Review of Environment and Earth Sciences
2014 Vol.1, No.2, pp. 37-45
ISSN(e): 2313-8440
ISSN(p): 2409-2150
DOI: 10.18488/journal.80/2014.1.2/80.2.37.45

MICRO LEVEL GEO-RESISTIVITY SURVEY THROUGH V.E.S. TEST FOR GROUNDWATER FEASIBILITY STUDY AND SELECTION OF BORE WELL SITES IN PIPILI BLOCK OF PURI

Tarun Kumar Lohani[1] --- Parikshit Barik[2] --- Bankim Chand Patnaik[3] --- Sanjay Kumar Mansingh[4]

[1,2,3,4]*Orissa Engineering College, India*

ABSTRACT

The geo-resistivity was conducted in an area near Jamukoli of Pipili block under Puri district of Odisha to study the groundwater feasibility and selection of site for installation of bore wells. The reason for choosing this area is due to the poor and backward inhabitants residing in the locality. Vertical Electrical Sounding Test most commonly known as Schlumberger Test was conducted at five locations to get a confirmation regarding groundwater occurrences and their feasibility to tap water from deep bore wells. It is surprising to note that during course of investigation there is a huge variation in groundwater occurrences within a span of a couple of meters. This is probably a fault zone which might have been extending in the SE to NW direction. Though the subsurface lithology shows a vertical dissemination of laterite and sandstone but aquifer has been recorded in the region where the lithology is either weathered or fractured. Groundwater exists at a depth of 70m – 90m and an expected 3000 l/hr. can be discharged comfortably in few locations.

Keywords: VES, Schlumberger configuration, Apparent resistivity, Aquifer, Bore well, Groundwater.

Contribution/ Originality

The research work undertaken is a state of art and is an innovation to this particular field. As per the actual result bore logs are the best way to find the existence of the aquifer, but it costs too much if a tracer fails to reveal groundwater existence in that area. To avoid the effective cost sounding method has been executed in five locations at least to find the subsurface occurrence of groundwater. In this regard, resistivity meter of make Geoenviron has been used to find the result of subsurface litho units of the area. Though a huge area is not considered for the research work, but confined work done in a patch of 52 acres of land is enough to depict the presence of aquifer and its discharge per hour.

1. METHODS OF INVESTIGATION

The science of Geophysics applies the principles of physics to the study of the earth. Geophysical Investigation of the earth involves taking measurement at or near the earth's surface that are influenced by the internal distribution of physical properties [1]. The geophysical sounding test measures variations in the electrical resistivity of subsurface lithological layers by applying electrical currents across arrays of electrodes inserted into the ground to determine the physical characteristics of formations in terms of water availability. The schlumberger array used, with maximum current electrode separation of 100m-150m electrodes are normally arranged along a straight line, with the potential electrode placed in between the current electrodes. This configuration is mostly used as it would provide subsurface information considering the depth of penetration which ranges between 1/3 and ¼ of the total current electrode separation [2]. The resistivity sounding curves were interpreted quantitatively; this is done by partial curve matching technique and computer iteration of the interpreted resistivity curves. Partial curve matching method involves a segment matching of the sounding curves with theoretical schlumberger layer [3]. Two current electrodes and two non-polarizing electrodes are set out in a standard configuration known as Schlumberger's configuration. Frequency current is applied across the two outer electrodes and the voltage is measured across the inner electrodes by AC Resistivity meter. The apparent ground resistivity is computed from the recorded values of current in mA and potential difference in mV at different electrode separation. Models of vertical variations in ground resistivity are obtained using an expanding electrode array centered on a reference point. Depth of penetration increases with electrode spacing. The resistivity readings are processed in computer to determine the thickness and true resistivity readings are processed in computer to determine the thickness and true resistivity of subsurface electrical layers. A curve is generated in log-log graph taking the current electrode spacing and the apparent resistivity value for each site for interpretation. The results are correlated with local geology and the subsurface litho layers are interpreted.

1.1. Hydrogeology

This area comes under Achaean formations consisting of Granites. Laterite forms as the capping rock in this area. The weathered and fractured Granite are considered as the main aquifer in this area. The depth of weathering is low to medium. Groundwater occurs under water table condition.

