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Full Length Research Paper

A Ground Integrated Geophysical Exploration for Sulphide Ore Deposits. Case Study: EPL A40 Mine Field, Lower Benue Trough, Nigeria

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An integrated ground geophysical exploration for sulphide ore deposits has been undertaken at the EPL A40 mine field, Lower Benue Trough, Nigeria. The mine field is about 5sqkm, underlain by two main geologic units. The Abakaliki Shale and the Ezeaku Formation. Self Potential, Resistivity and Electromagnetic methods were utilized. Data was interpreted using surfer 8 computer software and Ms Excel tool Kits. Iso-contour maps of Self Potential, Resistivity and Electromagnetic (EM-VLF) values and profile plots for anomaly variations were constructed. Results show good anomaly match across Self Potential and Electromagnetic data sets with a corresponding high apparent resistivity values which is indicative of sulphide ore deposits. Trend orientations of anomaly peaks occur roughly NW – SE and NE – SW in a cross – cutting stress pattern.

Keywords: Self potential, apparent resistivity, Electromagnetic, Anomaly, Stress pattern.

INTRODUCTION

The project site, EPL A40 mine field is located at Ishiagu in Ebonyi State (Figure 1). It lies within the geologic complex called the Lower Benue Trough. Mineralization at Ishiagu is quite intense as the area is dense with mining activities. Exploration for sulphide ore deposits (Lead – Zinc – Silver) at Ishiagu have been based on surface outcrop/vein location and hand picking of the Lead – Zinc minerals. Between 1948 and 1949 the inhabitants of the area produced about 11tons of handpicked Lead – Zinc (Cotsworth, 1949). Ground geophysical exploration data in the largely does not exist. Surface indications largely do not exist. Hence, the need for surface geophysics to be done is very expedient. The study involved an integrated geophysical approach for Lead – Zinc Silver ore deposits exploration, using Self potential, Resistivity and Electromagnetic methods.

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Physiography

The study area comprises of isolated conical ridges, deep gully valley and lowlands (figure 2). The ridges range in height from 60m to 90m above sea level. The area is practically drained by two rivers: Iyi Odu and Ikwo rivers. Climatically,

The study area falls within the forest belt climatic zone. This zone is characterized by relatively warm to hot temperature day of 36 to 40^{0}C and moderately cool nights of 17 to 28^{0}C. And vegetation is characterized by sparely vegetative cover on the high ridges and stunted trees at lowland areas.

Geology

Ishiagu area is underlain predominantly by Shale strata of the Asu River Group (Albian) which pass uncomformably upwards into Sandstone and Shale units of the Ezeaku Formation (late Cenomanian – Turonian) (Ezepue, 1984; Reyment,1965; and Burke, Dessauvagie and Whiteman, 1972; Nwachukwu,1972).

