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INTEGRATED GEOPHYSICAL MAPPING TO DETERMINE DEPTH TO BASEMENT AT AWA IJEBU, SOUTHWESTERN NIGERIA

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ABSTRACT

Integrated surface electrical resistivity, magnetic survey and horizontal profiling were conducted at Awa Ijebu, South-western Nigeria, to delineate the probable depth of basement and determine geological anomalies therein. Wenner resistivity profiling and magnetic data were acquired at intervals of 5.0m along four traverses of 100.0m long and five traverses of 250.0m long respectively. The resistivity data obtained revealed three subsurface geologic layers: top soil, weathered bedrock and intrusive pegmatite rock. The distinct high resistivity zone is interpreted as the intrusive pegmatite rock while the low resistivity zone is interpreted as fault zone. The magnetic survey result revealed that there was a high magnetic anomaly trending Southeast – Northwest direction and dipping westward.

Keywords: Resistivity, Magnetic Survey, Profiling, Pegmatite, Fault.

INTRODUCTION

An integrated approach comprising the electrical resistivity survey, magnetic survey and horizontal profiling was carried out at Awa Ijebu, Southwestern Nigeria to identify various solid minerals within and around the study area as well as determining their depths to basement. The rock formations found in this area are amphibolites, schistose amphibolites, quartz-schist, associated pegmatite, quartzite and gneisses. This study also extended to delineating the probable geological anomalies and infers the geological properties vis-à-vis susceptibility and remanence coupled with the resistivity values. Rocks like granite-gneiss and associated pegmatite as well as sediment of Dahomey basin were tilted and faulted; this was accompanied by erosion activities, Omatsola and Adegoke, 1981. The minerals found within the gneiss rock are allumi-nosilicate.

Keating and Pilkington, 2004 explained the use of Euler deconvolution method for the estimation of depths and delineating boundaries of magnetic anomaly bodies. Although the interpretation of potential method is inherently ambiguous, every interpretation method has its own disadvantages and limits. Some of the limitations associated with the deconvolution method are explained by Adepelumi *et al.,* 2005. Reid *et al.,* 1990 also explained the effect of absence of susceptibility and dip estimates.

LOCATION OF THE STUDY AREA

The study area is located at Awa Ijebu, South-western Nigeria and lies between latitude 3°30' to 4°00' and longitude 6°25' to

