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SP AND VES RESPONSES OVER PB-ZN AND ASSOCIATED SULPHIDES MINERALIZED ZONE OF IZZI AREA, NIGERIA

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ABSTRACT

Lead-Zinc mineralization in some parts of Izzi area has attracted a number of private miners into the area. The miners can not be said to have been very successful. This is due to the nature of mineralization which occur in isolated vein-lodes that are fracture controlled. Their information on the mineralization or prospecting has been based on reports of Villagers, Shallow hand-dug pits and of douncing rod exercise. Results of 30 electric Self Potential (SP) measurements at two prospective zones of the locality has positive responses for Sulphide mineralization indicated by high negative SP anomaly along two separate bands. The trend of anomaly shows prospective zones of mineralization in the North-South axis across the area, with dip direction towards the North, following the trend of the shale host rock and along the two prospective bands.

Result of seven Vertical Electric Soundings (VES) show that the overburden material to the shale host rock consisting of Sandy-Siltstone and Shaly-Mudstone has average depth between 25-39m, given thickness of 11-19m across the area.

The Shale host rock is classified into three layer-zones based on resistivity value. A non mineralized zone, with resistivity value less than 3000 (ohm-m). A mineralized zone with resistivity value between 3000 to 5000 (ohm-m) where sphelarite (Zinc ore) is predominant and a highly mineralized zone with resistivity value between 6000 to 8000 (ohm-m) where Galena (lead ore) is dominant. The two bands are due to faulting . Band A at the down throw portion of the fault corresponds to the topographically low area and Band B at the upthrown, corresponds to high topography zone of the study area.

Key words: Fault-fractures, Vein-lodes, Dip, Contours, Resistivity, Geo-Electric Section, Anomaly and Mineralization Potential.

INTRODUCTION

Izzi area in the South-West of Abakaliki, the capital of Ebonyi state is approximately located within latitudes $8^0 15^1$ S and longitudes 6^0 00^1 to 6^0 15^1E (fig.1).

Exploration and mining activity in the prospective lead-zinc mineralized zone of the area has started many years ago following discovery of sphalerite nodules by some villagers who embarked on hand digging of water wells or pits. Some individual prospectors have based their exploration on responses obtained from a pair of douncing rods. Consequently early miners who relied on such information as given by the villagers and reports of douncing rod prospecting abandoned their pits. This was due to lack of proper knowledge of the subsurface complexity in respect of depth, trend and nature of mineralization.

Geophysical prospecting by Electrical method through Sp responses has been used successfully to indicate presence of sulphide ores in many localities. Mineralization potentials are the main interest when prospecting with the self potential method.

The method has been used successfully in areas associated with sulphide ores of metals and sometimes with graphite and metal oxides, such as magnetite (Sata and Mooney, 1960). The potentials are associated with weathering of sulphate minerals, variation in rock properties at geologic contacts, bioelectrical activity, thermal and pressure gradients in the subsurface (Stern, 1945).

Dobrin and Savit, (1988) Telford et al, (1990) all discussed the origin of selfpotential anomaly of an ore body, to depend on differences in oxidation potential above and below the water table. They stated that self potential, sometimes in order of few hundred millivotts are measured where they intercept the ground surface. They confirmed that potentials, invariably of negative values show over sulphides. Lowrie, (1997), stated that the self-potential associated with an ore body is its mineralization potential. He confirmed that SP anomalies across ore bodies are invariably negative and most commonly associated with

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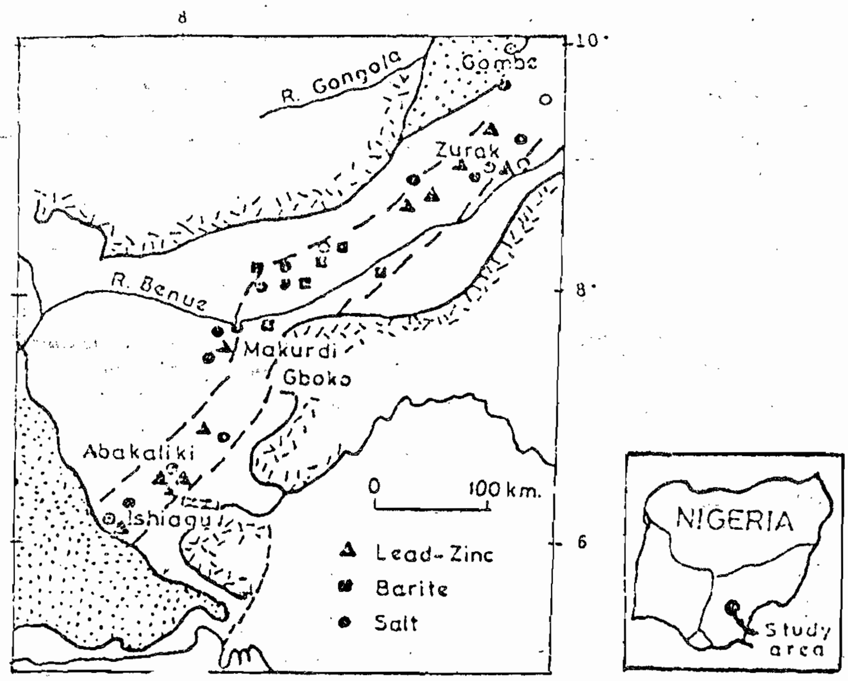

