THE APPLICATION OF REMOTE SENSING TO THE STUDY OF THE GEOLOGY OF THE AREA AROUND ZAGUN, BASSA L.G.A. PLATEAU STATE

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TITLE PAGE

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BY

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A THESIS SUBMITTED TO THE APPLIED GEOLOGY PROGRAMME, ABUBAKAR TAFAWA BALEWA UNIVERSITY,BAUCHI IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B.Tech) IN APPLIED GEOLOGY.

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DEDICATION

This work is dedicated to the memory of my late mother, Mrs. F.I. Omirinde and also to my sister and her husband, Rev. and Dr. (Mrs.) D. A. Oyebode. They helped me variously on my way to where I am today.

AKNOWLEDGEMENT

I am, as always, grateful to God Almighty for His mercy and His goodness to me. I am indebted to my supervisor, Mr. A. I. Haruna for bearing with me and showing me how to do a good job.

As a body, I am grateful to all the lecturers of the Geology programme A.T.B.U for teaching me what I know in geology.

My family have been an immense support to me, especially my Dad, Mr. J..A. Omirinde and my siblings.

The help I received at the national center for remote sensing was a gift and I am grateful for it. Especially to the Director, Mr. J. A.A.Ologun , Mr. A.Onwusulu,Rev. E.Omomoh and Mr. E. Eguaroje. I am greatly indebted.

APPROVAL

This project thesis has been carefully read and found to fulfill the requirements for the award of Bachelor of Technology (B. Tech) by,

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ABSTRACT.

The application of remote sensing to study the geology of the area around Zagun, Bassa Local Government area of Plateau State is the aim of this study. The properties studied are the significantly unique ways in which all the material on the earth surface and reflect electromagnetic radiation. This uniqueness is based on the molecular structure of the material which affect the way they reflect and absorb incident radiation.

The concept of spectral signatures was used to aid in the study while field observation were carried out to verify the accuracy of information gathered by these means. The structural geology and drainage pattern of the area was also studied to shed more light on the geology of the area.

Results obtained from the study shows the possibility of using remotely sense data to observe and accurately record the Geology of an area of the magnitude of the studied area. Such qualities as grain size, rock boundaries, drainage pattern , mineral deposits and so on can also be studied using remote sensing .

CHAPTER ONE

1.1 INTRODUCTION

The study area, Zagun, located to the north–west of Jos and west of the Jos–Bukuru Ring complex, is on sheet 168: Naraguta NW Located in Bassa Local Government Area of Plateau State, the 225km study location is drained by various streams.

The Geology of the area consists of Older Granites of the basement complex, which cover the large part of the study area, nodulized basalts of the Newer Basalt suite and of particular interest, a doleritic dyke in the north – eastern corner of the study area.

Remote sensing was applied as a tool to ease research methodology and as a basis of the research. The remote sensing data of the study area used are Landsat TM image of 2001 over most of Plateau State and part of Bauchi and NigeriaSat 1 image 2004 of the same area. The topographical sheet (sheet 168: Naraguta NW) was used to compare and guide interpretation of the images. Also, contours were digitized from the topographical sheet to aid in delineating geologic boundaries.

1.2 LOCATION AND ACCESSIBILITY

The study location is Zagun and the area surrounding it. It is located geographically within latitudes $9^0 49'59.86$ N $9^0 59'59$ 86" and longitude $8^0 39'59.88"$ E and $8^0 49'59.87"$E. *I*t is about 15km North – West of Jos and about 11km west of Bukuru. The area is located to the west of Jos–Bukuru Ring complex.

It is accessible by road from Jos via Rukuba, though , due to dense bushes and difficult terrain must part of the study location were inaccessible for study.

1.3CLIMATE VEGITATION AND DRAINAGE

The study area which is the part the Jos–Plateau is a niche (micro-habitat) within the semi–arid belt of Northern Nigeria. The highest annual rainfall is about 1140 – 1260 mm. It has one dry and one wet season. Wet season is from April to October. July and August mark the twin peaks of the rainfall. Rainfall is both conventional and orographic. Temperature is moderate.

Sparse trees, shrubs and herbs characterize the study location. The typical vegetation is mostly cacti *(Enpharbia Kammermica)* and Pennisetum. A small population of coconut palms are also found within the study area. Both *Enpharbia Kammermica* and Pennisetum have the regenerative ability of growing after destruction by bush burning and bush clearing.

1.4SETTLEMENT AND LAND USE

The native population are Rukuba by tribe. However, Hausa and Fulani settlers are notable within the area . must of the people living in scattered small settlements within the area with a central point at Zagun village.

Majority of population practice subsistence farming with irrigation along stream channels and terracing on the slopes. Agricultural products include maize, millet, sorghum ,beans , irish and sweet potatoes, tomatoes , cabbages, acha (hungry rice) etc. quarrying activities were also noticed along with evidence of previous mining activities.

1.5PREVIOUS WORK

Most of past work has being done on the general geology of either the Jos- Bukuru complex or the geology of the Jos Plateau as a whole.

McLeod et al (1971) worked on the geology of the Jos–Plateau. In 1956, he also worked on the geology of the Jos–Bukuru younger granite complex with particular reference to the distribution of columbite. He has worked a long side others extensively leading to the discovering of the rich tin and columbite fields within and around the complex.

Falconer , G.D. , (1921) and Makay et al (1949) have both differently worked on the geology of plateau tin fields.

1.7AIMS AND OBJECTIVES OF THE PROJECT

The aims of the project are :

a. To acquire basic understanding of the geology of the Zagun area.
b. To demonstrate the value of remote sensing to geology survey and mapping.

The objectives of the project are the same as the objective of remote sensing in general which are:

a. To eased research methodology using remotely sensed data. A lot of useful information can be easily gathered from a large area in rough terrain which may much more difficult or very near impossible through field work.

b. Remote sensing as a third eye to actual field work because important features that have been over looked on the ground can be identified

CHAPTER TWO'

2.1 HISTORY OF REMOTE SENSING

Remote sensing is defined as the act of gathering information about an object from a distance. This information could be colour, texture, shape, from and so on. A simple example of a remote sensing is snapping a picture with a camera.