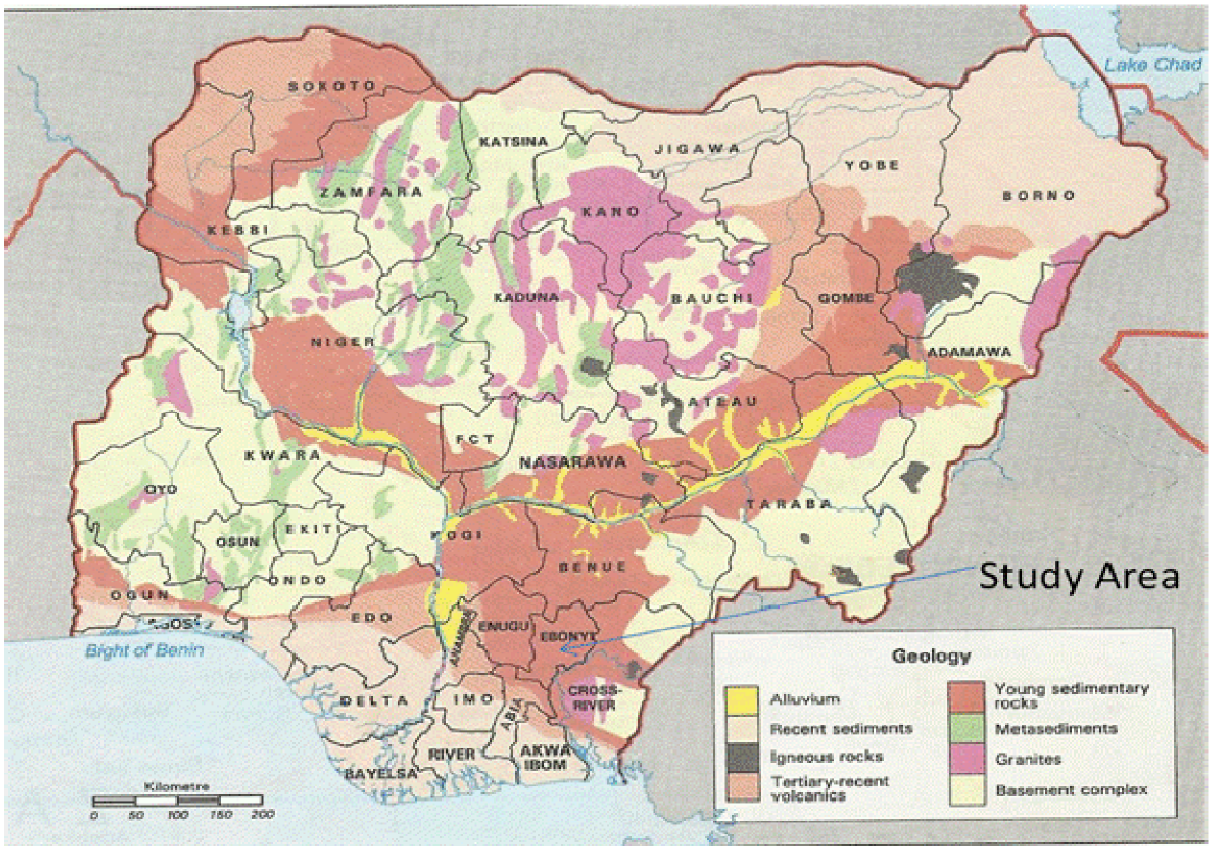


Figure 1. Geologic Map of Nigeria showing the location of study area (Balogun, 2000).

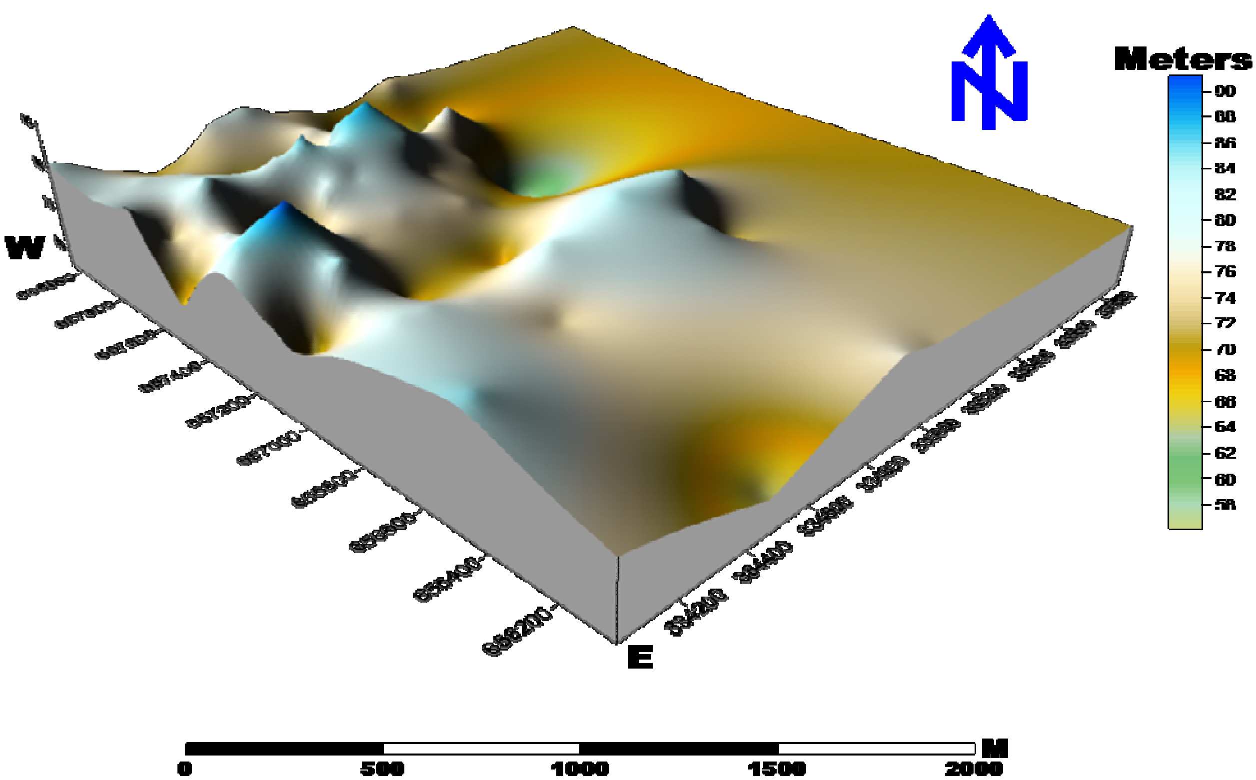


Figure 2. Surface map of the study area.

