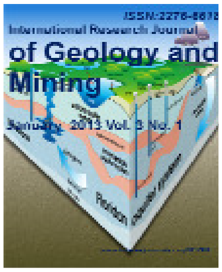

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Review

Interpretation of aeromagnetic data over Okigwe and Afikpo areas of the Lower Benue Trough, Nigeria

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Aeromagnetic data over Okigwe and Afikpo areas of the Lower Benue Trough of Nigeria were interpreted by forward and inverse modelling techniques. The anomalies over the study area were modelled by spherical or dyke-like bodies emplaced at various depths, ranging from 3.0km to 12.7km, either in the sediment or in the metamorphic basement. The magnetic susceptibilities of most of these bodies indicate that they are igneous intrusions. These intrusions with large lateral extents, occurring more at Afikpo area than the Okigwe area accounts for more mineralization at the former than the later. The high temperature that prevailed at the time of formation of these minerals suggests that the area might not hold any significance hydrocarbon potentials.

Keywords: Aeromagnetic, anomalies, intrusions, mineralization, hydrocarbons.

INTRODUCTION

The Benue Trough of Nigeria is a major tectonic feature in West Africa. It is an elongated rifted depression that trends NE-SW from the south, where it merges with the Niger Delta, to the north, where its sediments are part of the Chad basin successions. The origin and evolution of the Benue Trough of Nigeria is now fairly well documented (Wright,1968,976; Grant, 1971; Nwachukwu, 1972; Olade, 1975,1978; Petters, 1978; Ofoegbu, 1985). Generally, the Benue Trough is believed to have been formed when the South America separated from Africa (Petters,1978). The major component units of the Lower Benue Trough include the Anambra Basin, the Abakaliki Anticlinorium and the Afikpo Syncline.

The study area is characterized by a number of economic mineral deposits which have generated a lot of interest on the economic importance of this mineral zone. Intense geological investigations have been carried out in this area at different times in search for these mineral deposits (Uzuakpunwa,1974; Olade, 1976; Hoque,1984). On the contrary, not much detailed geophysical investigations have been carried out in this part of the Benue Trough for the hydrocarbon occurrences in the area. In order to contribute to our understanding of the geology and hydrocarbon potentials of this part of the Benue Trough, we have considered the use of aeromagnetic survey to delineate the subsurface structures which control the anomalous mineralization in the area. Forward and inverse modelling techniques have been employed for this purpose. This is with a view to delineating the areas of possible magnetic intrusions as well as their lateral and vertical extents.

Geology of the Area

The geology of the Lower Benue Trough has been described by several authors (Olade,1975; Nwachukwu,1972; Ofoegbu,1985). The Lower Benue Trough is underlain by a thick sedimentary sequence deposited in the Cretaceous. The oldest sediments belong to the Asu River Group (Figure 1) which unconformably overlies the Precambrian basement complex that is made up of granitic and migmatic rocks. The Asu River Group found in the Abakaliki – Afikpo basins has an estimated thickness of 2000m (Ofoegbu,1985) and is Albian to Cenomanian. It comprises of argillaceous sandy shales, laminated sandstones, micaceous sandstones and minor limestones with an interfingering of mafic volcanics

