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Ground Water Potential Assessment using Resistivity Sounding Method near Kalikunda, West Bengal

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Summary

Electrical resistivity survey is carried out for the feasibility study of the occurrence of groundwater in Kalikunda, Midnapur district of West Bengal. Soundings were conducted using Schlumberger array with a maximum 400-600 meters between the current electrodes. Interpretation of the resistivity sounding data is performed to delineate the suitable groundwater bearing zones. Linearised inversion technique is used for the interpretation of Schlumberger sounding taken at various locations in the area. In general, 4 to 5 layer structures were delineated in the area. Suitability of the subsurface structures in a particular area has been studied for groundwater potential. The overall study indicated that the groundwater prospecting in areas with less prospects of groundwater can effectively be done with the help of electrical methods in the delineation highly conductive potential water bearing zones. A number of locations were found to be suitable for drawing groundwater.

Introduction

1.1 Background

The electrical resistivity of rock is a property which depends on lithology and fluid content. The resistivity of identical porous rock samples vary considerably according to the salinity of the saturating water. The vertical electrical resistivity sounding method (VES) is depth sounding galvanic methods and used for determining resistivity of the rocks.

1.2 Lithology of the area

Kalikunda area is covered by laterite and older alluvium of Quaternary age. The greater part of the area constitutes a lateritic upland. The laterite is composed of two horizons viz. the hard crust and mottled clay. Alternate layers of sand and clay underlie the lateritic formations in the area under study.

Lithology	Resistivity (ohm-m)
Laterites and weathered laterites	300-3000
Laterite with morum sand	100-500
Coarse to very coarse sand with gravel	60-90
Medium to coarse sand with clay	21-40
Clay with fine sand	5-20

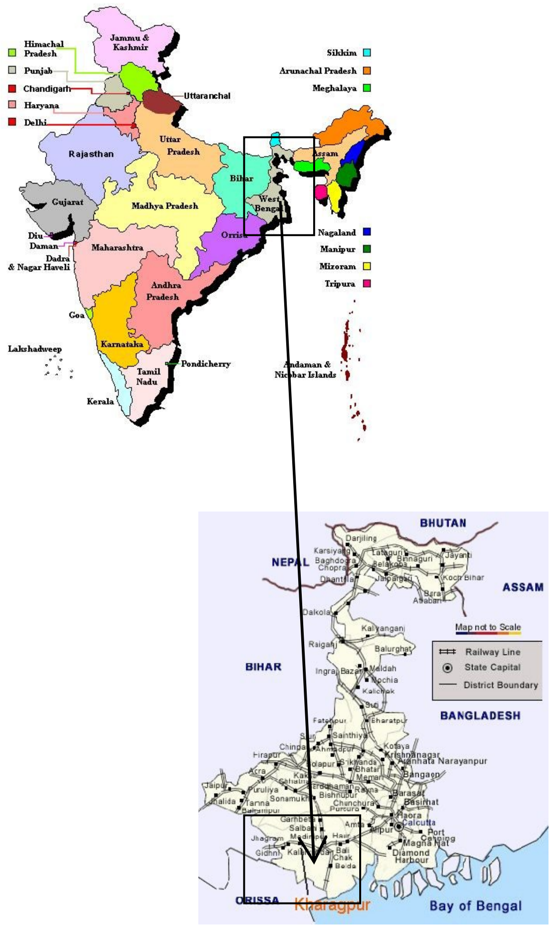


Figure 1: Map of Location area

Theory and Method

2.1 Resistivity measurement

The schematic electrodes configuration for schlumberger sounding is shown in the figure 2. Consider a direct current of strength I being introduced into a homogenous and isotropic earth by means of two point electrodes A and B, the potential difference between the two points M and N on the surface is given by the relation

$$\Delta V = \frac{I\rho}{2\pi}\left[\left(\frac{1}{AM} - \frac{1}{BM}\right) - \left(\frac{1}{AN} - \frac{1}{BN}\right)\right]$$

where ρ is the resistivity of the ground.

