GROUND-MAGNETIC STUDY OF IJAPO AREA OF AKURE, ONDO STATE, NIGERIA

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Abstract

Ground-magnetic survey of Ijapo area in Akure township which is situated in the western part of Nigeria and falls within the Precambrian basement complex terrain of the country was carried out with the intention of determining and establishing the geologic structures, its potential for groundwater accumulation and development.
Twelve traverses were established for the survey. The results presented as profiles, geomagnetic sections and ground-magnetic contour map showed that the low magnetic intensities are reflection of fractures, faults and joints, which are indicators of basement aquifers. Quantitative interpretation of the results showed that the overburden thickness ranges from 25.0m - 3.0m. The thin regolith underlined by fractures is relevant and adequate as well for groundwater wells.

Keywords: Aquifer, groundwater, geomagnetic sections, and profiles

Introduction

The demand for water is always on the increase because of population growth, rising living standards, increasing agricultural production and expansive industrial growth. In addition, rainfall is often unevenly distributed, both in space and time, resulting in droughts or floods, and causing considerable strain to a nation's economy. Ijapo the study area is not spared. However, a strong hydrological knowledge base both in terms of sufficient data and knowledge of the hydrological system, represents the back-bone of strategy development and political decision making.

Magnetic survey sets out to investigate subsurface geology on the basis of anomalies in the earth causing magnetic field to result from magnetic properties of the underlying rocks Phillips et al (1991). It's also used in mapping geological boundaries between magnetically contrasting lithologies including faults (Telford et al (2001))

A magnetic anomaly originates as a result of the magnetization contrast between rocks with different magnetic properties. Folami (1991, 1998) is of the opinion that magnetic methods are sensitive to the susceptibility within the subsurface geology and so are ideal for exploring in the basement complex regions.

The groundwater potential of Nigeria is related to its structural history. Basically Nigeria is underlain by both crystalline (basement) and sedimentary rocks occurring in almost equal proportions (Fig. 1). The basement complex rocks in their unaltered forms are generally characterized by low porosity values usually less than 1% and permeability values that are almost negligible Rahaman, (1976). The groundwater of such area therefore depends on, the presence of

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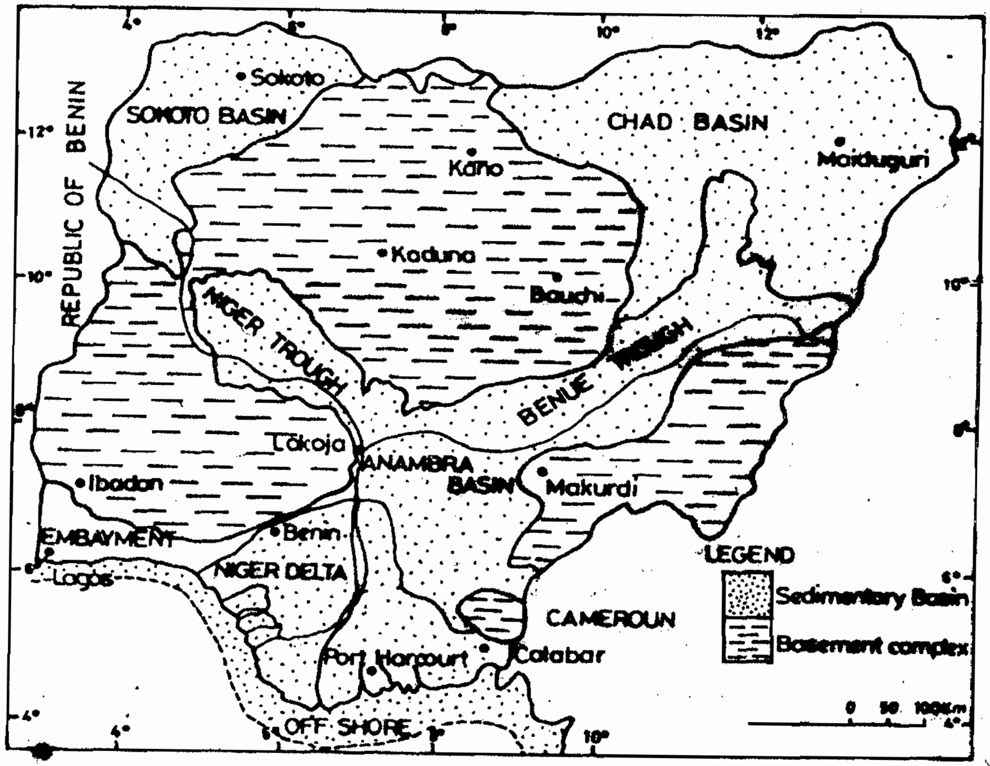