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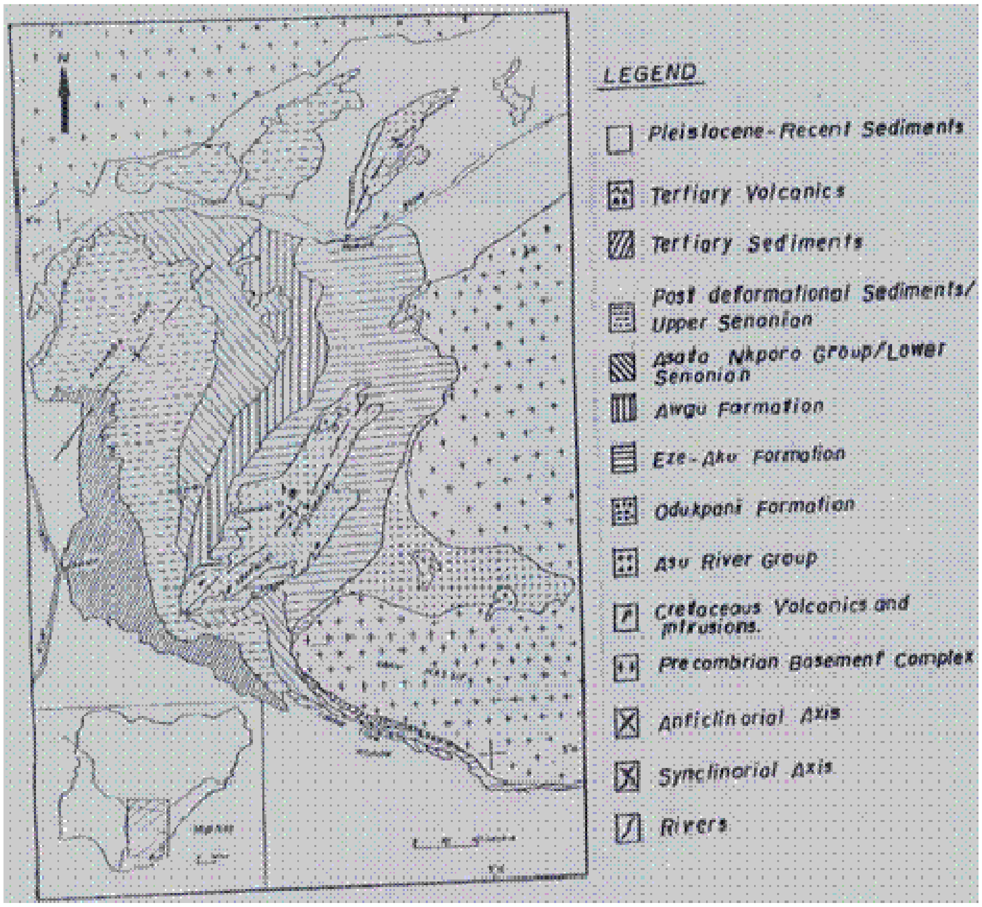

Figure 1. General Geology of Southern Portion of the Benue Trough (after Olade, 1976).

(Nwachukwu,1972). Deposited on top of these Asu River Group sediments in the area were the Upper Cretaceous sediments, comprising mostly the Eze-Aku Shales. The Turonian Eze-Aku Shales consist of nearly 1000m of calcareous flaggy shales and siltstones, thin sandy and shaly limestones and calcareous sandstones (Reyment, 1965).

The Eze-Aku Shales at the Afikpo Basin form the Amasiri Sandstones. The Nkporo Shales are the youngest unit of the Cretaceous sequence and overlies the Eze-Aku Shales unconformably. They are Campanian – Maastrichtian in age and are mainly marine in character, with some sandstone intercalations. The sediments of the Abakaliki Anticlinorium are exposed from about 8km north-east of Okigwe where the folded Eze-Aku Shales and the Asu River Group are unconformably overlain by the Nkporo Shales (Whiteman,1982).

Data Acquisition and Interpretation

Digitized aeromagnetic data was obtained from the Nigerian Geological Survey Agency, NGSA. The data was acquired from the airborne geomagnetic survey carried out in 2008 by Fugro Surveys Limited for the Nigeria Geological Survey Agency. The data was acquired at a flight altitude of 80m above the ground surface. The nominal flight line spacing was 500m while the tie line spacing was 2km.

Sheets 312 (Okigwe) and 313 (Afikpo) on a scale of 1:100,000 was used for this study. These cover the area within latitude 5^o 30^l and 6^oN and longitude 7^o and 8^oE. The isomagnetic surface maps of the Okigwe and Afikpo data are shown in Figures 2a and 2b respectively.

