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Two and Half Dimesional Modeling of the Precambrian Rocks of Malumfashi Area of Katsina State, Nigeria Using Aeromagnetic

A.A Rafiu and E.E Udensi
Physics Department, Federal University of Technology, Minna, Nigeria

Abstract

The GM-SYS 2 ½-D interactive modeling package is used to determine quantitatively the thickness of the rocks, nature, size and depth of the complex intrusions. The average thickness of schist in the study area is estimated to be 5km while the granite depth is estimated be an average of 4.2km and that of diorite is 3.4km. The average width of the schist bodies is 12.7km while that of granite is about 9.5km.

Introduction

The study area Malumfashi occupies an area of about 6500km^2 between longitudes 7^0 $30^1$and 8^0 30^1 E and latitudes 11^0 30^1 and 12^0 30^1 N(figures, 1 and 2). It has an average elevation of approximately 580m above sea level with a range of 190m. It lies within the schist belt of the north western Nigeria in Katsina state.

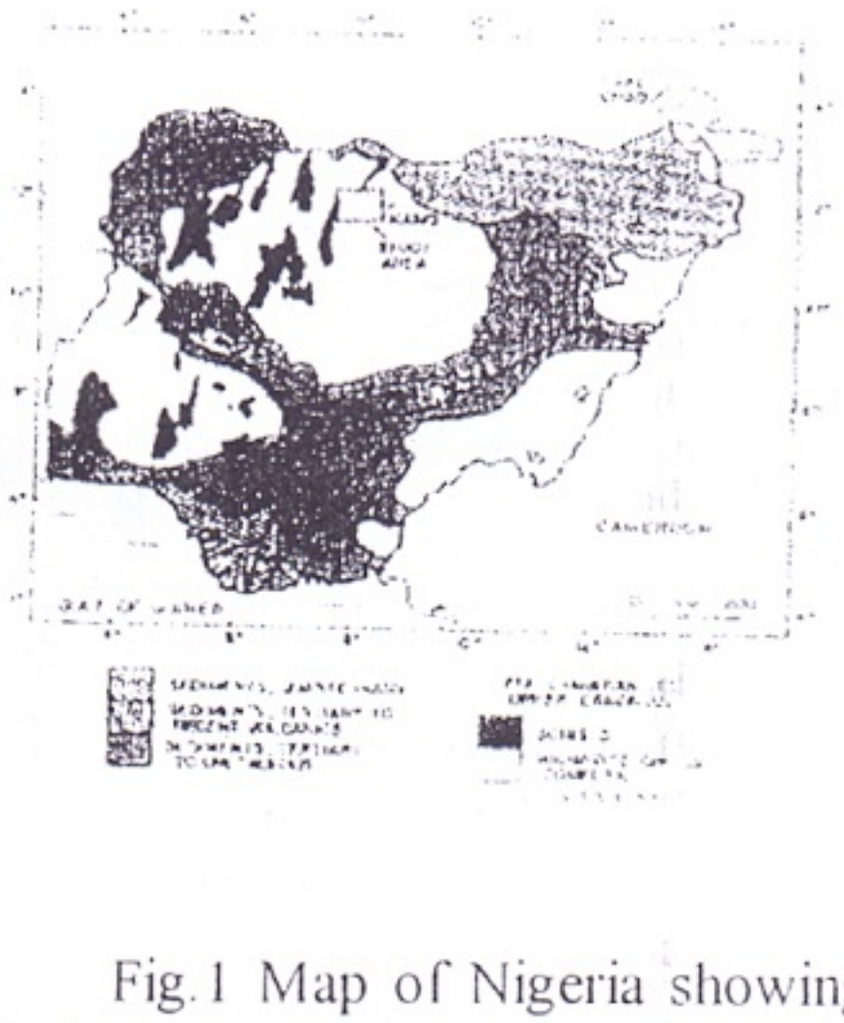

Fig. 1 Map of Nigeria showing the study area

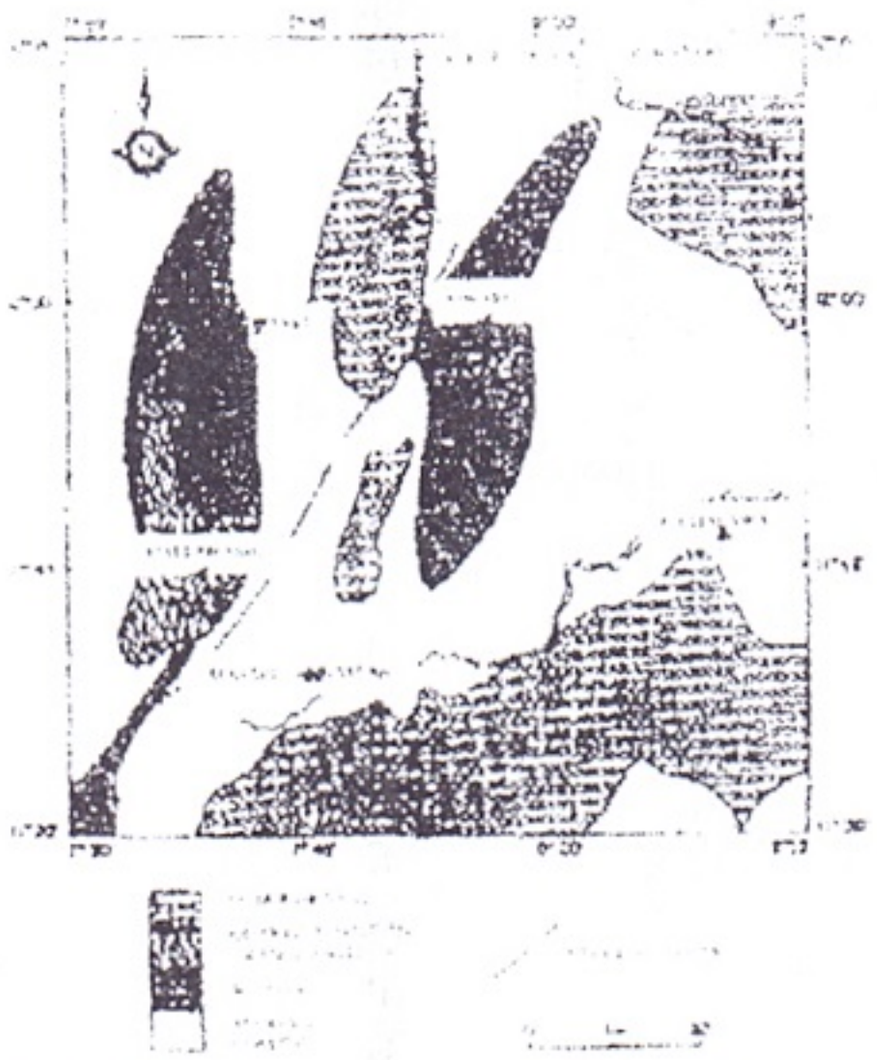

Fig. 2 Geology map of Malumfshi

Most of the study is characterized by a NE-SW trend. The northwest part of the map showed a W-E trend and repeated at the south-west part of the area(Umego,1990, Ajakaiye et al, 1991; and Udensi 2001). The strong anomalies in the map are an indication of the paleostructures that align in NE-SW (fig. 3. It also displays a fault AA^1 which agrees with Gandu et al 1986.

The focus of this study is to provide more information that could be used to determine the distributions of physical properties at the depth that reflect the local subsurface geology.

