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Full Length Research Paper

Evaluation of Self-Potential Anomalies over Sulphide Ore Deposits at Ishiagu, Ebonyi State, Southeastern Nigeria

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Abstract

An Evaluation of Self-Potential anomaly over sulphide ore deposits has been undertaken at Ishiagu, Ebonyi State, Southeastern Nigeria. The Project site is about 5sqkm, underlain by two main geologic units. The Abakaliki Shale and the Ezeaku Formation. The potential gradient array technique of Self-Potential method was employed. Data was interpreted using surfer 8 computer software and Ms Excel tool Kits. Iso-contour maps of Self Potential and profile plots for anomaly variations were constructed. Results show positive Self-Potential closures, with corresponding peaks in the profile plots which are 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, Anomaly, Potential gradient, Contour map, Trend Orientation.***

INTRODUCTION

The project site is located at Ishiagu, in Ivo local government area, southwest of 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. Recently, a good number of both foreign and indigenous firms have acquired exploration licenses in the area. It is this increased acquisition of mining blocks that necessitated this study by using the Self-Potential (SP) method, because SP method is good for sulphide ore explorations. 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, employing Self-Potential (SP) survey is expedient. Evaluation of the SP anomalies will help to decipher the mineral potentials and the mineralogical trends. When two electrodes which are non – polarizable are inserted into the earth within a reasonable separation, a potential drop is observed between these two electrodes (Dobrin and Savit, 1998; Corwin and Hoover, 1978). This observation is mostly predominant if sulphide ore bodies mainly those that contain lead (pbs), Zinc (Zns), Silver (Ags) and Pyrite (FeS_2). These mineral bodies are well-known for producing the most consistent and strong SP anomalies (Beck, 1981).

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.
The study area falls within the forest belt climatic zone. This zone is characterized by relatively warm to hot

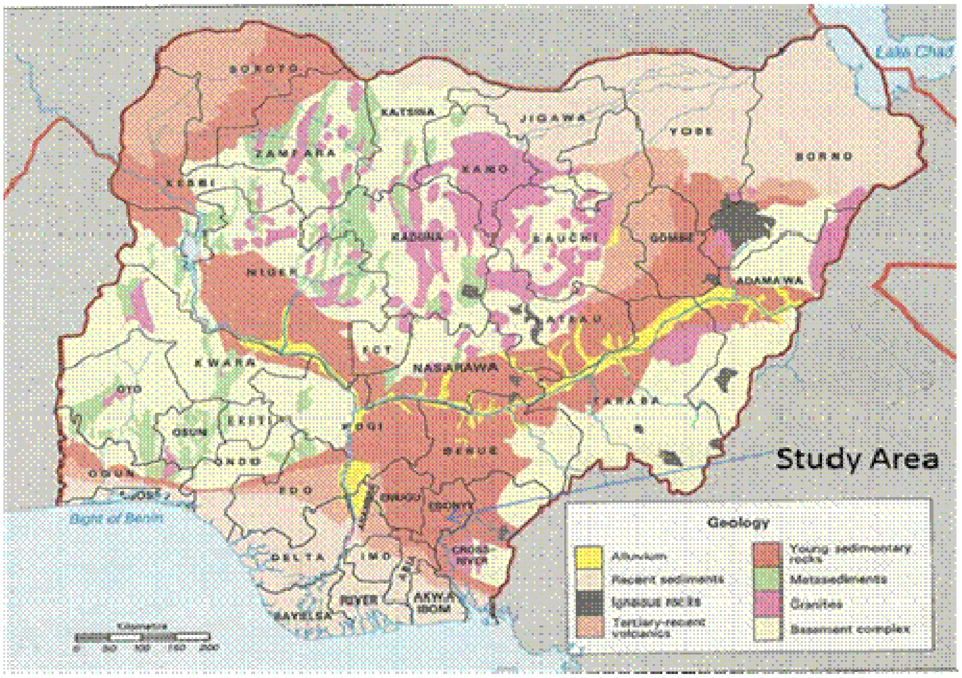


Figure 1. Geologic Map of Nigeria showing the location of study area (Balogun, 2000).