Interpretation of the acquired data was by forward and inverse modelling techniques. The software used for the modelling techniques was the Potent Version 4 (Geophysical Software Solutions,2010). Interpretation of the data using Potent begins with the observation of the image of the acquired data. The field image shows contours of the observed total magnetic intensity over the area. The regional field was first removed from the observed field by choosing a first degree polynomial in the regional tool of the Potent software. The first – degree polynomial surface, r, is given by:

$$r = a_0 + a_1 (x - x_{ref}) + a_2 (y - y_{ref})$$

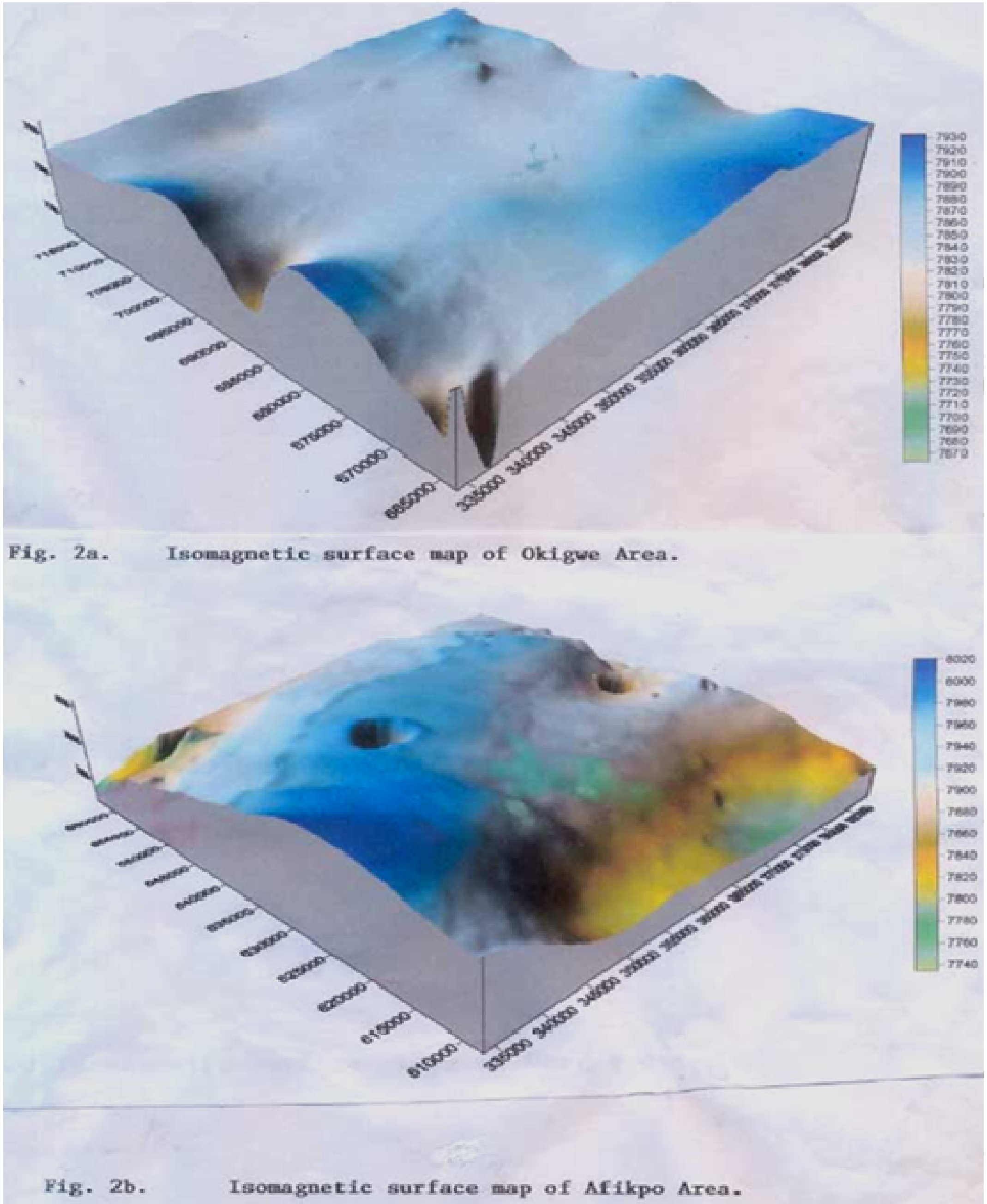

Figure 2(a). Isomagnetic surface map of Okigwe Area. **(b).** Isomagnetic surface map of Afikpo Area

Where Xref and Yref are the co-ordinates of the geographic centre of the dataset and a_0, a_1 and a_2 are the polynomial coefficients. The International Geomagnetic Reference Field (IGFR) was also removed from the observed data by putting the latitude, longitude and year (2008) into the Potent IGRF software to obtain the residual fields needed for forward and inverse modelling.

