The Nigerian Journal of Space Research

Volume 6

ISSN: 0794-4489

ASTRONOMY
ATMOSPHERIC SCIENCE
SPACE SCIENCE AND TECH. APPLICATION

Deutchetz Publishers

Number of publications per year

NJSR is published twice in a year, May and November. The present volume is the sixth since the founding of the journal.

Aims and objectives

NJSR serves as a medium or channel for the publication/dissemination of the works, findings and discoveries of researchers in Nigeria and other parts of the world in various areas of space science. Currently, NJSR is the only such important publication medium in Nigeria. Scientists/researchers themselves, during the workshop organised by CBSS in July 2004, identified the urgent need to have this journal. The journal publishes original papers, editorials, news, conferences and career/professional information that are relevant to space scientists/researchers in Nigeria.

Scope and areas of coverage

The Journal accepts for publication articles/papers that will serve the useful purpose of disseminating new research findings in space science, particularly in various areas of the space science, such as:

- Environmental Science
- Satellite/Communication/Remote Sensing Physics
- Astrophysics and Cosmology
- Atmospheric/Ionospheric Physics
- Meteorology
- Geophysics and Geodesy
- Observational Astronomy
- Instrumentation, Electronics and software development

Instructions to authors

The NJSR publishes papers in all aspects of Space Science and fields closely related to them. Papers should contain the results of original works, which have neither been previously published not are to be published elsewhere. Manuscripts must be written in English, and preferably **typeset** with **Microsoft Word**. It should be one and half-spaced.

Order of manuscript:

Manuscripts should be in the following order

NIGERIAN JOURNAL OF SPACE RESEARCH 6: 127-134, 2009 MAY 30

Trend Analysis of the Total Magnetic Signature of the Precambrian Rocks in Malumfashi Area of Katsina State, Nigeria

A. A. Rafiu

Federal University of Technology, Minna, Nigeria

Received July 28, 2008; accepted September 03, 2008

Abstract

A composite magnetic map of Malumfashi area of Katsina State has been compiled at a contour interval of 10nT. Four half-degree aeromagnetic maps cover the study area. The maps were digitized on a 2km by 2km grid and combined to form a composite aeromagnetic map of the area. Positive residual anomalies in the area are associated with high closures while negative residual anomalies are associated with low closures. The total field in the area generally trend NE-SW. There is a moderate discontinuity at the left flank of the area, which might indicate a major fault in the area. The high gradients of the closures show the sharp contact between the schist belt and the granites complex of the area. The negative anomalies reveal a cluster of schists in the area. The sharp contacts together with the presence of rotated xenoliths in granites, suggest that magmatic stopping was the mode of emplacement of the granite in the area.

Key words: Analysis, total magnetic signature and precambrian rocks

Introduction

The study area forms part of the Nigerian Basement complex and consists of the following lithological units (Figs1and 2).

- A crystalline complex of migmatite and gneisses, which are the dominant rock type.
- The metasediments and metavolcanics which form N-S trending schist belts.
- The older granites series intrude both the migmatite gneiss complex and schist belts

The area lies within schist belt of the Northwestern Nigeria in Katsina state. Distributaries of the River Kaka Duwa, River Watari and River Challawa pass through the area. It extends from longitude7^0 30^1 to 8^0 30^1 and latitudes 11^0 30^1 to with an average elevation of approximately 580m above sea level. This project was embarked on so as to use magnetic study to corroborate the gravity work of Gandu *et al.* (1986).

