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DISCOVERY, DEPTH OF OCCURENCE AND THICKNESS ESTIMATION OF PB-ZN-FE(S) MINERALIZATION IN NIGERIA. A CASE STUDY OF NDIKPA, EBONYI STATE SE, NIGERIA.

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ABSTRACT

The lead-zinc-Iron (sulphides) mineralization within Ndikpa has been studied. The study is in response to the demands of Aubel Mining Plc. Nigeria, to undertake a geophysical investigation of the mining lease (ML17436, P.R. No. 8/96) located at Ndikpa for the possible Pb – Zn – Fe (s) mineralization. The area is located between latitude $6^0$39N and longitude 8^0 31^0E and falls within the southern part of the Benue trough of Nigeria. The trough is a sediment filled graben which is an aborted arm of a triple rift system associated with continental drift. Geologically, Ndikpa falls within the lower Cretaceous sequence of south Eastern Nigeria, corresponding to the Albian age. The formation consists predominantly of shale and silt stones, a sequence with an estimated thickness of about 1500 meters and deposited unconformably on the subsiding basement and was deformed during the Cenomanian time. The self potential (Sp) and resistivity methods were employed to find out the areas of lead-zinc-iron (sulphides) mineralization, thickness, and depth of occurrence. The instruments employed include scintrex resistivity and Sp unit (RSP 6), Digital Adler Stratameter and Sp Geometer. Traverses were run in the E-W direction covering the lease boundaries. A total of 23 Sp traverses were covered at 30 meters traverse interval. VES traverses were run at locations of interest based on favourable Sp responses.

The results of the survey indicate that the Pb-Zn-Fe(s) mineralization is associated with the anticlinal axis and are discontinuous in a N-S direction. The thickness of the ore veins measures 19.0meters and confined within the shales at an average shallow depth of about 21.08meters.

INTRODUCTION

The study is in response to the demands of Aubel Mining Plc, Nigeria to undertake a geophysical investigation of the mining lease (ML17436 P.R. No 8/96) located at Ndikpa for the possible Pb-Zn-Fe(s) mineralization.

The aim is to identify the areas of Pb-Zn-Fe(s) mineralization, estimate the depth of occurrence, thickness of the ore lode and extent of mineralization.

The study was carried out using electrical resisitivity (ER) and Spontaneous potential (Sp) methods. The Spontaneous potential is based upon measuring the natural potential differences which generally exist between any two points on the ground. Self potential range in value from a fraction of a millivolt to a few tens of millivolts, self potential sometimes attain values of the order of a few hundred millivolts, and reveal the presence of a relatively strong subsuface "battery cell", such large potentials are observed as a rule only over sulphide and graphite ore bodies. The compliment of this system is the vertical electrical sounding (VES). This is a geophysical method of determining the variation of the resistivity of the formation with depth. The resistivity of rocks vary according to their lithology (Hogue 1977). Electrical resistivity method can be used to determine the depth to bed rock beneath an overburden sediments as well as the nature and thickness of the overburden materials. In resistivity surveys, thicknesses of various layers are obtained by curve matching method or by using resistivity interpretation computer programme to obtain best fits as is applied in this work.

GEOLOGICAL SETTING AND MINERALOGY

Ikpa Izzi is located within the southern Benue trough of Nigeria (fig. 1). The Benue trough of Nigeria is a sediment filled graben which was an aborted arm of a triple rift system associated with continental drift and developed by progressive mantle plume activities (Olade 1976). Reyment (1965) described the basin as the long arm of the Nigerian coastal basin. The Cretaceous sequence in the south eastern reaches of the lower Benue trough of which Ikpa Izzi is a part, consists predominantly of shale and silt stones-a sequence with an estimated thickness of about 1500 meters (Tattam 1950). Sediments of the Asu River group were deposited uncomformably on the subsiding basement topographic depressions during the first marine transgression into the trough (Burke et al 1970). Sediments belonging to this group were possibly deformed during the Santonian (Nwachukwu 1972). There is no surface expression of the mineralization in the area. The shales host the lead-zinc and shows no lateral changes. Galena and sphalerite are the two principal minerals of economic importance, while the associated gangue minerals include Quartz, siderite, pyrite, chalcopyrite Azurite and Malachite. The stratigraphic sequence of the lower Benue basin is shown in table 1. During the Santonian, Albian and Turonian, sediments were deformed along NE trending axis producing numerous gentle folds with anticlines transected by several NW and N trending tensional faults and fractures (Benkhlli 1987). These deformational features constitute traps for the migration of hydrothermal fluid, which crystallize into lead-zinc. The general geology of Abakaliki area is referred in both published and unpublished works of Roberts (1953), Orajaka (1977), Ofoegbu (1985), Ezepue (1979) among others.