The idea of gathering information about an object from a distance has fascinated man for a long time. As far back as 15^{th} century, Leonardo da Vinci and his invention the camera obscura , attempted this. From the camera obscura till date , remote sensing has undergone radical change. The censors have changed from ordinary cameras to digital censors which record and transmit well beyond the range of visible light. Also , the growth of remote sensing has being commensurate to the height of observation. From the fist hand held camera, to the aeroplane mounted cameras which fist came into use during the period between the World Wars, to the present day satellite borne imaging censors, the trend has being towards a higher vantage point for observation (Boardman et al 1994)

2.2 REMOTE SENSING SYSTEM

The remote sensing system is made up of four components.They are:

i **SOURCE**: the source of electromagnetic may be natural like the sun reflection of the earth's emitted heat. Or it may be man – made, like RADAR. If the source is sun or other natural sources, it is called passive remote sensing. On the other hand , when the source is man – made, is called active remote sensing.

ii **EARTH'S SURFACE INTERACTIONS**: the amount and characteristic of radiation emitted or reflected from the earth surface is depend upon the characteristic of the object of the surface. Since the reflection of an object is dependent on its molecular structure, spectral signature are unique to each material.

ATMOSPHERIC INTERACTIONS: electromagnetic energy passing through the atmosphere is either distorted , scattered , absorbed , or unaffected during it's passage through to the earth atmosphere.

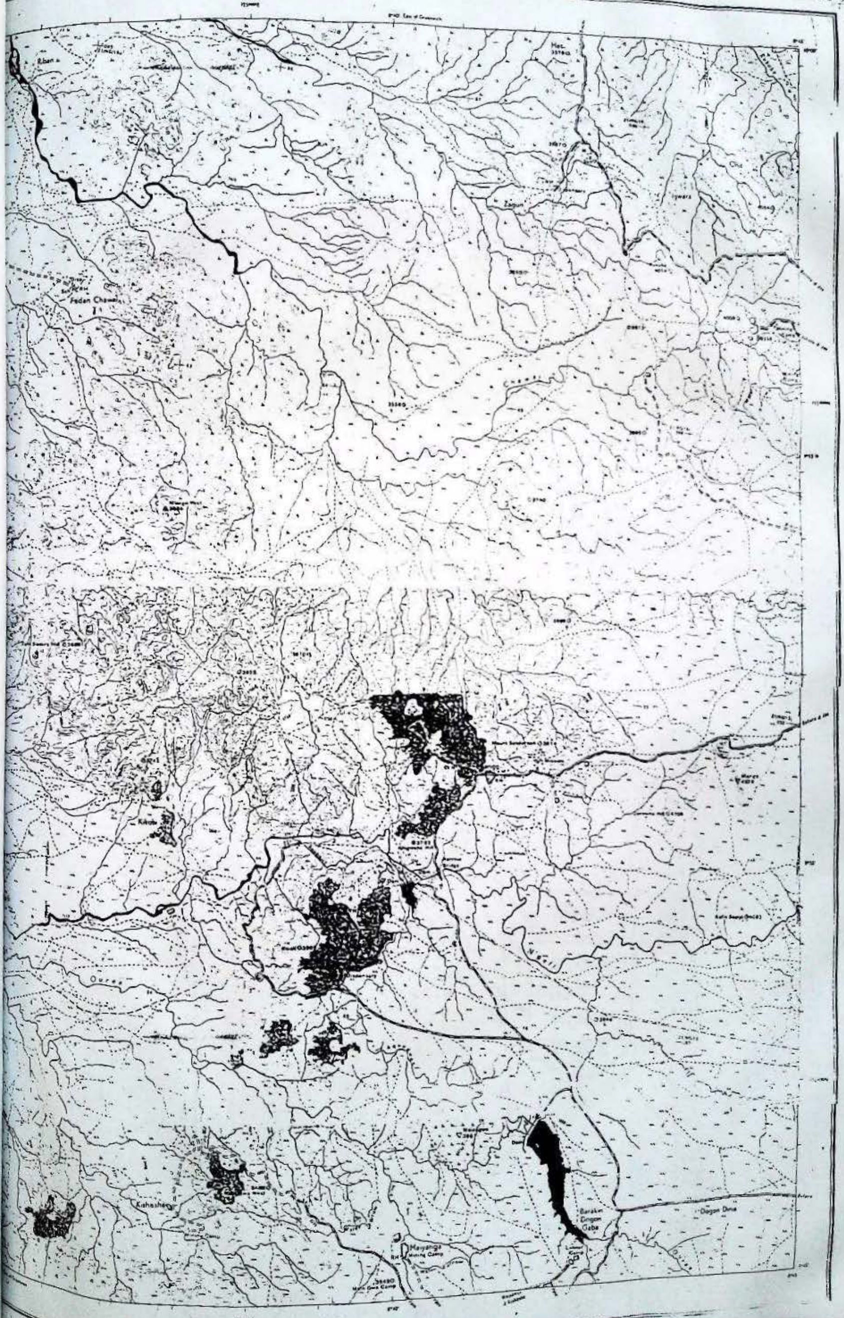
iii **SENSOR** : the electromagnetic radiation that has interacted with the surface of the earth and with the atmosphere is then recorded by a sensor .this can be radiometric sensor or a camera.

2.3 USES AND APPLICATIONS OF REMOTE SENSING.

Remote sensing has diverse uses and applications and this is better appreciated when it is considered as an earth science which gathers information about the surface of the earth. Thus it can be applied and used in all the earth sciences as well as some human and resource sciences the areas of application of remote sensing in geology are areas like mapping , ground water delineation , mineral exploration, oil and gas exploration and in geobotanical surveys (Das, 2001)

NARAGUTA N.W.