Fig.1: Showing the study area and the mineralized zone of Abakaliki district

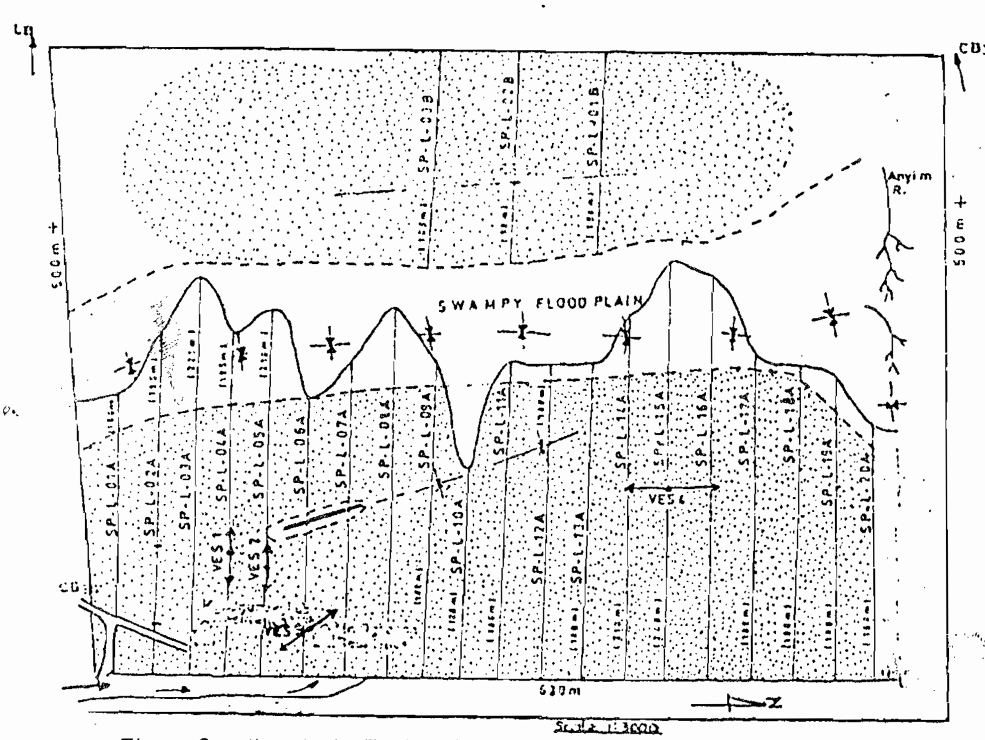

Figure 2 Ikpa Izzi - Exploration Map

Sulphide ores and some metallic oxides.

In all, the above workers hold self-potential as a feature of a stable system that can only be disturbed when electrical connection is made between the host rock and the Sulphide ore, through non polarizable electrodes. They have generally considered two field methods namely; the gradient and the total field methods. The gradient method which employs fixed separation between two electrodes and the SP measured between the electrodes after which the pair is