Two profiles were taken on the Okigwe field image and are given by lines AA^{l} and BB^{l} (Figure 3) while the three profiles taken on Afikpo field image are given by lines CC^{l}, DD^{l} and EE^{l} (Figure 4). The result of the forward and inverse modelling of the anomalies over the study area are given in Figures 5 and 6.

DISCUSSION

In the model results shown, the blue curves represent the observed field while the red curves represent the calculated field due to the model.

The Okigwe data generally showed low magnetic anomaly compared to the Afikpo data. The two profiles

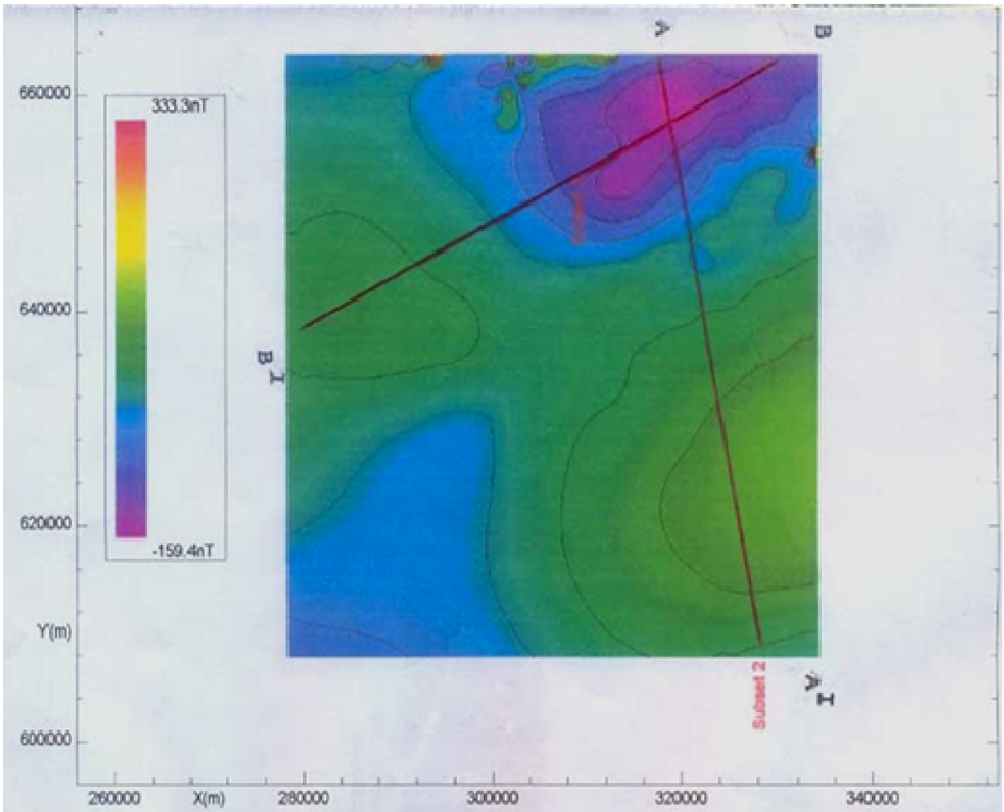

Figure 3. Profiles taken on Okigwe field image.