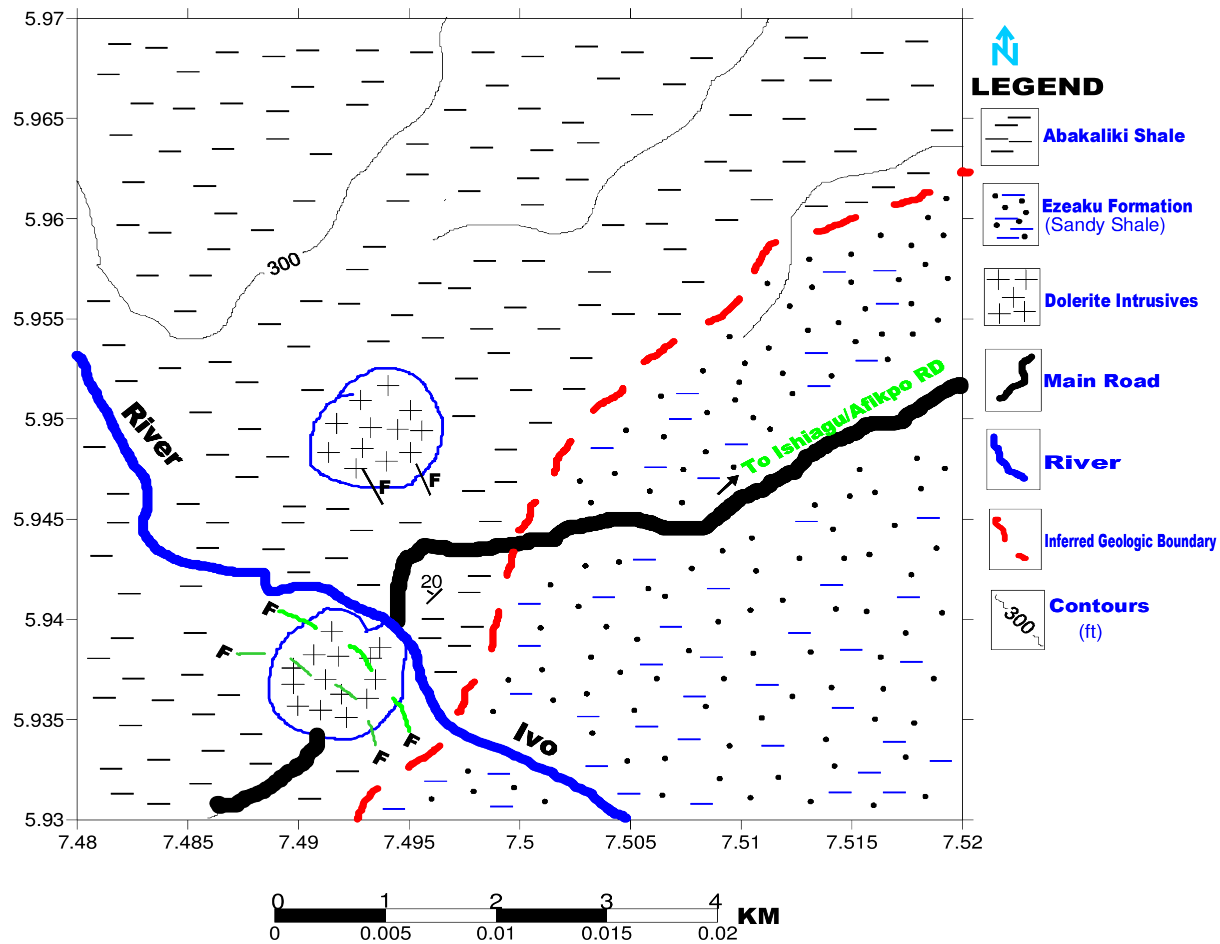


Figure 3. Geological Map of the study area.

The A40 mine field is practically underlain by the Shale/Sandstone facies of Asu River Group and Cretaceous intrusive (figure 3). The Asu River Shale (Abakaliki Shale) is typically dark grey and finely laminated, it alternates with carbonaceous and distinctly fissile clay and silt bands. While the Sandstone unit of the Ezeaku Formation exposed at the northern and southern parts of the study area is generally grayish white (turned brown by weathering) fine – grained and poorly sorted. The intrusive rocks are of intermediate to basic compositions and occur in the Albian Shales. Field relations show that the Igneous bodies in the zone of mineralization have been emplaced parallel to the enclosing shale; so they are sills. A representative sample of these sills is leucocratic to mesocratic, fine-grained and slightly porphyritic.

METHODOLOGY

Data Acquisition and Interpretation

In the present study, acquired co – ordinates (Longitude and Latitude) from mine cadastral, was used to locate the A40 mine field in a Topographical map. The area was extracted and gridded into areas equal squares with probe points and numbers (Figure 4). Ground geophysical survey was carried out over the delineated area using Resistivity, Self Potential and Electromagnetic methods.

The Wenner configuration (Maillet, 1947) was used for the resistivity profiling. Readings were taken simultaneously with the self potential. The high resolution versatile ABEM SAS 4000 was used. The very low frequency (VLF) technique was utilized for the electromagnetic survey. The ABEM WADI EM-VLF equipment was used. Surfer 8 and Microsoft Excel software were used to generate contour maps and the profile plot. The interpretation was basically qualitative (Mcneill and Labson, 1992; Yungul, 1950; Wright, 1988) across all dataset. Data profile and contour map variations were carefully observed for anomaly variations. For the self potential and EM-VLF, the positive values are diagnostic. While corresponding high resistivity was also observed at the anomaly zones.

