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Full Length Research Paper

Tectonic features interpreted from aeromagnetic maps of Okigwe – Oguta axis, South of Benue Trough, Nigeria

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Oguta and Okigwe are landmark towns within the Benue trough that are surrounded by many physical features, which may have some tectonic implications. Aeromagnetic maps covering this study area were digitized along flight lines, electronically gridded and contoured. Other data processing techniques like spectral analysis, modeling etc were applied. The results indicated that the study area is characterized by low positive and negative anomaly amplitudes, smooth contours, magnetic lineaments etc. Amongst other findings, the magnetic signatures trending in the NE – SW show the existence of the charcot fault zone within this region. Hence civil structures like dams, bridges etc. if located along or near this lineament zone may experience serious damages in case of any crustal disturbances.

Key words: Aeromagnetic, tectonic, Okigwe, lineament, charcot.

INTRODUCTION

This study area lies within the Niger Delta and the Anambra Basins of Nigeria, Figure 1. It is defined by these coordinates: Lat. 5°30´ – 9°00´N and Long. 6°30´ - 7°30´E.

The position of the Anambra Basin that falls within this study area had witnessed many geological and geophysical investigations culminating in the drilling of a test Well at Ihuo in 1951 (Nwajide, 2005). It was a dry hole whose depth was 3,368 m. Since 1955 when the first commercial oil discovery in Niger Delta Basin was made in Oloibiri, followed by another huge gas discovery at Afam, exploration activities have been intensified within the Niger Delta. Other physical features that make this area very interesting for research study include the presence of the linear elongated Oguta Lake, the Okigwe Cuesta etc.

GEOLOGICAL SETTING

The geological formations within the Niger Delta region are Benin, Agbada and Akata. Details about the structures and hydrocarbon potentials of these formations have been discussed by various authors (Allen, 1965; Avbovbo, 1970). The Niger Delta is Tertiary in age. It started building up during a general regression in the Eocene (Short and Stauble, 1967). The Anambra basin was initiated during the Coniacian and early Santonian periods. The basin developed in response to predominantly tensional crustal modification processes related to the Atlantic opening, (Reyment, 1965).

Data analysis

Three aeromagnetic maps were digitized along the flight line and new maps were produced, Figures 2, 3, 4 and 5. The data sets obtained were gridded and then processed using a first order polynomial fitting algorithm, PFIT123, developed by Geophysics group, Advanced Geophysical Research Laboratory, Physics department, Ahmadu Bello University, Zaria Nigeria, an off the shelf computer programs. The regional background anomaly was separated from the observed data set using polynomial fitting technique thus producing residual magnetic maps shown in Figures 6, 7 and 8.

These data were further subjected to spectral analysis because different anomaly sources occurring at different depths in the subsurface are characterized by distinct frequencies and spectral analysis via Fourier transform gives information about the depth to these sources of magnetic anomaly (Trietal et al., 1976). A plot of the logarithm power versus frequency yields series of points, which represent one or more straight lines. The slopes of these lines give average depths to the anomaly sources, Figure 9.

Finally, three profiles were taken across anomalies A, B and C (Figures 6 and 8). A $2^1/_2$ dimensional magnetic / gravity modeling software, GM - SYS, based on Talwani et al. (1959) was used for the modeling.