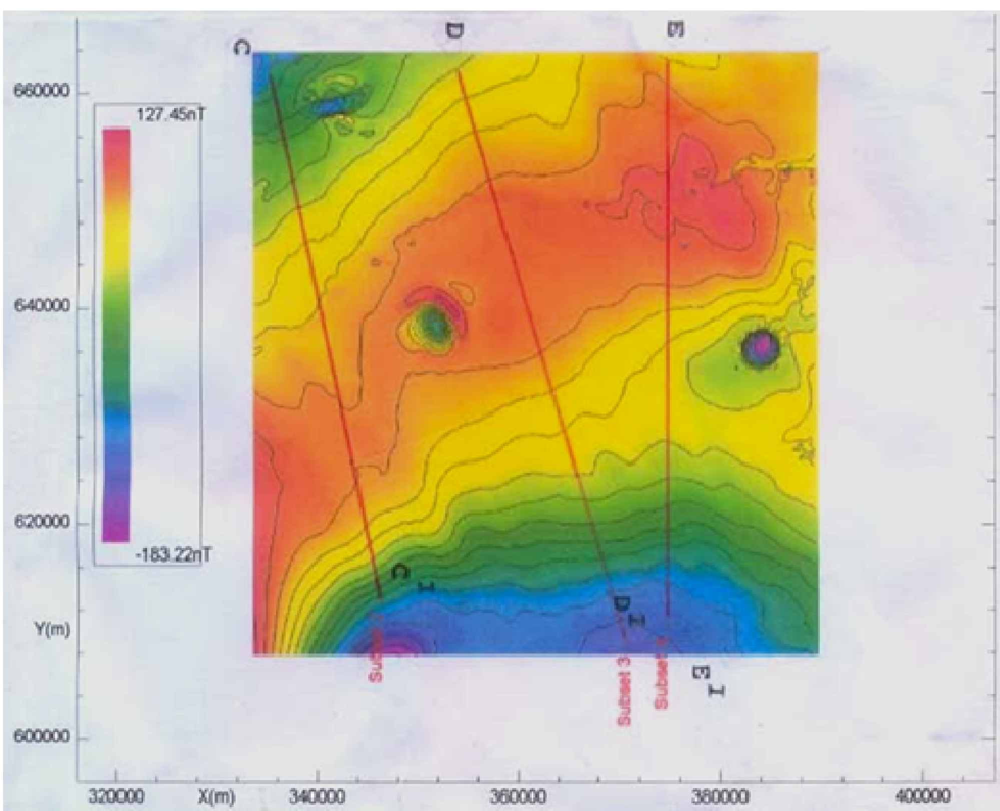

Figure 4. Profiles taken on Afikpo field image.

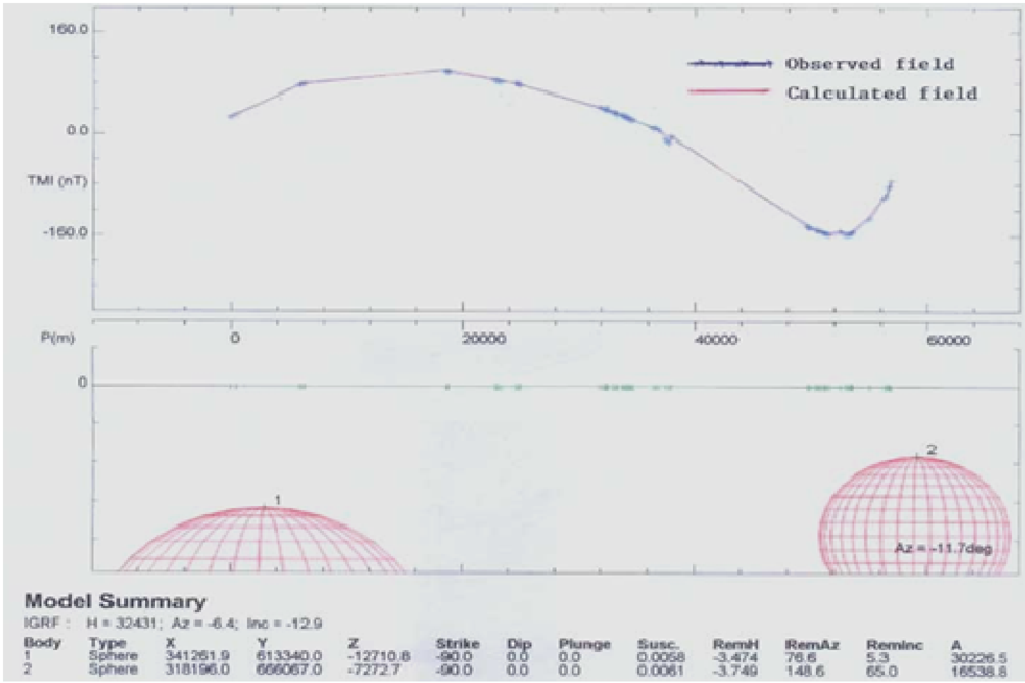

Figure 5a. Model result of subset 2 of Okigwe field image.