1.2. VES Test

1.2.1. Field Observations

The VES tests have been conducted at five locations adopted Schlumberger's configuration with a maximum electrode spreading (AB/2) of 150m. to delineate the subsurface formations and aquifer zones. The potential difference (ΔV) in mV and the current (I) in mA have been recorded through a digital AV resistivity meter of IGIS make at each site by applying current through two electrodes. The apparent resistivity is next calculated from each electrode separation as well as field observation.

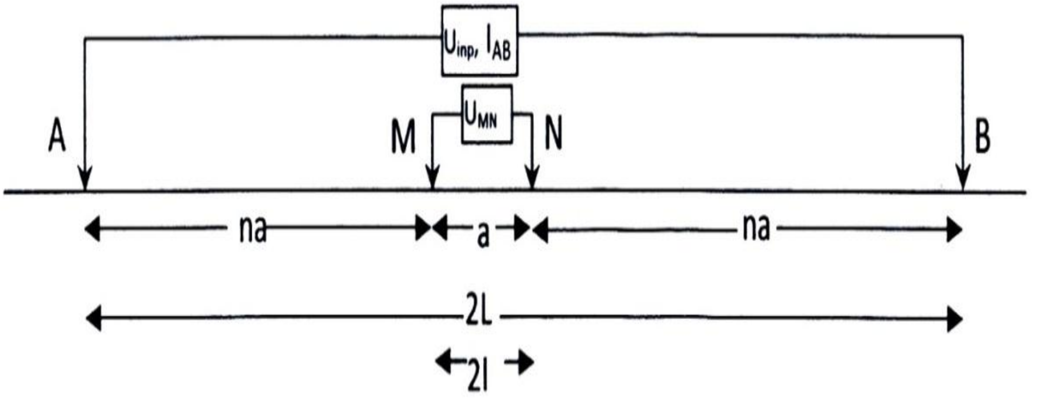
2. DATA ANALYSIS

The field data are processed in computer to determine the thickness and true resistivity of subsurface electrical layers by a curve generated in log-log graph taking the current electrode spacing and the apparent resistivity value for each site for interpretation.

2.1. VES Test Results

The results of VES tests conducted at all sites reveal the presence of five different electrical layers within about 100m. depth below ground level. These electrical layers have been interpreted basing on the local hydrogeology. The fresh water bearing zones or aquifers have been identified basing on the true resistivity values. The sounding test result for each site is discussed below.

Fig-1. Principle of Schlumberger Layout suitable for VES (Vertical Electrical Sounding)



Site No. 1

This site is located at 20⁰10′3.9″ N Latitude and 85⁰46′19.4″ E longitude. Laterite soil and laterite are found up to a depth of 6.9 m. underlying hard granite up to a depth of 58.6m.Granite less fractured is found below this zone which is considered as the aquifer, but this aquifer may not yield sufficient water. Hence, the site is practically not feasible to tap groundwater from deep bore well.

Fig-2. VES graph of Site No.1

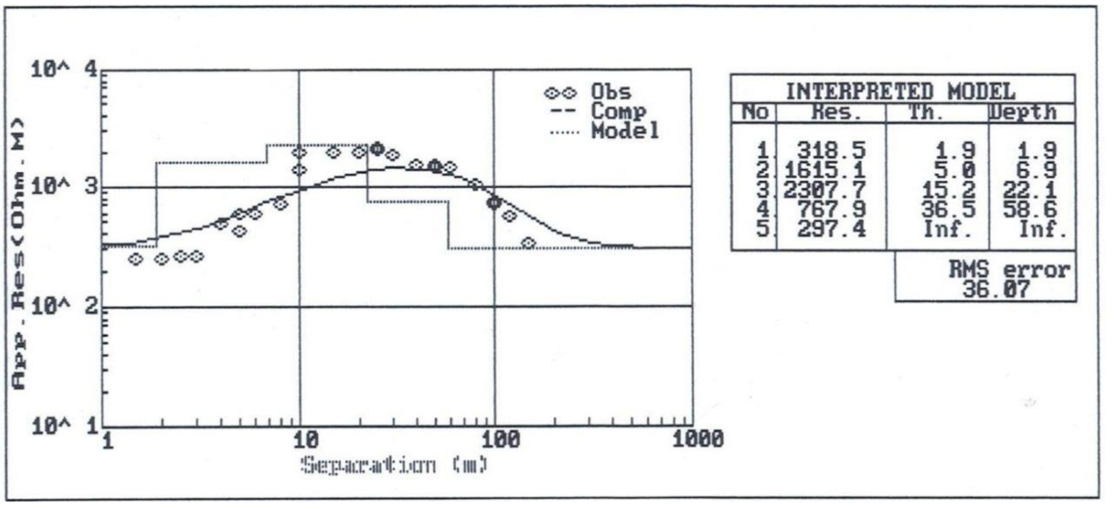


Table-1. Interpretation of Lithology as per their respective resistivity values for Site No.1