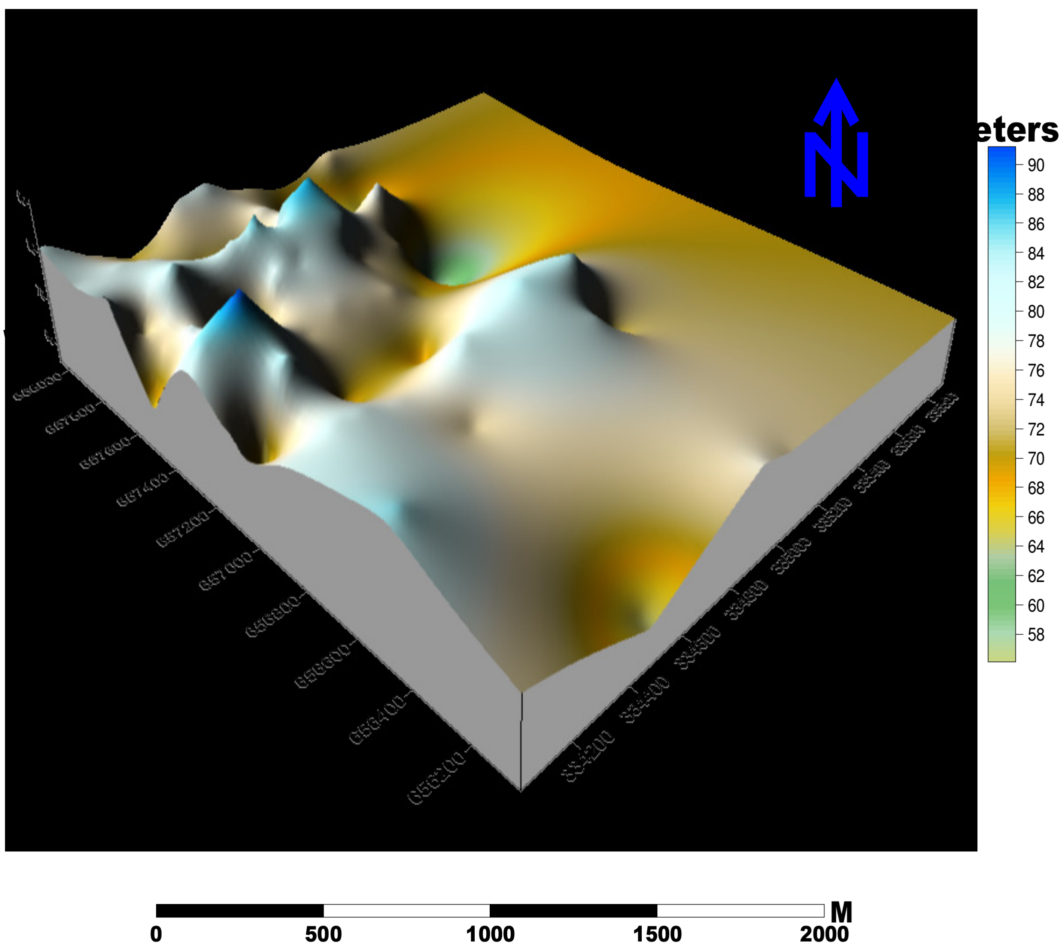


Figure 2. Surface map of the study area.

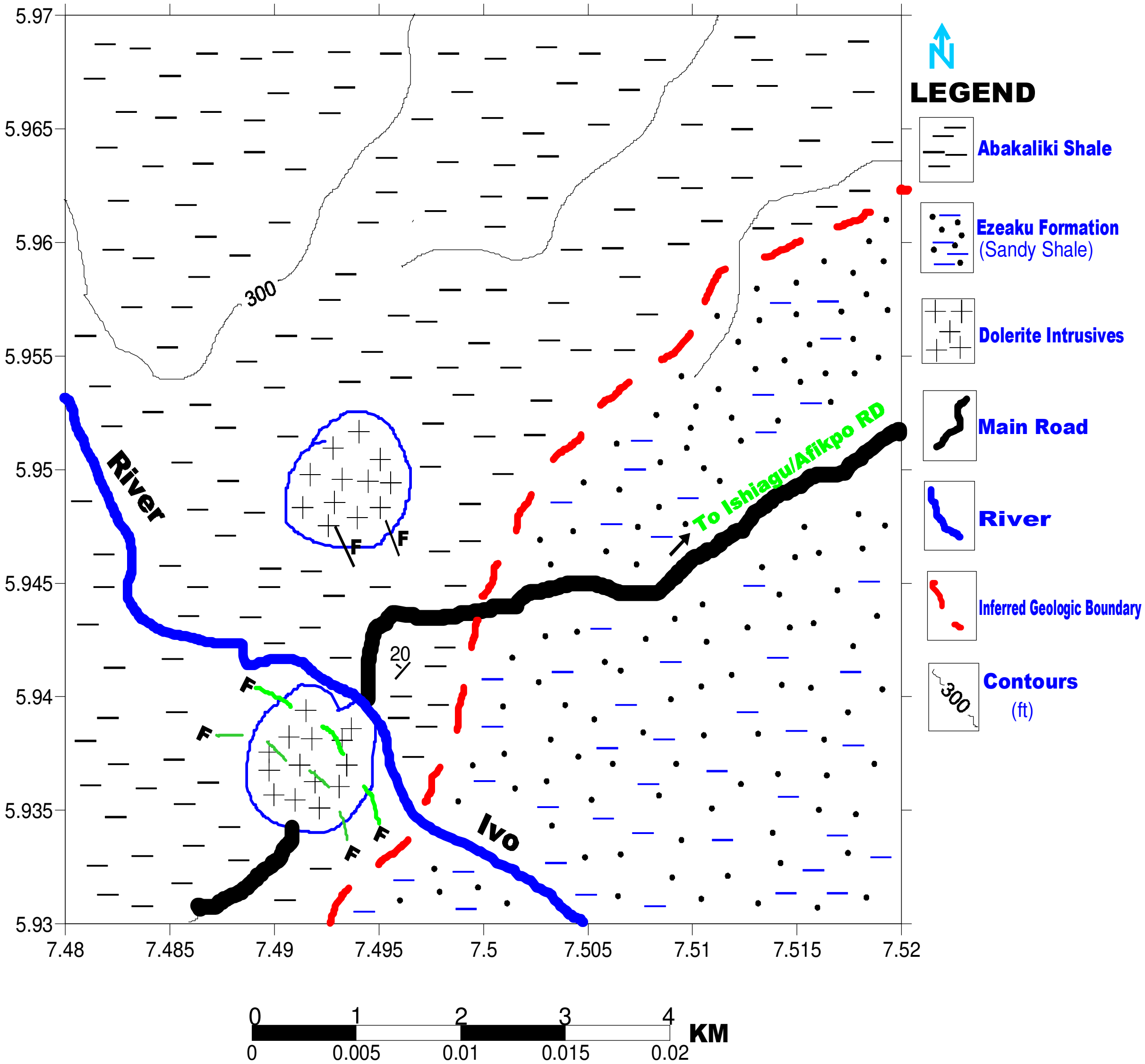


Figure 3. Geological Map of the study area.

Figure 4. Ore deposit vein pattern in an existing mine (Thickness 30-50cm).