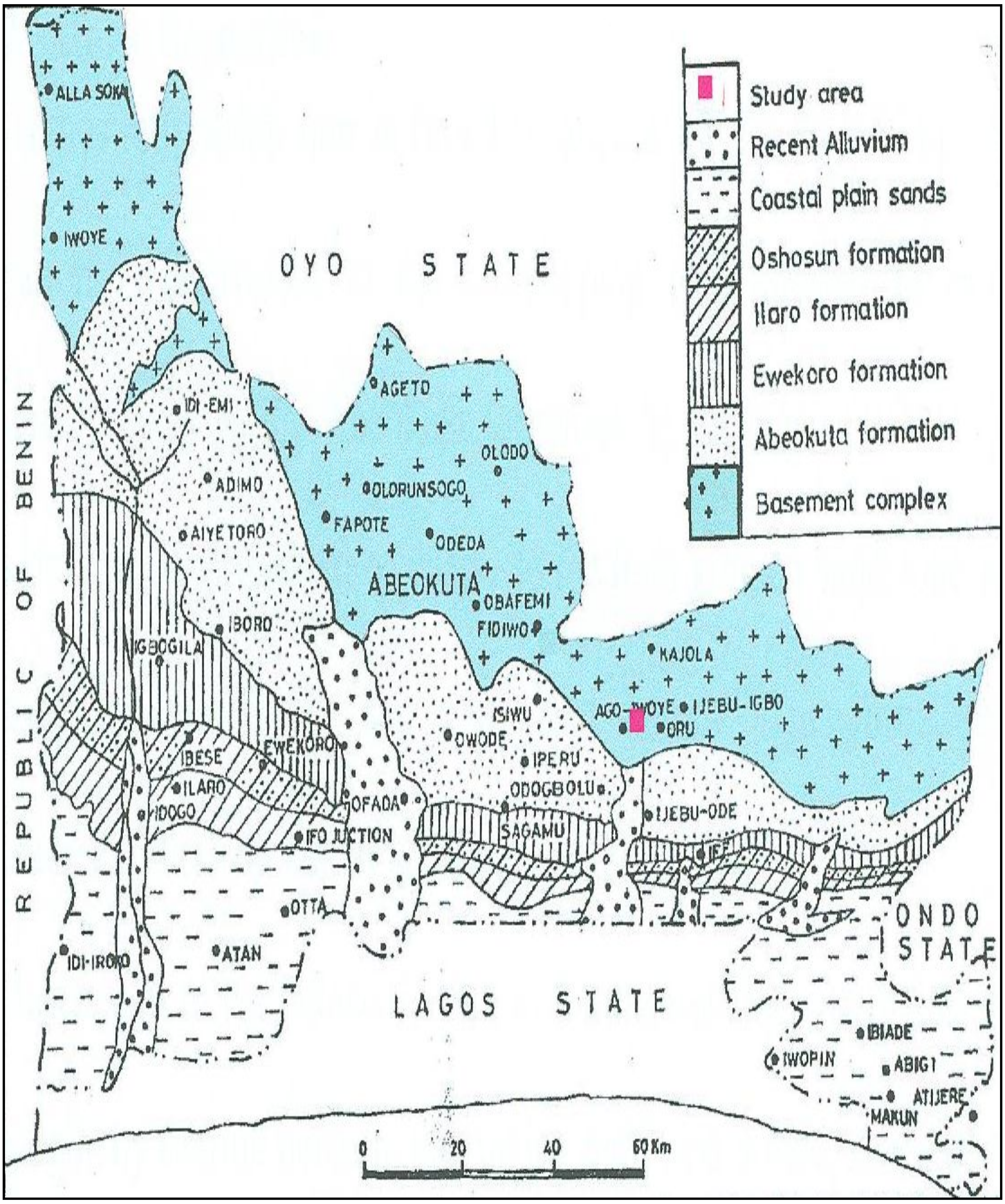

Figure 1.0: Geological Map of Ogun State Showing the Study Area

$7^{o}00'$ (Figure 1.0). This is part of the basement complex of the Southwestern Nigeria and overlain by sedimentary succession of the Dahomey embedment. The area is characterized by undulating plain and valley, connected to many villages and hamlets by footpaths.

MATERIALS AND METHOD

Field Techniques

Wenner Horizontal Profiling

Wenner resistivity survey was carried out along four traverses of the magnetic profile direction (Figure 2.0). The measured apparent resistivity data were interpreted using WingLink software which incorporates the least square inversion scheme. Finite element method was used for the model response calculation (forward modeling) in the inversion program. Marquardt approach was used for the inversion procedure, with recalculation of the Jacobian matrix of each model. The 2-D resistivity models of the subsurface showing the faults were obtained after the inversion process.

Ground Magnetic Survey

This was performed using the Proton Precession Magnetometer (PPM) called Geometric 816, along the five traverses with a separation of 5.0m (Figure 2.0). A total of 50 stations were sounded along each of the traverses. As a first step to processing and interpreting the magnetic data, magnetic readings were repeated at each station along two traverses and were averaged for subsequent use. In calculating the anomalous geomagnetic field, the known regional geomagnetic field of 32,000nT (Jakoskey, 1957) for Awa, was subtracted from the observed geomagnetic field so as to produce the residual geomagnetic field. As corrections to the data, a four point moving average linear filtering was applied (Breiner, 1999). This was done to improve the signal of noise ratio to the geomagnetic field data.

RESULT AND DISCUSSION

The traverses AA^1 and BB^1 were taken in the study area (Figures 3.0 and 4.0). Traverse AA^1 consists of VES01, VES02 and VES03 while traverse BB^1 consists of VES04, VES05 and VES06 revealing three geo-electric layers having resistivity values ranging between 39.4 to 2859Ωm (Table 1.0).
Results obtained show that the geo-electric section along traverse AA^1 has three geo-electric layers (Figure 3.0). The first layer (top soil) with resistivity ranging from 86.1 to 109.4Ωm and thickness from 2.94 to 4.53m. The second geo-electric layer revealed weathered bedrock with resistivity values 551.7 to 1196.1Ωm and thickness about 3.7 to 34.47m. The third geo-electric layer revealed the bedrock with resistivity values between 780.3 and 2850.3Ωm with thickness which could not be ascertained as the current terminated at this layer as a result of current electrode spacing.

The resistivity values for VES01 was between 92.9 and 1616.4Ωm while VES02 was between 86.1 and 780.3Ωm, indicating a sharp contrast with the host rock; an indication of suspected faults along the boundary of VES01.
The geo-electric section along traverse BB^1 (Figure 4.0) consists of VES04, VES05 and VES06 with three geo-electric layers. The fourth geo-electric layer is seen with the third layer and identified as an instructive dyke with resistivity values ranging from 4453 to 5205Ωm and centrally located along VES05. The section BB^1 provides insight subsurface geologic sequence and structural condition of the study area. The location of this centrally high resistivity anomaly coincides with the location of the intrusive dyke

(contact zone) as shown in figures 3.0 and 4.0. There is a low resistivity value between VES01 and VES06. This anomalous zone is parabolic in nature and has a Southwest – Northwest trend.

The iso-resistivity map (Figure 5.0) for the horizontal profiling revealed high resistivity value at the central location which crosses traverse BB[1] and coincides with the intrusive pegmatite dyke. The high resistivity value from the graph of apparent resistivity against distance were observed between 10 and 22m representing the dyke zone in traverse 01; 10 and 25m on traverse 02; 20 and 50m on traverse 03 and on traverse 04, it is between 40 and 70m. The computer observed diagram (Figures 6.0) where the traverses were joined together is to indicate an intrusive pegmatite dyke trending SE-NW direction and dipping westward.

