



The Use of Electrical Resistivity Technique to Delineate Gold Deposit site in Minna, Niger State, Nigeria

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ABSTRACT

0.5km² of an area in Niger State, Nigeria, suspected to have gold deposit was horizontally gridded. Ten profile were mapped out, at station spacing of 50 meters and profile length of 500 meters. Wenner array was utilized to profile the subsurface along the gridded lines. Subsequently, apparent resistivities obtained from the profiling were used to draw contour lines. From the contour lines eighteen vertical electrical sounding (VES) points were located. Of the eighteen VES points, ten were sounded. The results obtained from the VES indicated several points having apparent resistivity similar to mineral ores that bear gold.

Keywords: VES, Wenner array, gold, apparent resistivity, Niger State.

1. INTRODUCTION

The search for mineral deposits, its exploitation, and processing as well as marketing to generate income by small scale miners is widespread in North-Western Nigeria. Of the several minerals prospected for, gold is the most common. Gold is sought for all over the region, albeit incidents of Lead (Pb) poisoning are tragically associated with the process. Lately, many communities in the gold mining region have suffered Lead poisoning [1] because of the substandard methods used in the exploitation.

Electrical resistivity is a geophysical method that is utilized in profiling suspected areas to locate mineral deposits. It is an aged prospecting tool but still proficient for preliminary investigations. It is not only simple, cheap; it does not induce adverse effect during and after application.

This study employs wenner array for profiling, schlumberger array for vertical electrical sounding of points in the survey area that have low apparent resistivity.

2. METHODS AND MATERIAL

0.5km² of the site suspected to have gold deposit was carved-out for investigation. The investigation area was gridded into ten profile lines, each profile line fifty meters apart from the other and, 500 meters in length. On each profile line, wenner array was utilized to investigate apparent resistivity variation of the subsurface. The instrument used during this work is terrameter, four electrodes, four connecting wires of hundred meters each. A minimum of five people was required to carry out wenner array efficiently. Of the five people, four were moving and positioning the electrodes while the fifth man operates the terrameter. Readings from terrameter were taken, stored and later retrieved for analysis. Thereafter contour lines were drawn to locate points of equi-apparent resistivity.

2.1 Geophysical Electrical Resistivity: Mathematical Formulation

Resistivity studies in geophysics begin with:

$$J = \sigma E = \frac{1}{\rho} = -\frac{1}{\rho} \nabla V$$

J = Current density

E = Electric field vector

V = Electrical potential

ρ = resistivity measured in Ωm

σ = Conductivity measured in $(\Omega m)^{-1}$

Ohm's law for the electrode in half sphere with area $\frac{1}{2}4\pi r^2$:

$$J = \frac{1}{\frac{1}{2}(4\pi r^2)} = -\frac{1}{\rho} \frac{dV}{dr}$$

Integrating,

$$V(r) = \frac{\rho I}{2\pi r}$$

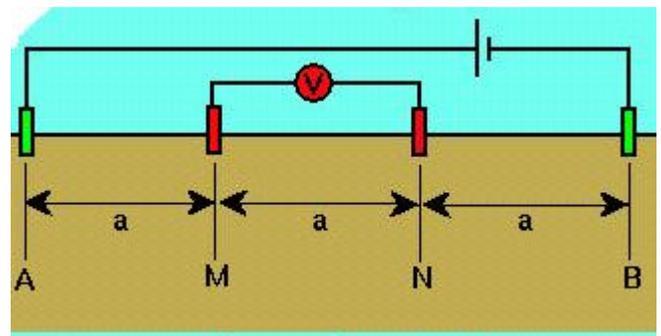


Figure 1: General Linear Array



The electric potentials measured at M and N in the general linear array of Fig. 1 due each of the two source electrode located at A and B [2]:

$$V_M = \frac{\rho I}{2\pi} \left(\frac{1}{AM} - \frac{1}{MA} \right)$$

$$V_N = \frac{\rho I}{2\pi} \left(\frac{1}{AN} - \frac{1}{NA} \right)$$

$$V_{MN} = V_M - V_N = \frac{\rho I}{2\pi} \left[\left(\frac{1}{AM} - \frac{1}{MB} \right) - \left(\frac{1}{AN} - \frac{1}{NB} \right) \right]$$

where $\rho = \frac{V_{MN}}{I} K$

$$K = 2\pi \left[\left(\frac{1}{AM} - \frac{1}{MB} \right) - \left(\frac{1}{AN} - \frac{1}{NB} \right) \right]$$