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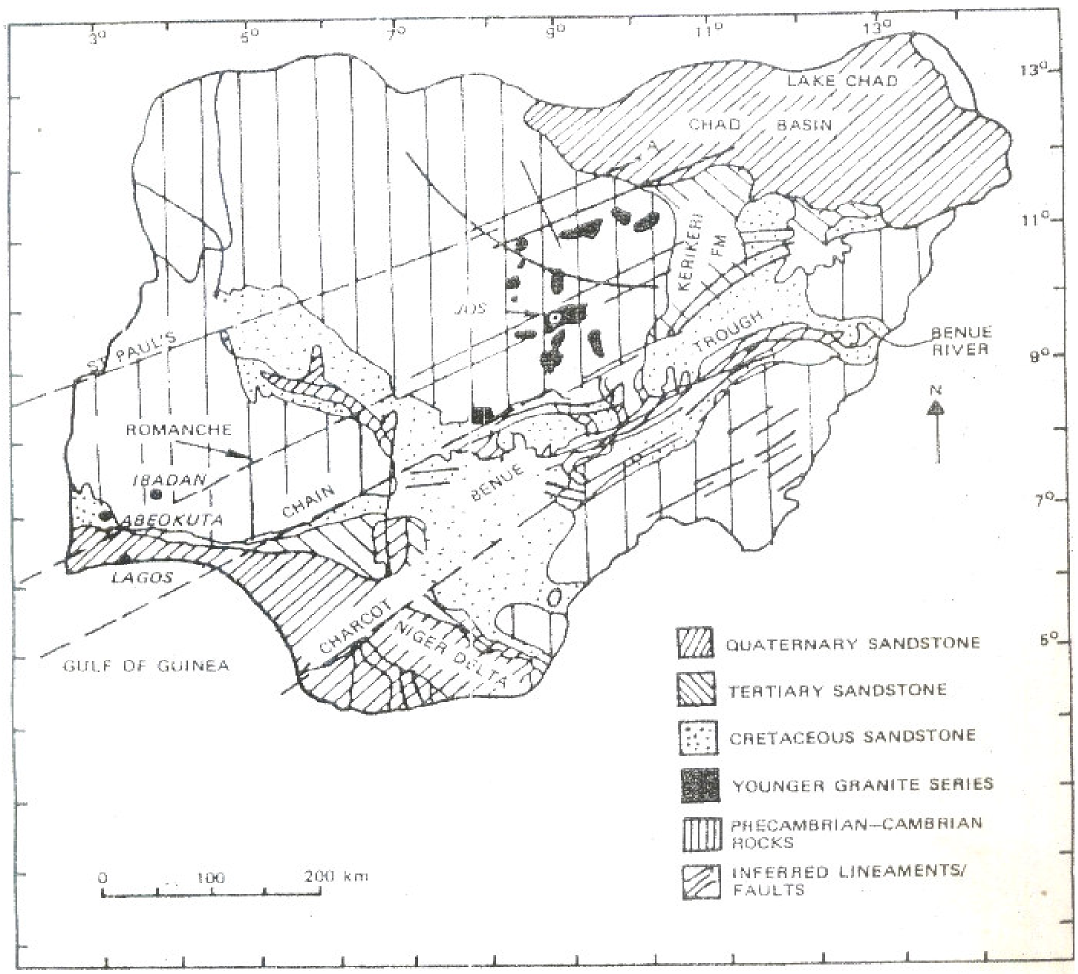

Figure 1. Geological map of Nigeria Showing the locations of the inferred Mega-lineaments (After Ananaba, 1991).

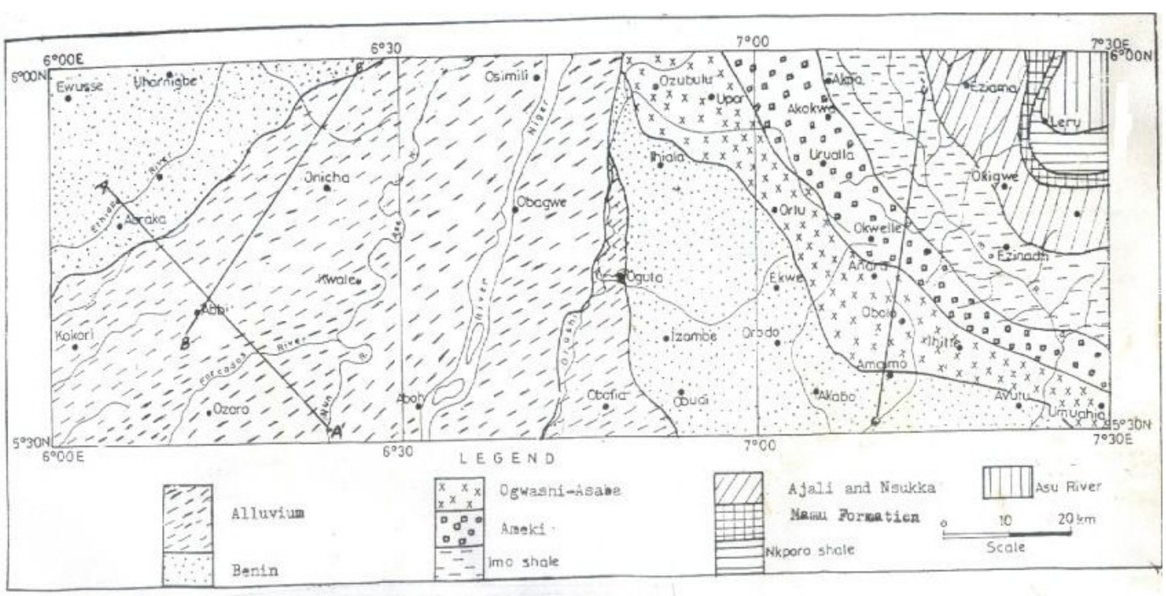

Figure 2. Geological map of the study area.