Sheet 168 NW



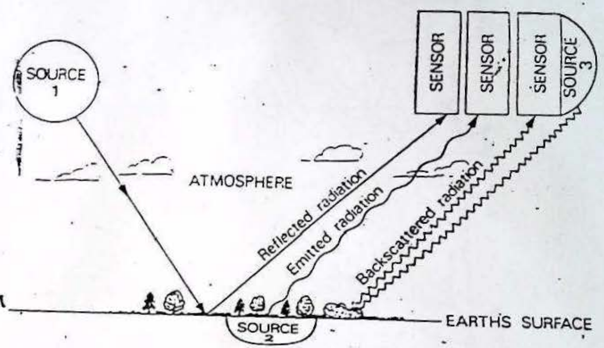
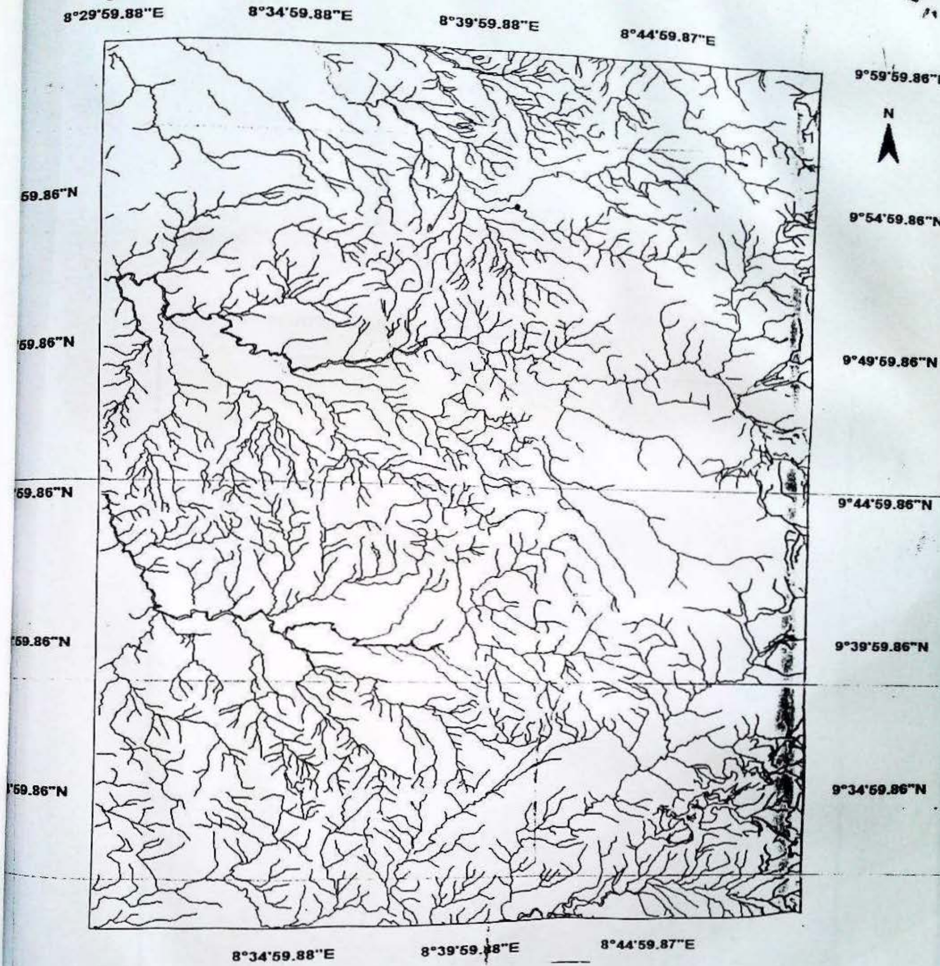
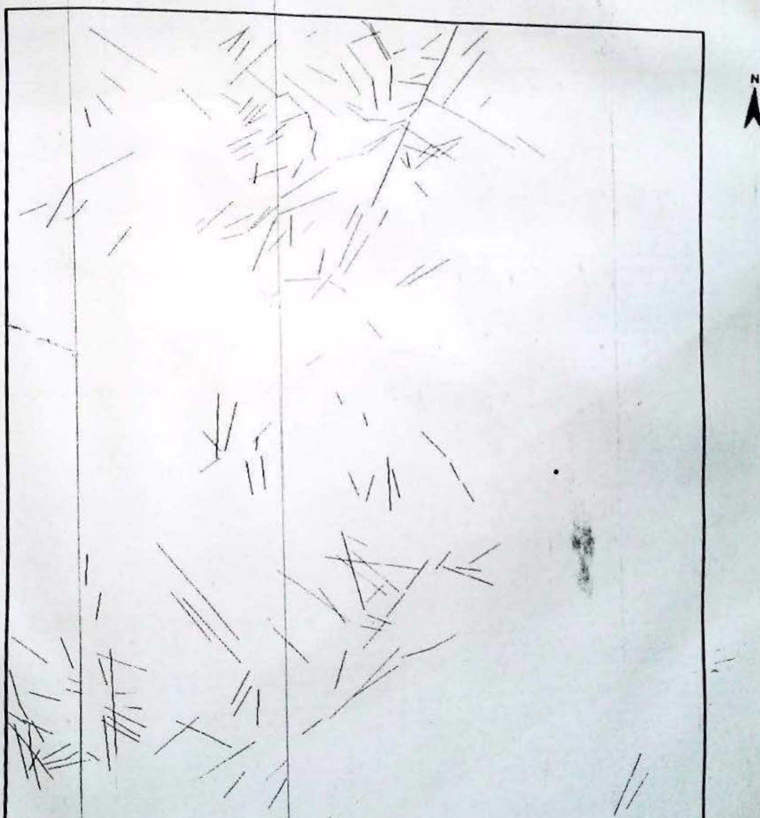


FIG2.
: A REMOTE SENSING SYSTEM

Fig. 4: Drainage Map



Lineament/fractures generated from the image



CHAPTER THREE

3.1 METHODOLOGY.

Satellite imageries of the study location were obtained and analyzed for spectral signatures of the different rock type present in the study location, Zagun. Lineaments and drainage channels were traced out from the image to produced drainage and lineament maps.(fig.3,and fig.4) also, contours were digitized from the topo–sheet and draped over the image to accentuate geologic boundaries. This was also used to produce a 3 dimensional image of the study location to aid interpretation of the data.

The instrument used include ILWIS (Integrated Land and Water Information Systems) a computer programme for analysing and processing data from satellite images , ERDAS,another programme for the same purpose, a computer system, a plotter and other peripherals were also used.

Field truthing exercise was carried out for 4 days to verify the accuracy and reliability of the analysis. Rock samples were taken from outcrops using the geologic hammer. Dip and strike of joint and fractures were measured and recorded in the field note book (see fig.5). Instrument and equipment used for the field work include a geographical positioning system (G.P.S), hammer , compass field note book and pen. A bag was used to carry the collected samples.