Fig. 1: Geological sketch map of Nigeria (Umo and Ajakaiye, 1993).

fractures, joints and extent of weathered overburden. However, delineation of linear geological structures associated with the basement terrain in order to serve as potential accumulation centre for groundwater development and its relevance to the hydrological study of Ijapo area, Akure, Ondo Sate is focussed on in this study.

Study Area

Ijapo area is located in latitude $5^0 6'$ to $5^0 12$E and longitude $7^0 19$ and $7^0 14$N. The area is situated at the southern part of Akure Township (Fig. 2). The area is easily accessible with network of roads but lack availability of enough groundwater for the consumption of the villagers. The producing aquifers in basement complex areas are usually limited to favourable structural features like fractures, joints and extent of weathered overburden (Ensulin 1961).

The natural vegetation is the high forest composed of many varieties of hardwood timber and it is characterised by dense evergreen forest vegetation. The swamp flats are the domain of fresh water swamp forest interior and units of mangrove vegetation near the coast. Over most of the area, the natural vegetation has been much degraded as a result of human activities. The study area has dry seasons, which lasts from November to march with December and January being the driest months Iloje, (1980, 1992). The temperature is uniformly between 25^0C and 30^0C throughout the year with high humidity during the wet season and low humidity during the dry season. The mean annual rainfall exceeds 2000mm. Geologically, the main rock types found in Ijapo area are the undifferentiated older granite, gneiss and charnockite. The topography is generally rugged with large outcrops of these rocks that are in form of hills.

Data Acquisition

Geometric proton precession magnetometer, model G-856, which is sensitive to acute magnetic gradients, was used for this study.