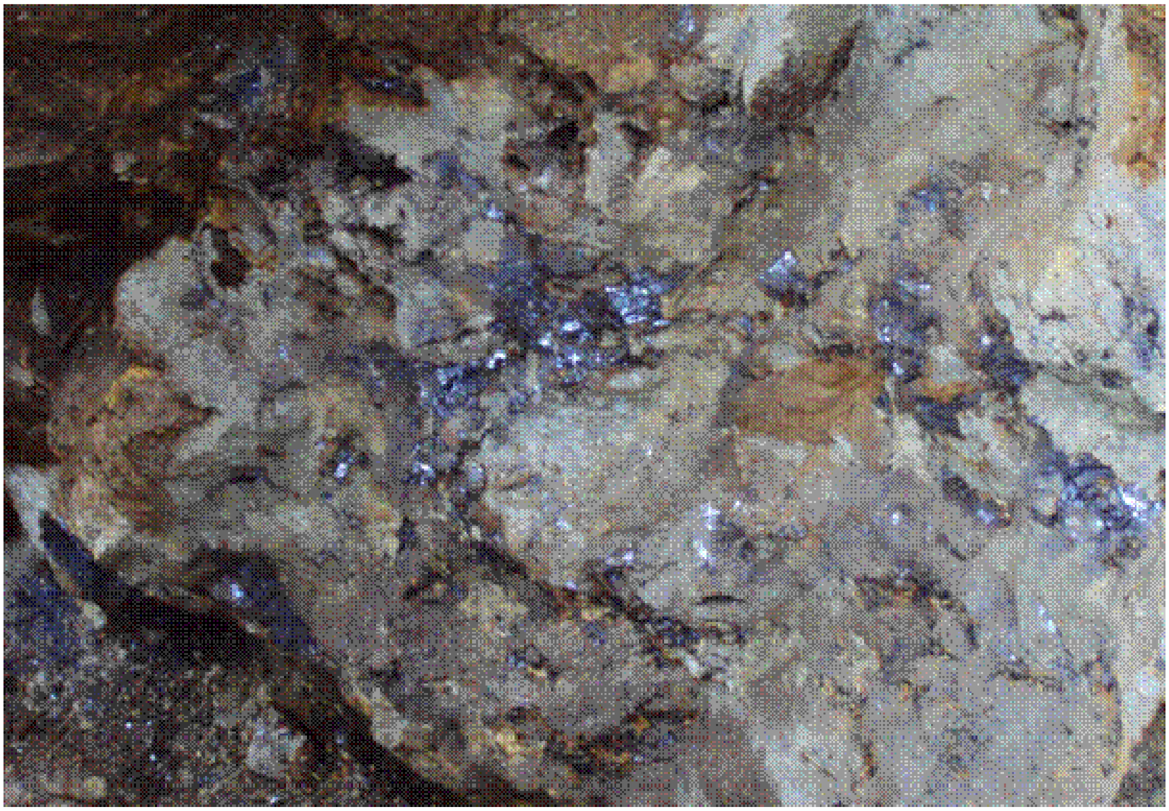


Figure 5. Galena patches on a highly metasomatized country rocks.

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). The project site 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 Shale. 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, existing mines were visited (Figure 4 and 5). Acquired co – ordinates (Longitude and Latitude) from mine cadastral, were used to locate the project site in a Topographical map. The area was extracted and gridded into areas of equal squares, with probe points and numbers and the perimeter of the area was secured by burying of location beacon (LB) and corner beacon (CB) – (Figure 6). Self-Potential survey was carried out over the delineated area using the potential gradient technique. This technique utilizes two electrodes system, with 10meters distance. The electrodes are connected to a resistivity meter with the use of cables. Adjusting the mode to SP, data was acquired linearly along the profiles. The high resolution versatile **ABEM Signal Averaging System (SAS) 4000** resistivity meter, USA made was employed (Figure 7). 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).

