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Structural Attributes, Geo-electrical and Induced polarization technique for mapping Abung Magnetite in Part of Oban Massif, South-Eastern Nigeria.

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Abstract

Magnetite ore deposit has magnetic properties once advances close to a magnet. These singular peculiarity was used as reconnaissance tool during surface geological mapping alongside measurement of the attitudes of the significant magnetic anomaly planes surfaces, A Compass Clinometer was used to measure about fifty two (52) attributes to ascertain the regional trend and strikes to aid in design of traverses. Magnetite ore deposit were evaluated for conductivity and resistivity potentials using DUK2A Resistivity system deploying 2-D dipole – Dipole array for a spread of 450 making a total of 1.8km for all the traverses. This research method can be described as ground-truth. Using Geo-electrical and Induced Polarization survey of Electrical methods which is cost efficient and relatively fast due to availability and accessibility. In this study, we examined the applicability of Magnet, Geo-electrical and Induced Polarization survey of Electrical methods to map ore bodies and country rock in order to depict potential area of magnetite ores deposit. The research interpretation of the attitudes and geophysical results are made base on geological trend and geophysical anomalies confirms magnetite prospect thus calling on the attention of federal Government to further exploration on this site.

Key words: Abung, Magnetite, Oban Massif, Ground-truth, Geo-electrical, Induced Polarization, Dipole-Dipole array, Chargeability

1.0 INTRODUCTION

Abung Magnetite is a mineralized zone within the Eastern part of Oban Massif, it is about 13km from Akor off Oban Ekang road (Figure 1.1), a deposit with high prospect if properly explored for exploit, these has called for a review of existing work and detailed investigation of the geological domain for minerals potentials.

Electrical methods depend on the contrasts in electrical resistivity (Telford *et al*, 1990). It has been proved that these methods are useful tools in detecting, tracking and mapping outcrop lithology to depth and fault systems (Hawke, 1997).

IP&Rs surveying along the earth's surface is a well-known and useful method in mineral exploration due to its conceptual simplicity, cost-effective and ability to detect disseminated minerals (Bery *et al.*, 2012) and (Saad *et al.*, 2012).

Most Iron ores are of sedimentary, metamorphic and igneous environments origin combined with oxygen and form iron oxide minerals such as magnetite (Fe3O4) or hematite (Fe2O3) (Saad *et al.*, 2012) and (Vella and Emerson, 2012). The properties of magnetite have been studied thoroughly. However, there is relatively limited published information on their electrical properties (Vella and Emerson, 2012).

The objective of the research is to evaluate the potentiality of the magnetite mineralization in the area, using Induced Polarization/Resistivity techniques to identify and mapped out prospect of magnetite ore deposit.