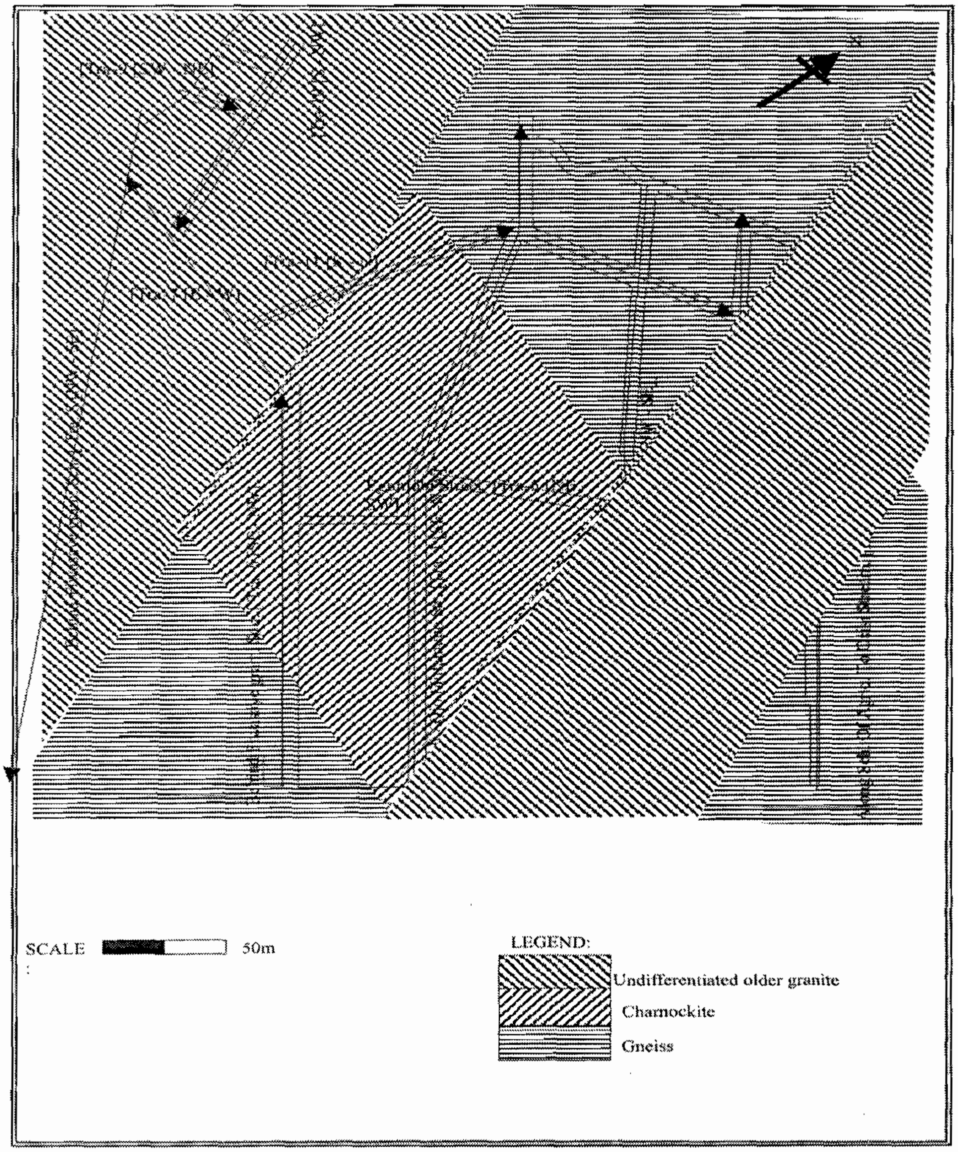

Fig. 2: Geological map of the study area (Ijapo) Akure, Ondo State.

The survey was carried out with a total number of 12 profiles established in South-North, East-West, Southeast-Northwest, Northwest-Southeast and Southwest-Northeast directions.

The profile length ranges from 130m-850m with station separation of 10m. The traverses were selected to cover the entire study area.

The geophysical investigation involved the actual data collection in Ijapo area establishing a base station to which every other magnetic reading is being referred.

The magnetic data obtained were corrected from non-mean, near surface effect and noise effect. A three point average filter was used, filtering in order to smoothen the profile such that plausible assumptions could be made.

The relative magnetic values were plotted against the station positions, the information provided from the data were presented as maps, geomagnetic profiles, and geomagnetic sections. Based on this information and the geology of the area, deductions were made on the subsurface characteristics of the study area.

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Results and Discussions

Both qualitative and quantitative interpretations were employed in this study. The qualitative interpretation of data for this study involves the inspection of geomagnetic profiles, some of which (Fig. 3(a, d, e, g &k)) were used to represent the whole profile while the quantitative interpretation involves the use of half-width method in estimating the overburden thickness to the top of the magnetic basement.

In profiles bb', cc' & dd' (Fig.3d), two main rock types which can be delineated from its characteristic anomaly pattern are gneiss and older granite with three, five and five magnetic lows respectively at various distance ranges with profile dd' having an indication of an intrusion due to complex sources consisting of several closely spaced anomalous bodies.