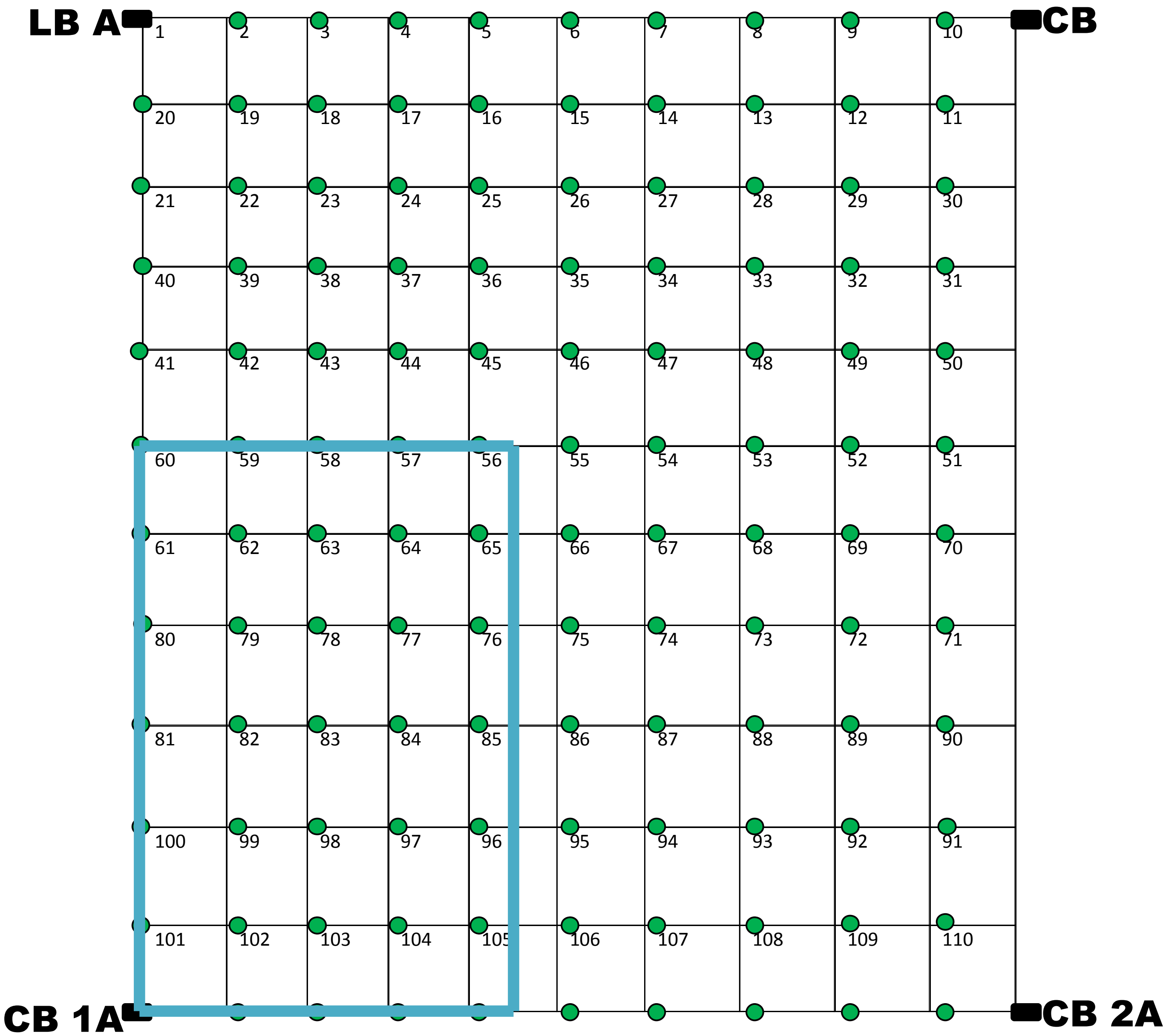


Figure 6. Gridded and Delineated Area of Interest (Light Blue Area) for Geophysical Investigation.

Legend

●	Probe Points
LB	Location Beacon
CB	Corner Beacons

Plot profile and contour map variations were carefully observed for positive and negative anomaly closures. The positive closures and peaks are most diagnostic.

RESULTS AND DISCUSSION

Self-Potential (SP) Contour maps and profile plots for anomaly variations were constructed. The SP contour map (Figure 8) shows variations of positive and negative SP closures. The positive SP closures are quite diagnostic. Possibly this is indicative of sulphide ore deposits (Okonkwo, 2012). In the Abakaliki area, the negative closure had been interpreted to show the presence of pyrite (FeS_2) sulphide orebodies (Chukwu, 2013). The interpretation by Okonkwo (2012) was quite plausible, based on the ore geology, deposition pattern and model (Figure 4). The ore-bodies are vein deposits

Figure 7. The versatile ABEM SAS 4000 – High resolution resistivity meter. Positioned at probe point.