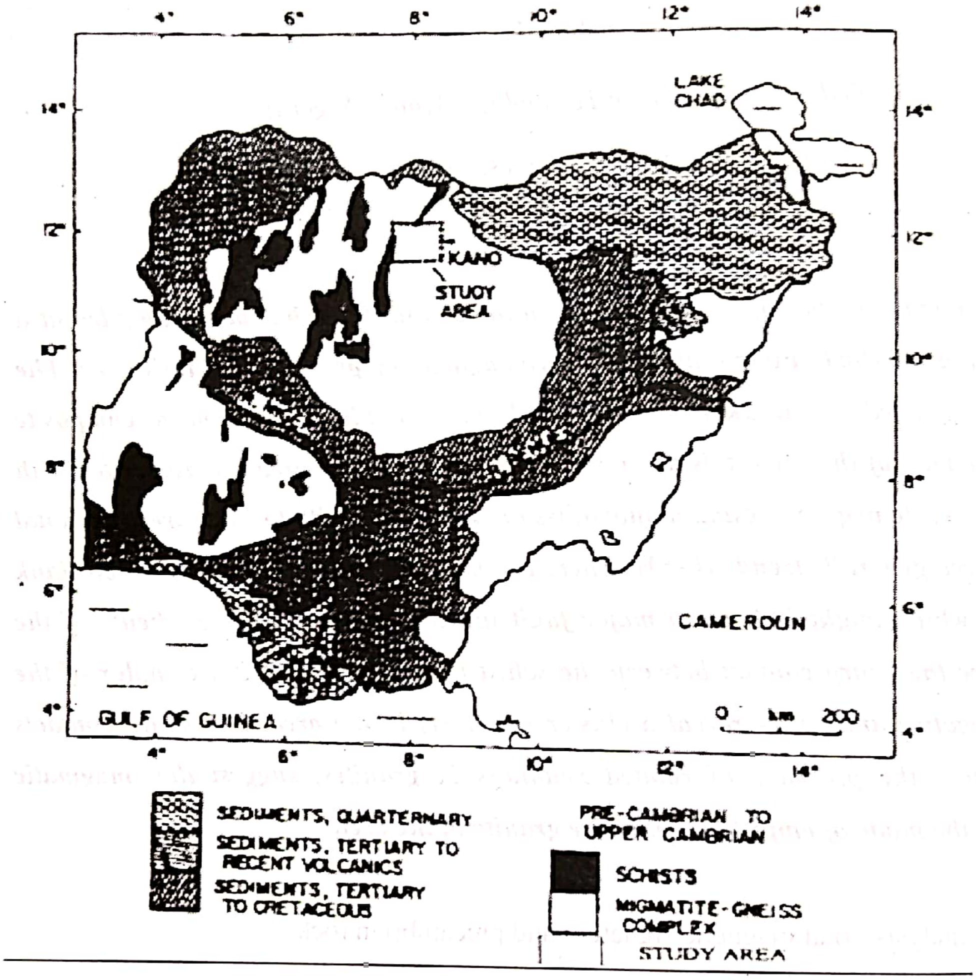

Fig. 1 Geology map of Nigeria

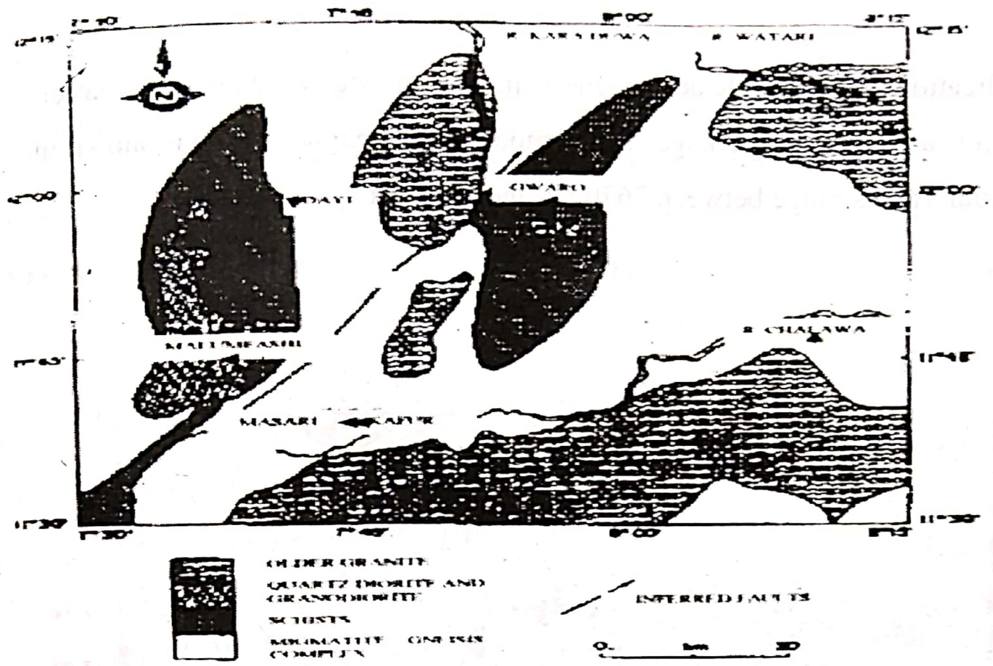

Fig. 2 Geology map of Malunfashi

Compilation of the Aeromagnetic Map

The Geological Surveys of Nigeria published aeromagnetic maps of parts of Nigeria in 1974. The aeromagnetic data were collected at a nominal flight altitude of 500 ft (152.4 m) along N-S flight lines spaced approximately 2 km apart. The maps are on a scale of 1:100,000 and half-degree sheets contoured mostly at 10 nT interval. A correction based on International Geomagnetic Reference Field (IGRF) epoch data January 1974 was applied to the data.

Four aeromagnetic maps, numbers 56, 57, 79 and 80 cover the study area. These maps were acquired from Geological Surveys of Nigeria Agency and digitized on a 2 km grid system using visual interpolation method. This method was adopted because the original data recorded on tape could not be obtained. The contour lines in all the maps were dense; therefore it was easy to adopt the method used with very minimal errors of human judgment. This spacing imposes a Nyquist frequency of $1/4km^{-1}$, thus the narrowest magnetic feature that can be defined by the digitized data has a width of 4km. Previous works with crustal magnetic anomalies e.g. (Hall 1968, 1974 and Udensi 2001) showed that the spacing is suitable for the portrayal and interpretation of magnetic anomalies arising from regional crustal structure.

A simple computer program was used to combine the digitized values from the four maps so as to form a dataset of the area. This program averaged the end values of successive maps to avoid point duplication. A composite aeromagnetic map of the study area was thereafter plotted with *surfer*- a contouring package. The composite aeromagnetic map is shown in Fig. 3. The contour values range between 7670 nT and 8010 nT.