METHOD OF INVESTIGATION

A combination of electrical self potential (Sp) and resistivity mehtods were employed. The instruments used in the verification include scintrex resistivity and Sp unit (RSP 6), Digital Adler Stratameter and Sp Geometer. A prismatic/clino compass was used as support instrument in order to maintain straightness and orientation of traverse lines and for measuring the attitude of the beds (Dip and Strike).

A total of 23 Sp traverses were covered at 30 meters traverse interval. The area under investigation was divided into Axis A and Axis B and they were used in naming the traverses. The length of each traverse was limited by the extent of the ridge at the traverse location. The traverse was run in the direction East-West cutting from CB_1 to CB_2 figs 2 and 3 of the exploration maps 1 and 2 respectively. The positions of the Sp responses on each traverse axis was

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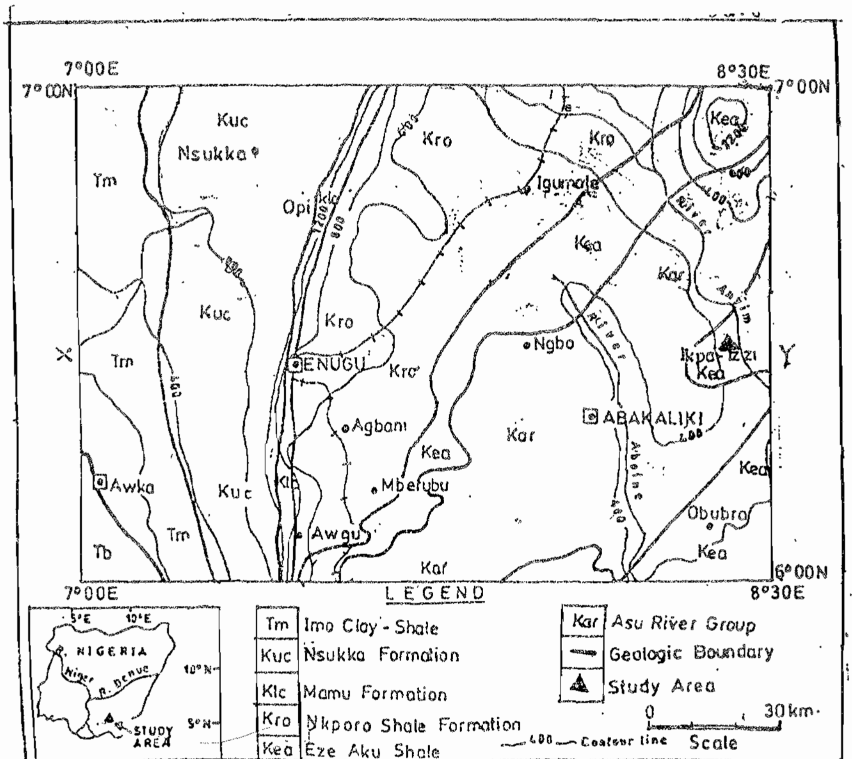
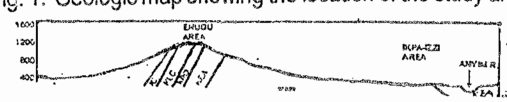