The magnetic profile shows a background anomaly of 850 nT along traverse 01 and about 5.0m wide, 650nT along traverse 02 and about 9.0m wide. This high magnetic gradient in both suggest a shallow basement as the pegmatite rock is seen on the surface and corresponds with high resistivity value of the horizontal profiling between 10 and 25m along traverses 01 and 02. On traverse 03, the magnetic anomaly is 100nTand 7.5m wide, this sudden drop in the magnetic intensity suggests deep basement which corresponds to a low resistivity value and indicates fault zone along the boundary of VES01. There is rise and fall in magnetic intensity on traverse 04 which possibly depict the occurrence of different rock types that signifies lithologic boundary between the two rock types along the traverse. On traverse 5, the observed magnetic gradient has an anomaly of 20nT and 7.5m wide as depicted in figures 7.0 a – d.

Table 1.0: Summary of VES Interpretation Showing Layer Resistivity, Thickness, Depth and Lithology

VES Stations	Layers	Resistivity Values (Ωm)	Thickness (m)	Dept (m)	Lithology
01	1	92.9	4.53	5.43	Topsoil
	2	588.6	3.87	8.40	Weathered rock
	3	1616.4	-	-	Basement
02	1	86.1	2.94	2.94	Topsoil
	2	551.7	34.47	37.4	Weathered rock
	3	780.3	-	-	Basement
03	1	109.4	3.08	3.08	Topsoil
	2	1196.1	3.70	6.77	Weathered rock
	3	2850.3	-	-	Basement
04	1	126.9	3.59	3.59	Topsoil
	2	2055.5	8.47	12.06	Weathered rock
	3	1811.1	-	-	Basement
05	1	39.4	2.82	2.82	Topsoil
	2	108.6	1.69	4.45	Weathered rock
	3	1805.0	-	-	Basement
06	1	60.9	2.64	2.64	Topsoil
	2	821.5	5.12	7.76	Weathered rock
	3	1761.5	-	-	Basement