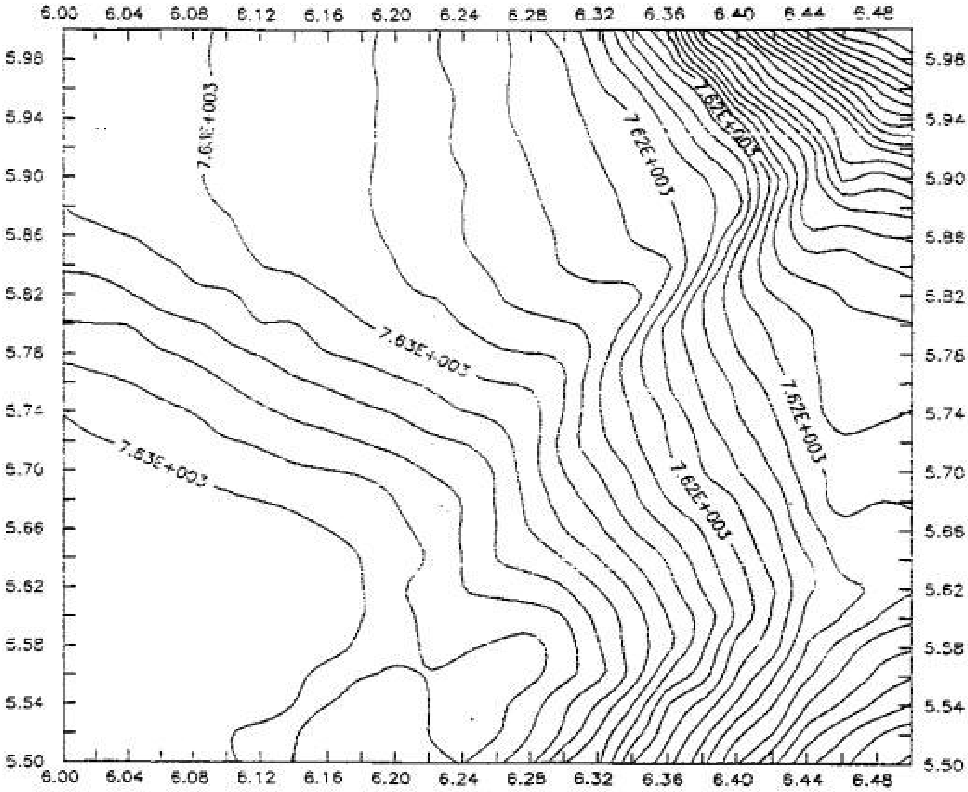

Figure 3. Total magnetic field of the study area, (Sheet 310).

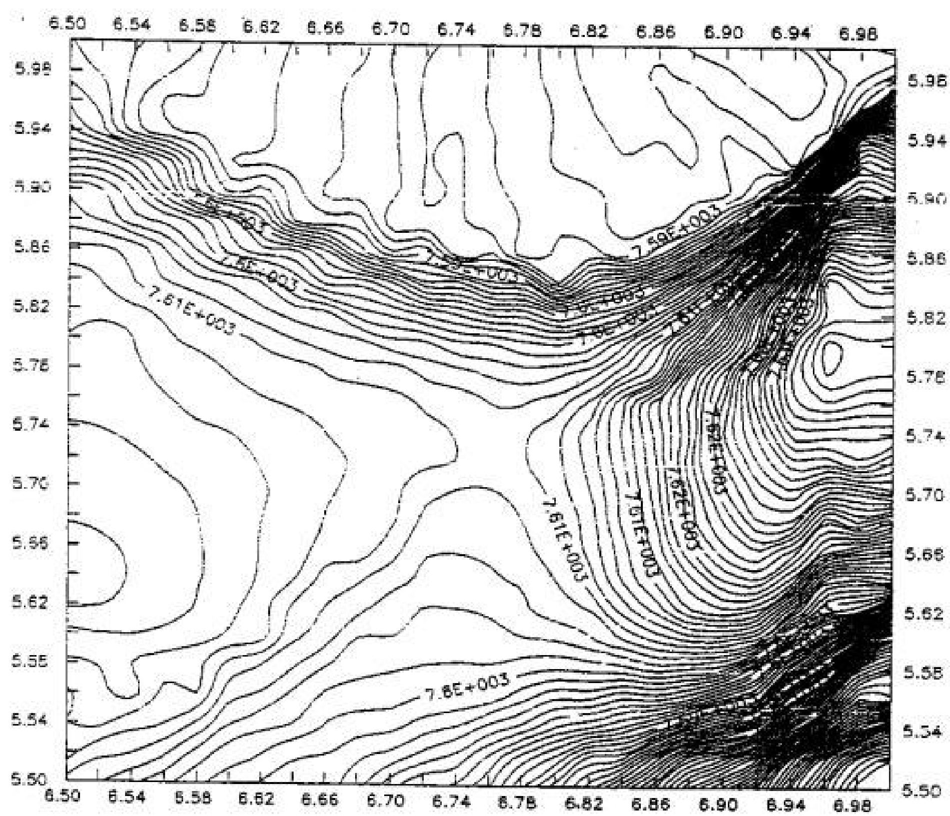

Figure 4. Total magnetic field of the study area, (Sheet 311).