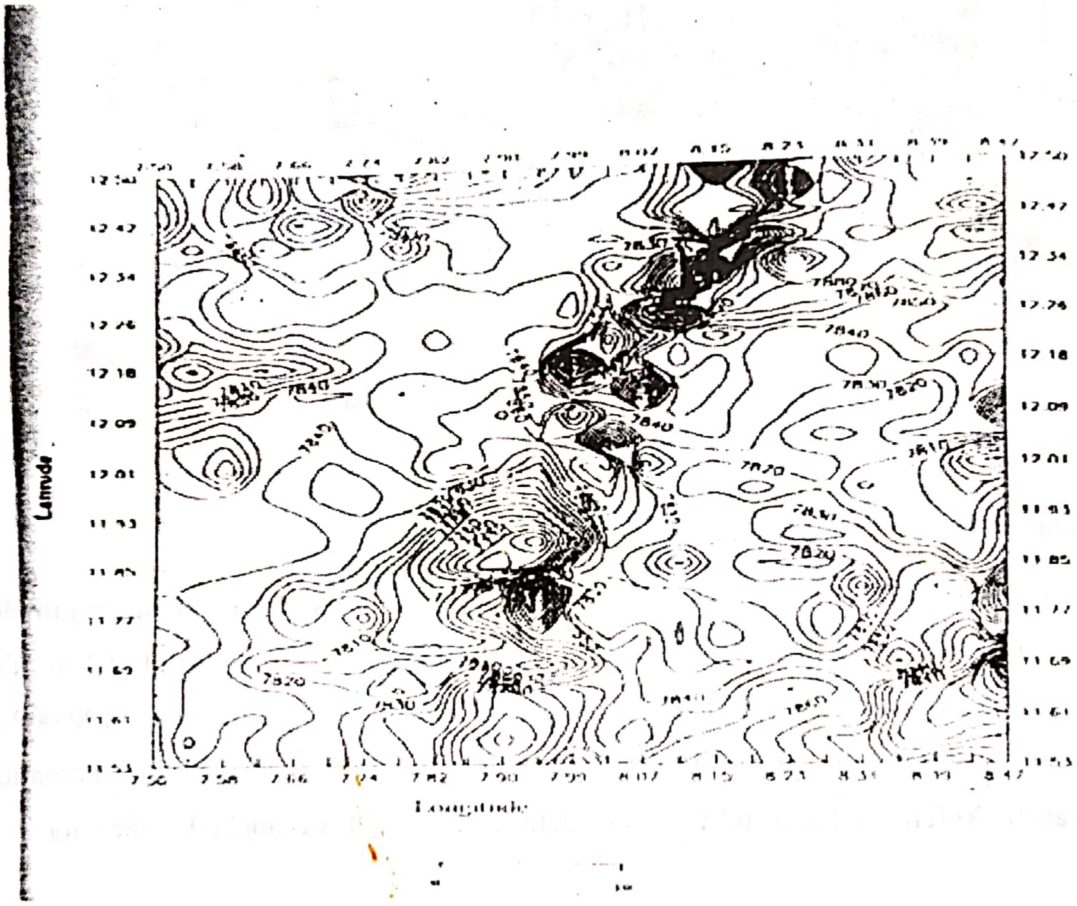

Fig. 3: Aeromagnetic Map of Malunfashi

Analysis of Magnetic Trends

Geophysical methods especially aeromagnetic field studies can be used to establish the existence of structures and trends. A major contribution in this direction was made by Ajakaiye *et al*, (1991). In their interpretation of aeromagnetic data across the Nigeria continental mass, they identified that NE-SW trending anomalies are the dominant magnetic features of most of this shied area. The magnetic lineaments are seen as narrow belts of negative anomalies with lengths ranging from 10 km - 450 km and amplitudes ranging from -150 nT to -250 nT. They deduced that these magnetic features might represent major tectonic trends, which may also continue across the adjoining schists belt region. They further pointed out that this concentration of magnetic lineaments appears to be connected with the occurrence of Younger Granites since almost the entire known Younger Granite complexes lie within the area dominated by these trends.

Part of the composite map (Fig. 3) match with the schist. The closures at northern and southern parts of the magnetic map match with granites located in the geology map. Another closure at the central part of the map also matches with the granite. The aeromagnetic map (Fig. 3) generally shows that most of the study area is characterized by a NE-SW trend. The NE-SW trends are correlated with the works of Busser (1966), Umego (1990), Ajakaiye *et al* (1991) and Udensi (2001). Closures in the area also align with the same trends. A close study of the magnetic map shows a discontinuity at the west-central area of the study area. This is marked AA' in Fig. 4 and it indicates a major fault in the area. This fault was recognized in the geology map but slightly shifted. The closures in most areas have high gradients.