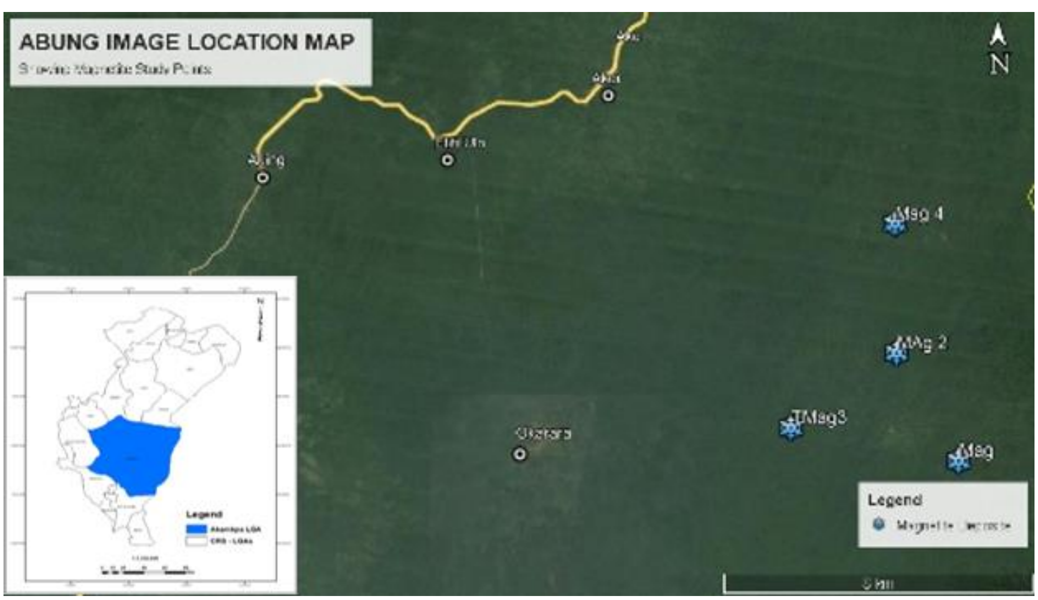

Figure 1.1: An Image Map Showing Location of Magnetite Ore Deposits at Abung

2.0 MATERIALS AND METHODS

Ground-truth techniques was of great importance in this research beginning with the use of magnet to confirm magnetic properties (plate 1- 2) follow by acquisition of attitudes data (Table 2.1); a total of fifty two (52) attitudes were measured using compass clinometer to establish strike and trend. The strike and trend guided choice and direction of cutting traverses. Traverses of geo-electrical and induced polarization were deployed (Plate 5). Induced polarization method was developed for detecting small concentrations of disseminated mineralization in base metal exploration (Seigel, 1949), (Hallof, 1957) and (Sumner, 1976). The elementary theory for these methods has been introduced via formulas for electrodes on homogeneous and layered half-space in (Ward, 1990).

Four (4) survey traverses were carried out on the area. Total length of four survey traverses is 1.8 km. Dipole-dipole array is used for the survey with 5m electrode spacing. Survey traverses were parallel at spaces 150m to 200m. For induced polarization (IP), stacks, signal time with second and arithmetic mode were chosen parameters.

Table 2.1: Attitude of structures measured at Abung area							
S/N	STRIKE	DIP	DIP DIRECTION	S/N	STRIKE	DIP	DIP DIRECTION
1	347	36	75	31	310	60	90
2	207	85	78	32	314	70	37
3	773	35	66	33	300	75	76
4	176	77	67	34	310	66	94
5	153	86	86	35	320	76	82
6	161	73	76	36	347	72	45
7	143	64	68	37	287	65	88
8	132	63	87	38	143	72	76
9	154	72	94	39	176	73	57
10	143	76	76	40	153	66	86
11	341	81	65	41	161	63	73
12	342	63	42	42	143	74	58
13	312	96	34	43	132	63	87
14	336	52	37	44	154	62	54
15	347	82	45				
16	187	63	88	S/N	TREND	PLUNGE	
17	143	82	76				
18	176	63	57	1	277	32	
19	153	76	86	2	276	31	
20	161	83	264	3	282	21	
21	143	64	58	4	281	34	
22	132	73	87	5	284	43	
23	154	72	54	6	274	23	
24	143	76	76	7	254	43	
25	324	73	58	8	289	23	
26	154	73	65				
27	354	64	76				
28	355	72	54				
29	312	73	88				
30	143	64	86				

