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ESTIMATION OF HYDROGEOLOGICAL PARAMETERS USING ELECTRICAL RESISTIVITY METER

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Abstract – *Vertical Electrical Sounding using the Schlumberger electrode configuration was used to investigate the hydrogeological parameters like the groundwater potential zones and lithology of area in and around Veettoor forest. The resistivity values thus obtained was plotted against penetration depth and the graphs were analyzed. The analysis of these graphs gave the lithological characteristics as well as the strong groundwater potential zones of the area. The area mainly consist of hard and compacted rock and strong groundwater potential zones were obtained at 15-25 m depth.*

Key Words: Electrical Resistivity Meter, Vertical Electrical Sounding, Schlumberger electrode configuration, Groundwater potential zones, Lithological characteristics

1. INTRODUCTION

Subsurface water is the fraction of total precipitation which infiltrates into the ground and fills the voids in the rock or unconsolidated materials. Thus it represents the part of subsurface water occurring in the zone of saturation (phreatic zone) below the water table. In water scarce areas the water table may be at very great depths. Thus, it is quite uneconomical to dig open wells as there always lies an uncertainty regarding the presence of water at reasonable depths. Therefore, an initial field survey using electrical resistivity meter can be done which gives a clear cut idea about the ground water potential zones of the area under consideration.

Various studies suggested that complex geohydrological problems related to occurrence of groundwater can be solved using geophysical methods, especially the electrical resistivity method, along with geological methods (Sajeena et al., 2014). Electrical resistivity meter studies were conducted in various areas and groundwater potential zones were found out with the help of Vertical Electrical Sounding (VES) data (Olandunjoye et al., 2013; Sikah et al., 2016 and Golekar et al., 2016).

2. OBJECTIVE

The objective of the study was to investigate and furnish the groundwater potential zone as well as the lithological characteristics of any specified location by VES technique of electrical method of geophysical exploration.

3. LOCATION OF STUDY AREA

The study area selected was the area in and around Veettoor forest in Mazhuvannoor panchayat in Ernakulam district of Kerala, India.

4. METHODOLOGY

Initially, the water well inventory was done at 25 houses in the study area and the data was recorded. Then, 9 locations were selected from the study area considering the area requirements for conducting the filed survey and they were marked.

Electrical resistivity surveys were conducted at all the 9 locations by VES technique using Electrical Resistivity Meter (Aquameter CRM 20).

VES method is based on determining electrical resistivity or conductivity of a medium by evaluating the voltage of electrical field induced by distant current electrodes. The Schlumberger electrode configuration was used in this study, which effectively measures the variation of resistivity with depth below the origin.

The apparent resistivity at sounding stations was plotted against corresponding half electrode spacing in Microsoft Excel to look for weaker or stronger groundwater potential zones.

In addition to this, the resistivity values obtained from the study was compared with the generalized ranges of resistivity values of different litho units given in table 1 and different soil strata were identified.

Table 1: Litho-units and Resistivity (Patil et al., 2015).

Litho-Units	Resistivity (Ω m)
Clayey/silty layer	1-3
Medium grained sandy layer	3-5
Loose sand and gravel bed	5-7
Clay with pocket of sand	7-15
Clay with lenses of sand	15-25
Compacted clay with pebbles, cobbles, gravels	25-45
Compacted clay bed	45-60
Hard and compact rock	Over 60

5. FIELD SURVEY, RESULTS AND DISCUSSIONS

The well inventory and surveys conducted in and around the study area during the months of February and March of 2016 gave a clear picture of the water scarcity of the area during summer season. VES was carried out at 9 locations denoted as LOC 1, LOC 2 etc. whose latitude and longitude details are as given in table 2.

Table 2: Location details in the study area.

Location Name	Latitude	Longitude
LOC 1	10.009585N	76.540213E
LOC 2	10.008675N	76.546280E
LOC 3	10.010539N	76.547340E
LOC 4	10.013500N	76.547816E
LOC 5	10.015335N	76.543335E
LOC 6	10.008234N	76.542739E
LOC 7	10.013022N	76.540216E
LOC 8	10.010579N	76.542334E
LOC 9	10.012111N	76.545598E

The resistivity vs penetration depth plot for all the 9 locations in the study area obtained is as shown in chart 1, 2 and 3.