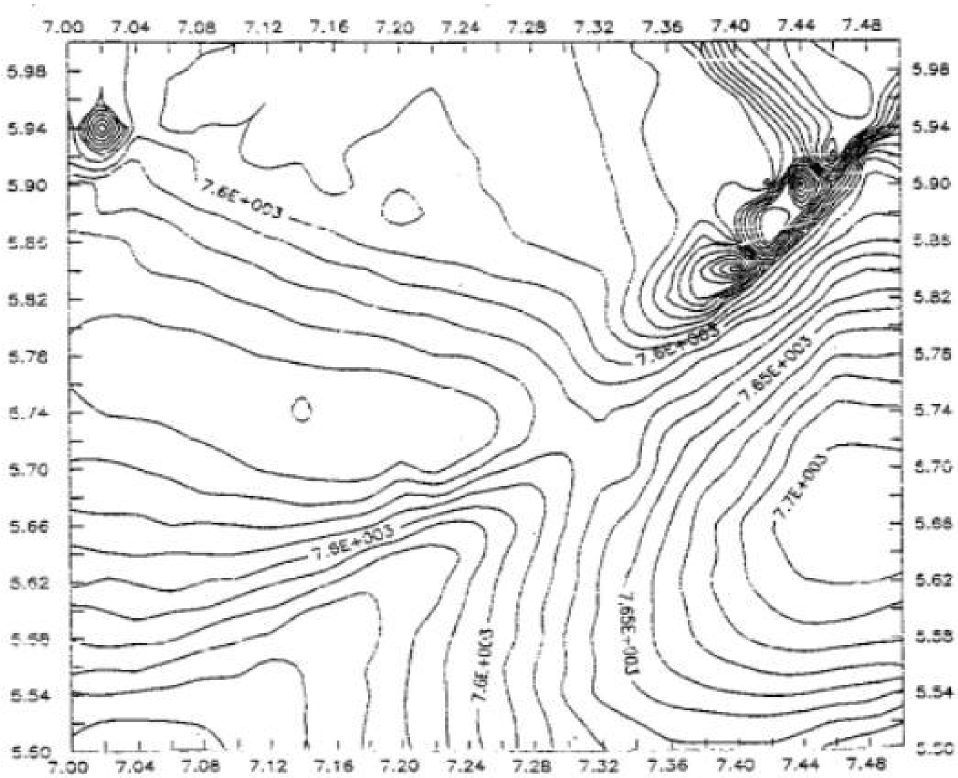

Figure 5. Total magnetic field of the study area, (Sheet 312).

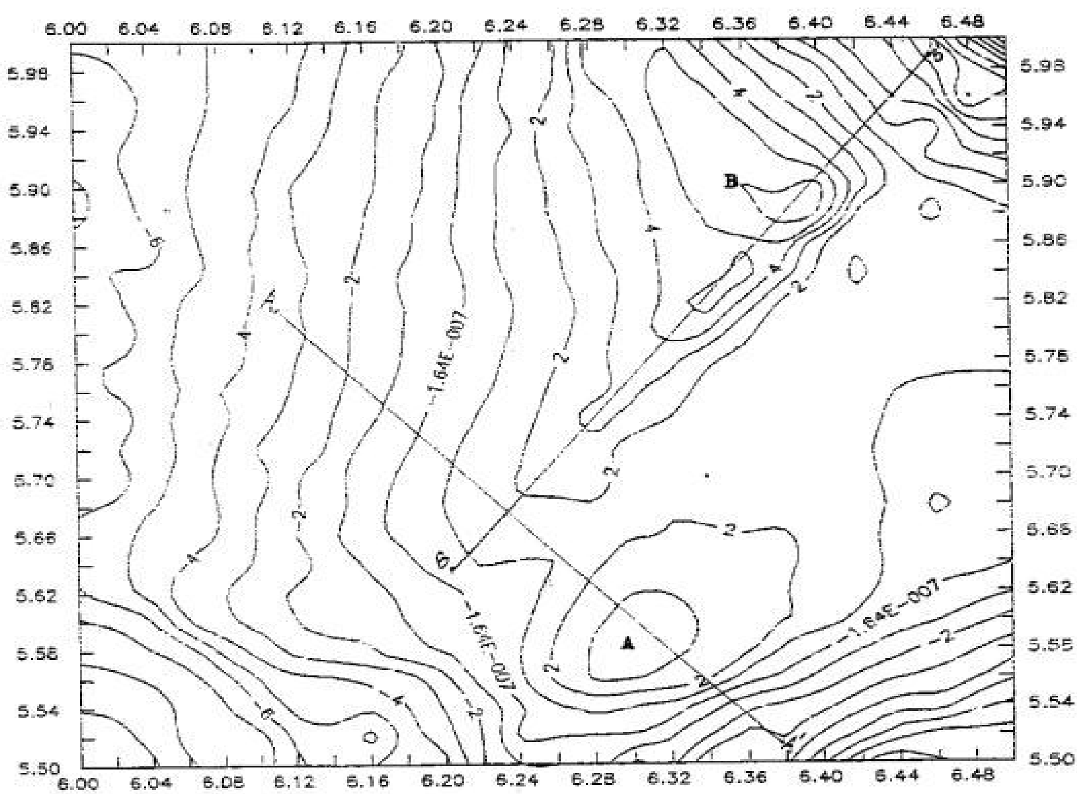

Figure 6. Residual magnetic field of the study area, (sheet 310), contour interval = 1 gamma.