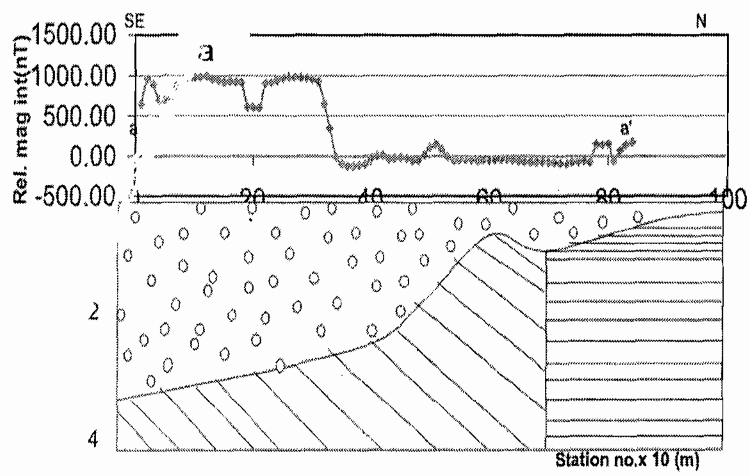

Fig. 3a: Groundmagnetic profile (aa') & geomagnetic section

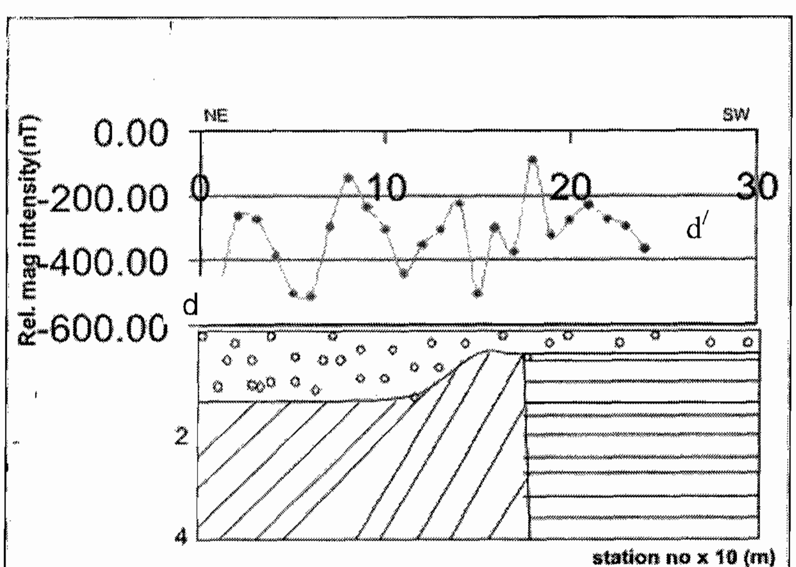

Fig. 3d: Groundmagnetic profile (dd') & geomagnetic section

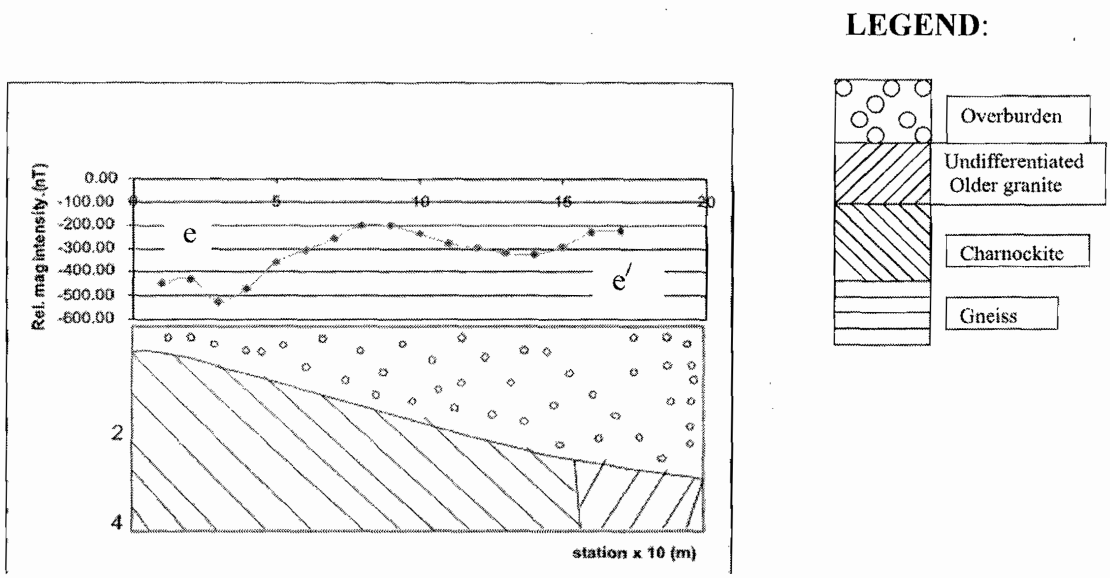

Fig. 3e: Groundmagnetic profile (ee') & geomagnetic section

Profiles aa' & ff' (Fig. 3a), revealed two rock types; charnockite and gneiss. No magnetic low was observed from profile aa' except a pronounced anomaly signature at a distance of about 340-410m corresponding to charnockite unlike profile ff' with six magnetic lows at distances 80, 130, 210, 300, 380 & 480m.

In profile ee' (Fig.3e) its characteristic anomaly allowed the delineation of two rock units namely charnockite and older granite with two magnetic lows at about 30 & 140m. Profiles gg', hh', ii' & jj' (Fig. 3g) shared similar features of only one rock type; older granite but with different magnetic lows of two, six, two, three and two respectively at different distance ranges. Profile ll' also showed anomaly signature establishing one rock type; gneiss with two distinct magnetic lows.

Profile kk' (Fig.3k) gave an anomaly curve where three rock types have been delineated. Distance of 60m corresponds to the older granite while the distance between 60-130m falls within the charnockite and distance at 130-160m corresponds to gneiss.