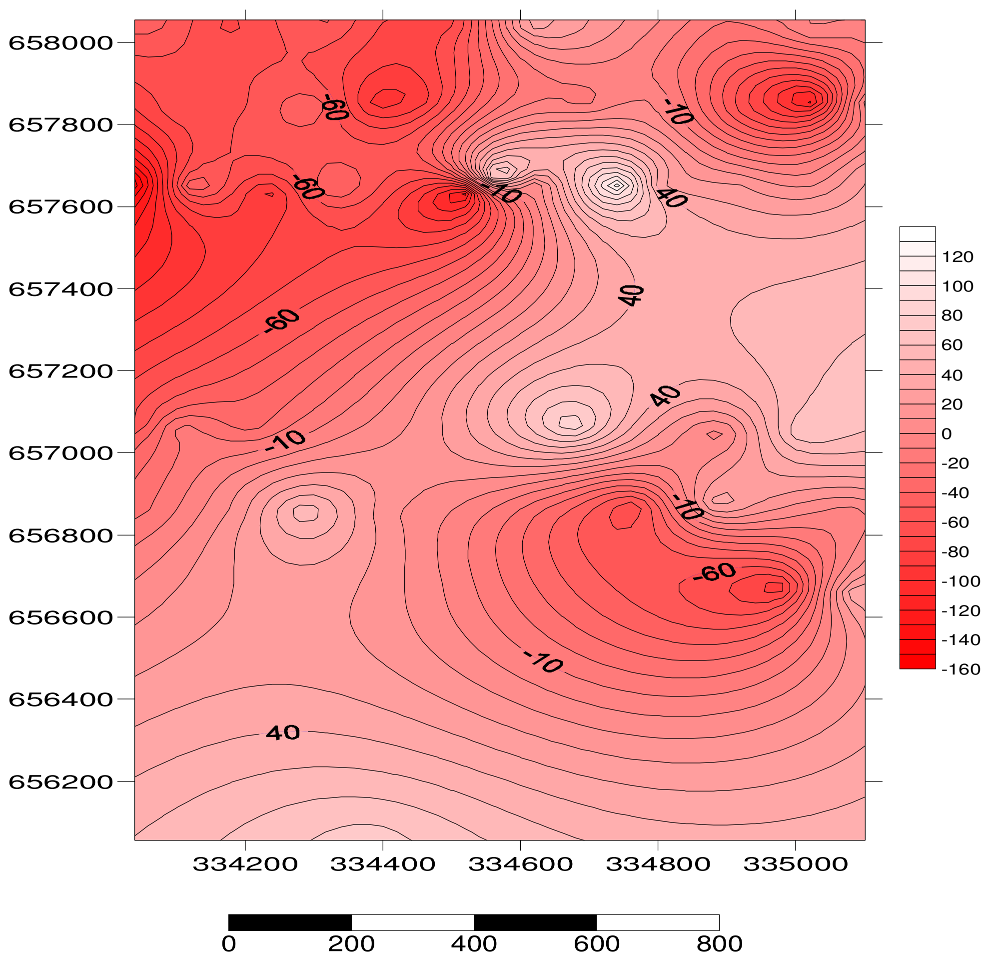
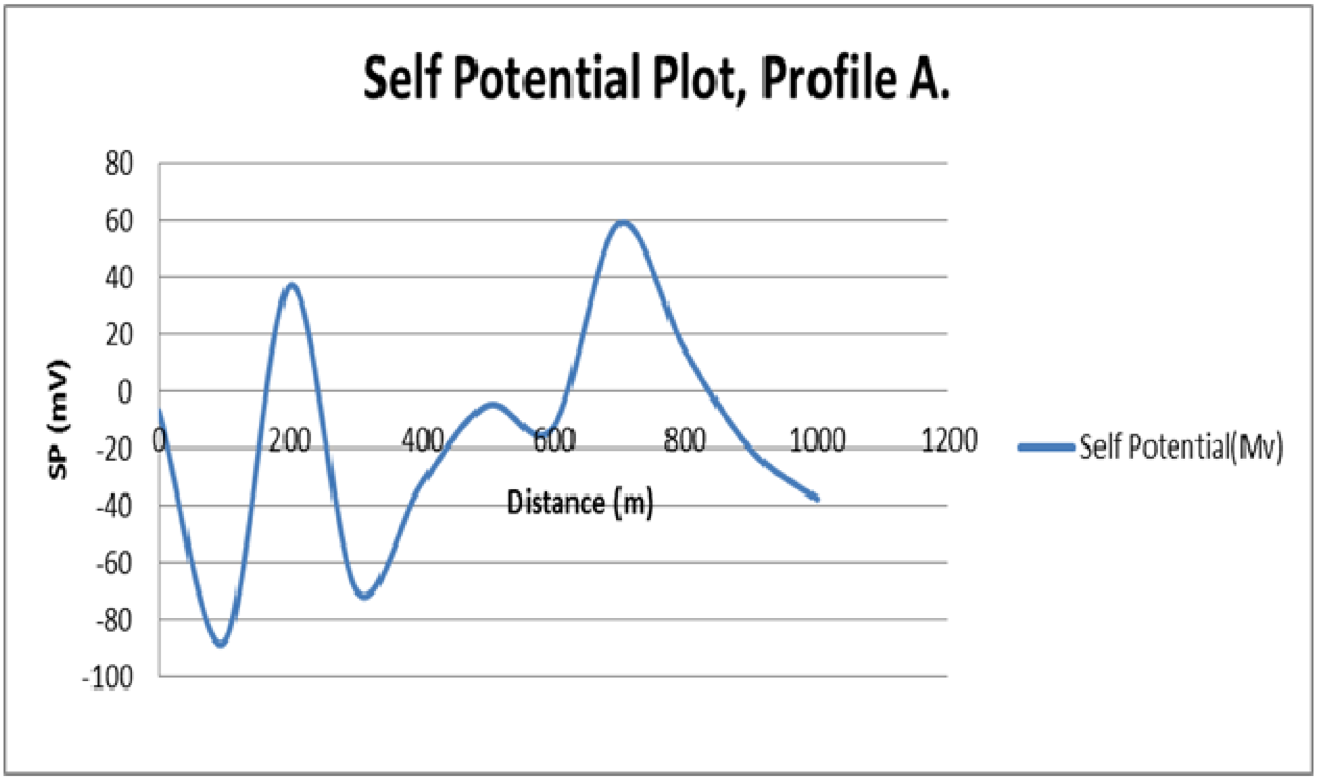


Figure 8: Self – Potential contour map (contour values in mV).