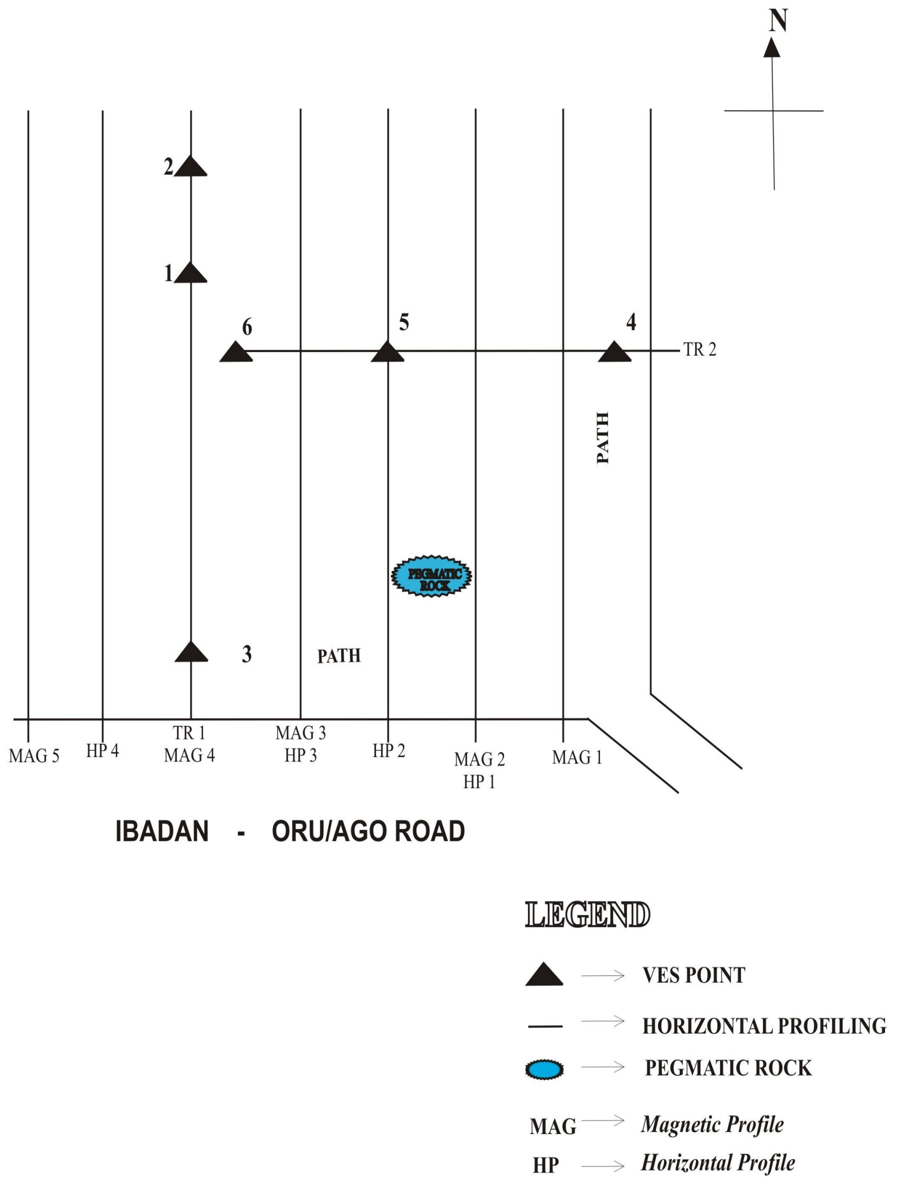

Figure 2: Data Acquisition Map

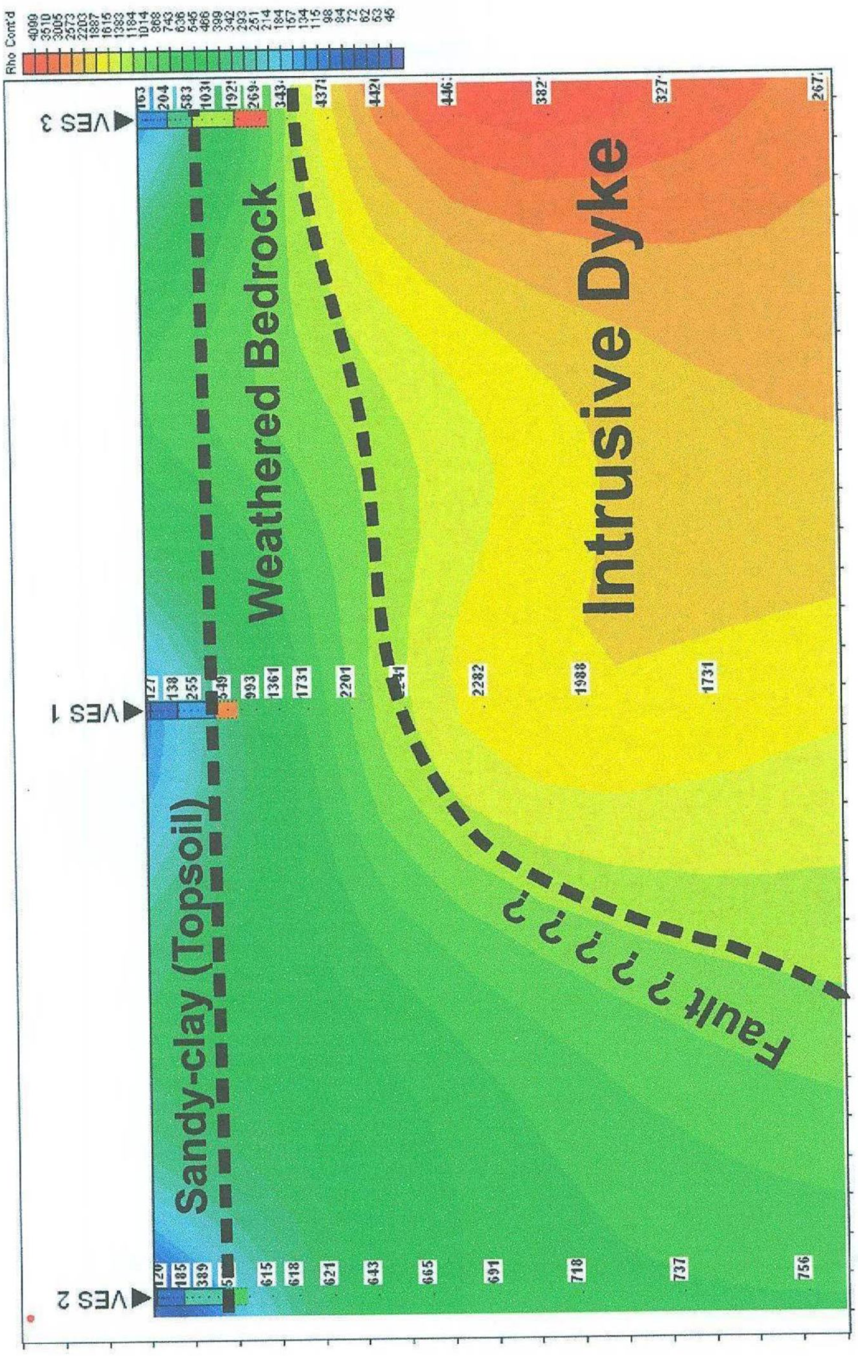

Figure 3.0: Geo-electric Section Beneath AA1

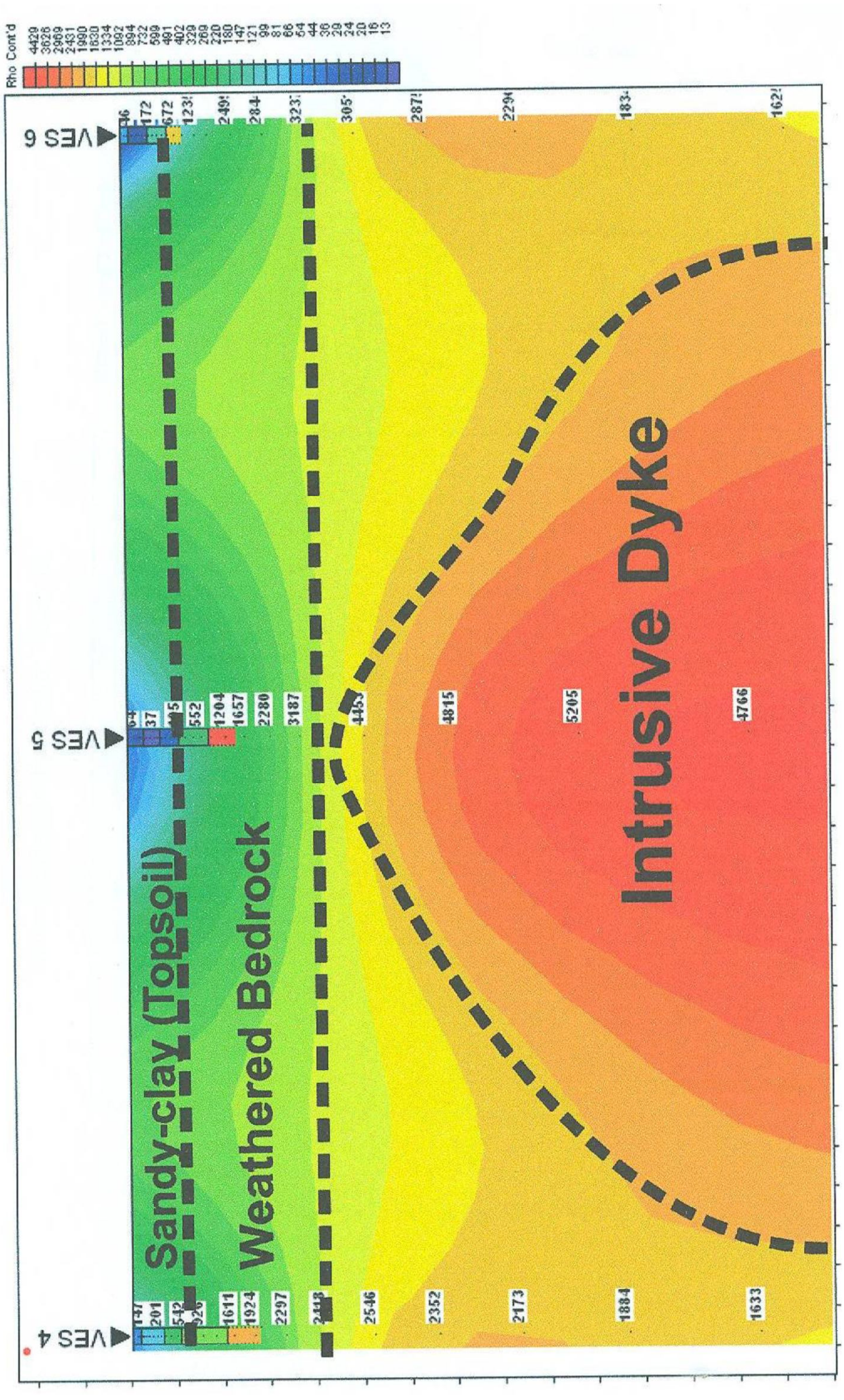

Figure 4.0: Geo-electric Section Beneath BB^1

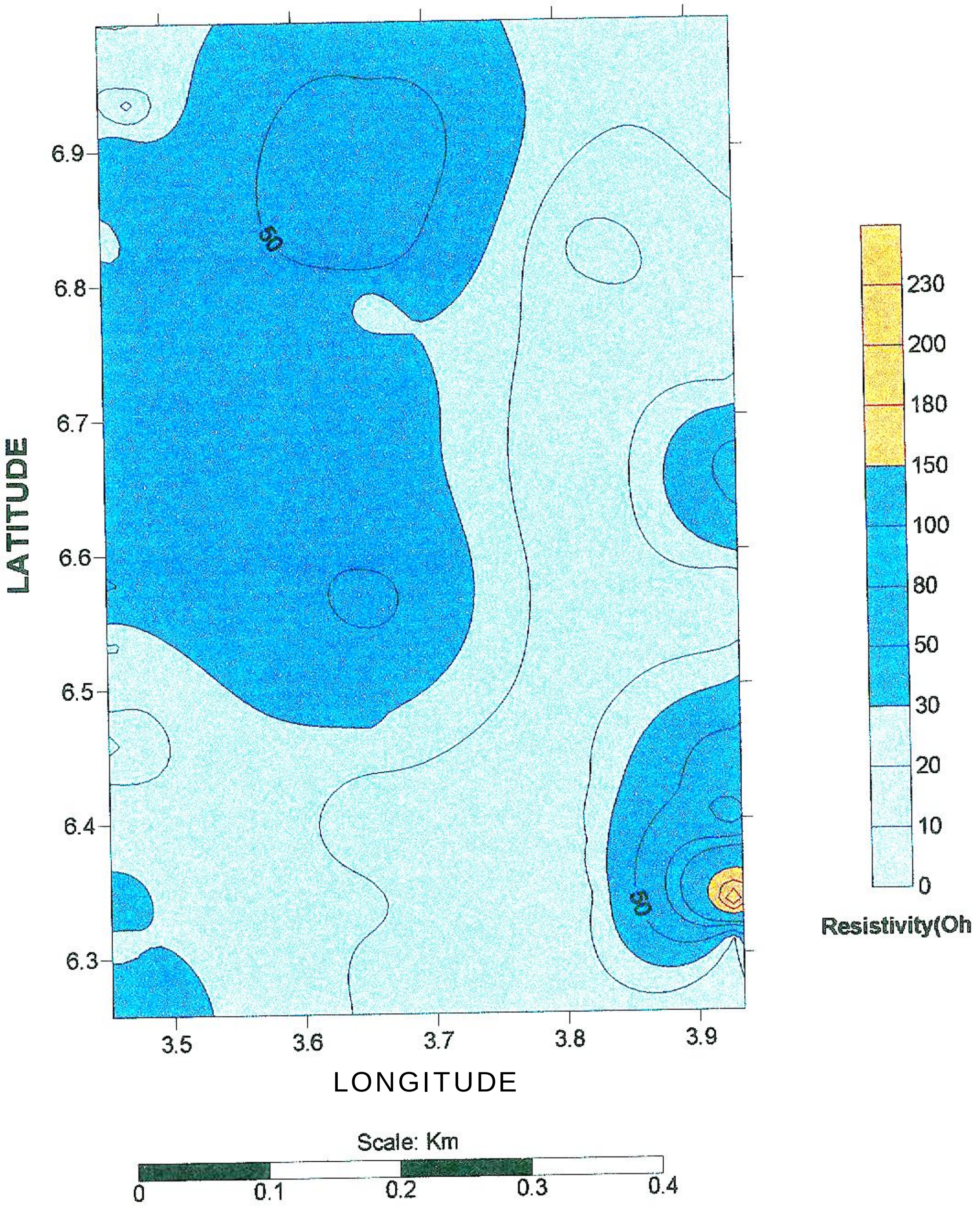