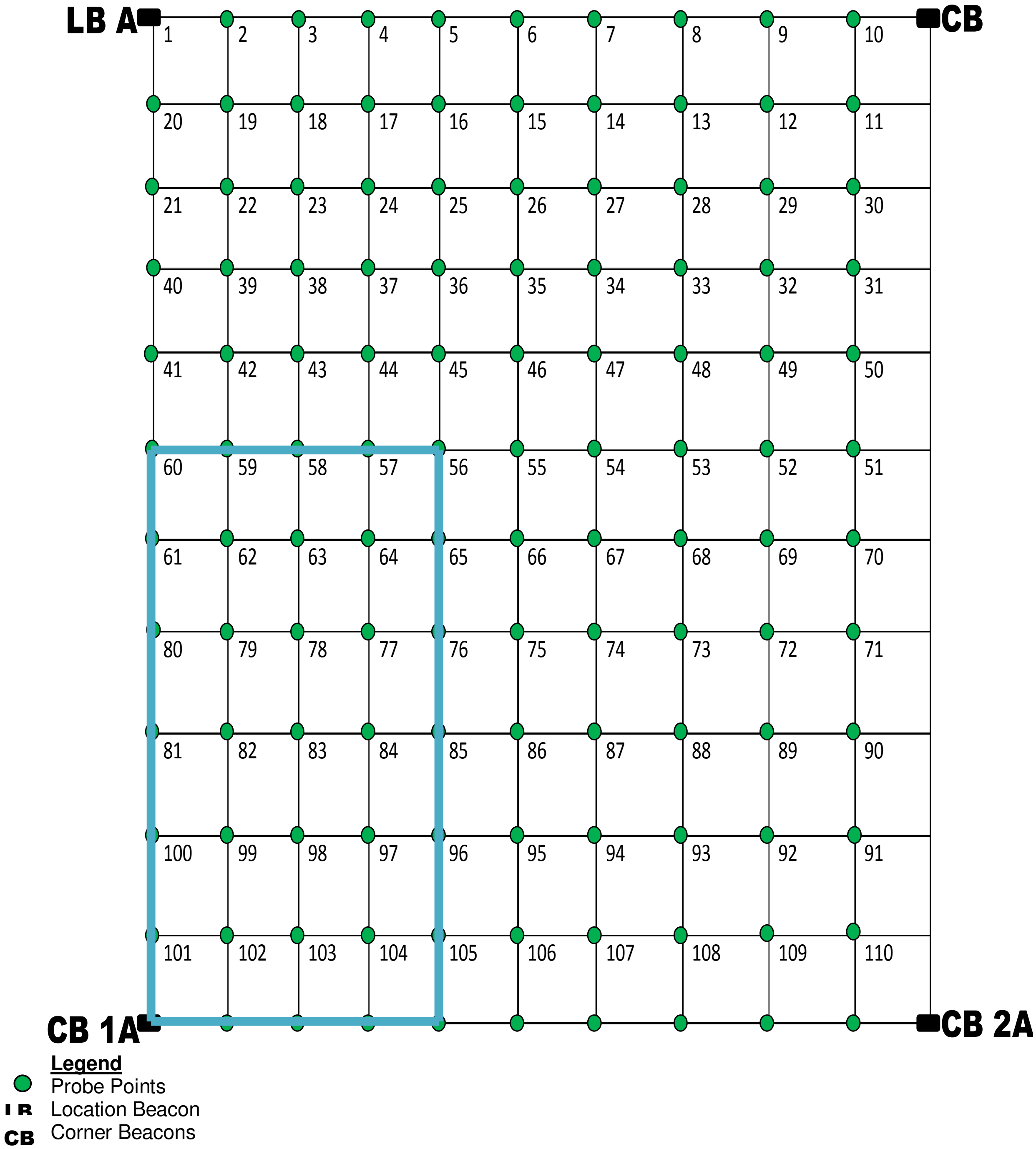


Figure 4. Gridded and Delineated Area of Interest (Light Blue Area) for Geophysical Investigation.

RESULTS AND DISCUSSION

Contour maps of self potential, apparent resistivity, electromagnetic (EM-VLF) values and profile plots for anomaly variations were constructed. The self potential (SP) contour map (Figure 5) shows variations of positive and negative SP values. The positive SP values are indicative of sulphide ore deposits. Green colour indicates positive peak anomaly while the red colour indicate negative SP anomaly. Trend orientation of positive SP peak anomaly occur roughly NW – SE and NE – SW in a cross – cutting stress pattern.

The apparent resistivity map (Figure 6) show high apparent resistivity (green colour) restricted to the extreme NW, with localized low values (blue colour) to the north, NE, west and east central. While the red