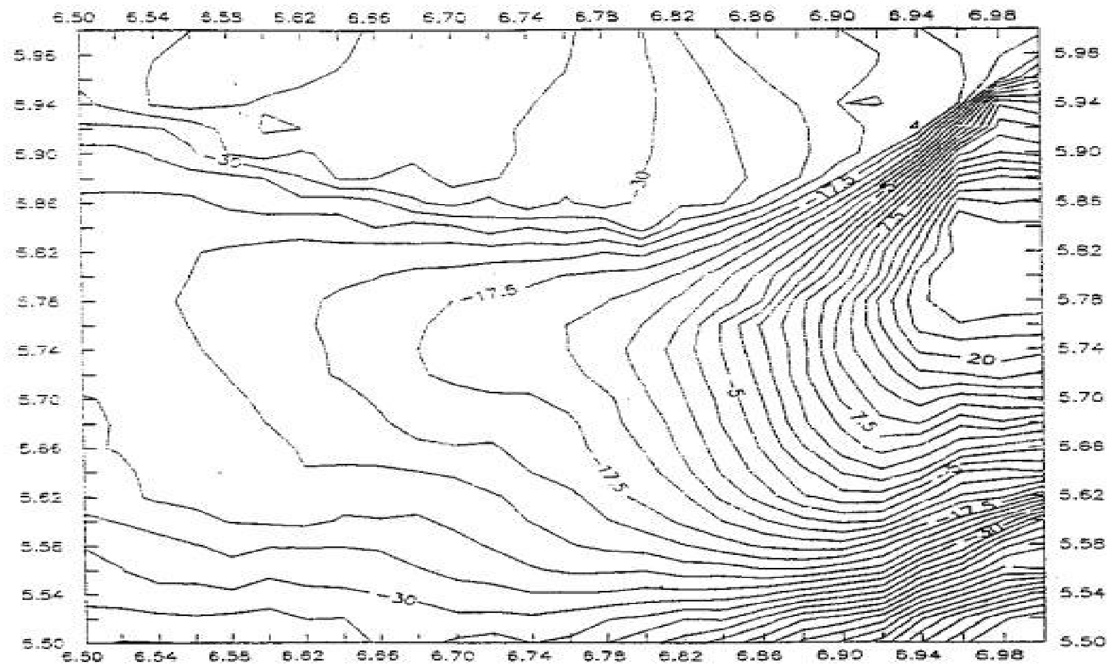

Figure 7. Residual magnetic field of the study area, (sheet 311), contour interval = 2.5 gamma.