K is the geometric factor that will acquire a particular value for a given electrode spacing. For wenner array, all of the separations are equal:

$$\rho_{wenner} = \left(\frac{V_{MN}}{I} \right) K = \left(\frac{V_{MN}}{I} \right) 2\pi a$$

$\rho =$ apparent resistivity.

3. RESULTS AND DISCUSSION

Figure 2 is the contour obtained from the horizontal profiling undertaken utilizing wenner array. The figure indicated eighteen VES points.

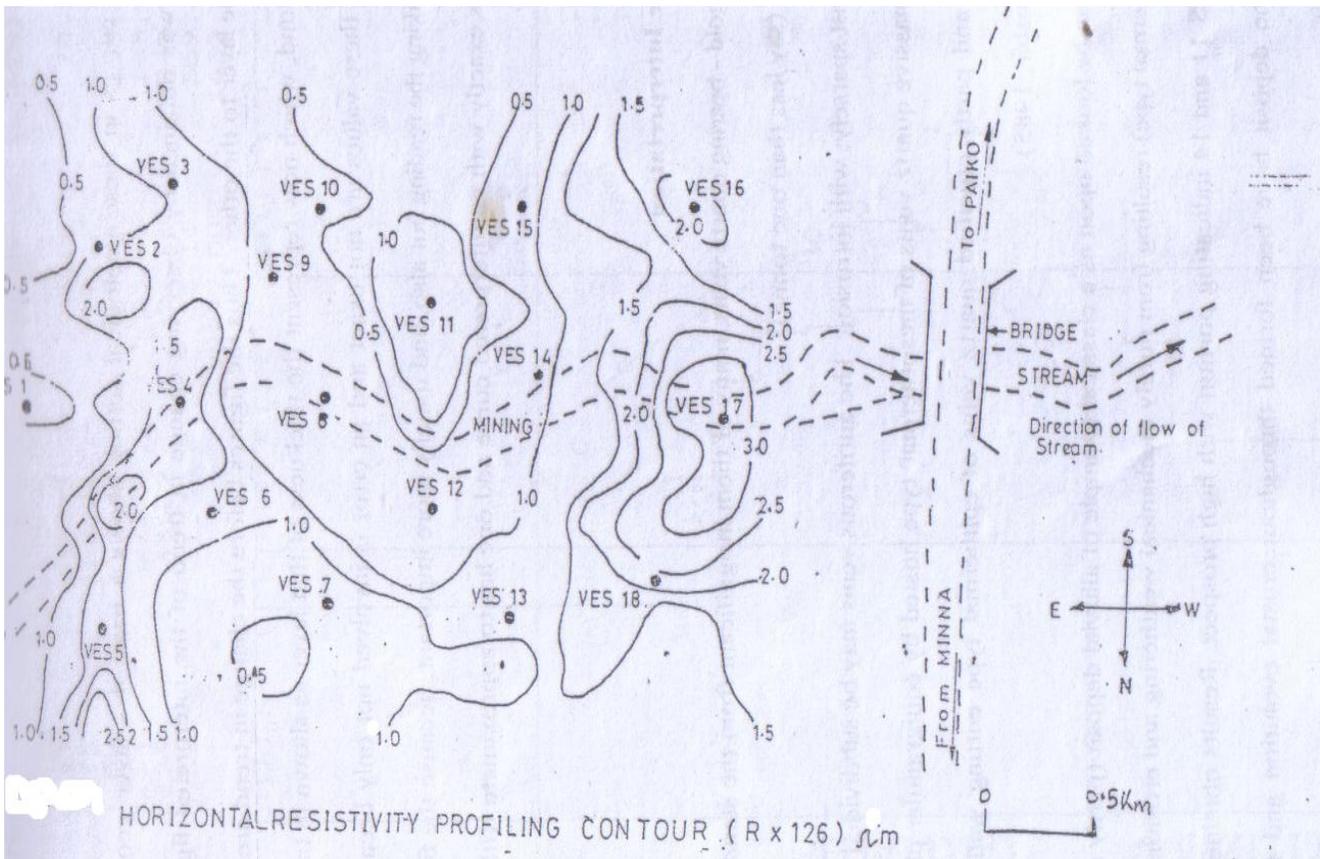


Figure 2: Contour of survey area.