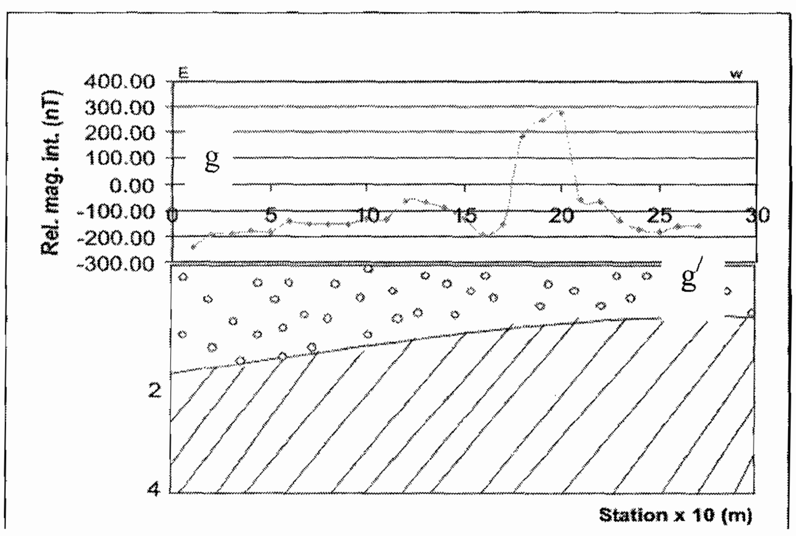

Fig. 3g: Groundmagnetic profile (gg') & geomagnetic section

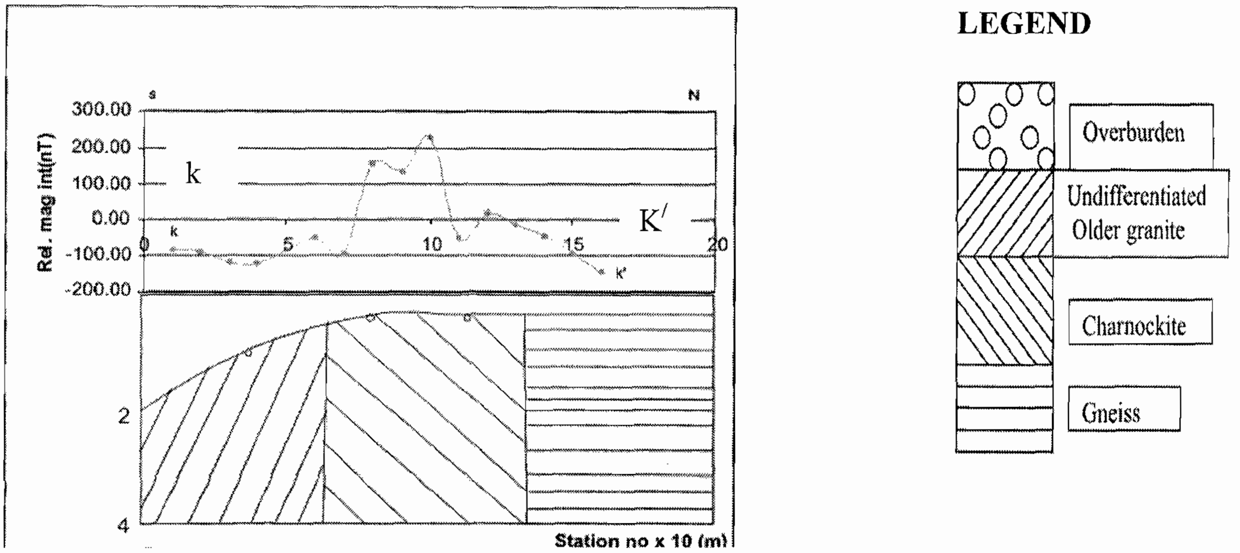

Fig. 3k: Groundmagnetic profile (kk') & geomagnetic section

The alternative qualitative interpretation method used is the ground magnetic contour map of the study area. The map showed an overview of the contrasting magnetic susceptibility and the distribution of weathered layer through the study area. Folami et al 1992, had ascertained that the portion with low magnetic intensity value depicts areas in the subsurface that are potentially good for groundwater accumulation and transmission.