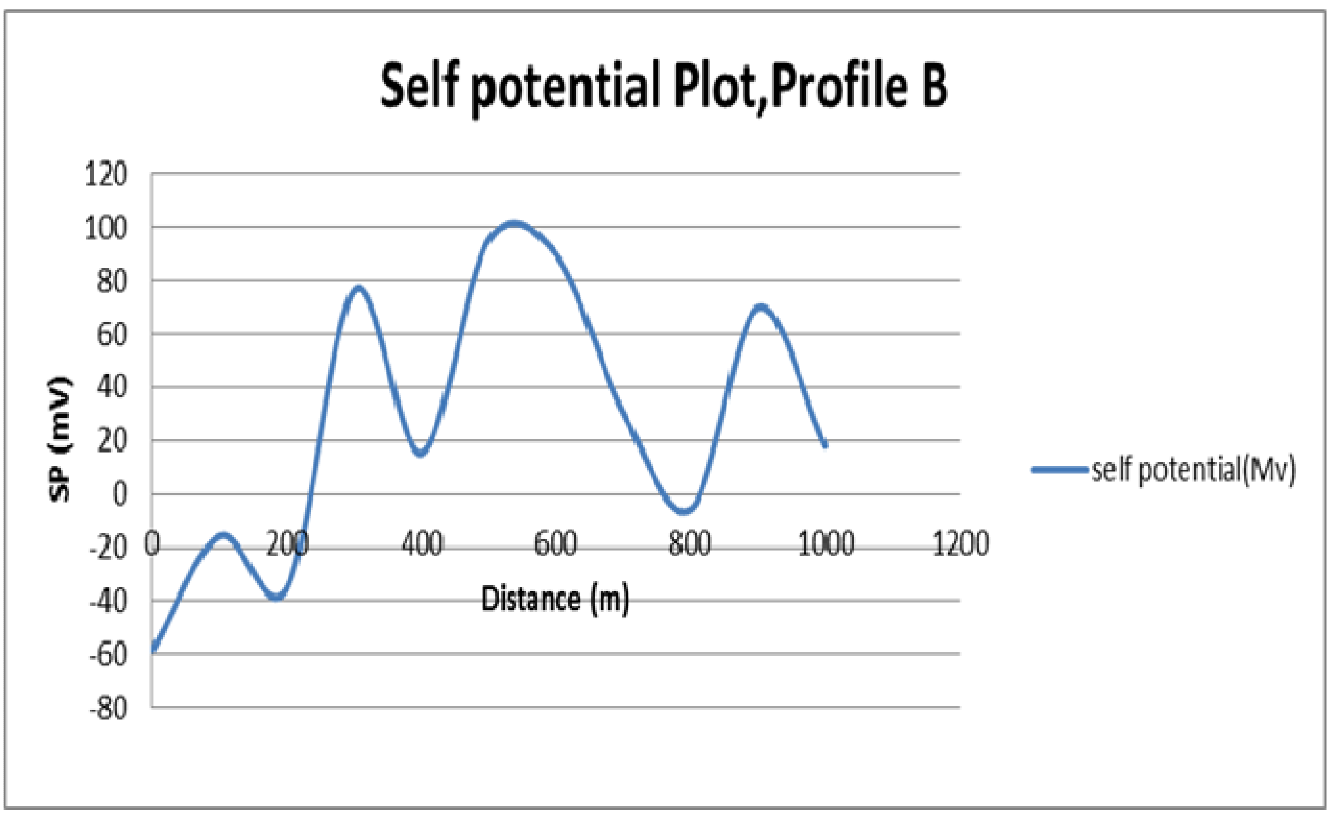


Figure 9a. Self – Potential profile plots.