Spectral analysis was carried out on both the Landsat TM image and NigeriaSat 1 image. The two were latter fused to form one image. (fig.6). The spectral analysis involves obtaining the reflectance values of each of the objects for each band present in the image and using these values to plot a graph of reflectance in percent against frequency in bands. The resulting graph is then compared with standard spectral signatures and objects, rock or portion of the image is thus characterized.

From the information acquired from the characterization of the image, a geologic map of Zagun was then prepared. This was achieved by draping the image with contours previously extracted from the topographic sheet (sheet 168 Naraguta NW). The aim was to enhance geologic boundaries and this facilitate easy mapping of the area.

Also, lineaments and drainage channels were traced form the image to produced a lineament map(Feg.5) and a drainage map (Fig.4). Lineaments traced may be joints, fractures , roads or other linear structures within the image. In addition to this, dip and strike of joints in the area were measured and recorded (fig .14). This was later used to geographical positioning system (G.P.S), hammer , compass field note book and pen. A bag was used to carry the collected samples.

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ntour generated from existing topographic map
erlain on the image enhances geological boundaries

FIGURE 7: SATELITTE IMAGE OF THE STUDY AREA.

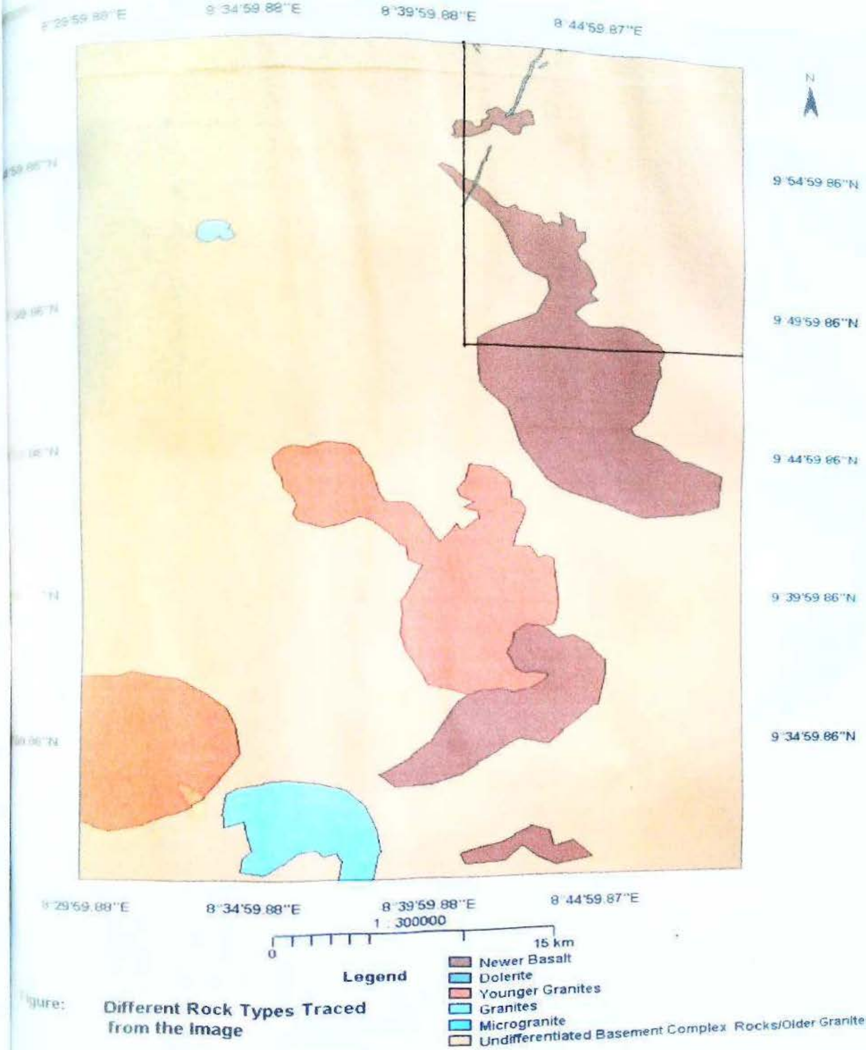

Figure: **Different Rock Types Traced from the Image**

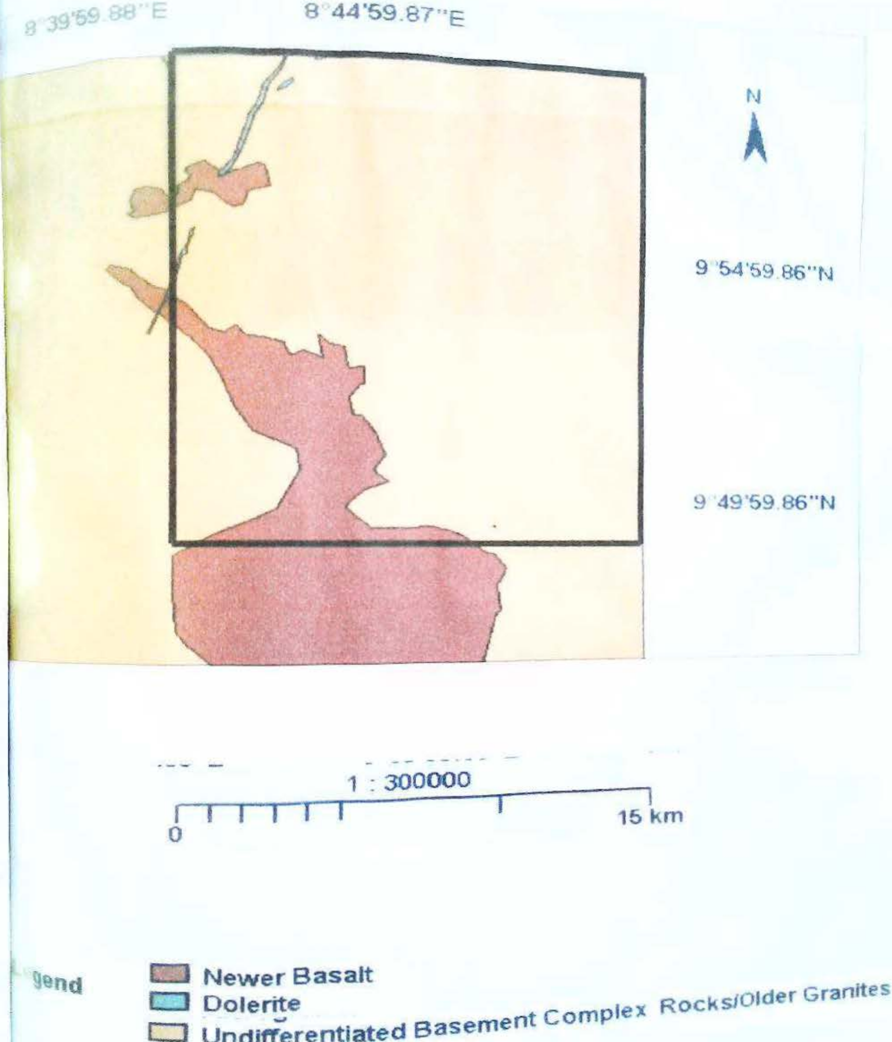

Figure: 9 Different Rock Types Traced from the image

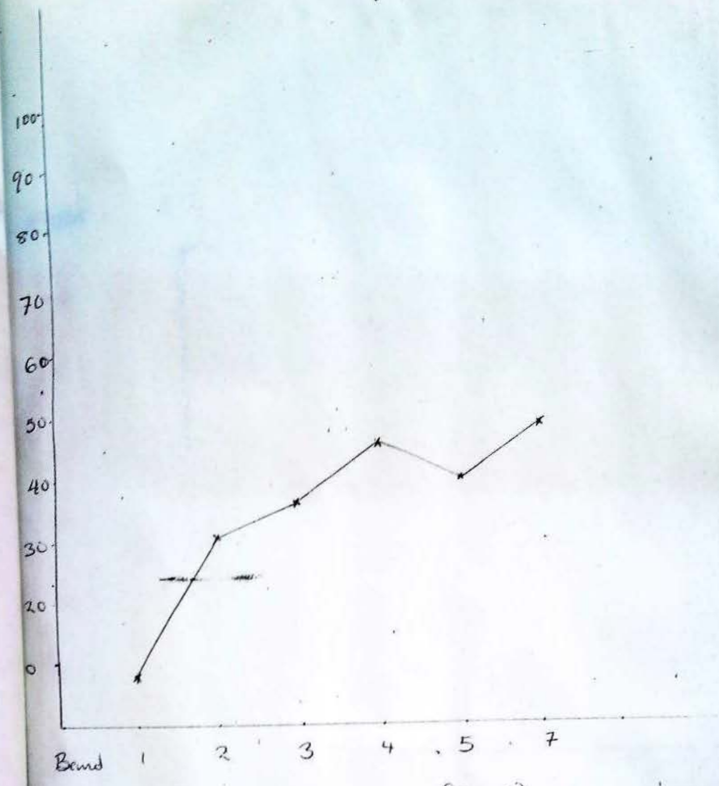

Figure 11: REFLECTANCE VALUES FOR GRANITE

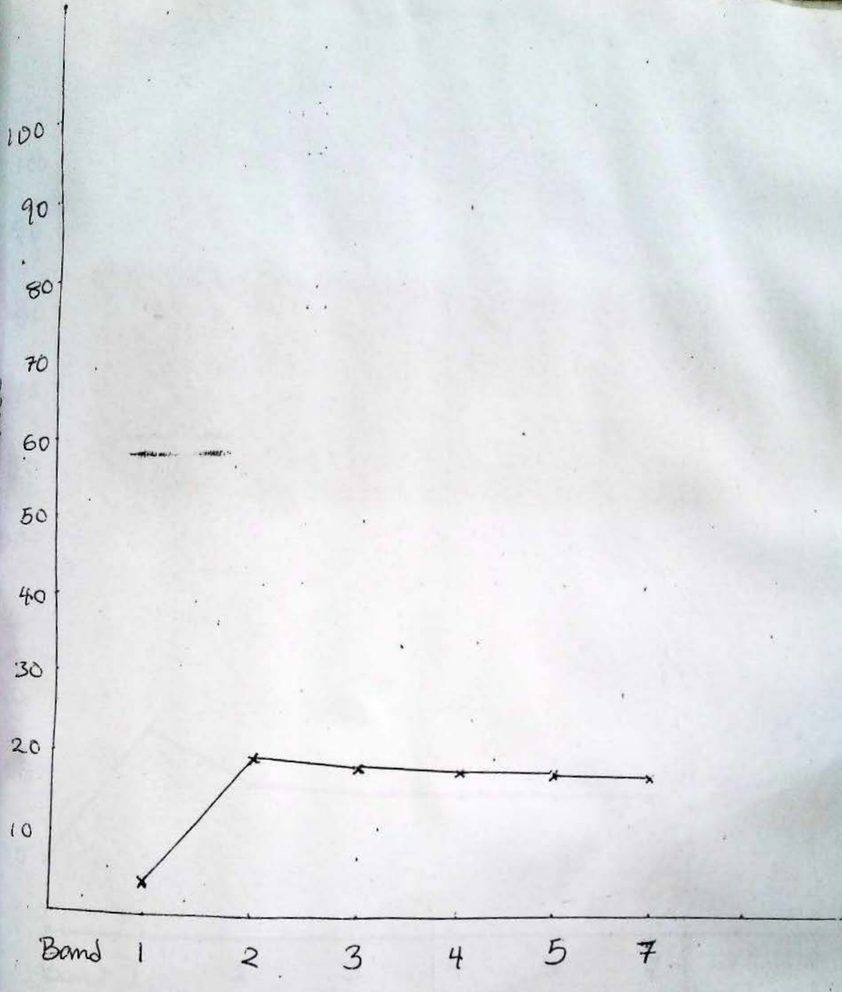

Figure 13: SPECTRAL REFLECTANCE VALUES FOR BASALT.