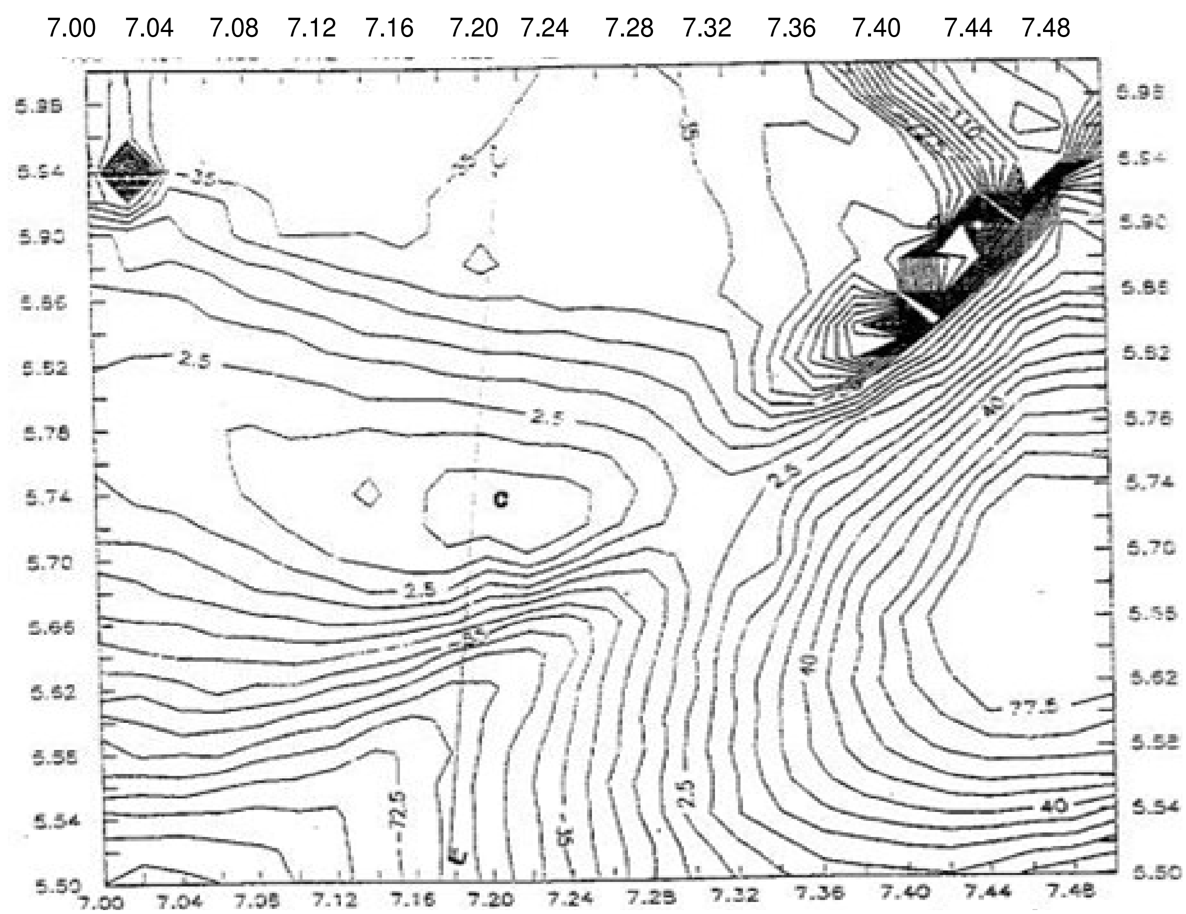

Figure 8. Residual magnetic field of the study area, (sheet 312), contour interval = 7.5 gamma.

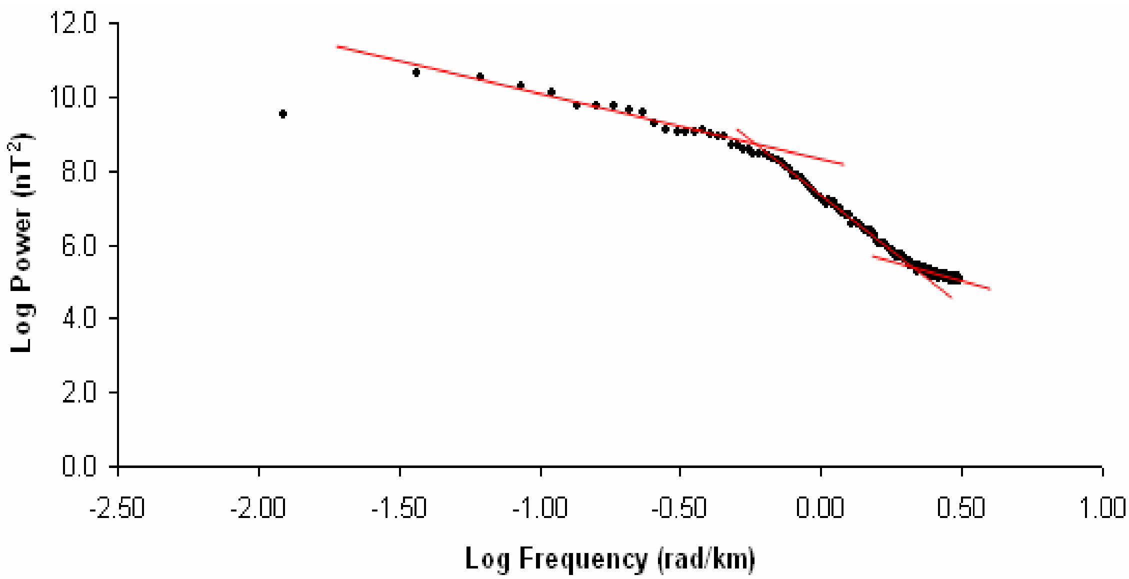

Figure 9. A spectrum plot of the residual field data. The three segments seen represents different geological layering as revealed by the spectral analysis.

Table 1. Results of the spectral analysis.

Map / Sheet number	Number of layers	Depth of basement (Km)
310	3	5.00
311	2	4.80
312	3	4.30

RESULTS AND DISCUSSION

The magnetic field contours were generally smooth with low amplitude anomalies. Visual inspection of the original magnetic map suggested the presence of sedimentary basin. The trend obtained when a first degree polynomial was fitted to the data showed a NNW – SSW one. The residual components after the removal of the regional fields represent effects of near surface shallow rocks, Figures 6, 7 and 8. The amplitude of the residual field intensity ranges between 77 and 125 γ. The anomalies of high amplitudes, short wavelength are probably caused either by susceptibility changes within the basement or by near surface intrusives (Ofoegbu, 1982).

From the residual map of Figure 6, the anomaly amplitudes are relatively small. The entire western part was characterized by negative anomaly intensity values ranging from –8 to –1 γ whereas the eastern part of the map was essentially characterized by positive anomaly intensity values from -78 to 6 γ. The zero contours are indicative of transition zones between rock units and probably faulted contacts. Table 1 shows the number of layers and the depth to the magnetic basement as obtained from the spectral analysis.