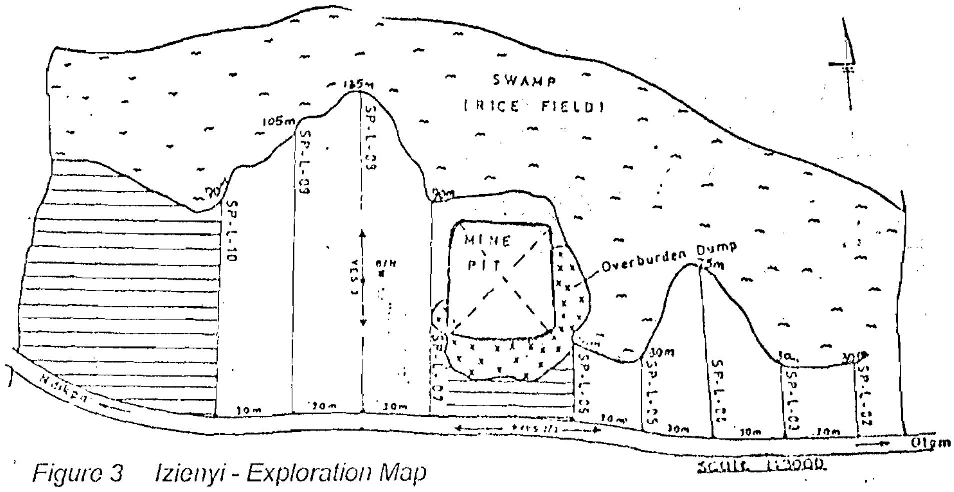

Figure 3 Izienyi - Exploration Map

moved forward along the survey line. Simultaneously the trailing electrode now occupies the location previously occupied by the leading electrode on same separation.

The total field method however involves the use of a fixed electrode positioned at a base station outside the area of exploration and a mobile measuring electrode. Here total potential is measured directly at each station of the mobile electrode. The mobile electrode is further moved with the connecting wire to another station at constant intervals. According to Lowrie, (1997), the gradient method though may be associated with cumulative error, is most preferred in difficult terrains. Consequently, the gradient method is hereby considered.

GENERAL GEOLOGY OF THE AREA

The Cretaceous Sediments of the Study area consist of poorly bedded shale's with sandstones and sandy limestone lenses belonging to the Asu River group. The sediments are found, associated with the Abakaliki fold belt. The transform fault, which according to Whiteman, (1982) may have been active from early Cretaceous to Santonian time when Abakaliki zone may have opened and closed produced the fold belt. Dips on anticline flanks of the fold are variable and as low as 5^0 within Abakaliki North-west. Dips in the lead-zinc mineralized area within the South of Abakaliki is as high as 80^0 to 90^0.

The fold belt host both extrusive and intrusive igneous rocks which consists of diabase, syenite and in some cases gabbro. McConnel, (1949); Farrington, (1952); Gunthet and Richard (1960), Burke (1971), Murat (1971) and Nwachukwu (1972) etc have discussed the geology and minerialization of lead-Zinc ore deposit along the