Litho Layer No.	Resistivity in Ωm.	Depth in m.	Probable Lithology	Remarks
1	318.5	1.9	Laterite soil with quartz pieces	
2	1615.1	6.9	Laterite soil with quartz pieces	
3	2307.7	22.1	Hard Granite	
4	767	58.6	Hard Granite	
5	297.4	Infinity	Less Fractured Granite	Aquifer Zone

2.2. Findings

This site may not be feasible for installation of bore well as the aquifer zone may not yield sufficient water.

Site No. 2

The latitude of this site is 20⁰10′3.8″ N Latitude and 85⁰46′18.4″ E longitude. Laterite soil and laterite are found up to the depth of 8.6m. underlying granite extending up to a depth of 51.3m. A less fractured granite zone is found below this zone but the zone may not yield sufficient water. Hence, this site may not be a suitable source for groundwater exploration.

Fig-3. VES graph of Site No.2

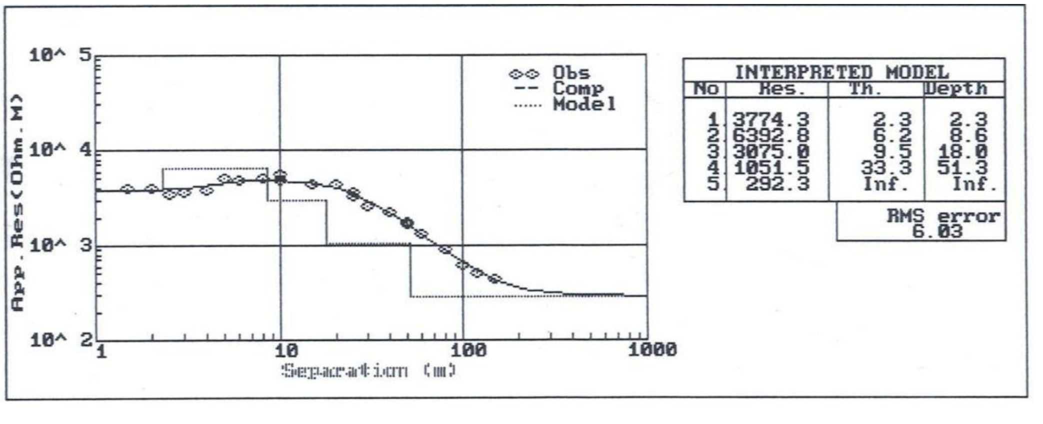


Table-2. Interpretation of Lithology as per their respective resistivity values for Site No. 2

Litho Layer No.	Resistivity in Ωm.	Depth in m.	Probable Lithology	Remarks
1	3774.3	2.3	Top Lateritic Soil	
2	6392.8	8.6	Laterite	
3	3075	18.0	Weathered Granite	
4	1051.5	51.3	Fractured Granite	Aquifer Zone
5	292.3	Infinity	Less Fractured Granite	Aquifer Zone

2.3. Findings

This site may not be feasible for installation of bore well as aquifer zone may not yield sufficient water.

Site No.3

This location has latitude 20°9′50.5″ N and longitude 85°46′22.4″ E. laterite soil and laterite is found up to a depth of 7.2m. A thick weathered granite zone of 38.6m. is located beneath the laterite layer and underlying a blanket deposit of 48.6m. thick fractured granite. These shows a more suitable and pertinent zone of potential aquifer in which perennial source of groundwater can be exploited. As per the groundwater statistic the aquifer may have a depth of 75m. This needs a casing of 40.0m. and expected discharge is about 3000 L/Hr.