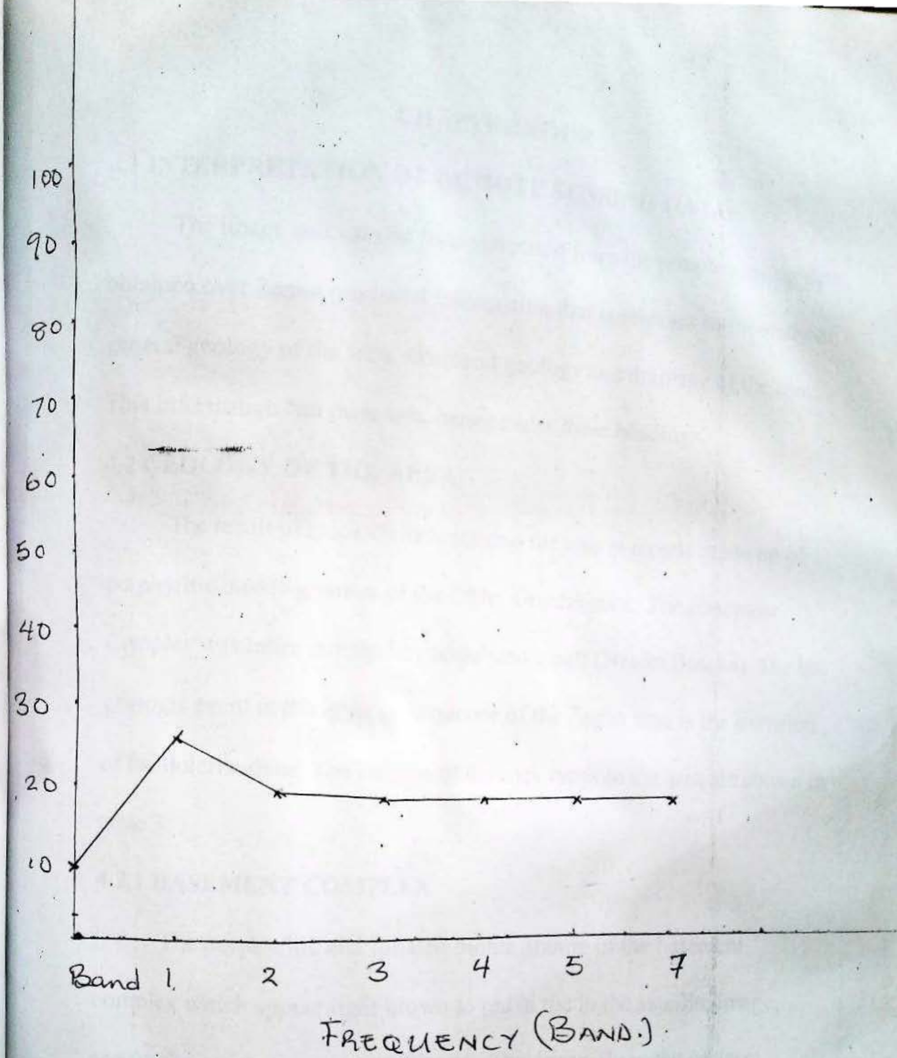

Figure 13. SPECTRAL REFLECTANCE VALUES FOR DOLERITE

CHAPTER FOUR

4.1 INTERPRETATION OF REMOTE SENSING DATA:

The image and various map generated from the remote sensing data obtained over Zagun produced information that is relevant to the study of general geology of the area, structural geology and drainage of the area. This information can therefore, better under these headings.

4.2 GEOLOGY OF THE AREA

The result of research indicate that the area is mostly made up of porphyritic biotite granites of the Older Granite suite. The Basement Complex was latter intruded by nodulized basalt (Newer Basalts). The last geologic event in the igneous sequence of the Zagun area is the intrusion of the dolerite dyke. The colours of the rock types in the area are shown in table 3.

4.2.1 BASEMENT COMPLEX

The porphyritic and foliated biotite granite of the basement complex which appear light brown to red in the in the satellite image, covers the greatest portion of the area. This is mostly in the eastern portion of the image. The spectral signature displace a consistent rise from band 1 and 2 to a peak in band 4 followed by a fall in band 5 and another peak in band 7.(fig.11 and table 1)

4.2.2 BASALT

The basalt which appeared very dark green (almost black) in exposed areas , to green in area covered with vegetation , trends NE – SW in the lower portion of the image. The spectral signature of basalt show a steady raise in band 1 which levels at below 20 % reflectance in the remaining bands. This spectra is due to nature of basalt which is a melanochratic rock, absorbing most of the incident radiation. Reflectance values remains steady due to the reflection of the component of white light In equal proportions by small crystals of quartz in the rock. (fig. .12.)

Another aid to the identification of basalt was the geobotanical analysis carried out over the area. This was also done using remote sensing data. The colour of the plant over the basalt was noticed to be a different shade of green from plants over other areas. This is due to the release of metals from mafic minerals within the basalt which alters the spectra of the plants slightly in band 1(Blue). This is shown in a comparison of fig.16 for normal plants and fig.16.for plants over the basalt.

4.2.3 DOLERITE

The dolerite dyke which appears as dark brown linear structures in the North eastern to the top of the image and out of the study location, display similar spectral signature with basalt. This result from the fact that dolerite is chemically and petrologically equivalent to basalt. The only distinction between the two rock is bluish appearance of dolerite in hand specimen. This difference makes a marked difference in the spectra of dolerite. The band 1 (blue) value for dolerite peaks at 25% reflectance while that of basalt remains under 20%reflectance. The rest of the bands remain the same for both rocks. (fig.13)

4.3 STRUCTURAL GEOLOGY

Geologic structures are basically dictated by the magnitude and direction of the tectonic evolution and nature of the magnetic activity that affected the environment of the area considered . From remote sensing data structures may only be observed as linear bodies. In reality , however , they be joints , fractures , stream courses , contact between rock bodies etc.

To attempt a structural interpretation of the Zagun area, the dip and the strike of joints were measured . These measurements were taken by the use of compass. The values obtained from the measurements were used to plot a Rose diagram. (fig.14 and 15 and table 2) This diagram tells the direction in which the joints are trending , which is NW – SE. Also, it indicates the trend of the dolerite dyke which has an altitude of N25 E, 40 W. The dyke extends discontinuously for more than 10km within the study area and even beyond the boundaries of the study area. The dyke has an average width of 150cm and shows chilled contacts with the host granite.