The horizontal resistivity profiling contour in Fig. 2 indicated east and west ends having apparent resistivity higher than the middle region. The middle region is characterized by two anomalous traits; the closure of the contour near the illegal, small scale mining site and the exhibition of the lower

apparent resistivity. Eighteen vertical electrical sounding points were chosen based on the apparent resistivity of the points. The data obtained from the VES were analyzed using the direct method of interpretation program by Zohdy and Bisdorf [3].

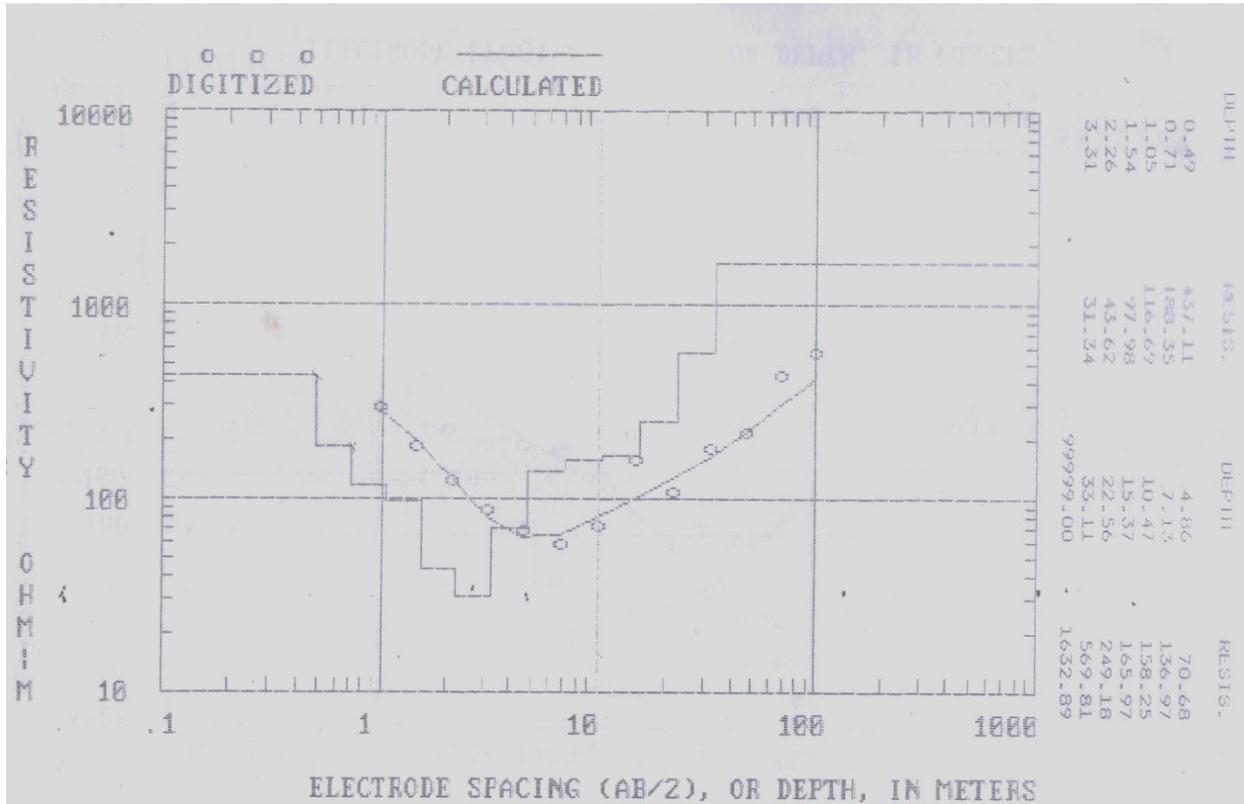


Figure 3: Digitized analyzed data sheet.