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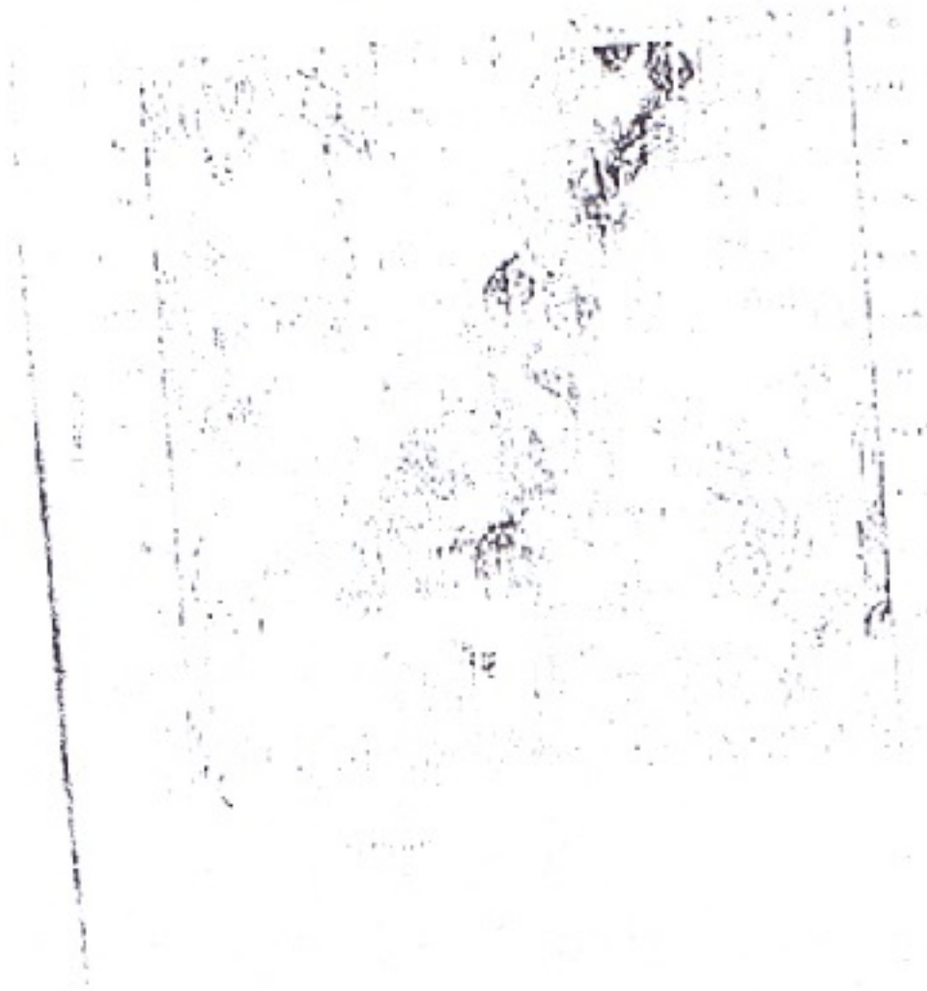

Fig.3 Composite aeromagnetic map of Malumfashi.