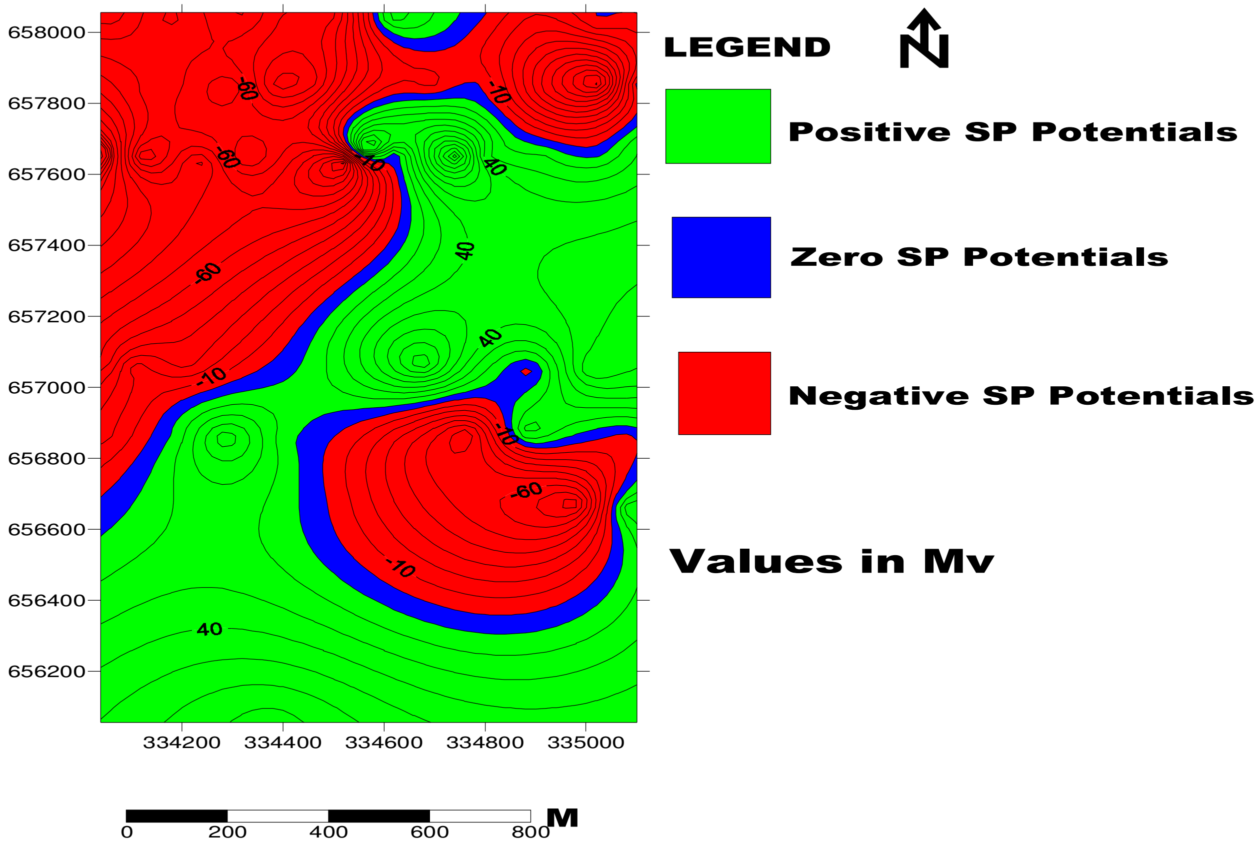


Figure 5. Self Potential (SP) contour map

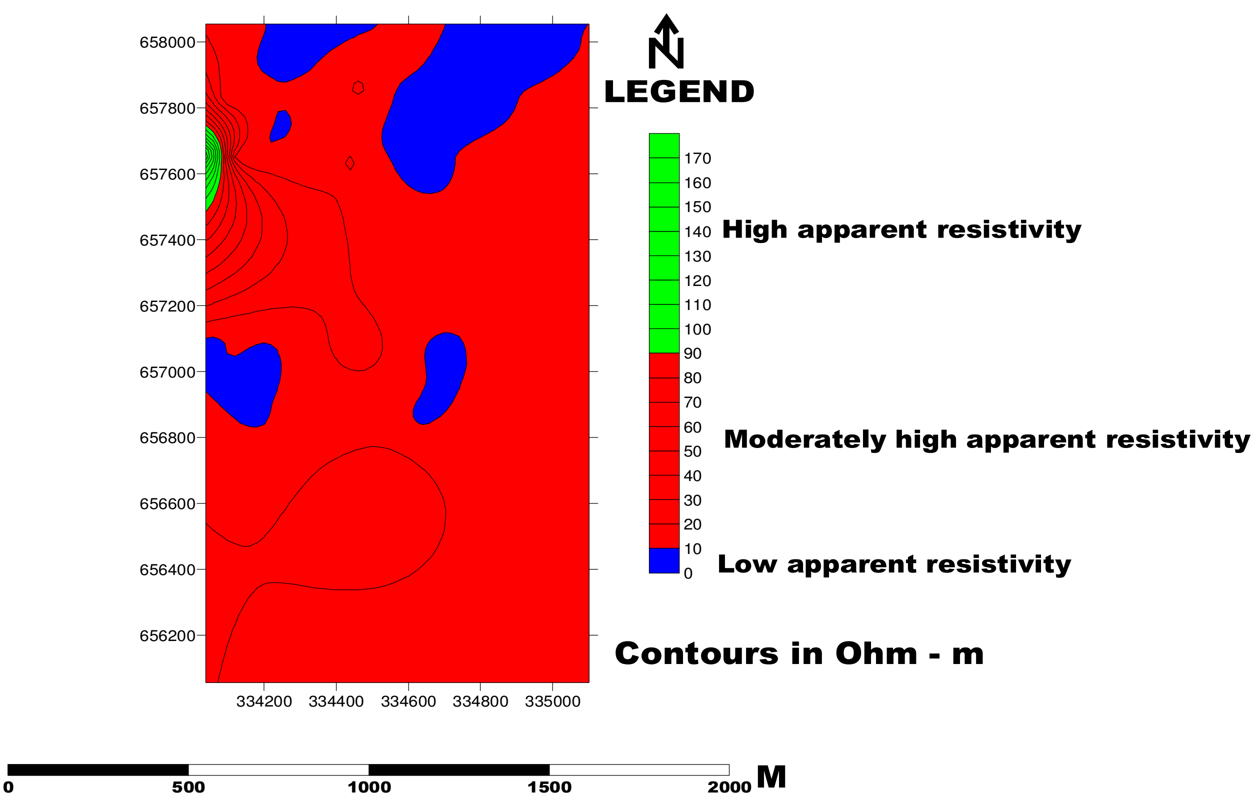


Figure 6. Apparent resistivity contour map.