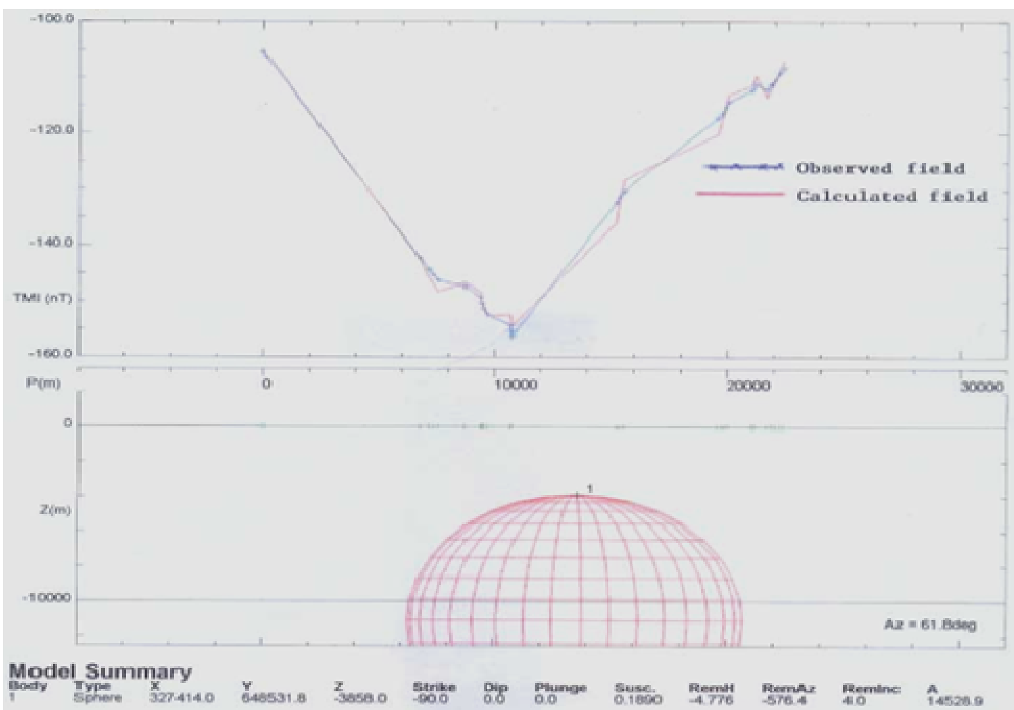

Figure 5b. Model result of subject 3 of Okigwe field image.

taken on the Okigwe field image were both modelled by spherical bodies at various depths of about 3.9 to 12.7km, either within the Cretaceous sediments or in the metamorphic basement (Figures 5a and 5b). The three profiles taken on the Afikpo field image were all modelled by dykes. The dyke – like bodies were emplaced at