Fig-4. VES graph of Site No.3

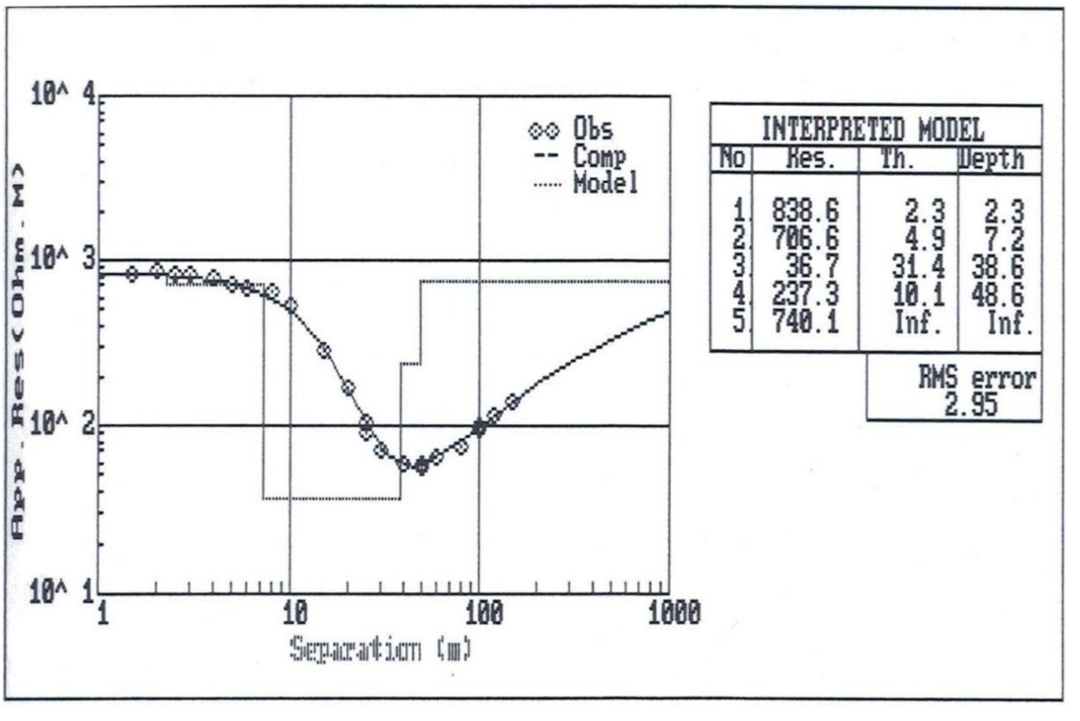


Table-3. Interpretation of Lithology as per their respective resistivity values for Site No. 3

Litho Layer No.	Resistivity in Ωm.	Depth in m.	Probable Lithology	Remarks
1	838.6	2.3	Top Latritic Soil	
2	706.6	7.2	Laterite	
3	36.3	38.6	Weathered Granite	
4	237.3	48.6	Fractured Granite	Aquifer Zone
5	740.1	Infinity	Less Fractured Granite	Aquifer Zone

2.4. Findings

This site is feasible for installation of bore well as a prominent aquifer is found at this site.

Site No.4

This location is situated at 20⁰9′49.5″ N Latitude and 85⁰46′19.9″ E longitude. Laterite soil and laterite are found up to a depth of 9.3m. A less thick weathered granite zone of 49.9m.is found below laterite capping. There is no sign of groundwater storage in this zone and hence cannot be suggested for groundwater boring.