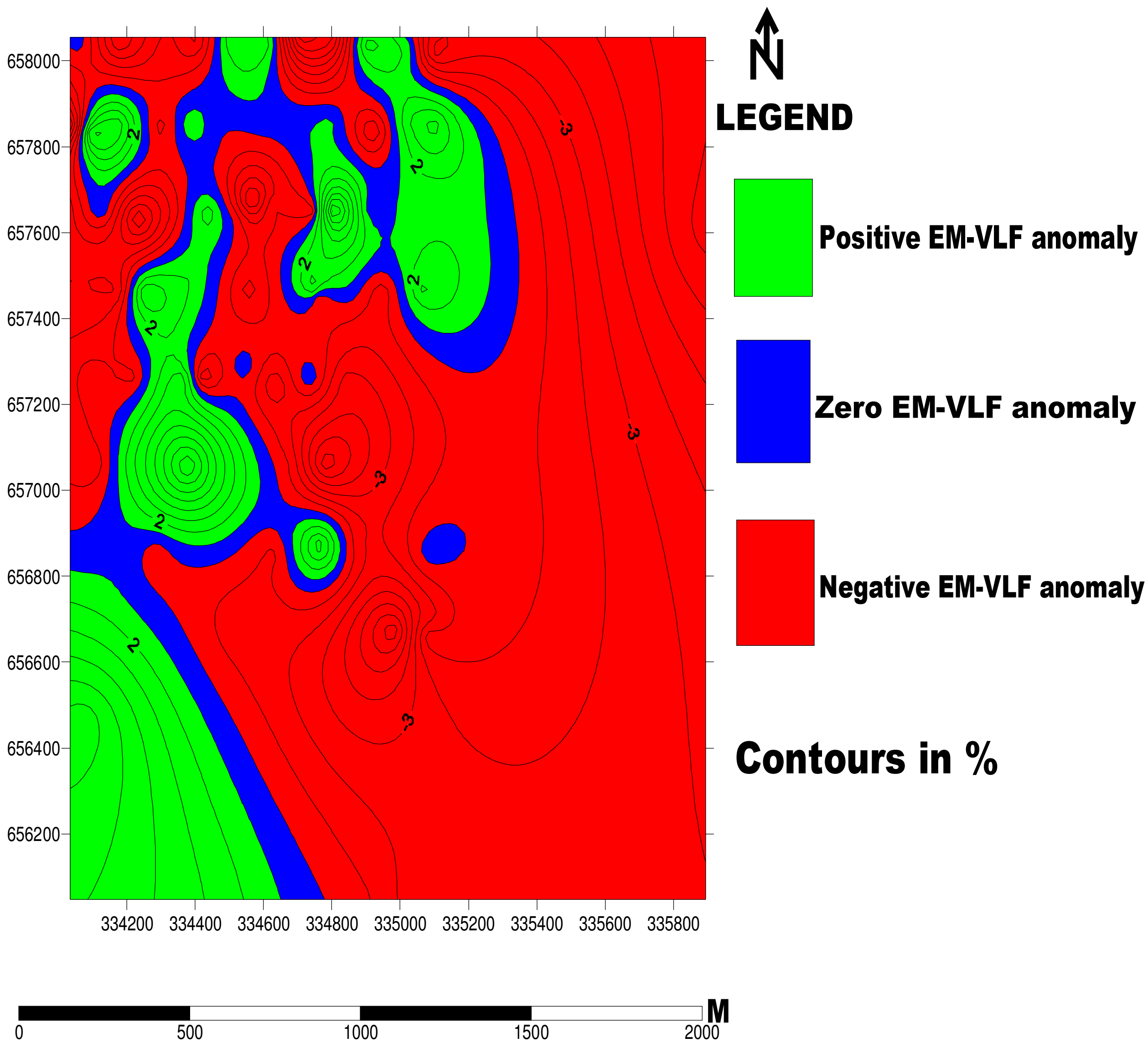
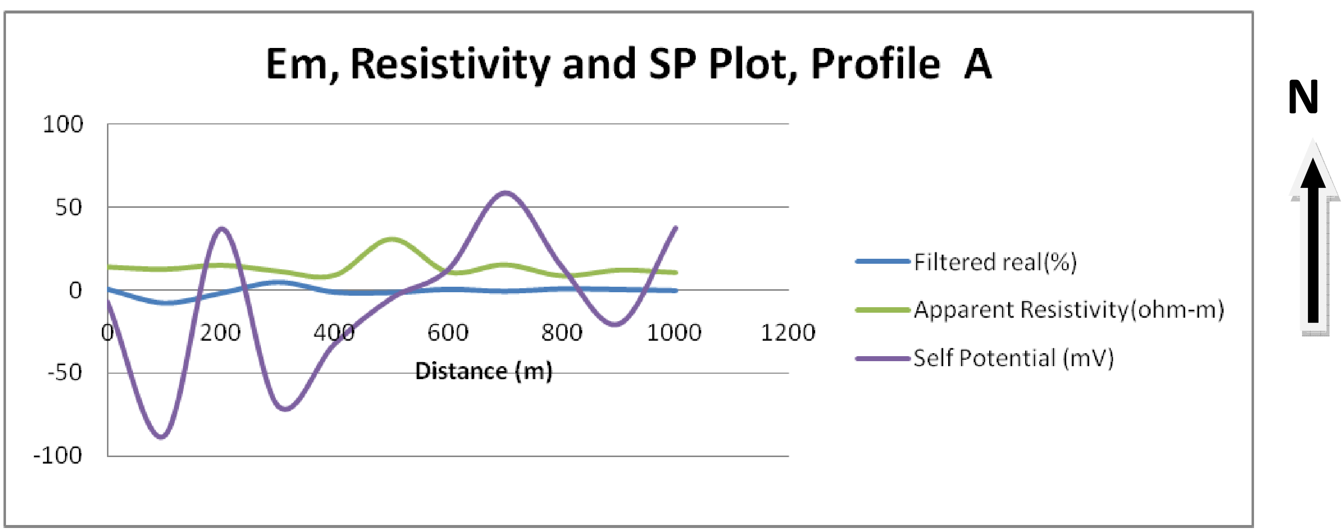