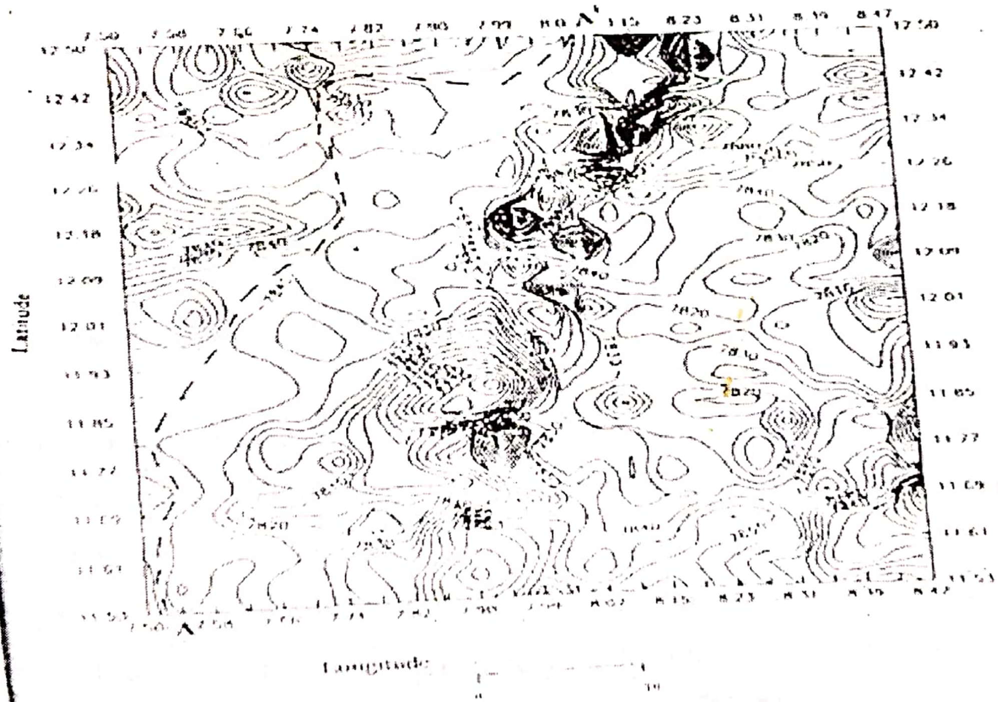

Fig. 4: The composite magnetic map of the Malumfashi area

Regional-Residual Separation

The picture that usually emerges from a composite map is one that shows the superposition of disturbances of noticeable different order of sizes. The larger features generally show up as trends, which continue smoothly over considerable distance. They are caused by deeper heterogeneity of the earth crust and are known as regional trends. Superimposed on the regional fields, but frequently camouflaged by them, are the smaller, local disturbances, which are secondary in size but primary in importance. These are the residual anomalies. These may provide direct evidence of the existence of reservoir type structures or mineral ore bodies.

In order to interpret potential field data (magnetic and gravity), the residual anomalies must be removed from the regional background field.

The least squares method was applied to separate the residual anomalies from the regional background field. The study area does not have complex geology and has limited spatial extend, therefore it was assumed that the regional field is a first polynomial surface.

The resultant regional map is shown in Fig. 5. The map trends NW-SE, which agrees with trends in some parts of the country adjacent or near the study area (e.g. Gandu *et al* 1986).