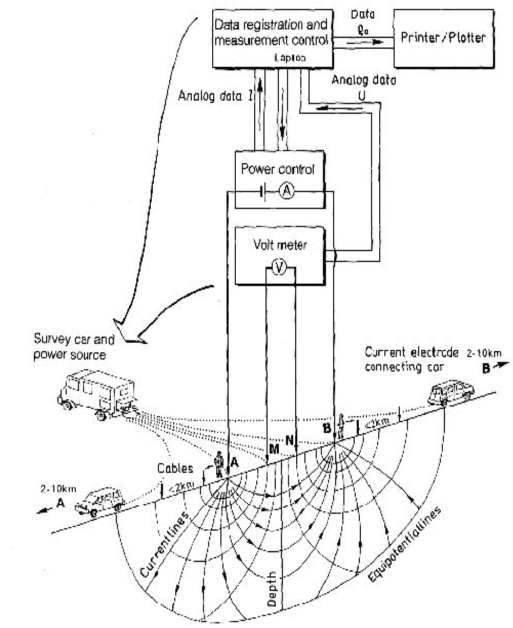


Figure 2: Schematic Field layout of Schlumberger Sounding method.

2.2 Data Processing

The resistivity layer gives the value of resistance (V/I). This data is multiplied with corresponding geometrical factor for the current and potential electrode spacing. It is given by equation.

$G = \pi \{ (AB/2)^2 - (MN)^2 \}$

Where, AB is current electrode spacing and MN is the potential electrode separation. The multiplied value is the apparent resistivity, which is plotted on a bi-logarithmic transparent sheet of modulus 62.5mm. against current electrode spacing.

2.3 Methodology

Forward Modeling Method: Computation forward modeling technique has been applied for the linearized inversion of the geoelectric sounding curves.

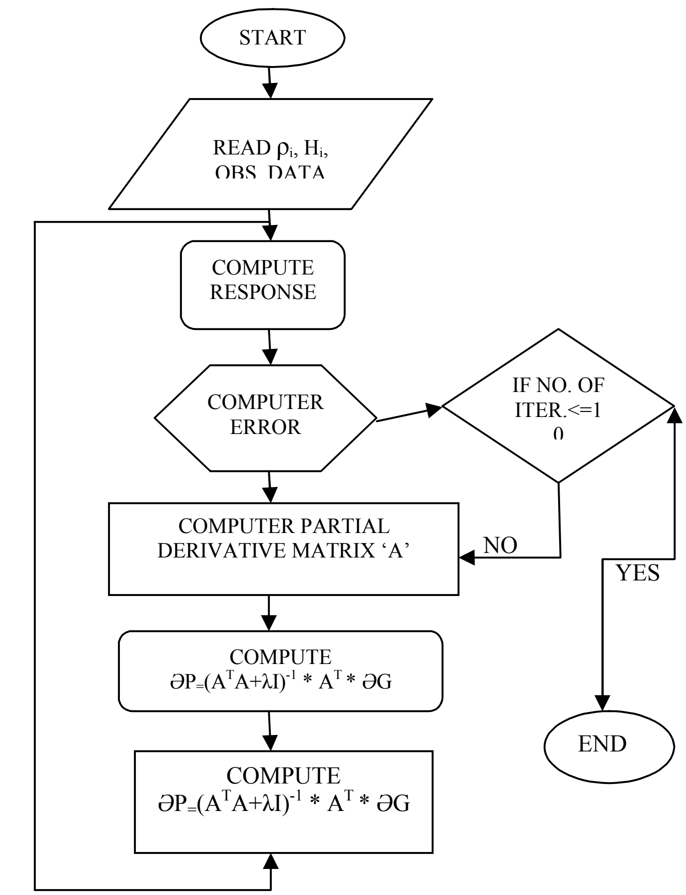


Figure 3: Flow chart of forward modeling algorithm

2.3 Interpretation Technique

Interpretation of field data may be classified in two ways:

- Qualitative:
  Qualitative interpretation of sounding curve includes visual inspection to identify the types of sounding curve.
- Quantitative:
  Quantitative information includes information about resistivity and thickness of each geoelectric layer in the layered earth system.

There are total 21 soundings and the data of each sounding is processed by using forward modeling method. Data is interpreted as shown in following example.