Figure 7. EM-VLF contour map.



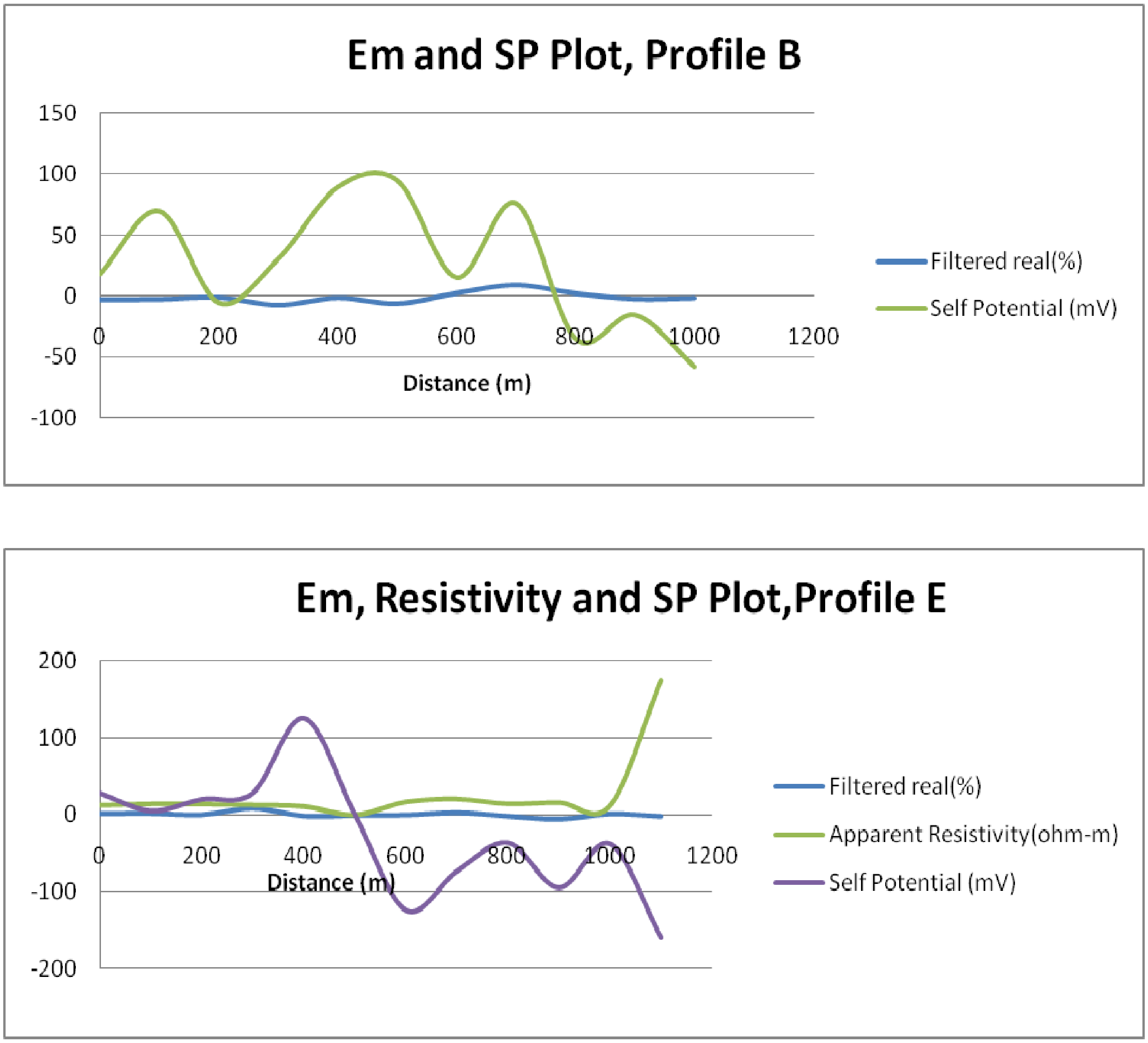
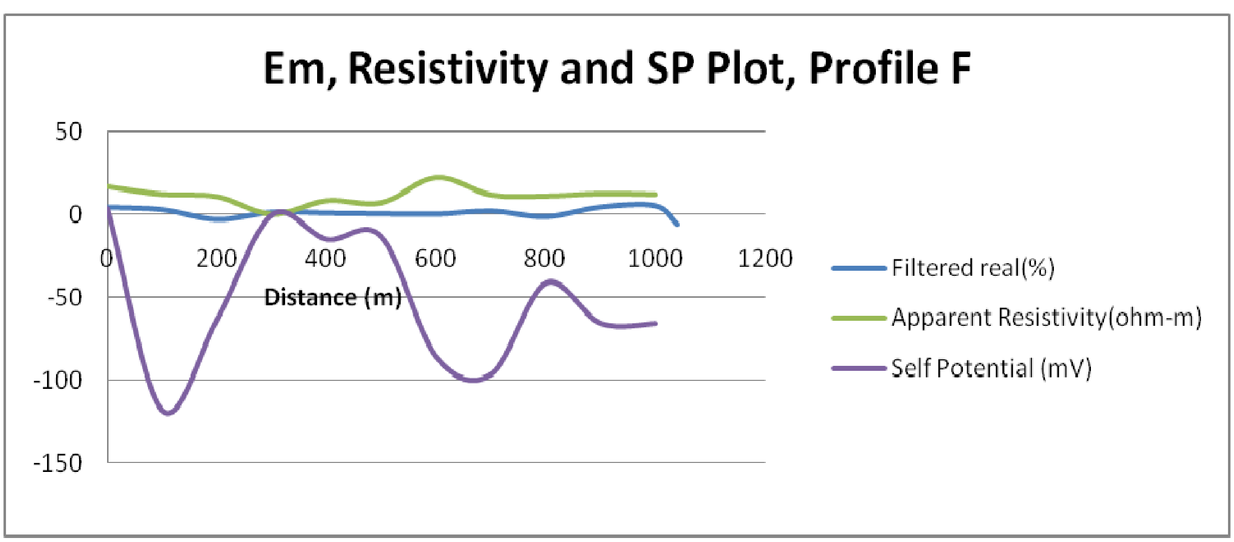
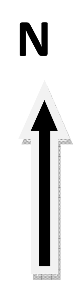