Fig-5. VES graph of Site No.4

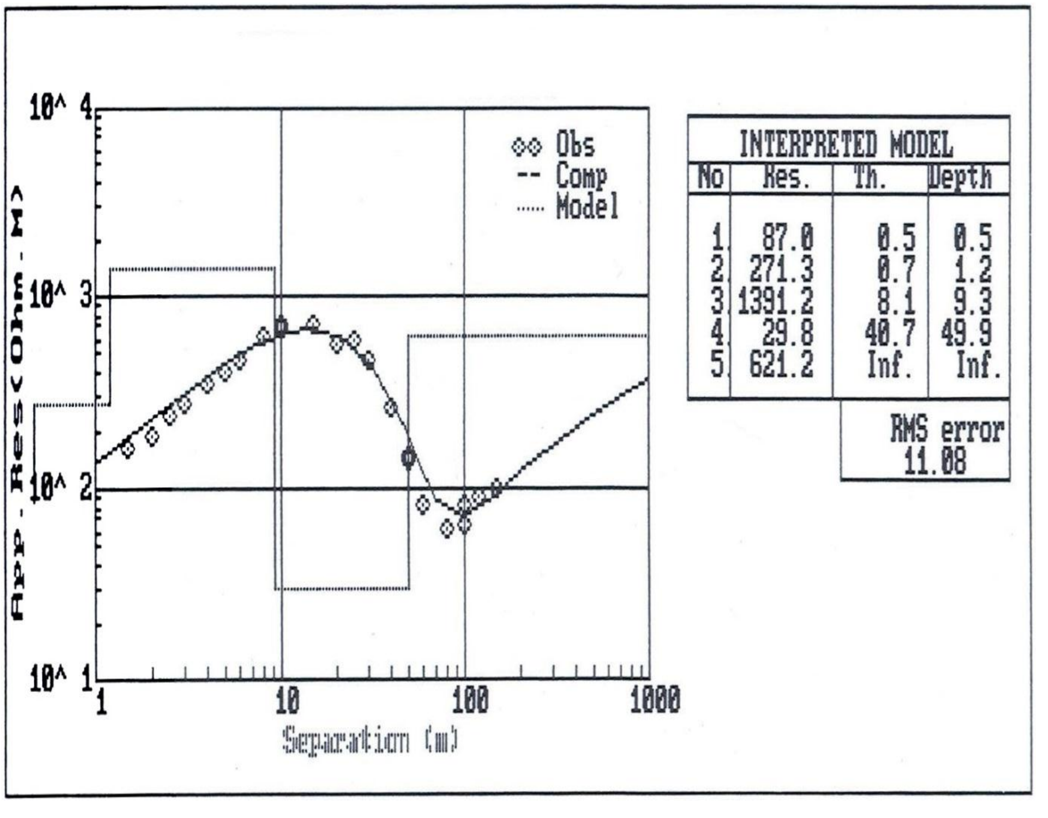


Table-4. Interpretation of Lithology as per their respective resistivity values for Site No.4

Litho Layer No.	Resistivity in Ωm.	Depth in m.	Probable Lithology	Remarks
1	87	0.5	Top Latritic Soil	
2	271.3	1.2	Weathered Laterite	
3	1391.2	9.3	Latrite	
4	29.8	49.9	Weathered Granite	Aquifer Zone
5	621.2	Infinity	Less Fractured Granite	Aquifer Zone

2.5. Findings

This site is not feasible for installation of bore well as aquifer is not found at this site.

Site No. 5

This is the last location on which VES was conducted. The location has a latitude of $20^0 10'2.8''$ N and $85^0 46'22.6''$ E longitude. The top layer is laterite in characteristic and is 16.0m. thick only underlying by hard granite of 63.7m. thick. A fractured granite zone considered as aquifer is a feasible zone of aquifer that lies just beneath this hard granitic terrain. The thickness of this aquifer is nearly 95.0m. which requires a 10.0m. casing that can suffice 3000 litres of water per hour.