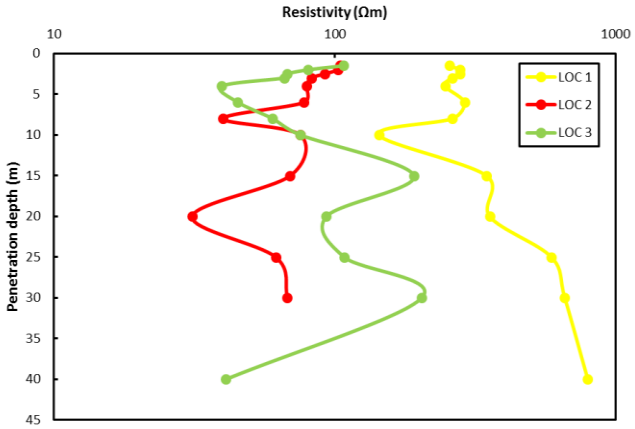

Chart -1: Resistivity vs Penetration depth graph for LOC 1, LOC 2 and LOC 3

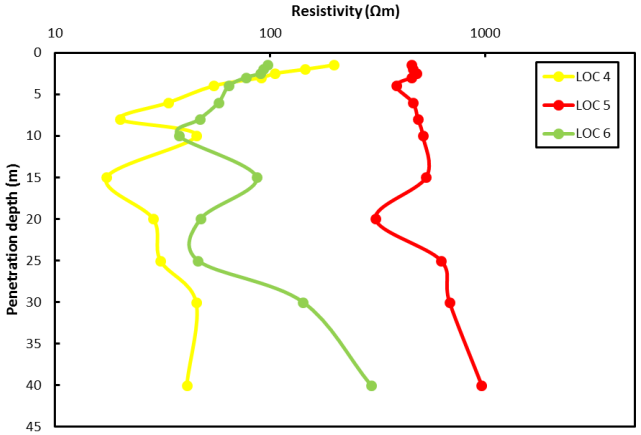

Chart -2: Resistivity vs Penetration depth graph for LOC 4, LOC 5 and LOC 6

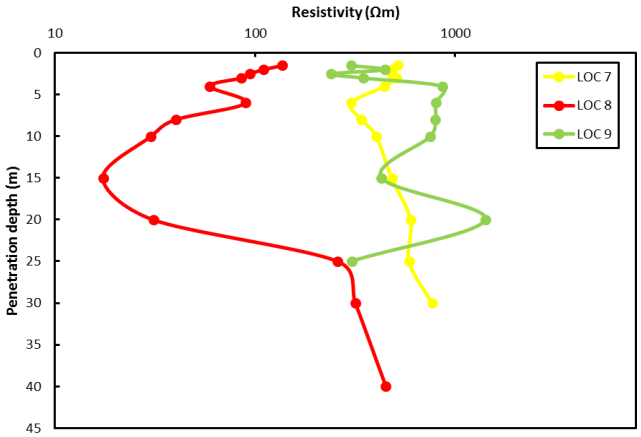

Chart -3: Resistivity vs Penetration depth graph for LOC 7, LOC 8 and LOC 9

The analysis of the curves at different locations gave the idea about the groundwater potential zone and the basic lithology of the specific location.

At LOC 1, the water zone was observed at a depth of 10 m and there is presence of hard and compact rock up to a depth of 40 m.

At LOC 2, water zones were observed at depths of 8 m and 20 m and there is presence of hard and compact rock up to a depth of 6 m and 10-15 m and 25-30 m depths. At 6-10 m and 15-25 m depths, the presence of a layer of compacted clay with pebbles, cobbles, and gravels is observed.

At LOC 3, water zones were observed at a depths of 4 m and 20 m and there is presence of hard and compact rock up to a depth of 3 m and 8-30 m depth. At 3-6 m and 30-40 m depths, the presence of a layer of compacted clay with pebbles, cobbles and gravels is observed.

At LOC 4, water zones were observed at a depths of 8 m and 15 m and there is presence of hard and compact rock up to a depth of 3 m. At 3-4 m, 8-10 m and 25-30 m depth, the presence of a compacted clay bed and at 6-8 m depth, presence of a layer of compacted clay with pebbles, cobbles, gravels are observed.

At LOC 5, water zones were observed at a depths of 4 m and 20 m and there is presence of hard and compact rock up to a depth of 40 m.

At LOC 6, water zones were observed at a depths of 10 m and 25 m and there is presence of hard and compact rock up to a depth of 4 m and 10-15 m and 30-40m depths. At 4-8 m and 15-25 m depths, the presence of a compacted clay bed and at 8-10 m depth, presence of a layer of compacted clay with pebbles, cobbles, gravels are observed.

At LOC 7, the water zone was observed at a depth of 6 m and there is presence of hard and compact rock up to a depth of 30 m.

At LOC 8, water zones were observed at a depths of 4 m and 15 m and there is presence of hard and compact rock up to a depth of 3 m and 4-6 m and 20-40m depths. At 3-4 m depth, the presence of a compacted clay bed, at 10-15 m depth, presence of a layer of clay with sand lenses and at 6-10 m and 15-20 m depths, presence of a layer of compacted clay with pebbles, cobbles, gravels are observed.

At LOC 9, water zones were observed at a depths of 4 m and 25 m and there is presence of hard and compact rock up to a depth of 40 m.

6. CONCLUSIONS

The Vertical Electrical Sounding using Electrical Resistivity Meter at the study area gave the following conclusions:

- Bore wells can be constructed up to a depth of 15-25 m to explore groundwater from the potential zones which could cater the water requirements of the people of the area during summer.
- The lithology of the area comprises hard and compact rock with small layers of compacted clay in between.

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