4.4. DRAINAGE INTERPRETATION

Drainage channels within the area are generally controlled by structural directions in the area .The relief of the area also affects the drainage, producing a radial pattern around areas with high relief. This is particularly true of the central portion of the area where the drainage map(fig.4)shows clearly , streams channels radiating around an area of high relief. (fig.16)

JOINTS

N 20° E, 20° E	N 25° E, 30° E	N 10° W, 25° W	N 20° W, 30° E
N 20° E, 30° E	N 45° E, 30° E	N 20° W, 30° E	N 45° E, 20° E N
40° W, 40° E	N 10° W, 25° E	N 10° W, 40° E	N 30° W, 20° E
N 15° W, 20° E	N 35° W, 20° W	N 15° W, 20° E	N 20° W, 20° E
N 17° E, 30° E	N 20° W, 25° W	N 29° W, 30° E	N 35° W, 30° E
N 50° E, 10° E	N 30° W, 20° W	N 40° W, 30° W	N 30° W, 10° E
N 70° W, 20° E	N 50° W, 25° E	N 20° E, 30° E	N 80° W, 30° E
N 50° E, 40° W	N 45° W, 30° E	N 15° W, 35° W	N 15° E, 27° W
N 45° E, 40° W	N 10° E, 20° W	N 15° W, 20° E	N 55° W, 30° W
N 30° W, 30° W	N 20° E, 40° E	N 10° W, 30° W	N 50° E, 35° E

Figure 14: List of Joints

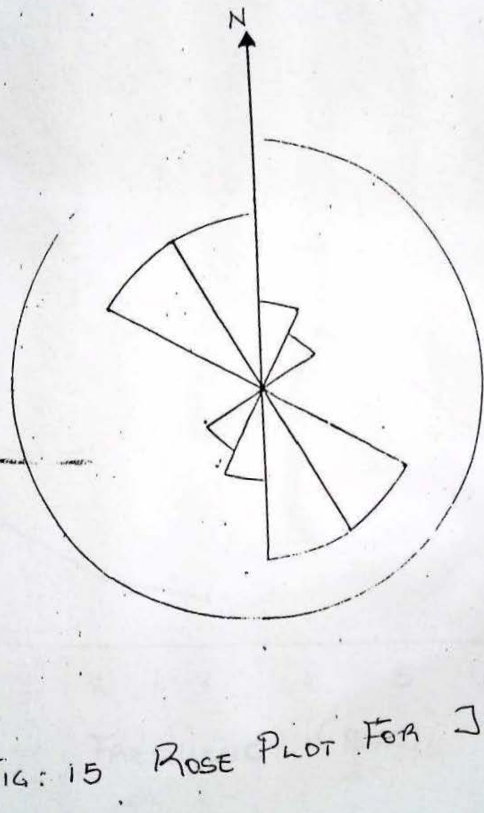

FIG: 15 ROSE PLOT FOR JOINTS

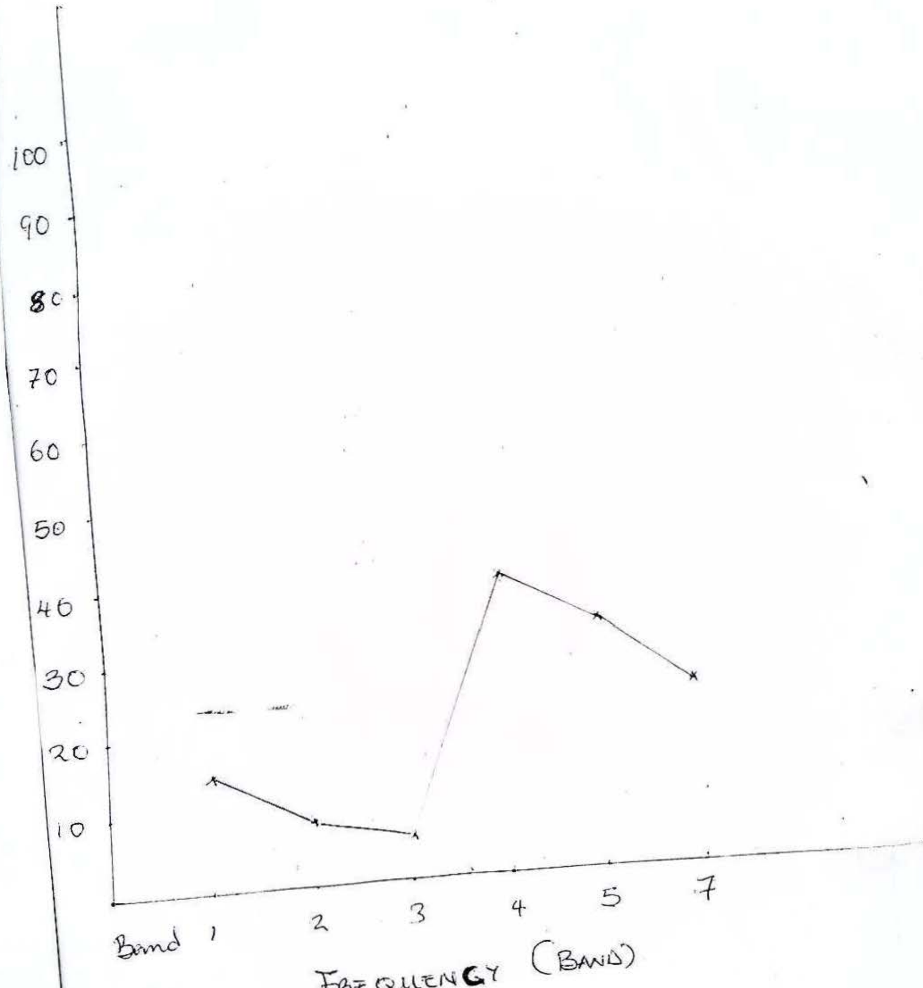

Figure 16: REFLECTANCE VALUE FOR VEGETATION GROWING OVER BASALT.