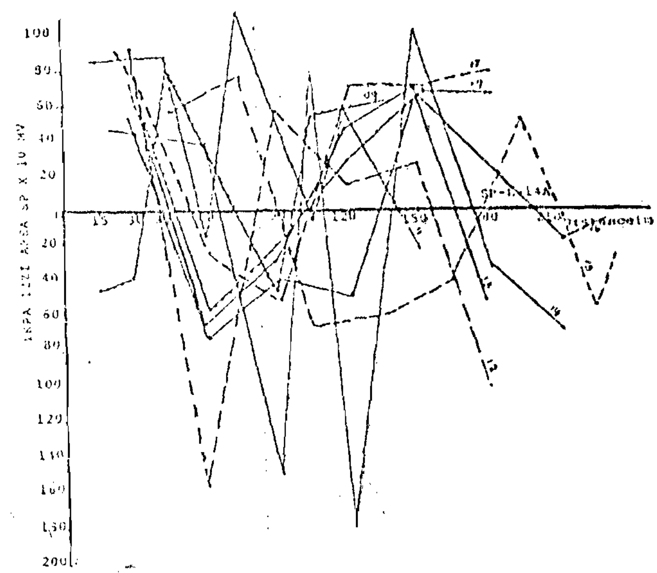

Figure 4 SP Response in spectral Display Ikpa Izzi Area

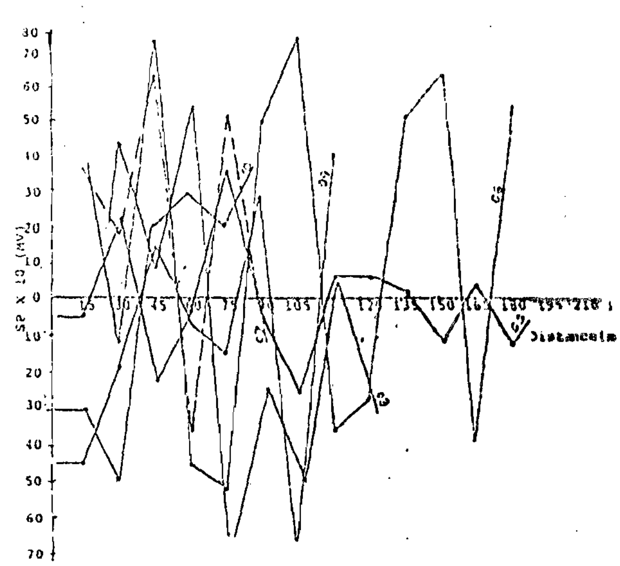

Figure 5 SP Responses in spectral Display Izenyi Area

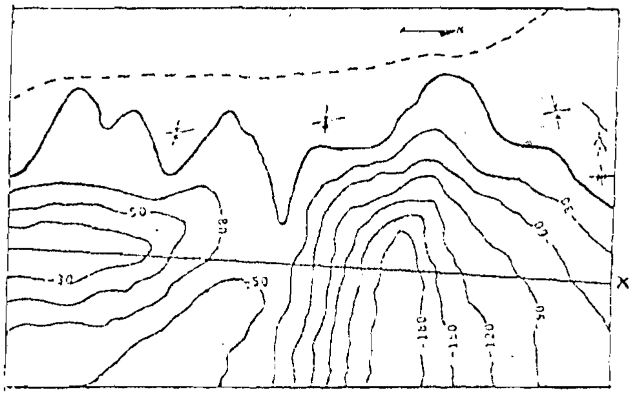

Figure 6a *SP Anomaly Contour Map*

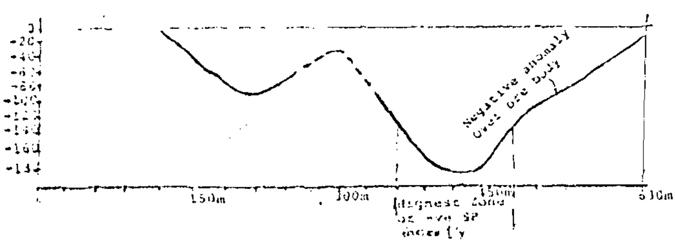

Figure 6b *SP Anomaly Profile x-x*

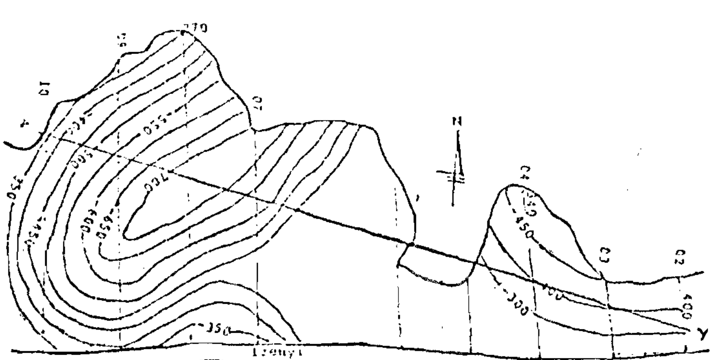

Figure 7a *SP Anomaly Contour Map*

Figure 7b *SP Anomaly Profile y-y'*

fold belt which covers a total length of more that 209 kilometres and more than 129 kilometres wide from Ishiagu, near Okigwe (Fig. 1). Low temperature origin has been suggested for the ore deposit due to close association of the Pb-Zn deposit with saline springs. The materialization is fracture controlled and two main sets of fractures are already identified; The first set which cuts the anticlinal axis almost at right angle and second set of fractures, though less developed are associated with jointing.

The minerals associated with the lead-Zinc ores include chalcopyrite, marcasite, siderite, Calcite, Quartz and Barite. It was observed that the earlier intrusives were unmineralized by sulphides except pyrite.

FIELD TECHNIQUES

Scintrex Resistivity and Self potential Unit (RSP-6) and digital Geometer were used to conduct SP and VES measurements.

A total of 30 SP traverses were covered at 30m interval. Length of each traverse was limited by the foot of the fold belt traversing the area. Twenty-one traverses were run in the East to West direction within Ikpa Izzi area (Fig. 2) and nine in the North-South direction within Izenyi area (Fig. 3).

The SP measurement was followed by four VES in Ikpa Izzi area and three in Izenyi area. VES measurements were run at locations of interest, based on favourable SP responses, as shown in exploration maps (Fig. 2&3)

Due to the rugged terrain, two potential electrodes were moved simultaneously at regular intervals of 15m and occasionally 30m without change in their polarity. (The gradient method).

For the VES, Schlumberger electrode configuration was used for a minimum half electrode spread ($^L/_2$) of 100m.