Fig-6. VES graph of Site No.5

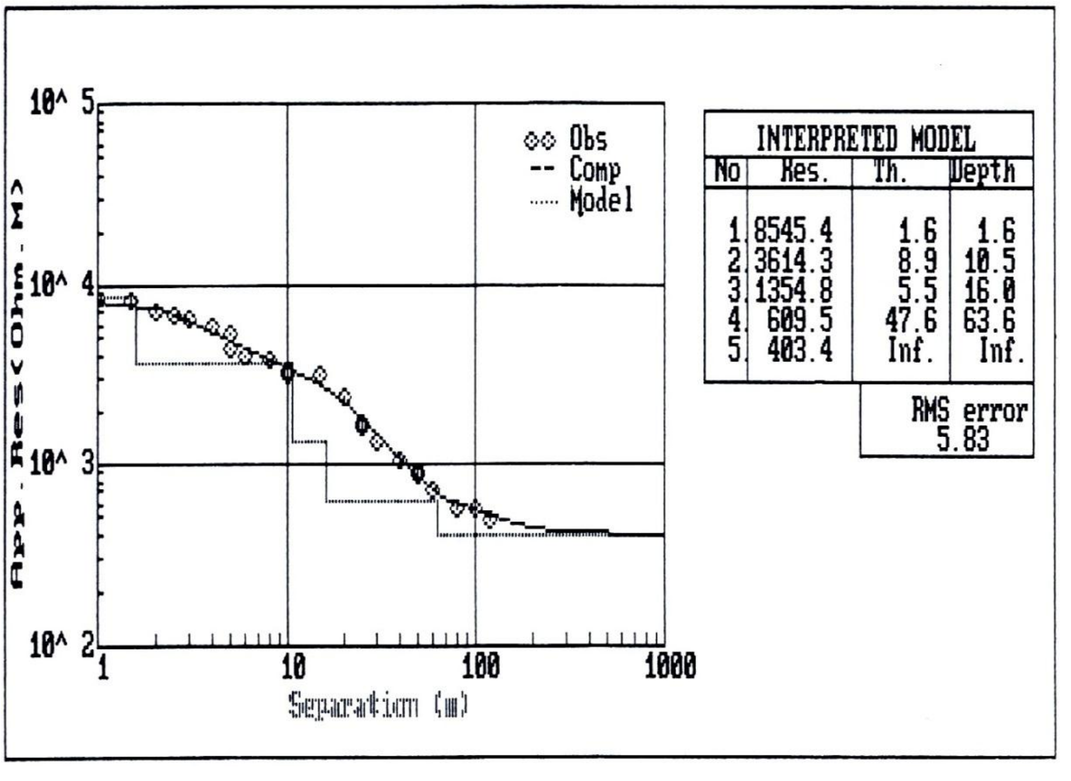


Table-5. Interpretation of Lithology as per their respective resistivity values for Site No.5

Litho Layer No.	Resistivity in Ωm.	Depth in m.	Probable Lithology	Remarks
1	8745.4	1.6	Top Latritic Soil	
2	3614.3	10.5	Latrite	
3	1354.8	16.0	Laterite	
4	609.5	63.7	Granite	
5	403.4	Infinity	Fractured Granite	Aquifer Zone

2.6. Findings

This site is feasible for installation of bore well as prominent aquifer is found at this site.

3. RESULTS AND DISCUSSION

The vertical electrical sounding (VES) data are presented as depth sounding curve, which are obtained by plotting apparent resistivity values against electrode spacing on a log-log or bi-log graph paper [4]. The depth sounding curves are classified based on layer resistivity combinations. Resistivity soundings in this area clearly identified the nature of the lithological depths and proved useful at identifying water-bearing zones [5]. Five random points are selected for resistivity survey and in each point five layers have been defined. The datum in each case is defined by compact or very less fractured granite and it is true that aquifer rests comfortably on this igneous mass which may be considered as of Proterozoic formation of eastern ghat region. There is a clear picture that in few locations perennial source of groundwater can be tapped and in few other cases bore wells may fail to discharge considerable groundwater [6].

4. CONCLUSION

Vertical electrical sounding technique of the electrical resistivity method has proven to be successful and highly effective in the identification and delineation of subsurface structures that are favorable for groundwater accumulation in a crystalline basement complex area. The electrical resistivity survey method used in this project entails locating a favorable borehole at five subsurface geo-electrical layers. These consist of the topsoil, weathered layer and the fractured basement. However the fractured basement is found in all the segments of the study area.

REFERENCES

[1] T. A. Lateef, "Geophysical investigation for groundwater using electrical resistivity method - A case study of annunciation grammar school, IkereLga, Ekiti State, South-Western Nigeria," *IOSR Journal of Applied Physics (IOSRJAP)*, vol. 2, pp. 01-06, 2012.

[2] L. M. David and O. Ofrey, "An indirect method of estimating ground water level in basement complex regolith," *Water Resources*, vol. 1, pp. 34 -41, 1989.

[3] A. Mallam and C. O. Ajayi, "Resistivity method for groundwater investigation in sedimentary area," *Nig. J. of Physics.*, vol. 12, pp. 34 – 38, 2000.

[4] Van-Dycke Sarpong Asare and Aboagye Menyeh, "geo-electrical investigation of groundwater resources and aquifer characteristics in some small communities in the gushiegu and Karaga districts of Northern Ghana," *International Journal of Scientific & Technology Research*, vol. 2, pp. 25-35, 2013.

[5] Abdulaziz Mohammed Al-Bassam, "Resistivity methods for groundwater exploration in the cretaceous-tertiary sedimentary sequence. East of Jeddah, Saudi Arabia," *Journal of Environmental Hydrology*, vol. 13, pp. 1-9, 2005.

[6] T. K. Lohani, K. P. Dash, and P. K. Parida, "Groundwater investigation around Nabajyotivihar, Jatni, Bhubaneswar by vertical electrical sounding," *International Journal Of Civil and Structural Engineering*, vol. 2, pp. 689-696, 2011.