Fig. 1: Geologic map showing the location of the study area a



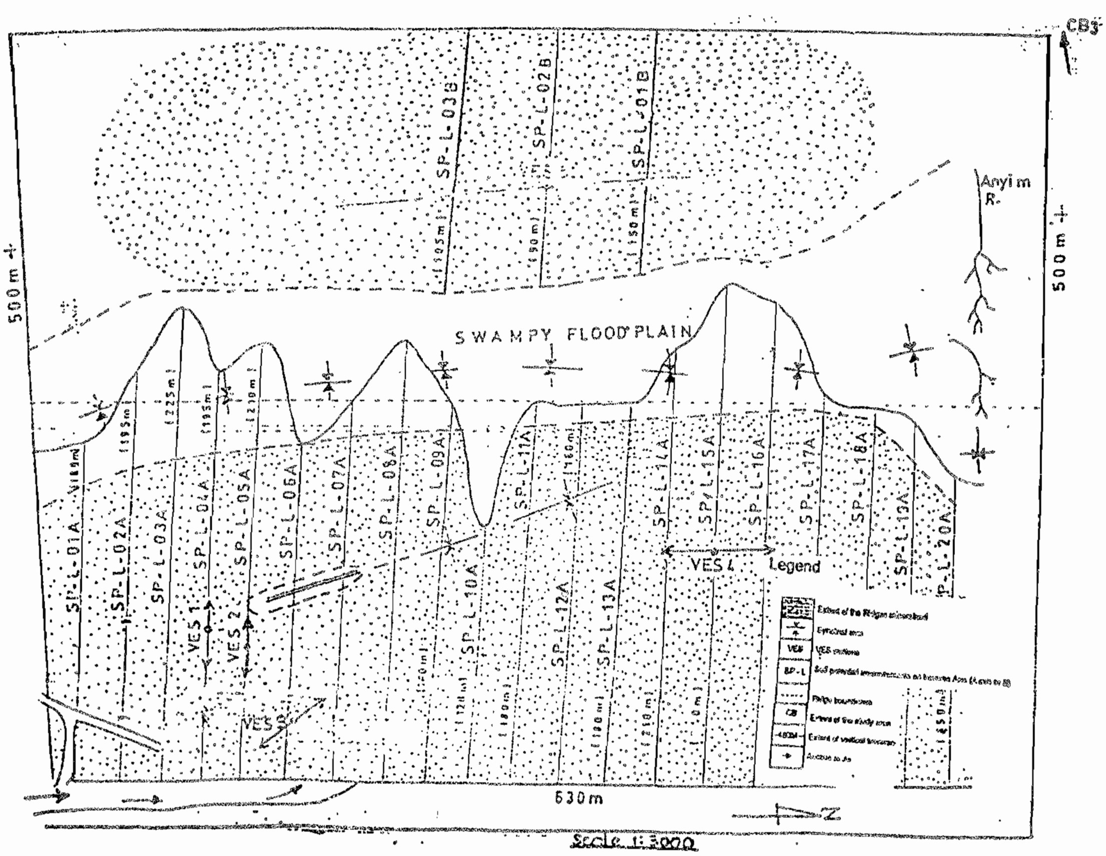


Fig. 2: EXPLORATION MAP - 1

IKPA IZZI

TABLE 1: CRETACEOUS STRATIGRAPHIC SUCCESSION IN THE BENUE TROUGH OF NIGERIA. ADOPTED FROM REYMENT 1965

AGE	FORMATION		
	LOWER BENUE	MIDDLE BENUE	UPPER BENUE
LATE MAASTRICHTIAN EARLY	NSUKKA AJALI MAMU	LAFIA	GOMBE
CAMPANIA SANTONIAN CONIACIAN	NKPORO SHALES MAJOR UNCOMFORITY (DEPOSITIIONALEPISODE) AWGU SHALES	AWGU SHALES	NUMANAH
LATE TURONIAN TO EARLY	EZEAKU SHALES	EZEAKU / MAKURDI	PINDIGA YOLDE
LATE CENOMA- NIAN TO EARLY	??????	KEANA	BIMA SAND STONES
LATE ALBIAN TO MID ? ?	ASU RIVER GROUP (Shale, sandstone lime Stone)	AWE ASU RIVER GROUP (SHALE SANDSTONE LIMESTONE	? ? ?
PRE-ALBIAN	BASEMENT	ROCKS	

Table 2 SP responses along the A and B Axis.

Traverse No	Mineralised Zone	Traverse No	Mineralised Zone
SP-L-01A	No Indication	SP-L-014A	Between 75-135m
SP-L-02A	No Indication	SP-L-015A	Between 90-150m
SP-L-03A	Between 90-105m	SP-L-016A	Between 60-120m
SP-L-04A	Between 90-120m	SP-L-017A	Between 60-90m
SP-L-05A	Between 90-105m	SP-L-018A	Between 45-75m
SP-L-06A	Between 0-60m	SP-L-019A	Between 60-90m
SP-L-07A	Undefined	SP-L-020A	Between 0-120m
SP-L-08A	Between 30-60m	SP-L-01B	Undefined
SP-L-09A	Between 0-30m	SP-L-02B	Undefined
SP-L-010A	Undefined	SP-L-03B	Undefined
SP-L-011A	Between 90-105m		
SP-L-012A	Between 45 – 75m		
SP-L-013A	Between 60-90m		

narked and later joined and this shows the mineralized zones fig. 3). The Sp measurements were complimented with four vertical electric sounding (VES) measurements. VES raverses were run at locations of interest based on favourable Sp responses.