A prismatic compass was used for the traverse survey, thereby maintaining straight traverses in all cases. Traverse lines were cut prior to measurements. The two instruments were used simultaneously in some traverses and readings were cross-checked to ensure accuracy.

DATA PROCESSING

After data collection, SP values in millivolts, as recorded with the two instruments were plotted and compared. A graph of millivolt against measurement point for each traverse was produced. It was observed that a good number of the graphs showed spectral movement or cuts into the positive and negative regions of the graph. The graphs which show predominant negative anomaly were properly identified in Fig 4

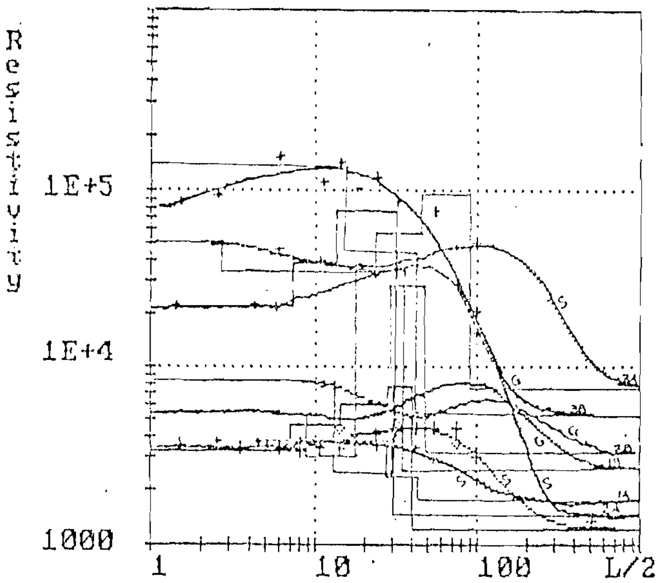

Figure 8 VES curves of Ikpa Izzi

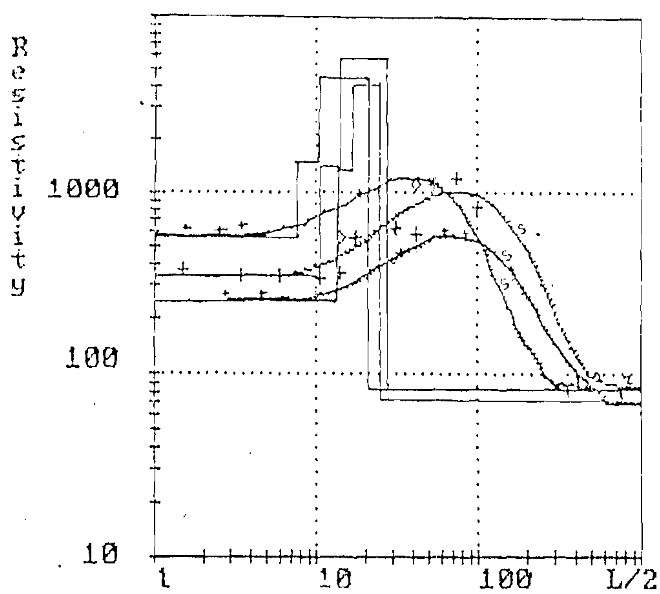

Figure 9 VES curves of Izenyi

and 5 for Ikpa Izzi and Izenyi respectively. Values of the negative responses were later posted against their measurement points in the respective traverses. The posted values were contoured, to produce SP anomaly contour maps (Fig. 6a) for Ikpa Izzi and SP anomaly contour map (Fig. 7a) for Izenyi area. To observe the anomaly signature or geometry, Cross-Section X-X[1] was made in the Ikpa Izzi area and Y-Y[1] for Izenyi area giving the SP anomaly curves (Fig. 6b and Fig. 7b) respectively.

The VES data was subjected to computer processing technique, using the Schlumberger VES automatic analysis package developed by Henkel, (1982). A graph of apparent resistively against $L/2$ for each VES was produced with details of their subsurface layers and corresponding resistivity and depths. Thereafter, the seven VES curves for Ikpa Izzi area were superimposed onto VES traverse 4 computer graph to produce Fig. 8 while the three VES curves of Izenyi area were superimposed onto VES traverse 2 computer graph to obtain Fig 9. VES readings were taken simultaneously with the two instruments for some traverses and plotted as shown. This was for purposes of comparing performance of the instruments. The identical nature of the curves and the apparent consistency of results are observed.