Plate 2.1 Magnet with outcrop at Abung

Plate 2.2 Magnetization with outcrop at Abung

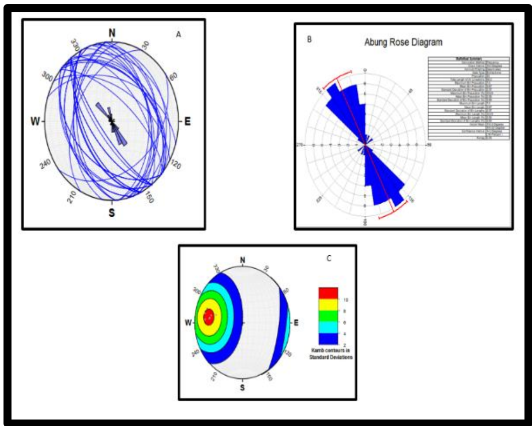

Figure 2.1: Plot of Attitudes data at Abung

Plate 2.3: IP & Resistivity Survey at Abung

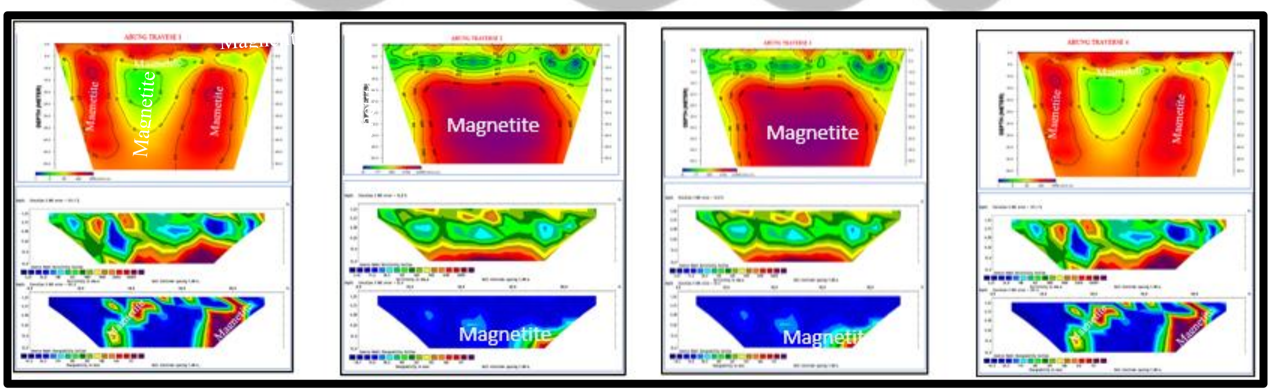

Figure 2.2: IP models up and Resistivity models for traverse 1 to 4

3.0 GEOLOGICAL SETTINGS

Abung is in the eastern part of Oban Massif and belongs to the Nigeria Basement complexes system that is of Pan-African belt which has been assigned an age of 450-750Ma though Rahman *et al,* 1981 suggested 450-1100ma the occurrence of Bauchite – Charnokite intrusive at around the western Oban Massif. The rocks here exhibit striking similarity in terms of mineralogy and petrography with those that have been reported in the northern part of Nigeria. This striking similarities, the Lithologic and Litho-tectonic setting between the basement of Oban massif and those in the Northern part of Nigeria suggest that the metamorphic evens tectonism, magmatism and metasomatism which the basement rocks were subjected to were the same (Rahman *et al,* 1981).

A detailed studies on the geology of the Oban Massif (Figure 3.1), can be found in Ekwueme (1985, 1987); Ekwueme and Onyeagocha (1986). The lithostratigraphy in the area varies from phyllites, schists, gneisses, migmatites and amphibolites at and around Akpet and its environs which is part of the eastern Oban Massif. Intrusive into these rocks are granodiorites, pegmatitic granites and olivine dolerites. Phyllite is a regional metamorphic rock characterized by weak foliation, lustrous, often undulating, well developed cleavage surfaces intermediate between slate and mica schist. Schists have well developed parallel orientation of minerals. Three groups of fine-grained, medium-grained and coarsed-grained schists have been identified by Ekwueme (1987) and consist dominantly of quartz, mica and chlorite. The chlorite schist which is green shows well developed schistosity.

