief, this coupled with numerous and pronounced set of open joints allow for water storage and shallow to deep ground water occurs most in the decomposed zones overlying the fresh rock, and these are extensively developed for domestic purposes, by means of numerous hand-dug wells and machine dug wells.

Despite all these limitations observed boreholes produces moderately highly and with more systematic and scientific siting of the boreholes, improved drilling techniques, fissures could be located and opened more widely for maximum exploitation.

CHAPTER SIX

SUMMARY AND CONCLUSION

SUMMARY

The mapped area is underlain mainly by crystalline rocks and these rocks occur as low-lying poorly outcroping homogeneous mass, in other places they outcrop fairly well as slightly elevated hills. The mapped area consists almost entirely of gneisses, granites and diorites, with the gneisses being the oldest rocks in the area.

The gneisses in this area could have been formed by the regional metamorphism of granitic rocks in these area.

The rocks of the Older Granite series include granites and diorites which are believed to be emplaced during the Pan African thermotectonic event.

Joints and foliations which are of tectonic origin are abundant in the rocks of these area. Other structures are mainly minor faults and folds, both sinistral and dextral strike slip faults was observed in the area mapped.

Weathered and fractured parts of the crystalline rocks form the main aquifer system in the area. Though no economic mineral deposit was encountered in the cause of the mapping, it will be too early to conclude that the rocks of these area are barren.

The crystalline rocks can be quarried for different constructional purposes.

CONCLUSION:

The geology of Dass area in south-west part of Bauchi can be classified mainly as being part of the basement complex of Nigeria.

In a broad group the rocks can be grouped mainly into two namely: the Gneisses and the Oldergranite rocks.

From petrographic studies and Rose diagrams plotted, the data's are consistent with the idea of an Older crust anatexis which greatly influenced the petrogenesis of the basement rocks. The gneisses are derived from the regional metamorphism of rocks of granitic origin.

The rocks of the granitic series are of igneous origin and still retain most of their igneous texture.

The rose diagrams plotted shows a consistent North east-south west trend which is consistent with the trend direction recorded in North-east Nigeria during the Pan African Orogeny.

Most of the rock types have all been affected by various fracturing events leading to the formation of joint sets and microfaults, showing a reflection of the polycyclic nature of the Nigeria Basement.

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