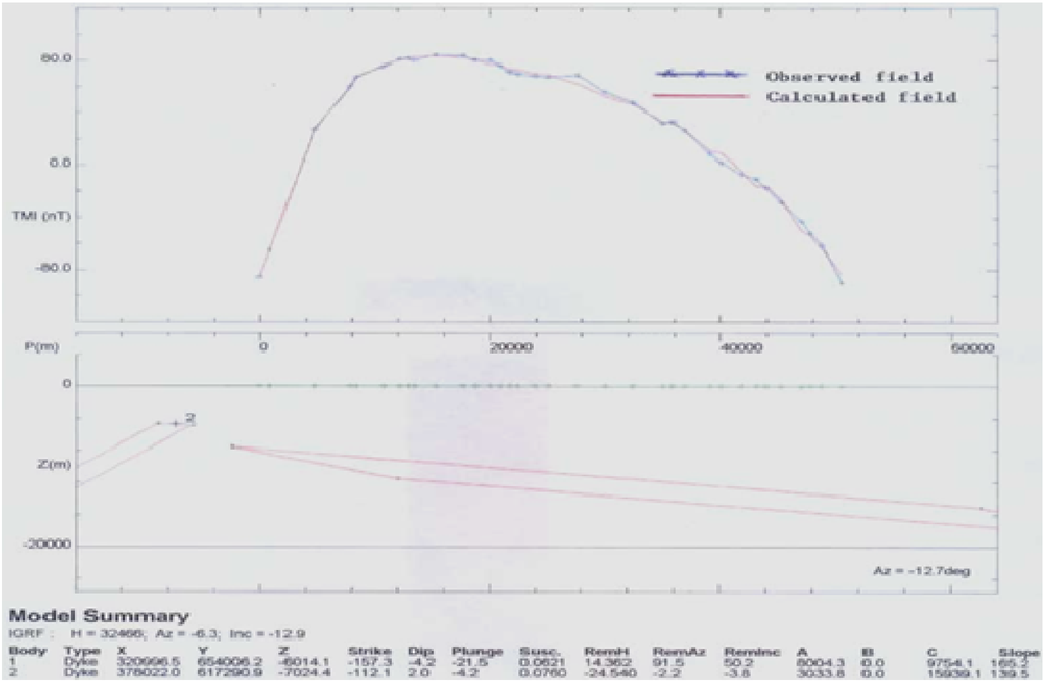

Figure 6a. Model result of subset 2 of Afikpo field image.

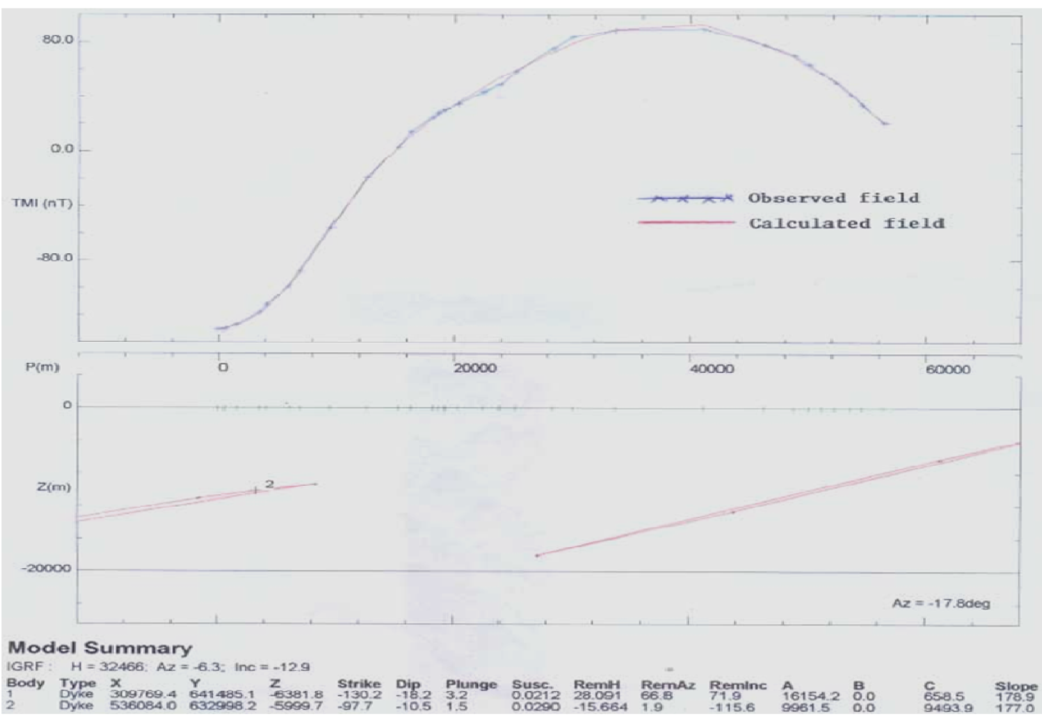

Figure 6b. Model result of subset 3 Afikpo field image.

depths of about 3.0 to 7.0km, either within the Cretaceous sediment or in the near surface basement (Figures 6a, 6b and 6c). The magnetic susceptibilities of most of these bodies (Figures 5b, 6a, 6b and 6c) suggest that they are igneous intrusions of basic to intermediate composition (typical of gabbros, rhyolites and basalts). This is in agreement with the rhyolites and basalts recorded by Obi et al (2010) in their aeromagnetic modelling of subsurface intrusions in the Lower Benue Trough.