Profile A – A´

This profile runs in the NNW – SSE direction. The anomaly associated with this profile is centered at latitude 5.68° and longitude 6.32°. Figure 10 shows the plausible model, which could account for the residual anomalies. This model displays slight variation of basement topography. The average sedimentary thickness is 5.5 km. Three different rock units of susceptibility contrasts 0.00017, 0.00010 and 0.00030 were identified.

Profile B – B´

Profile B – B´ runs in the NNE – SSW direction. Anomaly B is located at latitude 5.88° and longitude 6.38°. A plausible model that could be responsible for the residual anomalies is shown in Figure 11. The model represents

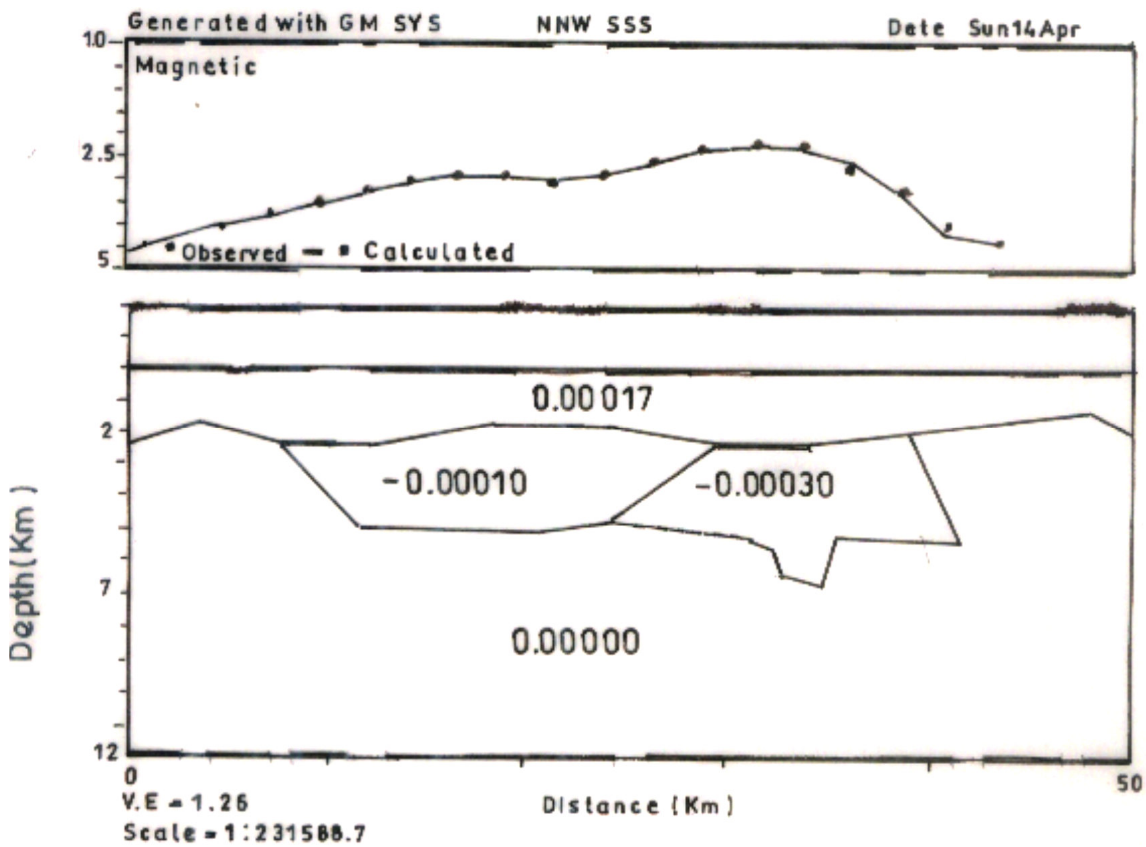

Figure 10. A 2½ Dimensional Model of Profile A – A'.