Example

Sounding curve below shows four layer earth model as observed from the nature of the sounding curve and their resistivity as calculated from the forward modeling computational method are 71.26 ohm-m, 2.61 ohm-m, 170.83 ohm-m, 74.02 ohm-m and 28.5 ohm-m for sounding 1 with thickness 0.51m, 0.12m, 2.26m, 10m respectively. Thus from the fitting of the observed and calculated apparent resistivity values as shown in their respective sounding curve we observe that in this area thickness of the first layer is very low and the intermediate layer is relatively conducting then the uppermost and the lowermost layers.

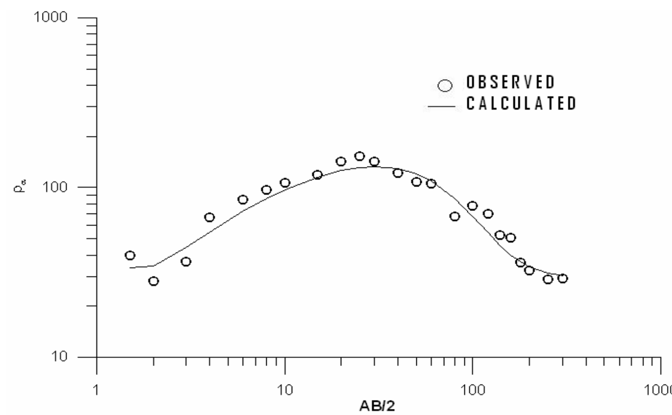
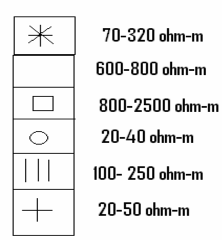


Figure 4: Sounding Curve representing observed and calculated data

Discussion of Geoelectric Section

From the 21 sounding curves we get number of layers and their thickness and resistivity.
Similarly we get thickness and resistivity of different layers for 21 soundings. The picture of each layer below the earth surface is as shown in the following figure.

Scale of figure: along X axis1inch=100m
And along Y axis 1inch=10m.



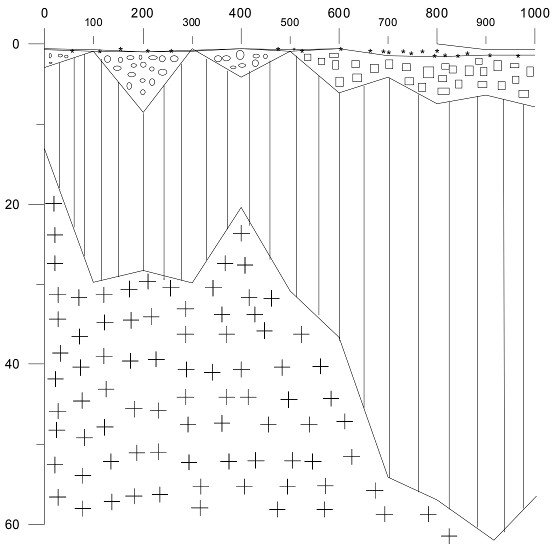


Figure 5: Picture of different Resistive Layers

Conclusion

The resistivity of the overlying layers is very high and confirms the presence of laterite at depths in this area. Thus the possibility of decrease of resistivity due to the water presence in the fractures increases. The thickness of the first layer in most of the places was found to be very low close to or less then even 1m. Thus we conclude that this region has high potential for under surface water bearing zones.

Reference

Chow, V.T., 1964. Handbook of applied hydrology, Mc Graw Hill Book Company, New York, N.Y.

Gosh D.P, 1971 1a. The application of linear filter theory to the direct interpretation of geoelectric sounding measurements. Geophysics prospecting 19, 192-217

Gosh D.P, 1971 1b. Inverse filter coefficient for the computation of apparent resistivity sounding curves for a horizontally stratified earth. Geophysical prospecting 19, 769-775

Kearey, P., Brooks, M.: An Introduction to Geophysical Exploration, Blackwell, 2002

Keller G.V and Frischknecht F.C 1966. Electrical Methods in Geophysical Prospecting. Pergamon Press, inc.

Koefoed O. 1979, Geosounding Principles I, resistivity sounding measurements Elsevier Science Publishing Co.

Lines L.R., Schultz A.K and Treitel S. 1988, Cooperative inversion of geophysical data. Geophysics 53, 8-20.

Reynolds, J. M.: An Introduction to Applied and Environmental Geophysics, Wiley, 1998