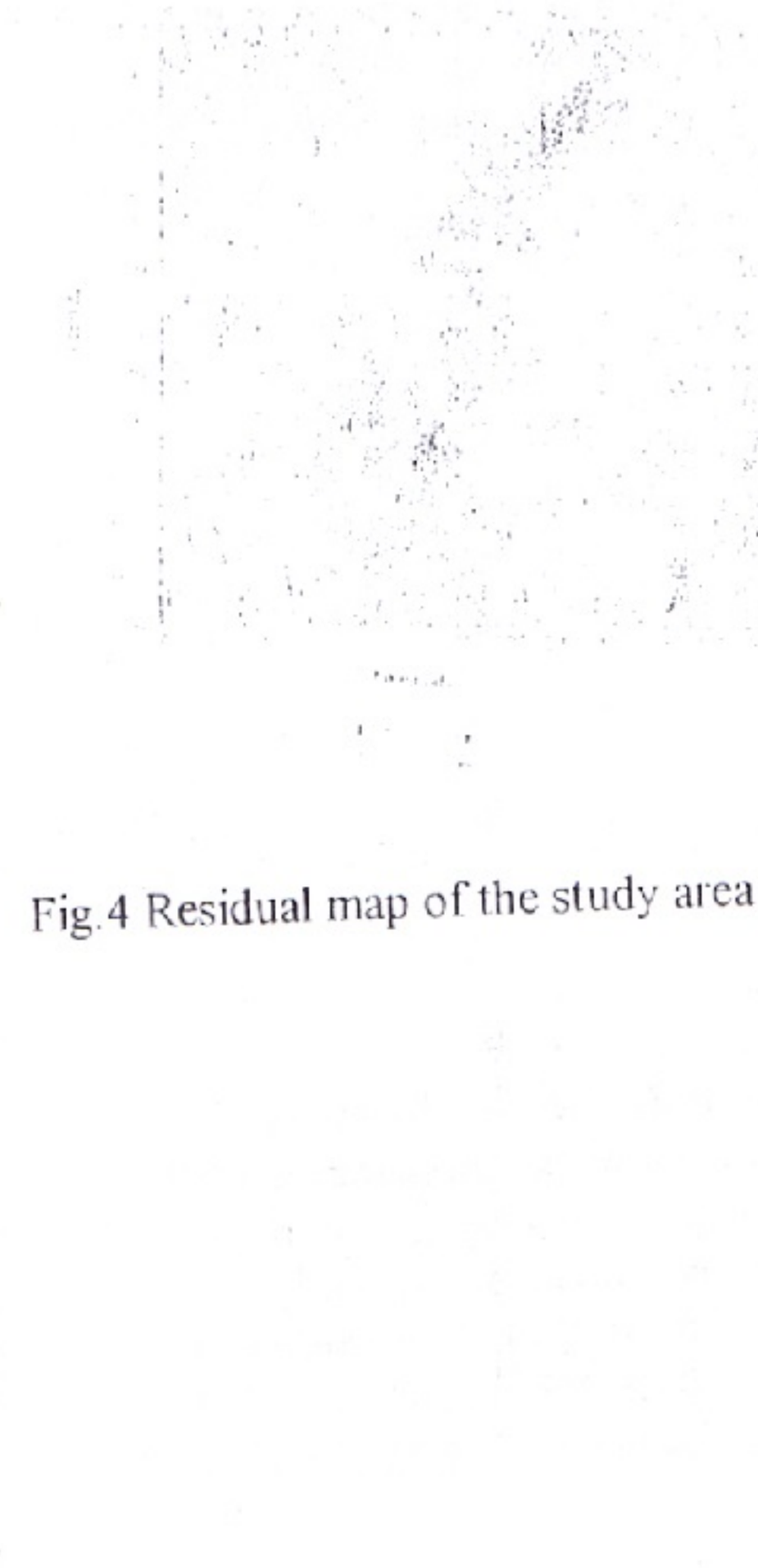

Fig.4 Residual map of the study area

Fig.4 Geological map of the study area superimposed on the residual map

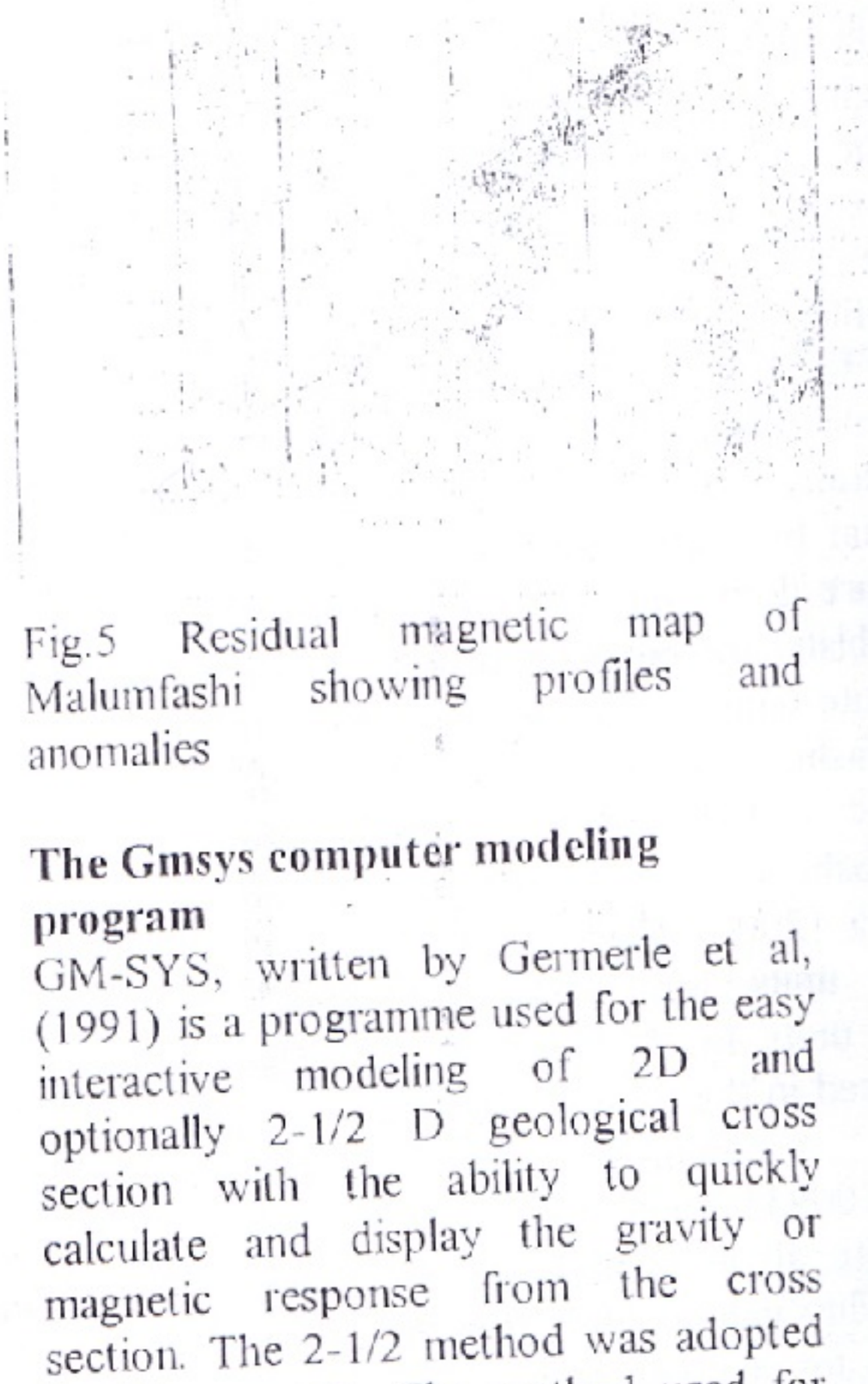

Fig.5 Residual magnetic map of Malumfashi showing profiles and anomalies

The Gmsys computer modeling program

GM-SYS, written by Germerle et al, (1991) is a programme used for the easy interactive modeling of 2D and optionally 2-1/2 D geological cross section with the ability to quickly calculate and display the gravity or magnetic response from the cross section. The 2-1/2 method was adopted in this research. The method used for calculating the magnetic response and model is based on the methods Talwani et al, (1959) and Talwani and Heirtzler, (1964), which made used of algorithms

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described in Wen and Bevis (1967). The 2-1/2 calculations are based on Rasmussen and Pedersen(1979).

The modeling of anomalies within the study Area

The magnetic residual map Fig. 4 is complicated a expected in magnetic studies. Nevertheless, some major anomalies stand out. Profiles were drawn across the magnetic residual map as shown in Fig.4 in order to model these major anomalies.

Seven major anomalies were selected for modeling numbered 1 to 7 for easy identification. Profiles AA^1 passes through anomalies 4 and 7. Profile BB^1 runs across anomalies 1 and 2. Profile CC^1 passes across anomalies 3 and 5. Profile YY^1 cuts across anomalies 7and 1. Profiles YY^1 and ZZ^1 were drawn in order to estimate the width of the Precambrian rocks.

The study area is believed to be underlain by migmatite-Gneiss complex, which are dominant rock types. Granites and Schists are believed to intrude the Migmatite-Gneiss complex beneath Malumfashi (Gandu, 1986). No magnetic susceptibility data exist for Malumfashi area. However Udensi and Ozazuwa (2002) used value of 0.0008 Gausian units for Schist and 0.0013 Gausian units for basement rocks. The values used in this study were 0.0023 for Gneiss complex,0.0008 fort Schists,0.00933 for Granites and 0.0467 for Diorite all in Gausian Units. These susceptibility values fall within the range of values for average rocks (Telford et al, 1976). The average ambient magnetic field, magnetic inclination and declination values used for this study were 33000nT, -4^0 and -5^0 respectively.