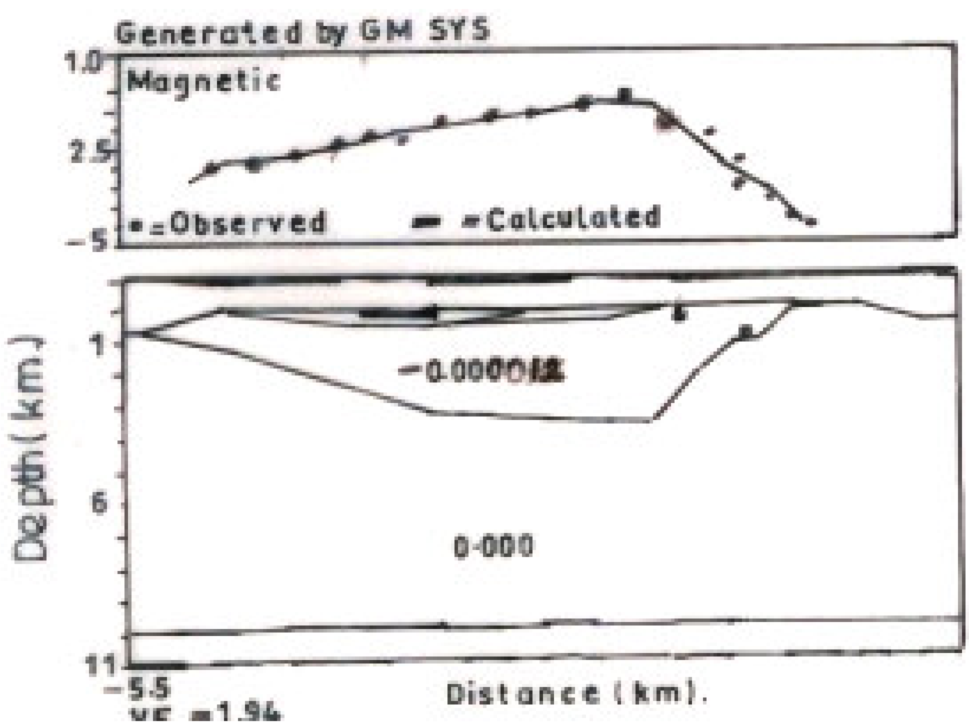

Figure 11. A 2½ Dimensional Model of Profile B – B'.

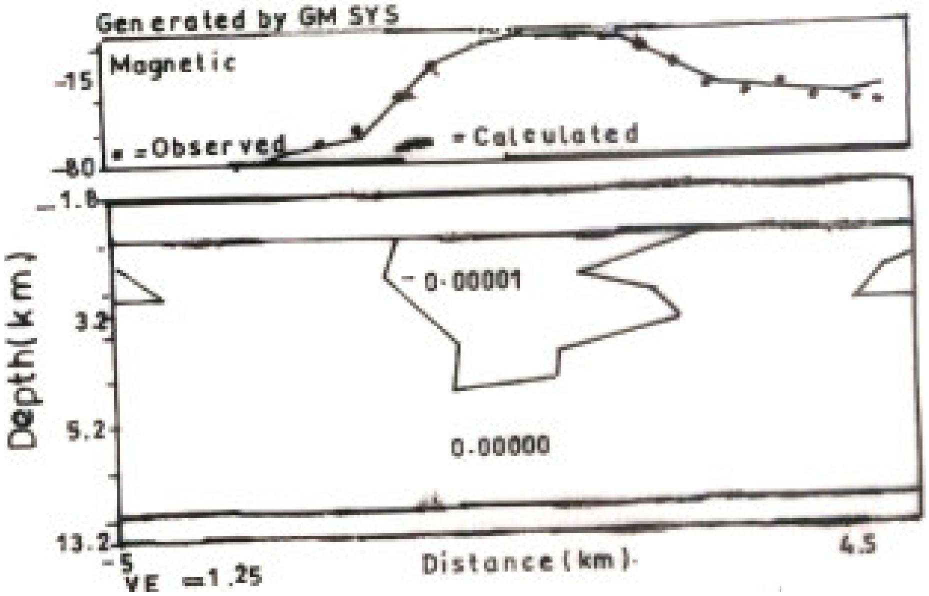

Figure 12. A 2½ Dimensional Model of Profile C – C'.

in addition to basement complex, two distinct layers of susceptibility contrast, 0.00270 and 0.00290, respectively. The top layer which outcrops on the surface has a max thickness of about 0.6 km whereas the deeper layer extends to about 3.6 km below the ground surface.

Profile C - C´

This profile, about 48.7 km long, runs in the SSW – NNE direction with an azimuth of 12^{o}, Figure 12. It cuts across anomaly C at latitude 5.74° and longitude 7.24°. The earth's total field intensity over this anomaly is 31664.68γ with inclination 11.37° and declination 6.07°. Depth to the top of the causative body is about 4.3 km, while the susceptibility contrast is – 0.00050.

Conclusion

The magnetic responses showed variations in magnetic susceptibility and characteristics of the underlying rock units within this study area. The zero contours indicated transition points / zones between rock units. These zones are probably faulted contacts. These zero contours could also be viewed as marking the boundaries separating the zones of negative anomalies from those of positive anomalies. They specify regions of different susceptibilities.

A linear magnetic anomaly extending from the south to the north at the eastern end of this study area is suspected to be a sort of en-echelon structures trending in a NE – SW direction. Two major lineaments (Chain and Charcot) cut across the Niger Delta, Figure 1. This has been confirmed by Okereke (1996). One of these lineaments (Charcot) is suspected to pass through this study area around longitude 7.0°E – 7.5°E and latitude 5.5° – 6.0°N. The trend of the magnetic signatures in the NE – SW could be due to the existence of Charcot fault zone. Civil structures like dams, high raising building etc that are located along / near these lineaments fall within "danger zones". In case of any crustal disturbances, these structures could be affected.

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