RESULTS

The results of the SP measurements figs 2,3 and able 2 show favourable responses at different vertical distances along fifteen traverses within the A axis namely traverses 3,4, 5,8,9,11,12,13,14,15,16,17,18,19 and 20 (Table 2). The three traverses conducted within the B – axis show no SP response and are therefore undefined. Traverse 3A shows mineralization from 90-105metres traverse 4A shows mineralization from 90-120metres. Traverse 5A (90-105m) Traverse 6A (0-60m), traverse 8A (30-60m), Traverse 9A (0-30m), traverse 11A (90-105m), Traverse 12A (45-75m).

Traverse 13A (60-90m); Traverse 14A (75-135metres), Traverses 15A (90-150metres) Traverse 16A (60-90m), Traverse 20A (0-120m). All the traverses within the B axis show no SP response, and are therefore undefined. Also traverse 1A, 2A, 7A and 10A within the A axis show no SP responses and are therefore undefined. The SP responses when displayed in a spectral array shows the distribution of the SP response across the area fig 4 and when these anomalous values are contoured and the cross section drawn, the highest

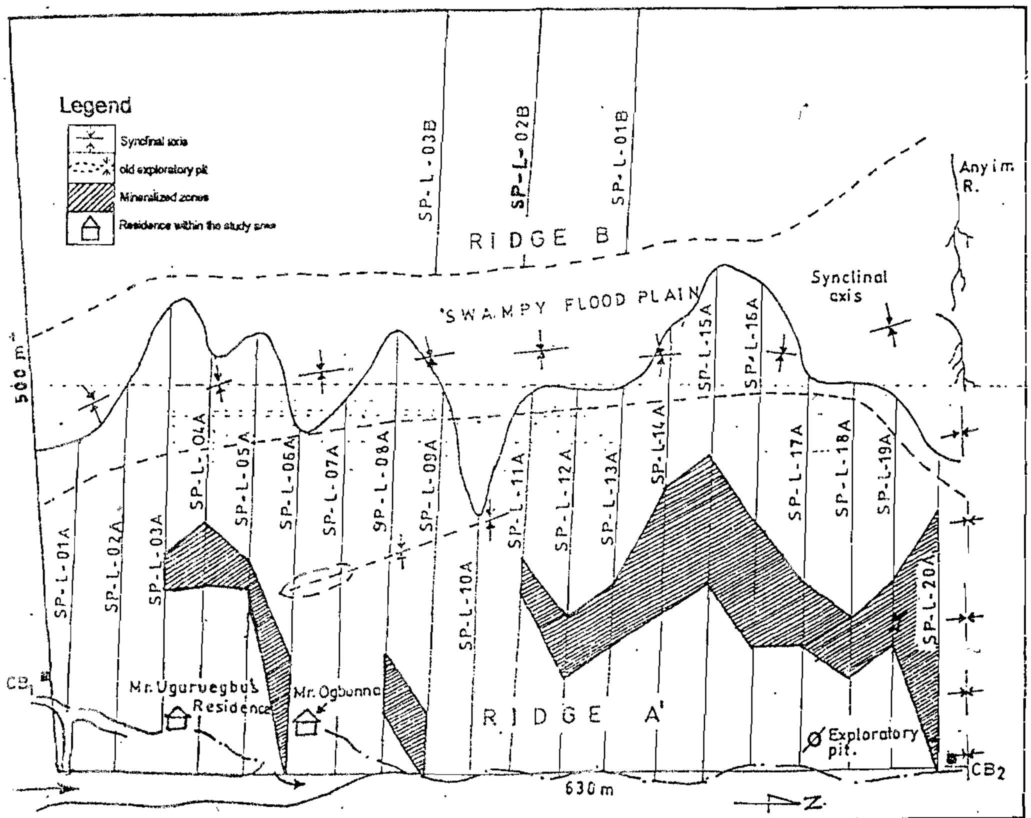


Fig. 3; EXPLORATION MAP - 2

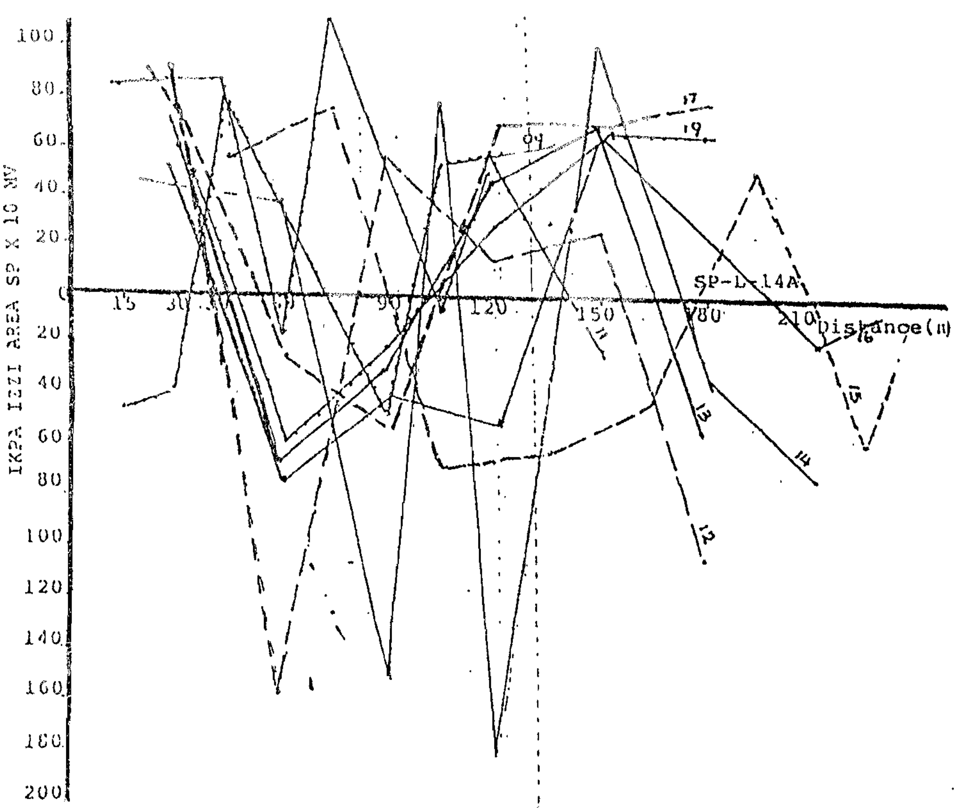


Fig. 4. SP Responses I n spectral Display Ikpa Izzi Area

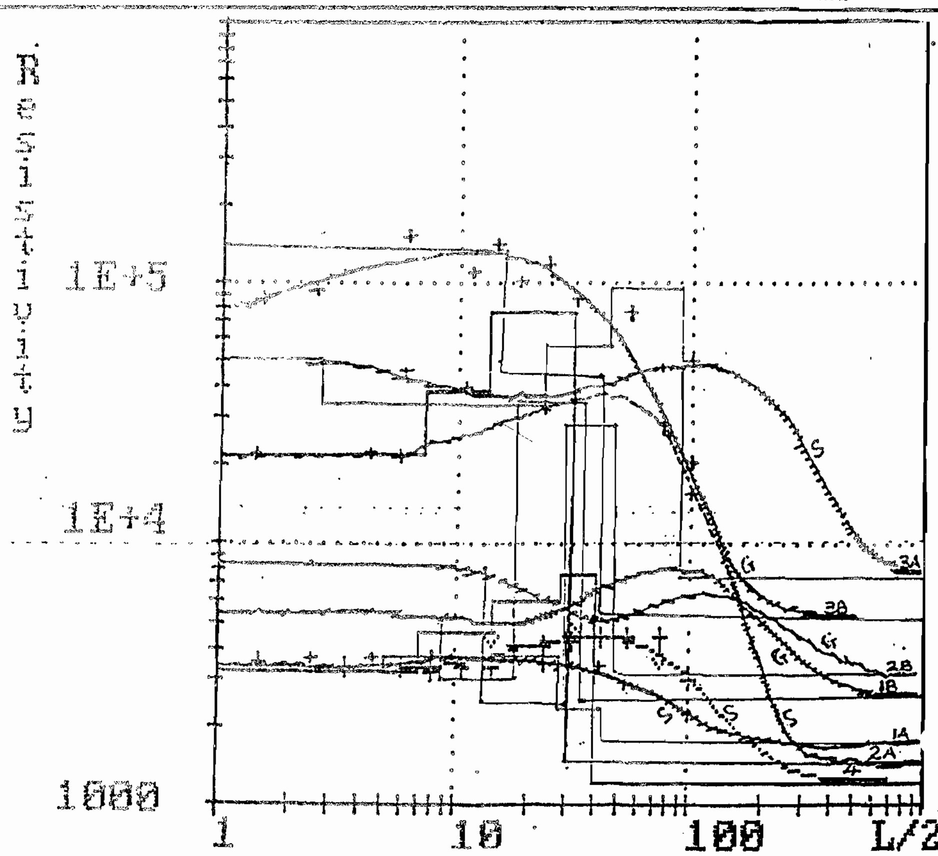


Fig. 5: VES Curves of Ikpa Izzi Computed form scrintex and Geometer

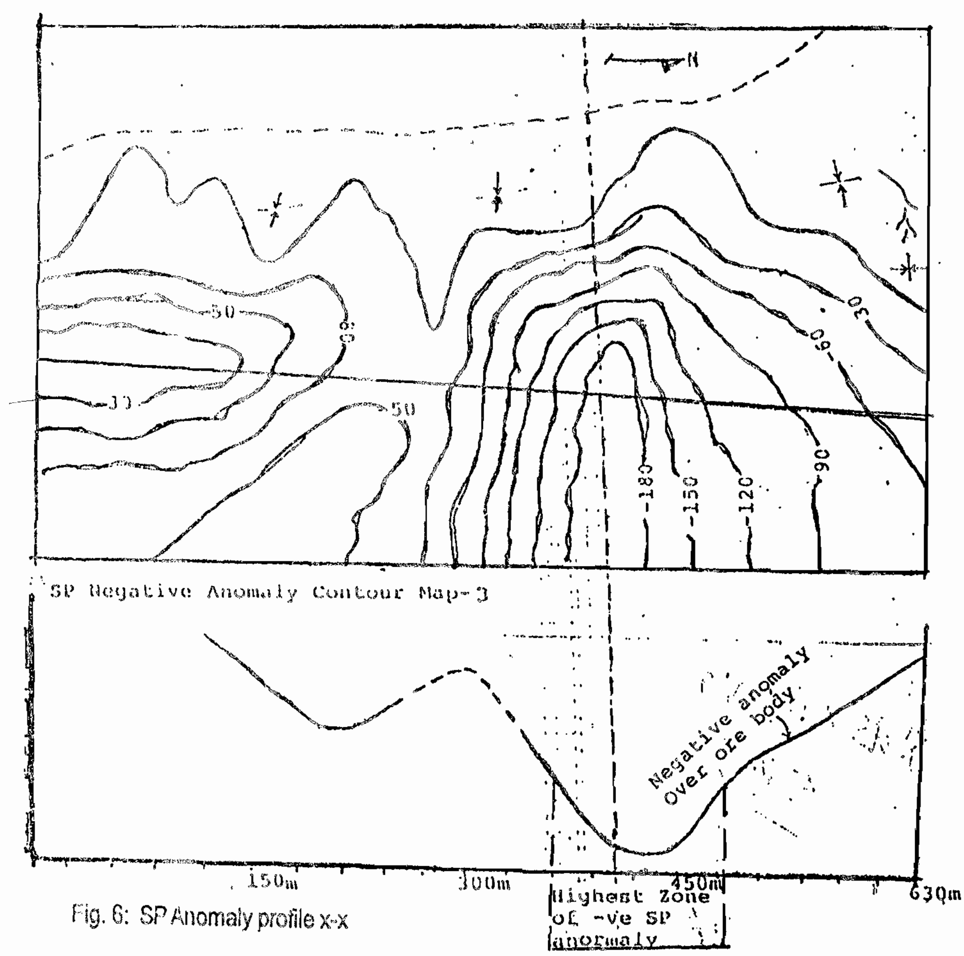


Fig. 6: SP Anomaly profile x-x

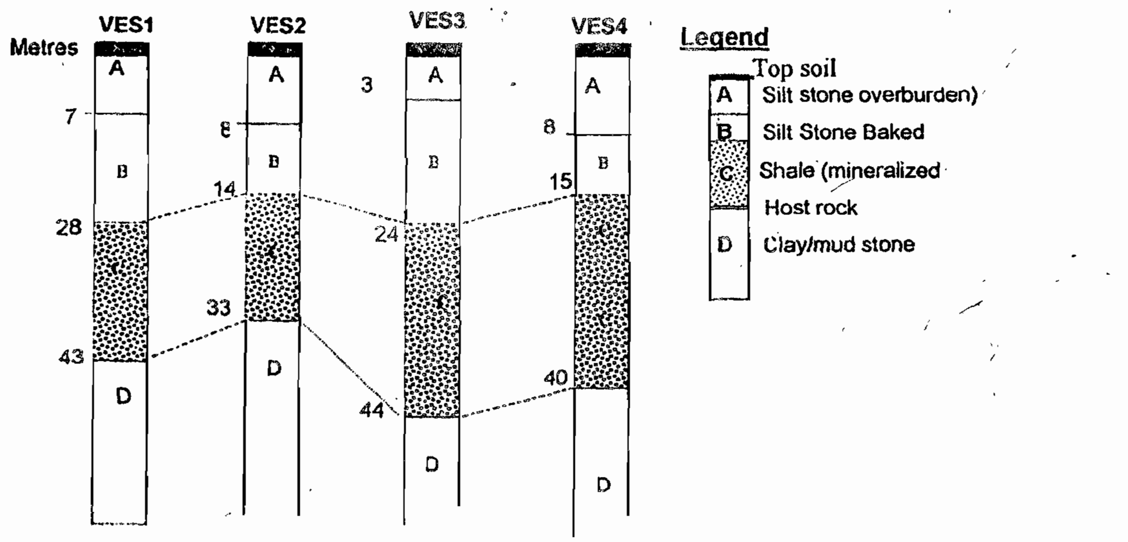


Fig 7: Thickness and correlation of the mineralized units computed from VES 1-VES 4.

Table 3: Vertical lithologic characteristics computed from 4 VES sounding result at the areas of favourable SP response.

VESIA

Depth Metres	LITHOLOGY
0-6.6	Silt stone (overburden)
7-27.6	Silt stone (Baked)
28-42.4	Shale mineralized Host rock
>43	clay/mud stone

VES 2A

Depth (Metres)	LITHOLOGY
0-7.4	Silt stone (overburden)
8-13.7	Silt stone (Baked)
18-33.5	Shale mineralized Host rock
>34	clay/mud stone

VES 3A

Depth (Metres)	LITHOLOGY
0-2.6	Silt stone (overburden)
3-23.2	Silt stone (Baked)