Anomalies 1, 3, 4, and 6 are shown to be older granites. Anomaly 5 which is not shown on the geology map could be embed in to Gneiss complex. Most of the Schist bodies in the geology map that are not shown on the aeromagnetic map produced are due to the low susceptibility of the Schist.

Fig. 6 shows the model of profile AA^1. It shows two granites body a diorite body and a schist body. The first granite body has a thickness of about 3km which is about 6.5km wide. The Schist has thickness which increases progressively to about 4km. This body is about 27km wide. The second granite body is not shown by the geology map of the study area but was modeled because of the residual observed. It has a thickness that varies between 3.5km to 5km which is about 8km wide.

Fig.6 Model of profile AA^1

The model of profile BB^1 is shown in Fig.6. It passes through the anomalies 1 and 2. It shows a granite body and two schist bodies. The thickness of the body varies between 2.7km to 4km. The width of this is about 13.7km. the thickness of the schists vary between 2.87km to

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4.7km, their width vary between 8km to 16km.

Fig. 7 Model of profile BB^1

The model of profile of CC^1 is shown in fig.8. It is embedded by a granite body that is about 3.2km thick and about 13.5km wide. It also revealed a schist body that has a thickness which vary between 2.4km to about 6km and a width of about 18km.

Fig.8.Model of profile CC^1

Fig. shows the model of profile YY^1. It passes through anomaly 3. The thickness of the first schist body is about 3.7km and about 6km wide, while the second schist body thickness vary between 1.6km to 5.6km and width of about 10km . The granite body has thickness 5.4km and a width of 6.4km.

Fig.9 Model of profile YY^1

Fig. 10 shows the model of profile ZZ^1. It passes through anomaly 1. The thickness of the schist bodies revealed varies between 2km to 5km and the width varies between 3.3km to 11km. The granite bodies have thickness of 5km to about 6km; their width increases from 1.3km to 5.4km.

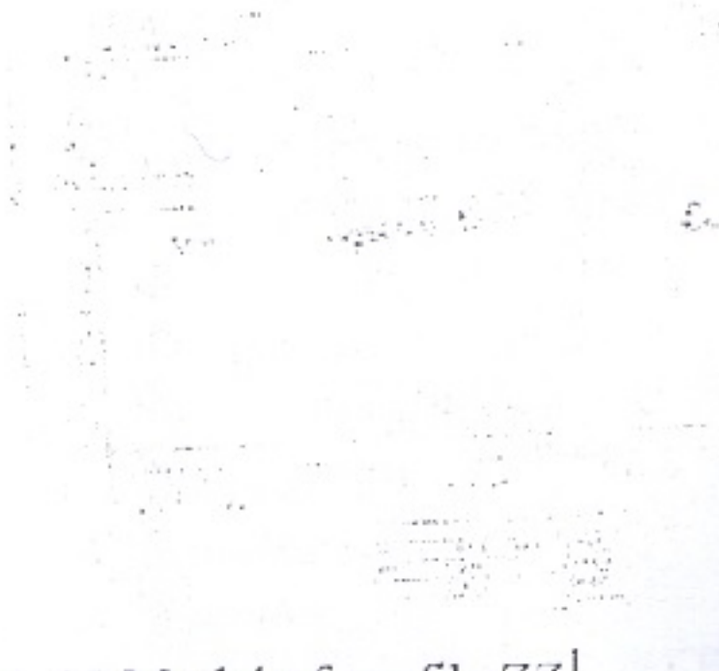

Fig. 10.Model of profile ZZ^1

Conclusion

The thicknesses of the Schists vary from 4km to 5km while that of granite bodies is 4km. The average width of the granite bodies in the area is 15km while that of schist is 20km. The depths from this study are far below the estimates of Vacquier and Afleck (1941) and Bhattahayya and Morley (1965). Thus

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rocks would remain magnetic at the depth since the Curie points were unlikely to have been reached

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