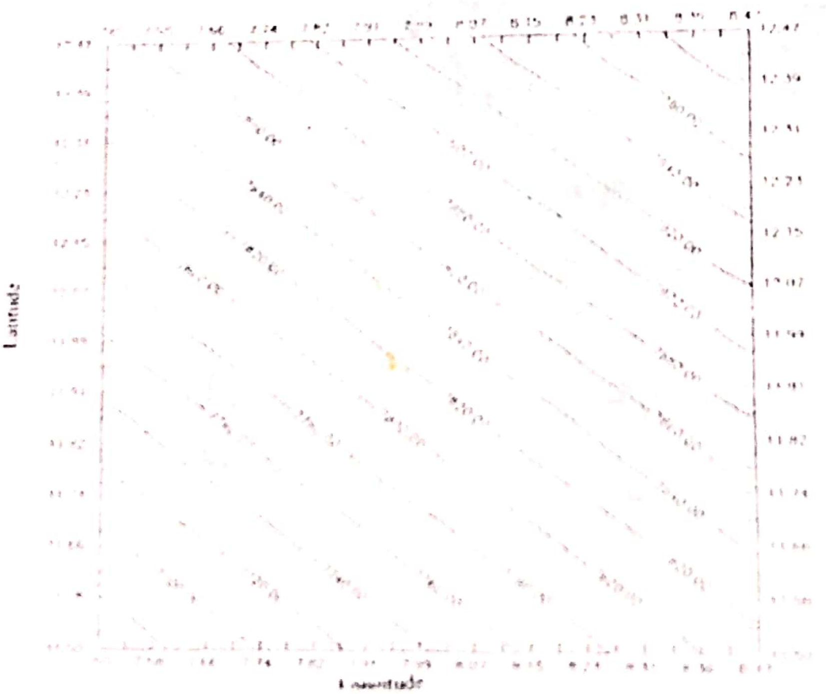

Fig. 5: Regional map of the study area

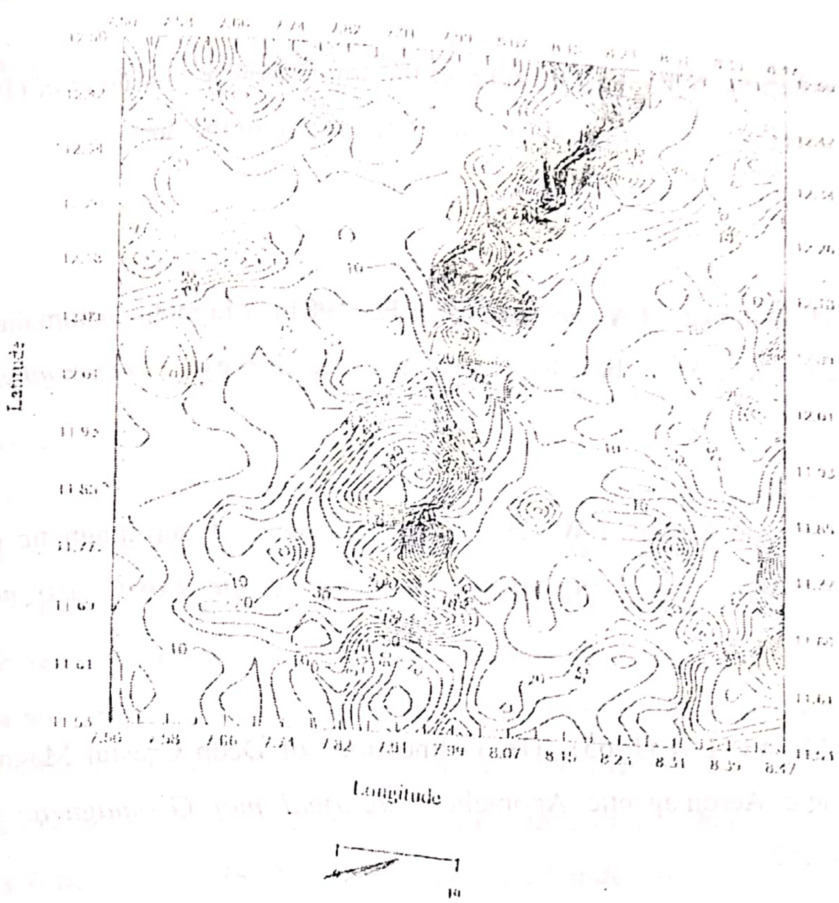

Fig.6: Residual map of study area

Discussion and Conclusion

The Malumfashi area is characterized in some parts by positive residual anomalies ranging from 0.07nT955nT, which correlate well with the granite in the area. It is also characterized in some parts by negative residual anomalies ranging between -884.38nT to -0.04nT which correlates well with schists. The dominant trends in total magnetic field of an area are usually an indication of the features that give rise to the faults and fractures. Faults are usually identified with discontinuities in magnetic map (Telford et al 1976; Ajakaniye *et al* 1985, 1991). A discontinuity at the west-central area of the study area marked AA' in Figure 3 shows a major fault line in the area. The negative anomalies reveal a cluster of shists in the area. These anomalies are shallow and trend in NE-SW. The high gradient of most of the closures in the area indicates the sharp contact between granites, the schist and gneiss, as well as the presence of contact metamorphism of the country rock. The foregoing together with the presence of rotated xenoliths in granites; all support the suggestion of Gandu *et al* (1986) that magmatic stopping was the mode of emplacement of the granite in the area.

References