Figure 5.0: Isoresistivity Map

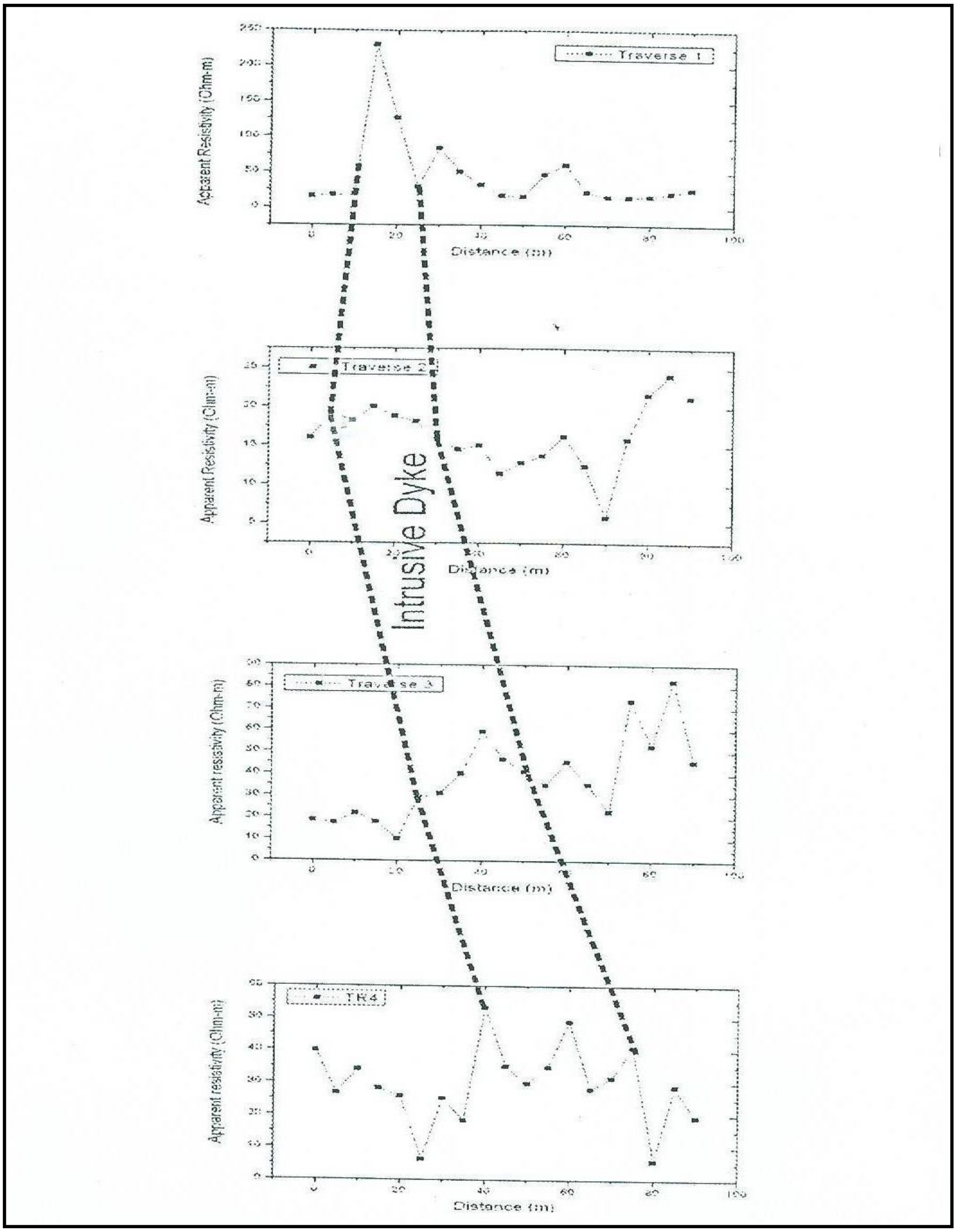

Figure 6.0: Horizontal Profiling Showing the Intrusive Dyke

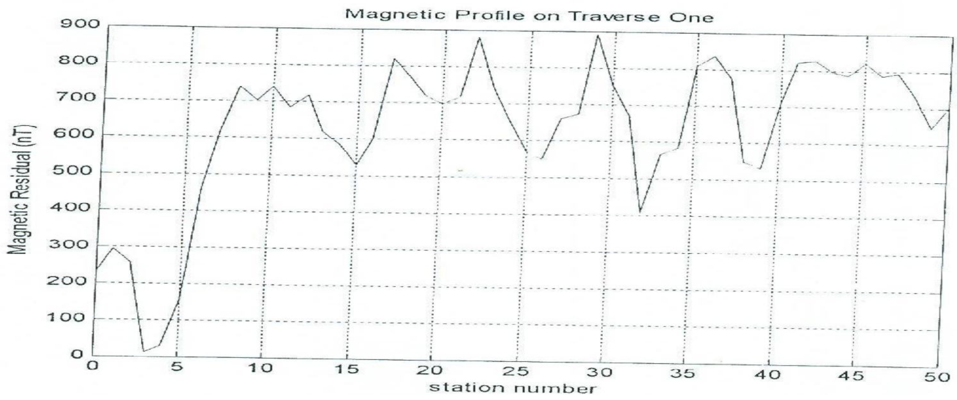

Figure 7.0a: Magnetic Profile along Traverse 1

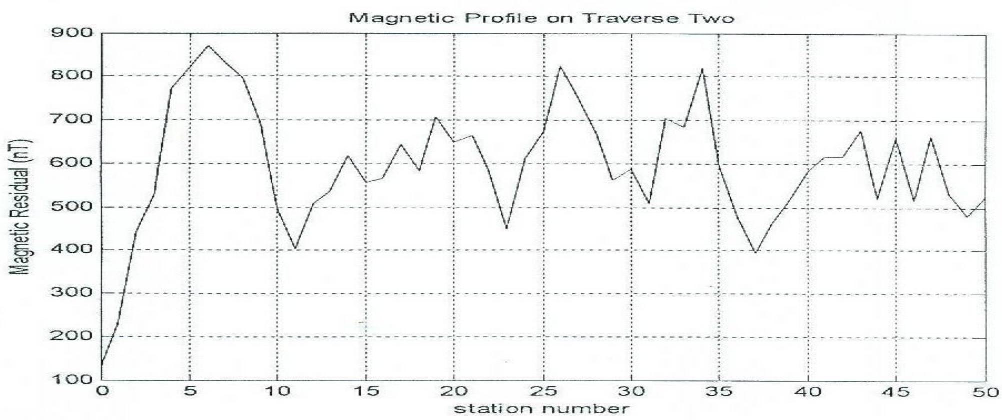