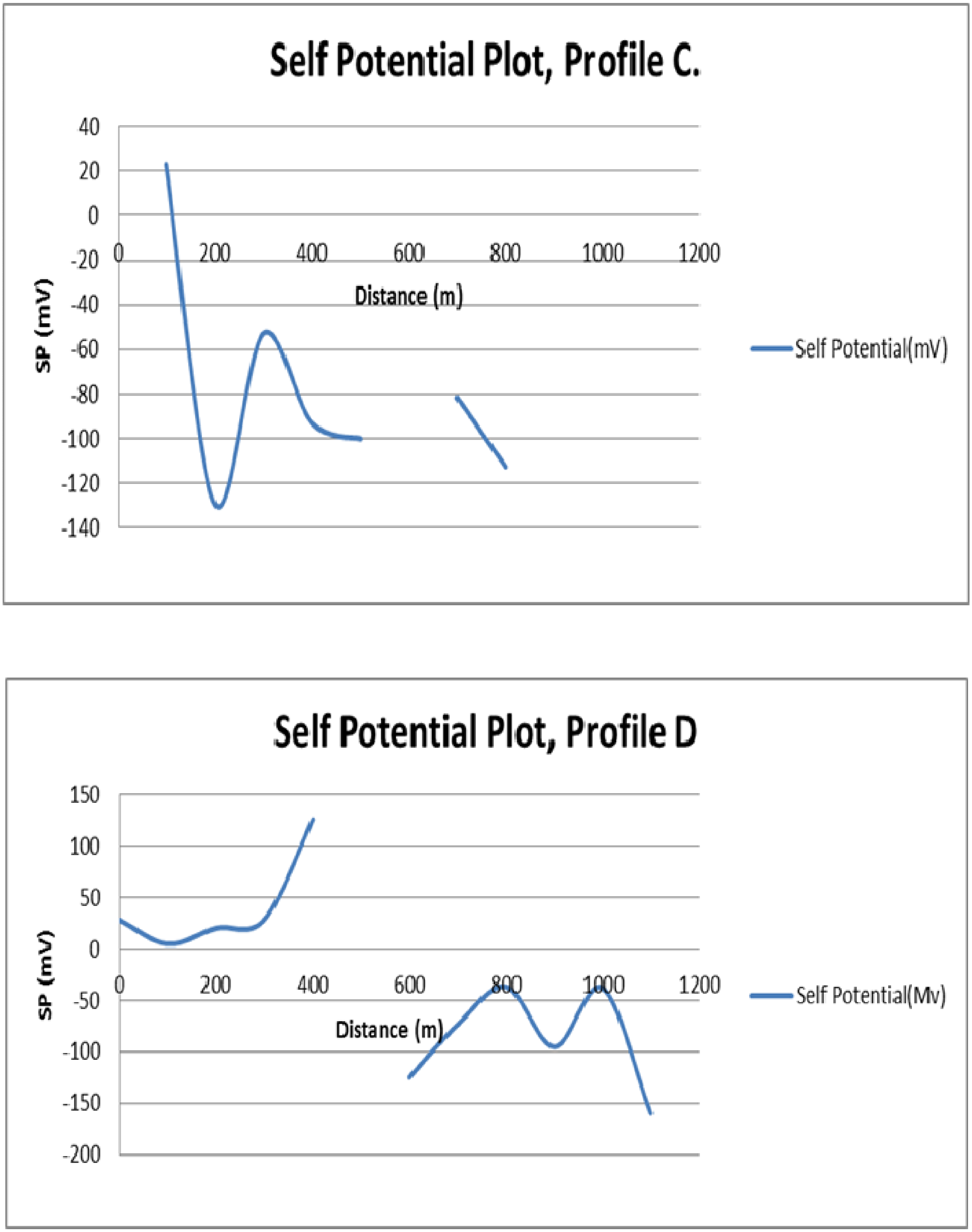
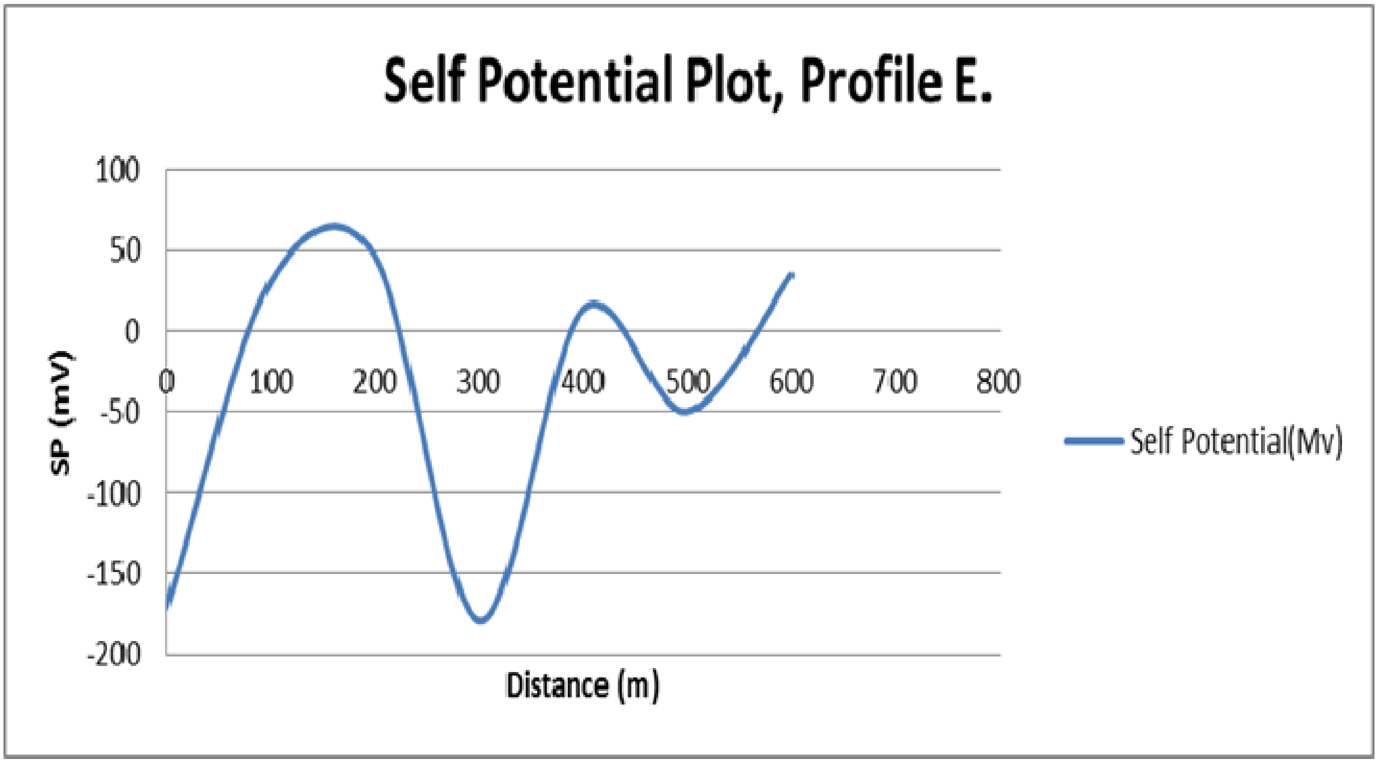