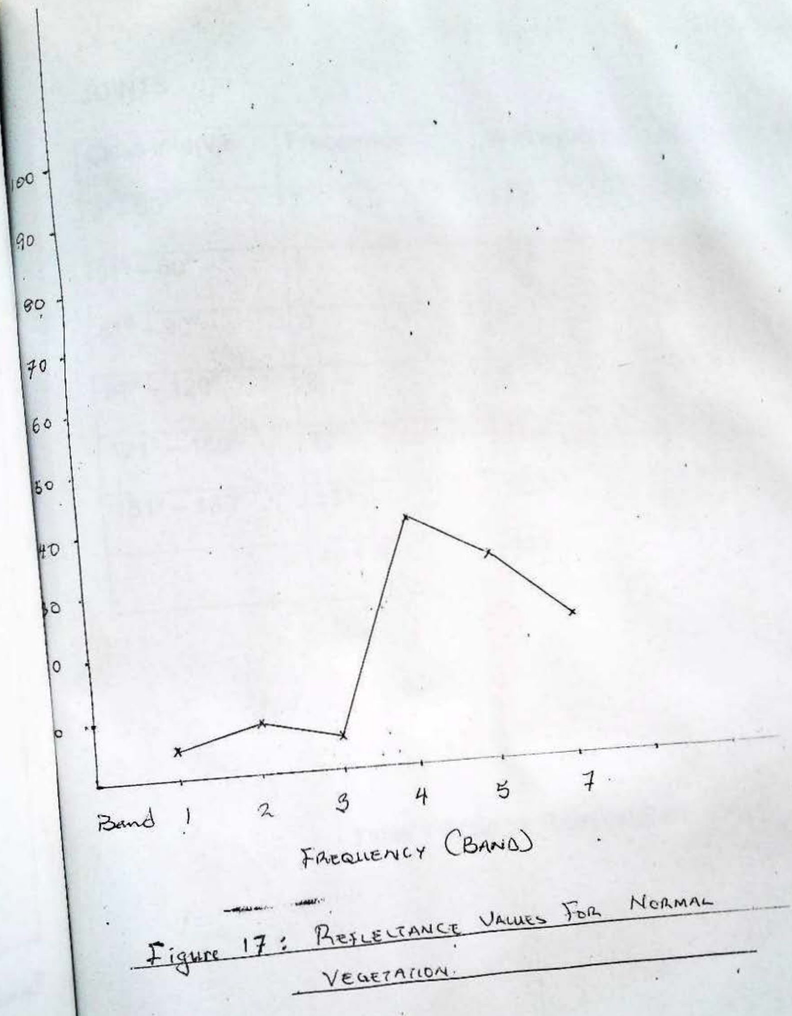

Figure 17: REFLECTANCE VALUES FOR NORMAL VEGETATION.

JOINTS

Class interval	Frequency	% Frequency	Scale 1cm = 10%
$0^{o} - 30^{o}$	7	17.5	1.75
$31^{o} - 60^{o}$	5	12.5	1.25
$61^{o} - 90^{o}$	0	0	0
$91^{o} - 120^{o}$	2	5	0.5
$121^{o} - 150^{o}$	13	32.5	3.25
$151^{o} - 180^{o}$	13	32.5	3.25
	40 = n	100	

Table 1 Scale for Rose diagram

Percentage reflectance.

	Biotite granite porphyry. Basement	BASALT	DOLERITE
BAND 1	7	4	4
BAND 2	30	19	19
BAND3	35	18	18
BAND4	45	18	18
BAND5	40	18	18
BAND7	49	18	18
	TABLE	1. Reflectance Value	

Oject	Colour Range
Granite (basement complex)	Pink – red
Result	Green – very dark green
Dolerite	Bround
Shallow Water body.	Light blue
Dept Water	Dark blue – violet
Vegetation	Green.

Table 3. Color representation of objects in the land sat TM image.

CHAPTER FIVE

5.1 DISCUSSION OF RESULTS.

The general geology of the study area, Zagun compares favorably with result obtain from the same area by other researchers. In his work, Onwusulu (2004) obtain similar result for part of the area of study and the area directly north of it. This work has it focus on the dolerite dyke and general geology of the area. In this wider study, the same rock sequence are observe with the present study.

In another related study, the National Center for Remote Sensing, in her study of mine devastated lands, studied most part of 5 Local Government area including Bassa L.G.A. and the study area. This study, though an environmental study help to understand the mining ponds located within and around the study location.

Further more, Kobge et al classified the Never Basalts with diorites and dolerites which he said are usually highly altered. In his classification, he recognized that they occur in dyke and net veined intrusion. The rocks therefore follow true to type in their occurrence within the area especially after noting that dolerites rarely occur in any other for except in dyke and lenticular bodies.

A wider study would indicate that the area is still within the Younger Granite province because Younger granites are noted outside the study are to the west and north-west. Particularly, a ringed structure composed of younger granites is observe in the south western corner of figure 6. Another similar structure is also observed south of the study location. This emphasises the fact that the geology of the area is greatly related to that of the younger granite ring complexes, with special reference to the Jos-Bukuru complex which lies west of the area.

Comparatively, the structural directions observed in the area and that of the younger granite suites is found to be quite similar. This follows the NW-SE trend of structure within the younger granite suites. This structural plane is the plane of weakness through which the younger granite intruded and are traceable to the basement complex rocks. The foliation in the biotite granite observed in the area also the same trend (NW - SE).

CHAPTER SIX

6.1 LIMITATION.

a. Spectral confusion arises when two object of close reflectance values are in the same Areas. Often they are confused with one another. This is particularly common in built-up areas where read and house give reflectance values that may be confused with rocks. And roofing sheets are confused with standing water bodies.

b. Spectral fixing which occur when two object are close enough that their reflectance are mixed. The resultant signatures are quite different from that of either of the objects. On the study area, vegetation was often spectrally mixed with rocks. Thus the method called spectral unmixing was used to separate the target materials from the background by estimating approximate sub-pixel abundance of the target materials in the images and restoring the images to a more processible format.

c. The terrain was quite rough, therefore some part of the study location could not be reach for verification of the information gathered.

6.2 RECOMMENDATIONS.

1 The application of remote sensing to geologic survey should be greatly encouraged, considering the fact that it saves time which is wasted trying to cover large area with conventional field methods.

2 Numerous ponds in the Zagun area, particularly at the south-east corner of the study location could be put to more profitable use. This may be in the form of tourism attraction (like the Rayfield resorts in Rayfield, Jos South) or as irrigation reservior for extensive mechanized farming.

3 A detailed study of the area for tin and columbite deposite is strongly advised. Also tailing dumps (mining wastes) in the area can reworked for tin and columbite, this is particularly needful because a lot of ore grade tin and columbite still remain in the tailing dumps.

6.3 CONCLUSIONS.

1. The geology of area is made up of a sequence starting with the basement complex rocks succeeded by Newer Basalts and then by the dolerite dyke.
2. Structures within the area follow the structural trends found in the Late Pre Cambrian to Late Palaeozoic. Basement complex rocks. The structures also loosely control the drainage pattern of the area.

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