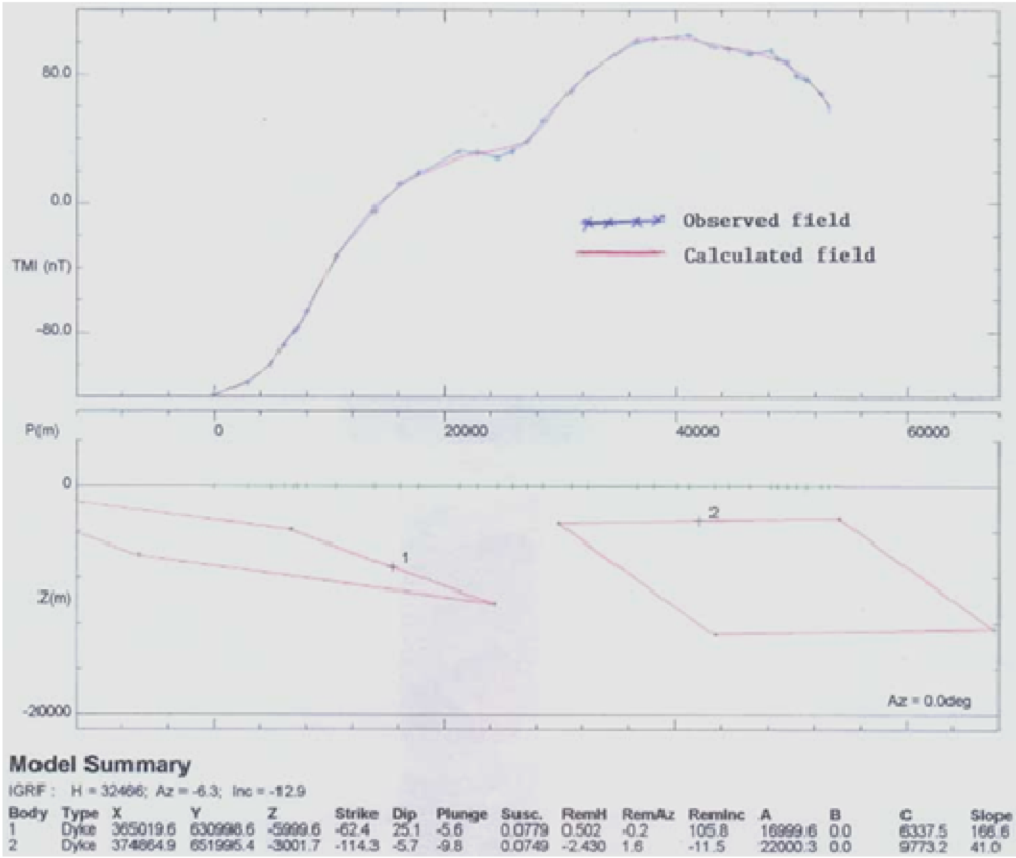

Figure 6c. Model result of subset 4 of Afikpo field image.

Igneous intrusions in the form of dykes are common features in regions favourable for mineral exploration (Telford,1976). Hence the occurrence of these intrusions accounts for the mineralization in the study area. Nwachukwu (1975) estimated that temperatures of 100 – 160^{0}C prevailed at the time of formation of these minerals. This temperature is high enough to destroy any hydrocarbons that might have been formed in the area.

CONCLUSION

Aeromagnetic data over Okigwe and Afikpo areas of the Lower Benue Trough has been interpreted in terms of spherical and dyke – like intrusive bodies. The bodies are emplaced at various depths of between 3.0km and 12.7km, either within the sediments or in the metamorphic basement. The magnetic susceptibilities of most of these bodies suggest that they are igneous intrusions of basic to intermediate composition. The intrusions identified by the present study include gabbros, rhyolites and basalts. These intrusions account for more mineralization at the Afikpo area than at the Okigwe area of the Lower Benue Trough. Thus this work supports the ore genetic model (Olade, 1975,1978; Petters,1978) which emphasizes the close relationship between mineralization and the tectonic evolution of the Lower Benue Trough.

The occurrence of a number of igneous intrusions in the area indicates an exceedingly high temperature history capable of destroying any hydrocarbons that might have been formed in the thermally over mature source rocks. Hence this area of the Lower Benue Trough might not hold any significant hydrocarbon potentials.

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