Figure 7.0b: Magnetic Profile along Traverse 2

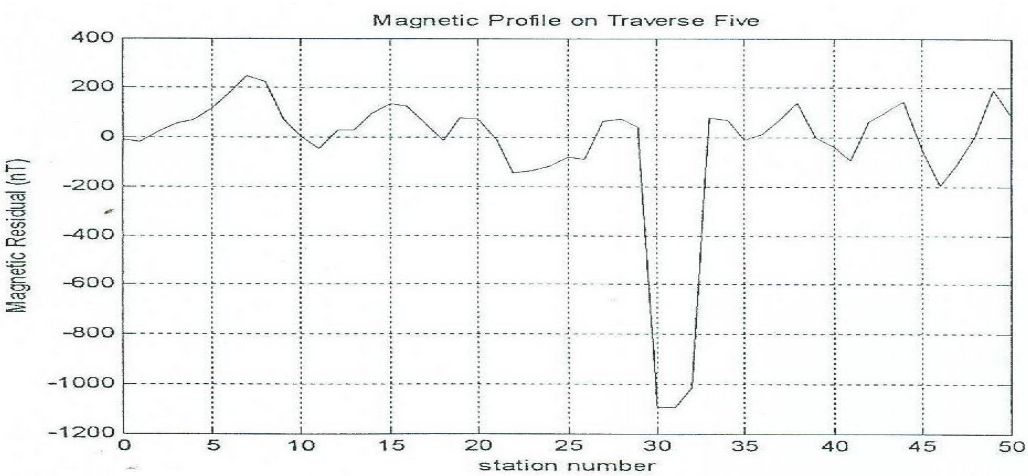

Figure 7.0c: Magnetic Profile along Traverse 3

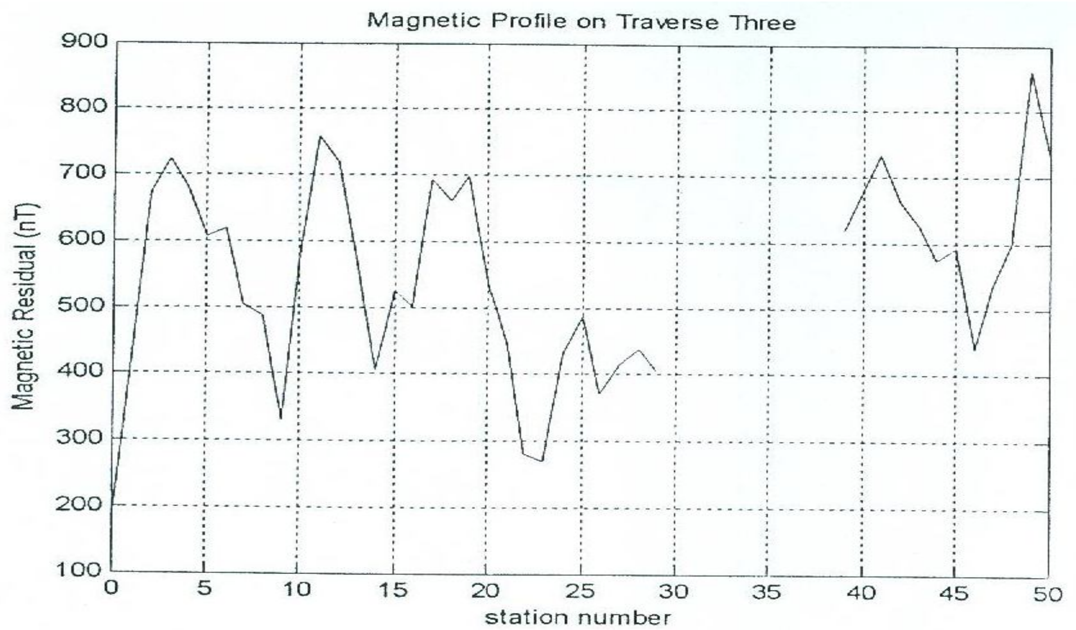

Figure 7.0. d: Magnetic Profile along Traverse 4

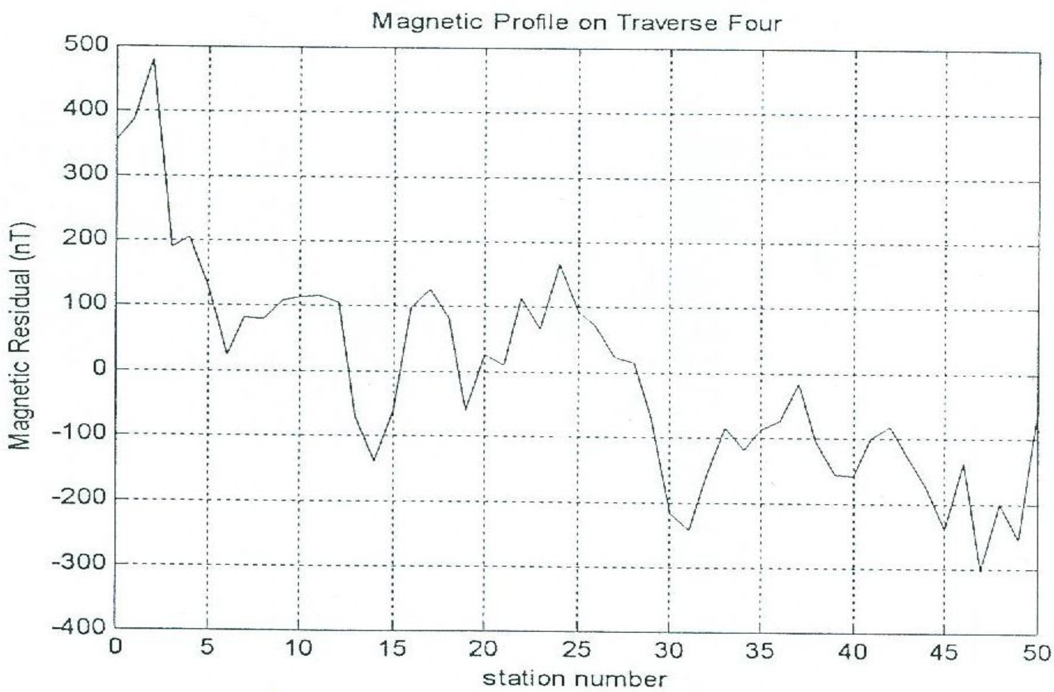

Figure 7.0e: Magnetic Profile along Traverse 5

CONCLUSION

The results of the three geophysical methods revealed the existence of an intrusive pegmatite dyke in the study area. Anomaly from magnetic survey profile was obtained about the same location where high resistivity values had been observed both in the geo-electric section and the horizontal profiling.

As a result of this geophysical survey, the study area has potentials for mineral exploration of gemstones associated with the pegmatite dyke at greater depth.

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