Figure 8. Comparison of profile plots for the EM-VLF (filtered real), Resistivity and Self Potential.





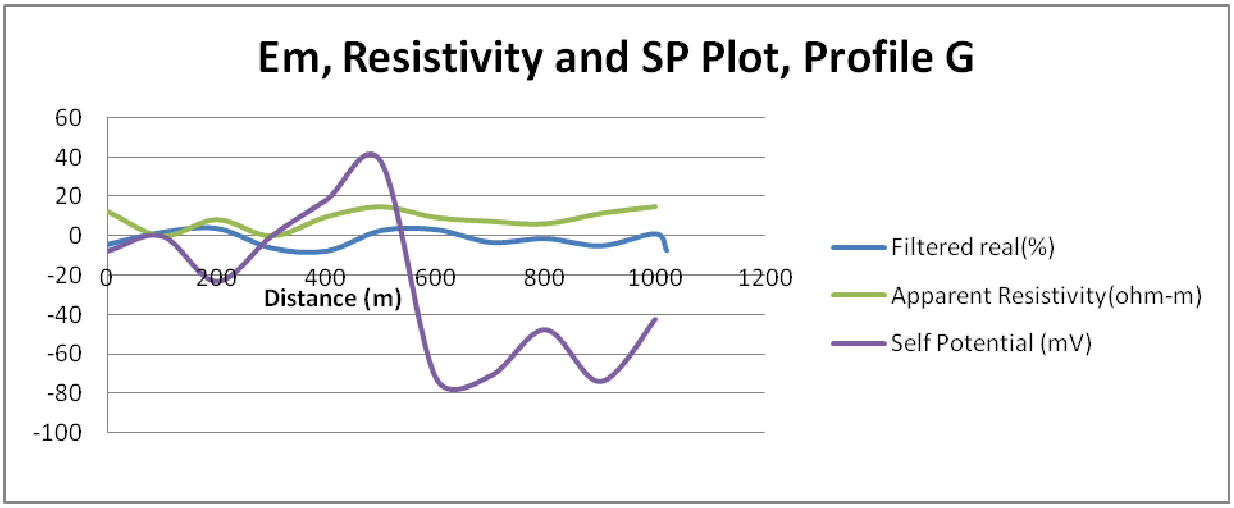


Figure 8. Compared profile plots for EM-VLF (filtered real), Resistivity and Self Potential

background is of moderately to high apparent resistivity. The low values may be indicative of shale/clay layers in the study area. The EM-VLF map (Figure 7) equally show similar trend with the SP contour map.

The EM-VLF contour map shows the positive EM-VLF anomaly in green. The EM-VLF anomaly in blue. While the negative in red colour. From the anomaly variations, the positive EM-VLF anomaly being diagnostic shows a roughly north – south to NE – SW trend. Relicts of NW – SE and W –E exists. Hence these are the suspected ore sulphide vein trend. The suspected ore deposits are well disseminated, that is, occur in patches.

Profile plots were also constructed for the three dataset (Figure 8). This enabled comparison of anomalies across the three datasets. The Data show fairly good comparison.

CONCLUSION

The integrated geophysical study has provided useful information on the anomaly pattern of the sulfide deposits in the area. The orientation corresponds to the regional geologic setting of sulphide ore deposits. Professionals in mining sector should emphasize on the use of integrated geophysical exploration. This will reduce the incidence of abandoned mine fields and increase exploration and exploitation successes.

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