RESULTS

In each of the locality, two distinctive veins can be identified oriented in the direction North South. The two veins are designated Band A and B (Fig. 10).

Baked Siltstone-Mudstone with relatively higher resistively than the ordinary siltstone is mainly identified at higher elevations within the study

Table1: VES Result, Ikpa Izzi
(**) = Mineralized, (*) = possibly Mineralize

VES	Geo-Electric Layer	Layer Resistivity ohm-m	Depth (m)	Lithology
1	1	19.74.0	7.5	Silty sand
	2	2000.0	22.5	Siltstone
	3	2900.0	38:0	Baked Siltstone
	4	924.0	-	Clay-Mudstone
2	1	1530.0	10.1	Silty Sand
	2	2008.0	21.2	Baked Siltstone
	3	3240.0	39.4	Shale
	4	217.5	-	Clay-Mudstone
3	1	725.0	0.8	Silty Sand
	2	1420.0	15.7	Siltstone
	3	1444.0	42.8	Siltstone
	4	53.3	-	Clay
4	1	3300.0	7.0	Shaly-Siltstone
	2	4600.0	14.3	Shale-Mudstone
	3	5960.0	28.1	Shale-(*)
	4	7710.0	39.0	Shale (**)
	5	1220.0	-	Mudstone

Table 2: VES Result, Izenyi Area.

VES	Geo-Electric Layers	Resistivity (nm)	Depth (m)	Lithology
1	1	567.0	7.4	Siltstone
	2	1460.0	10.5	Shaly-Mudstone
	3	4490.0	20.0	Shale (*)
	4	84.0	-	Clay
2	1	335.0	10.8	Siltstone
	2	1390.0	14.3	Shaly-Mudstone
	3	5810.0	27:7	Shale (**)
	4	83.0	-	Clay
3	1	236.0	13.7	Siltstone
	2	1320.0	17.1	Shaly-Mudstone
	3	4030.0	26.4	Shale (°)
	4	82.0	-	Clay

Table 2; VES Result, Izenyi Area.

area. The topographically low sections of the area are predominantly shaly. Overburden depth across the area varies between 14-28m and followed by the shale host rock which has average thickness of about 11m across the area (Table 1-2).

Absence of the near surface baked siltstone at low elevations in the area and the relative displacement of the prospective shale unit show evidence of faulting with large throw. The mineralized shale unit found at higher elevations consist predominantly of Quartz, Sphalerite and Siderite as in the equivalent upper mineralized shale of the low portion. The very lower shale unit (28-39m), predominantly hosts the Galena (Table 1-2). The asymmetry shape of the SP anomaly curves, along the profiles suggests that the ore body dips toward the North. Position and characteristics of the prospective bands have been illustrated in the geo-electric sections of the two prospective areas (Fig. 10). Relative displacement confirms Izenyi to be less prospective located on the upthrown axis while Ikpa Izzi located on the downthrown area is more prospective.

RECOMMENDATION

Exploratory holes should be drilled along and within the area designated as highest zone of negative SP anomaly. A core rig is most adequate for this exercise. Exploratory holes should penetrate total depth of the mineralized

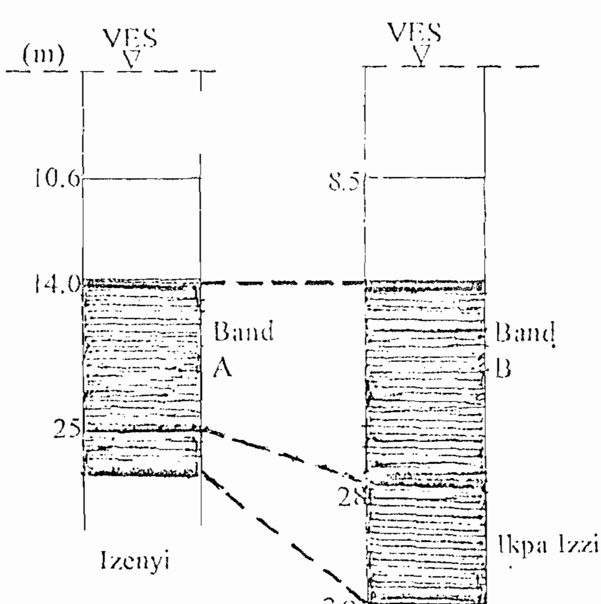

Figure 10 Correlation of band A & B between Izenyi and Ikpa Izzi areas.

shale unit. The economic potential of the study area in respect of lead-Zinc and other associated Sulphide minerialization is attractive.

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