Results obtained in this study show that the absolute concentration of gold in the younger Granite is generally low but do not provide adequate contrast between gold-bearing and barren granites [4]. Moreover distribution pattern are erratic and individual anomalies may have relatively higher or low gold

contents as can be deduced from horizontal resistivity profiling contour anomaly. This may be attributed to the mode of occurrence of gold as disperse or fracture controlled mineralization.

Table1: Resistivity and Height of Layer 1-4

| Station | Top soil | | Second layer | | Third layer | | Fourth layer | |
|---------|------------------|------|------------------|------|------------------|------|------------------|------|
| | $\rho(\Omega m)$ | h(m) |
| 1 | 247 | 0.75 | 57.60 | 2.37 | 70.68 | 5.99 | 1632.89 | ∞ |
| 2 | 4.98 | 0.35 | 39.80 | 1.29 | 50.2 | 5.46 | 1243.08 | ∞ |
| 3 | 260.32 | 0.67 | 78.70 | 2.13 | 149.05 | 4.37 | 747.80 | ∞ |
| 4 | 43.73 | 0.44 | 33.87 | 0.80 | 33.99 | 3.68 | 245.67 | ∞ |
| 5 | 31.32 | 0.35 | 29.13 | 1.01 | 64.35 | 2.98 | 1238.83 | ∞ |
| 6 | 14.50 | 0.64 | 7.98 | 1.38 | 19.54 | 2.51 | 860.60 | ∞ |
| 7 | 4644.18 | 0.35 | 511.30 | 0.66 | 51.43 | 1.20 | 890.89 | ∞ |
| 8 | 1134.50 | 0.26 | 3420.60 | 0.56 | 225.50 | 1.50 | 1514.57 | ∞ |
| 9 | 476.13 | 0.44 | 50.67 | 0.64 | 4.34 | 2.37 | 2198.44 | ∞ |
| 10 | 234.60 | 0.44 | 539.64 | 0.64 | 7.76 | 3.02 | 348.29 | ∞ |



The near-surface topsoil (loose, dry, lateritic) is generally highly resistive, comprising principally unsaturated minerals above the water table. Since the conductive weathered zone, which often constitutes an aquiferous unit is bounded by a highly resistive material; resistivity measurement over this site is generally characterized by low resistivity anomaly over the middle zone as can be observed in the VES curve.

4. CONCLUSION

This study reveals that there are injections of deposits, that is, haloes of deposits are distributed over the site. Nature of study is alluvial and has the average depth of 5-6 meter from the surface. It is deduced that gold is strongly dispersed by chemical and mechanical processes resulting in haloes that could extend several kilometers [5].

Electrical resistivity technique has been helpful in discovering and/or delineating gold deposit but it is suggested that other geophysical technique be used as a comparative technique.

REFERENCES

- [1] Bello, A., Funtua I. I., (2012). Characterization of Lead (Pb) poisoning gold ores from North Western Nigeria using PIXE technique. *The IUP Journal of Physics*. 58J-2012-01-03-1.
- [2] Rhett, Herman, (2001). An introduction to electrical resistivity in geophysics. *American Association of Physics Teachers*. DOI: 10.1119/1.1378013.
- [3] Zhody, A. A. T., Bisdorf, R. I. J., (1989). Schlumberger sounding data processing and interpretation program for United State Geological survey.
- [4] Telford, W. M., Geldart, L. P., Sheriff, R. E., (1990). *Applied Geophysics*, 2nd ed., Cambridge University Press.
- [5] Foster, R. P., (1993). *Gold metallurgy and exploration*