Ajakaiye, D. E., Hall D.H., Ashiekaa, J.A., and Udensi E.E. (1991) 'Magnetic Anomalies in the Nigerian Continental and Mass based on Aeromagnetic Surveys'. *Tectonophysics,* 192: 211-230.

Ajakaiye, D. E., Hall D.H. and Millar, T.W (1995) 'Interpretation of aeromagnetic data across the central crystalline shield of Nigeria'. *Journal of the Royal Astronomy Society*,83: 503-517.

Bhattachchyya, B.K and Morley, L.R (1965) 'The Delineation of Deep Crustal Magnetic Bodies from Total Field Aeromagnetic Anomalies'. *Journmal mof Geomagnetic and Geoelectricity*, 17: 237-252.

Cratchley, C.R and Jones, G.P (1965) 'An Interpretation of the Geology and Gravity anomalies of the Benue Valley', *Nigeria Overseas Geol.Sur., Geophysics Pap.*, No.1.

Gandu, A.H , Ojo S.B and Ajakaiye D.E (1986) 'A gravity Study of the Precambrian Rocks in the Malunfashi area of Kaduna State, Nigeria'. *Tectonophysics,* 126: 181-194.

Mc Curry, P. (1976) 'The Geology of the Precambrian to Lower Paleozoic Rocks of Northern Nigeria'. A review in Kogbe, C.A (Editor). *Geology of Elizabethan, Lagos pp15-39.*

M.N Umego, (1990) 'Structural Interpretation of Gravity and Aeromagnetic Anomalies Over Sokoto Basin Northwestern Nigeria' Ph.D Thesis, Ahmadu Bello University, Zaria.

Udensi, E E (2001) 'Interpretation of the Total Magnetic Field over the Nupe Basin in West-Central Nigeria using Aeromagnetic Data', Ph.D Thesis, Ahmadu Bello University, Zaria.