Figure 9b. Self – Potential profile plots.



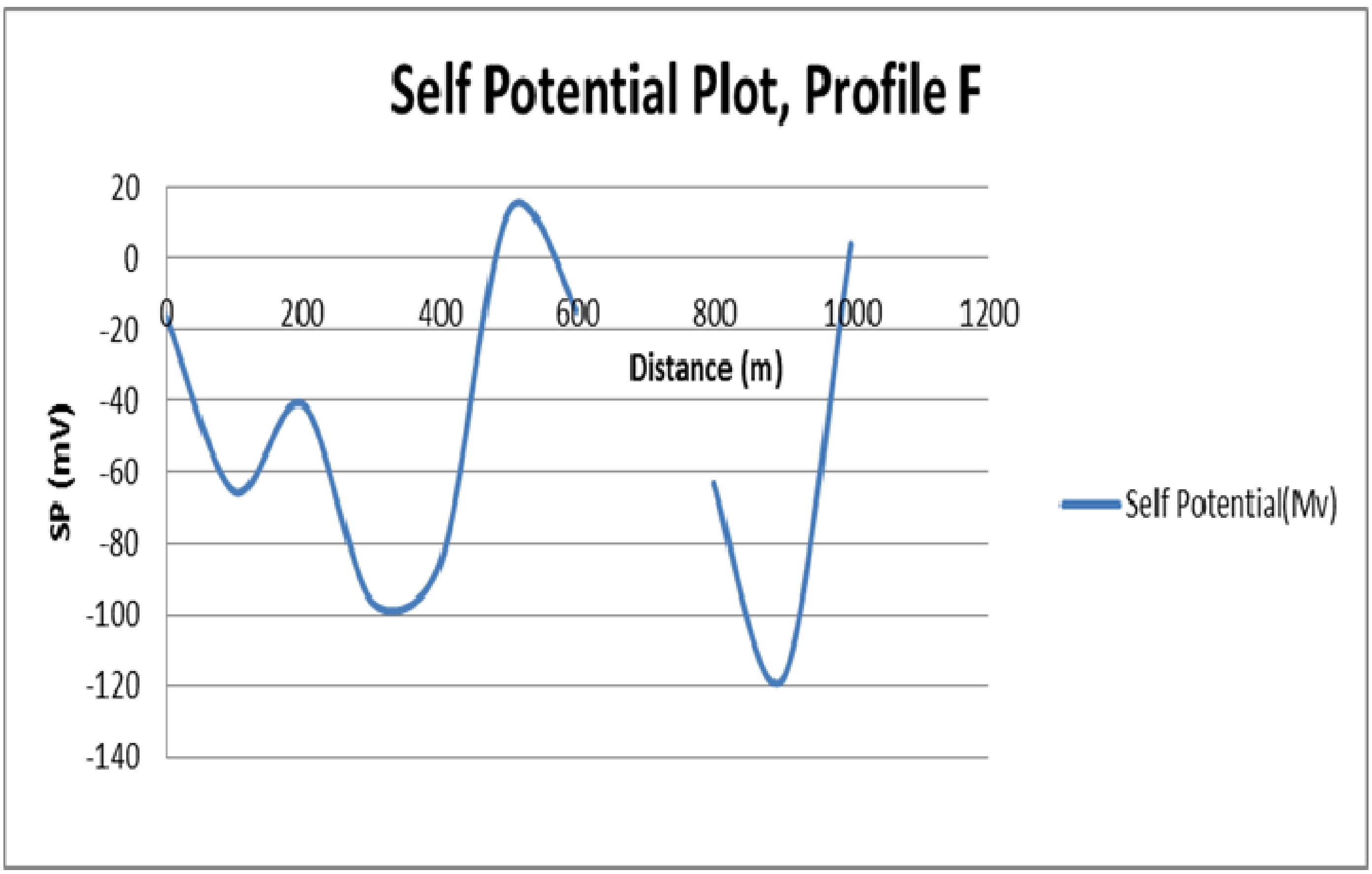


Figure 9c. Self – Potential profile plots.

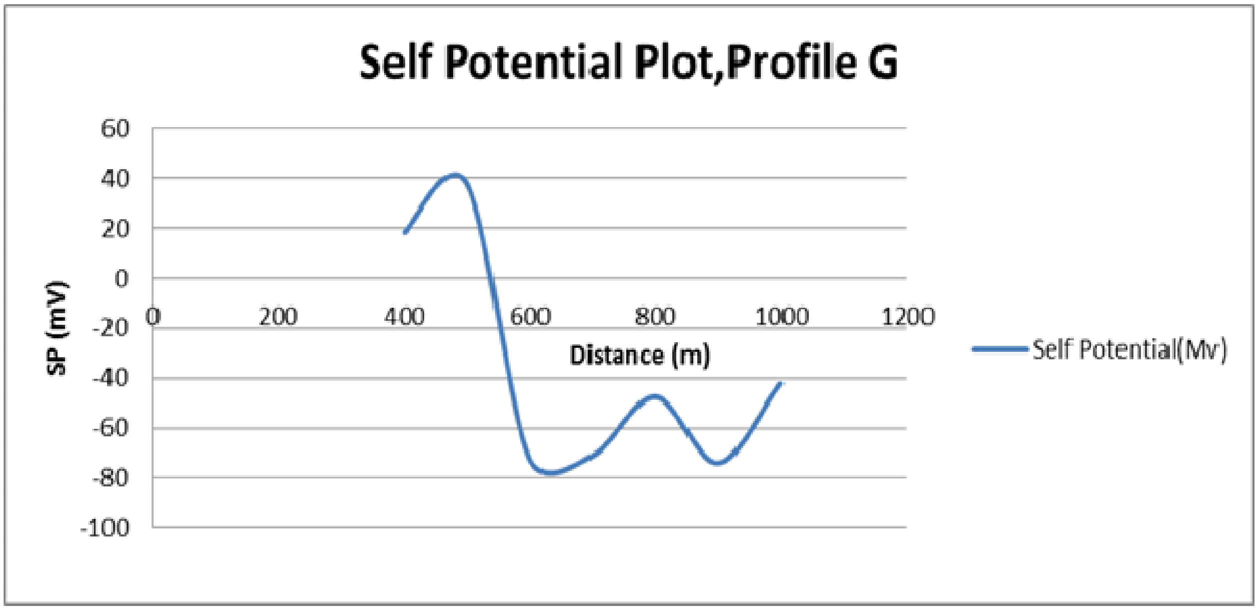


Figure 9d. Self – Potential profile plots.

and well occur above the water table. This disposition changes the electrolytic pattern, where the positive is at the top and the negative at the base. Hence, the positive SP anomalies appear diagnostic for the sulphide ore deposits. The positive SP closures trend in a NE – SW direction with magnitude of 110mV. Profile plots constructed (Figure 9a, b, c, d) – profile A to G indicatives a dominancy of positive SP peaks. In profile A, positive peaks was observed at 200 and 700meters distance. While in profile B positive peaks dominates ranging from 200 to 900meters distance. In profile C negative SP lows dominates while in profile D there is a disjointed data flow as a result of swampy nature of the traverse. Profile E and F has a positive SP peaks at 300 and 500 meters distances respectively, while in profile G data measurement started at 400meters distance. The suspected ore deposits are well disseminated, that is, occur in patches. The Data show fairly good comparison.

CONCLUSION

The Self-Potential (SP) method is the cheapest and less cumbersome in term of the field procedure. In the SP anomaly variations, the positive SP anomalies was beat diagnostic as this is indicates the sulphide ores. However, a better check to this investigation is by integrating other geophysical methods like Gravity or Magnetics and Electromagnetic. This will provide a true picture of the ore deposit and pattern of deposition.

ACKNOWLEGDEMENT

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