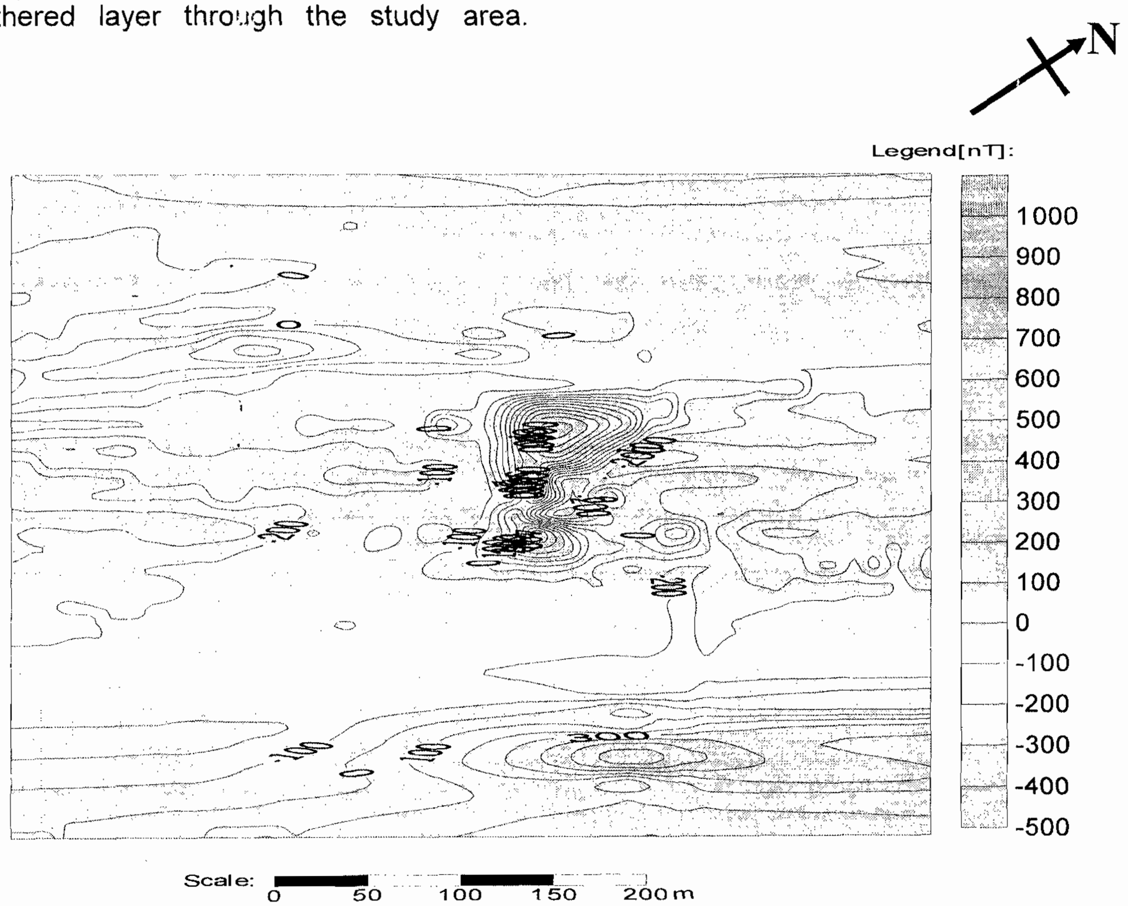

Fig. 4: Ground magnetic Contour map of the study area.

Portions that are bluish in colour on the contour map (Fig. 4) have low relative magnetic intensity and thus depict a weathered basement.
The southeastern flank (middle portion) of the map depicts a weathered /fractured basement (low relative magnetic intensity), this indicates that the portion is potentially good for groundwater accumulation.
The upper, lower and central portion of the map have relatively high magnetic intensity, hence this depicts that these portions are not potentially good for groundwater accumulation.
For the quantitative interpretations the half-width method which was adopted in estimating the overburden thickness to the top of the magnetic basement, method once used by Folami (1998).

Table1: Table showing the anomaly estimates of observed profiles

Profile No	Profile Line	Anomaly Number (m)						
		1	2	3	4	5	6	7
1	aa'	25.0	16.0	5.00	15.0	4.00		
2	bb'	10.0	3.50	19.0	24.0			
3	cc'	3.00	12.0	8.00	12.0	5.00	11.0	
4	dd'	13.0	12.0	6.00	6.00	6.00		
5	ee'	7.50	22.0					
6	ff'	16.5	5.70	4.50	5.00	5.00	9.00	
7	gg'	12.0	9.00					
8	hh'	4.00	14.0	16.0	4.00	9.00	6.00	16.5
9	ii'	6.00	6.00					
10	jj'	12.5	9.00	7.00	10.0			
11	kk'	10.5	3.50	3.00				
12	ll'	6.50	4.50					

The method made use of a minimum of two anomaly estimates and a maximum of seven anomalies (Table 1) were observed. The varying depth extent from the magnetic profile showed that varying basement topography characterized the area. The depth ranges from 3.0m-25.0m.

Conclusions

From the interpretations it can be concluded that magnetic method had proved effective in delineating linear, structural features such as fractures zones joint system and lithological boundaries as can be observed from the qualitative interpretation of the study area. It can be seen that the sources of the anomaly signatures observed from some of the profiles may be due to complex sources consisting of several closely spaced anomalous bodies whose effect merges to give a broad anomaly and that the magnetic lows observed too could be produced by steeply dipping interface which is indicative of a linear geologic structure with a possibility influence of fractures.
That a network of lineaments was suspected to be fracture zones whose trends are generally in the Southeastern flank and the magnetic response showed varying intensities in magnetic contents of the underlying rocks in Ijapo area.
While the quantitative interpretation of the magnetic profiles suggested that some of the linear features are deep seated, two approximate depths of the bedrock (Table 1) indicated the overburden thickness ranges between 3.00m and 25.0m confirming similar findings of Folami (1998). Indicating that Ijapo area could actually be saved from water problems if boreholes are sited at the delineated areas.

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