24-43.5	Shale mineralized Host rock
>44	clay/mud stone

VES 4A

Depth (Metres)	LITHOLOGY
0-7	Silt stone (overburden)
8-14.3	Shale Possible
15-28	Shale mineralized
29-39.5	Shale (mineralized
>40	clay/mud stone

zone of negative SP anomaly appears fig 6. The result of the four VES soundings computed using Schlumberger computer analysis package indicated the nature of the vertical lithology; depth and thickness of the formations including the Pb-Zn-Fe(s) mineralization Table 3, and when represented and correlated on a lithologic geoelectric cross section, the distribution of the areas of mineralization are reconstructed fig 7. The Pb-Zn-Fe(s) mineralization is hosted by the shale horizon at an approximate average depth of around 21.08metres.

From table 3, the average depth and thickness of the mineralized shale is calculated as: Average depth to the mineralized shale unit in A axis = (28+14.3+24+18)/4=21.08m Average thickness of the mineralized shale unit in A axis= (43-28)+ (34-18) +(44-24)+(40-15) $= \frac{76}{4} =$ 19.0metres

The above computation indicates that about 19.0metres thickness of the mineralized shale should be exploited after excavating 21.08metres of the over burden siltstone.

SUMMARY/RECOMMENDATION

The area is mineralized to an appreciable extent. The lithology consists of a sequence of top soil, siltstone and shale. The shale is the host rock for Pb-Zn-Fe(s) mineralization. The average depth to the ore lode is 21.08 metres while the thickness of the ore bearing shale is 19.0 metres. The siltstone which overlies the shaley formation (host rock) is of considerable thickness and varies between 14 metres to 24 metres.

Test drilling is recommended for the area as to confirm the findings and obtain samples for grade determination. If this approach is favourable then mine openings and exploitation should commence. Emphasis should be laid on areas of favourable Sp responses and this must take into consideration the entire thickness of the shaley horizon which harbours the ores oriented in the N-S direction.

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