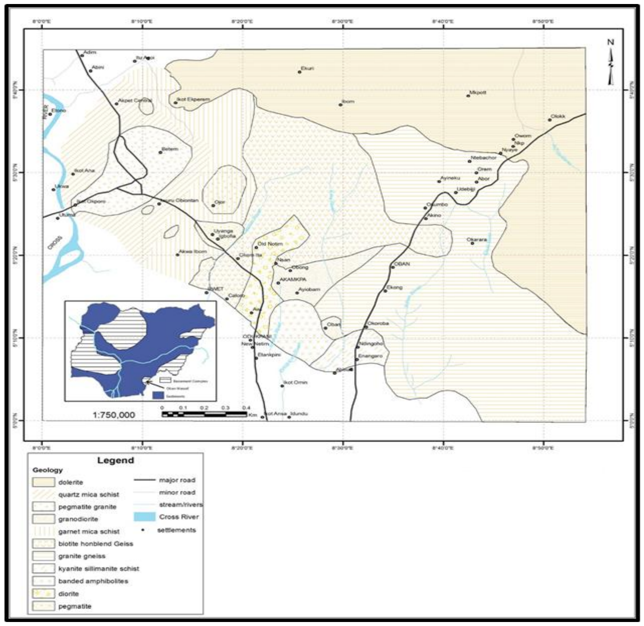

Figure 3.1: Geological map of Oban Massif modified from Ekwueme 1995

4.0 DISCUSSION

A total of fifty two (52) attitudes were mapped in and around Abung eastern part of the Oban area asw. Ekwueme (2003) identified four maxima from stereogram plot of lineaments, with dominant trend in all cases in N–S to NE–SW (0–500) and NW–SE (10°–140°) direction but this research agree in some and disagree in most of the structural attributes.

Oden (2012a) established structural features in NNW–SSE as the dominant preferred orientation and Oden *et al*, (2012) conclude that fracture lineaments of Oban massif basement area fall naturally into four principal sets, with the NW- SE set being most dominant agreeing to some most which are in disagreement confirming other forces other than tectonics of Pan Africa orogeny. This studies with attitudes of lineaments, planar and linear structures of NE/SW, NNE/SSW, NNW/SSW, NW/SE and N/S reveal deformation, metamorphism, metasomatism, magmatism and Pan Africa Orogeny as traverses were design to cut the regional trend.

The conductive and chargeable nature of certain kinds of magnetite in iron-oxide copper-gold ores was discussed by (Vella and Emerson, 2009), (Hart and Freeman, 2003) and (Esdale *et al.*, 2003).

In 2012 Vella and Emerson demonstrated that sulphide-free magnetite-rich rocks can indicate a measurable Induce Polarize response. Moreover most of Iron ores are porous and micro-porous, (Taylor, 2001) which results in high chargeability. Hence the mentioned features became a motivation to conduct electrical survey to aid mapping hematite deposit.

Two dimensional sections of resistivity and chargeability derived from dipole-dipole of survey traverses are shown, respectively. The resistivity 2-D -section is plotted on the upper part of the map for each of the lines, and the chargeability pseudo-section is plotted on the lower part. The IP data. Anomalies have IP reaches 15 msec and above, correlate with a low resistivity. The potential area for hematite ore exploration is the area with chargeability value more than 15msec. Therefore this chargeability is acceptable due to geology and lithology of the study area.

The shape of the anomaly suggests dykes and sill structures along which mineralization occurs. As is often the case, mineralization is the strongest in areas of cross– structure and demonstrated that magnetite deposit ore has been charged in all sections and correlates with electrical resistivity which can be easily tracked as marked on the sections (2.2).

5.0 CONCLUSION

The electrical response of magnetite depends on factors such as texture, grain size and quantity which can be noticeably increased by relatively small amount of sulphides (Vella and Emerson, 2012). Interpretation of the pseudo-sections shows that magnetite deposit ore has been properly charged due to porosity and consisting of a small amount of sulphides. Moreover the contrast between intrusive igneous and mineralized zone in this area provides us the desirable distinction to track mineralized zone. Results show that Induced Polarization/Resistivity method successfully mapped magnetite mineralization with magnetization as preliminary tool and provided more detailed resolution of boundaries and dips. Hence it is mapping and tracing subsurface magnetite mineralization and attitudes measurement reveal mineralization and country rocks striking and trending in.

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REFERECES

Bery, A. A., Saad, R., Mohamad, E. T., Jinmin, M., Azwin, I. N., Tan, N. M. A., Nordiana, M. M., 2012, Electrical resistivity and induced polarization data correlation with conductivity for iron ore exploration: Electronic journal of geotechnical engineering, v 17, 2981-2988.

Ekwueme B. N. (2003). The Precambrian Geology and evolution of the southeastern Nigeria basement complex, vol 39. *Calabar University Press*, Calabar, 60.

Ekwueme B. N. (1995). The Precambrian Geology of Oban Massif south - eastern Nigeria. Geological excursion guide book to the Oban Massif, Mamfe Embayment and Calabar f lank. Southeastern Nigeria. In: *31st annual conference of the Nigerian Mining and geosciences Society Calabar.* 12–16.

Ekwueme, B. N. (1987). Structural Orientations and Precambrian Deformational Episodes of Uwet Area, Oban Massif, SE Nigeria. *Precambrian Res*. 34 269-289.

Ekwueme, B.N. & Onyeagocha, A.C. (1986). Geochemistry of metasedimentary rocks of Uwet area, Oban massif, Southeastern Nigeria. *Geol. Rundsch*; 75, 411-420.

Esdale, D., Pridmore, D. F., Coggon, J., Muir, P., Williams, P., Fritz, F., 2003, The Olympic Dam copper-uranium-gold- silver-rare earth element deposit, south Australia: A geophysical case study: Geophysical signatures of South Australia mineral deposits, 147-167.

Hart, J., Freeman, H., 2003, Geophysics of the Prominent Hill prospect, South Australia: Geophysical signatures of South Australia mineral deposits, 93-100.

Hallof, P. G., 1957, On the interpretation of resistivity and induced polarization results: Ph.D. thesis, MIT, Cambridge.

Hawke, P.J., and Flis, M.F.,, 1997. Application of Electrical Techniques for Iron Ore Exploration, Exploration Geophysics 28, 242-246.

Saad, R., Adli, I., Mohamad, A. S., 2012, The study of iron ore prospecting using 2-D resistivity and induced polarization method: Electronic journal of geotechnical engineering, v 17,2981-2988.

Seigel, H. O., 1949, Theoretical and experimental investigations into the applications of the phenomenon of overvoltage to geophysical prospecting: Ph.D. thesis, University of To ronto.

Sumner, J. S., 1976, Principals of induced polarization of geophysical exploration: Elsevier scientific publishing company.

Taylor, D., Dalstra, H. J., Harding, A.E., Broadbent, G. C., Barley, M. E.,, 2001. Genesis of High-Grade Hematite Orebodies of the Hamersley Province, Western Australia, Economic Geology, 96, 837-873

Telford, W. M., Sheriff, R. F., 1990, Applied geophysics, 2nd edition, Cambridge university press.

Oden M. I. (2012a). The pegmatitic veins of western Oban Massif. Tec- tonic and lithological controls on physical properties of rocks. *J Environ Earth Sci* 4,381–389

Oden M. I., Okpukpani T. A., & Amah E. A. (2012). Comparative analysis of fracture lineaments in Oban massif and Obudu areas, southeastern Nigeria. *J Geogr Geol* 4(1):36–44

Rahaman, A. A. M S., Ukpong, E. E., & Azmantullah, M., (1981). Geology of part of Oban Massif southeastern Nigeria. *Jour. Min. Geol. 18 (1);* 60-65.

Vella, L., Emerson, D. W., 2009, Carrapateena: Physical properties of a new iron-oxide copper-gold deposit: 20th International Geophysical Conference and Exhibition, Adelaide, Extended abstracts, 1-13.