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Identification of Groundwater Potential Zones in Granitic Terrrain of Rangareddy District, Telangana State: A Case Study from Pendyala Village

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Abstract (10pt)

Groundwater investigations in Pendyala village, Rangareddy district, Telangana State, South India has been carried out. Twelve (12) Vertical Electrical Sounding (VES) was conducted within the study area, using the Schlumberger Array Configuration. Data acquired were processed and interpreted using IPI2WIN software. Three geoelectric layers were obtained showing a sequence of top soil, weathered soil, fractured granite and massive granite. The K-curve type predominates with a water table depth of 40meters. Contour maps of Iso-resistivity and Aquifer depth were constructed. Variations of these data show a possibility of groundwater occurrence at potential points. Two sites were recommended for drilling. Drilling with Down-The-Hole Hammer (DTH) was carried out at the recommended sites down to 120 to 150m depths. The recommended VES results matched well with the test soundings carried at the drilled bore well resistiviites. The yields of bore wells vary from 2000 to 6000 liters per hour (lph). The yield is expected to be low in areas with no incidence of fractures. The use of Electrical Resistivity method has proved useful in evaluating the groundwater potentials within and around the study area.

Keywords:

Electrical resistivity;
Isoresistivity;
Hard rock region;
Weathered/fractured Granite;
Groundwater.

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1. Introduction

Groundwater investigation in hard rock terrain is a challenging task. In hard rocks, groundwater occurs in secondary porosity developed due to weathering, fracturing, faulting, etc., which is highly variable within short distance and contributing to near surface in homogeneity. The groundwater level has considerably declined due to over-exploitation and irregular rainfall. The successful exploitation of basement terrain groundwater requires a proper understanding of its hydrogeophysical characteristics [1]. This is particularly important in view of the discontinuous nature of basement aquifers [2]. It is well known that electrical resistivity technique is being widely used to image the geoelectric structure of the shallow subsurface earth [3]; [4]; [5]; [6]; [7]; [8]. The Vertical Electrical Sounding (VES) had been used to delineate the different

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sub-surface layers, aquifers unit and their characteristics, the sub-surface units and their characteristics, the sub-surface structure and the depth to water table. This study was aim at delineating suitable sites for groundwater development in Pendyala village.

2. Location of the Study Area

The Pendyala village is located in South-Eastern part of the Rangareddy district at a distance of 35 Kms from Hyderabad, exists between 17° 7'30.00"N to 17° 7'33.60"N latitudes and 78°22'12.00"E to 78°22'48.00"E longitudes. The average elevation is about 392 m above mean sea level (M.S.L) and falls in the Survey of India Toposheet no. 56L/13 (Figure 1). Average annual rainfall is about 615 mm. The minimum and maximum temperatures range from 26 to 39°C [9].

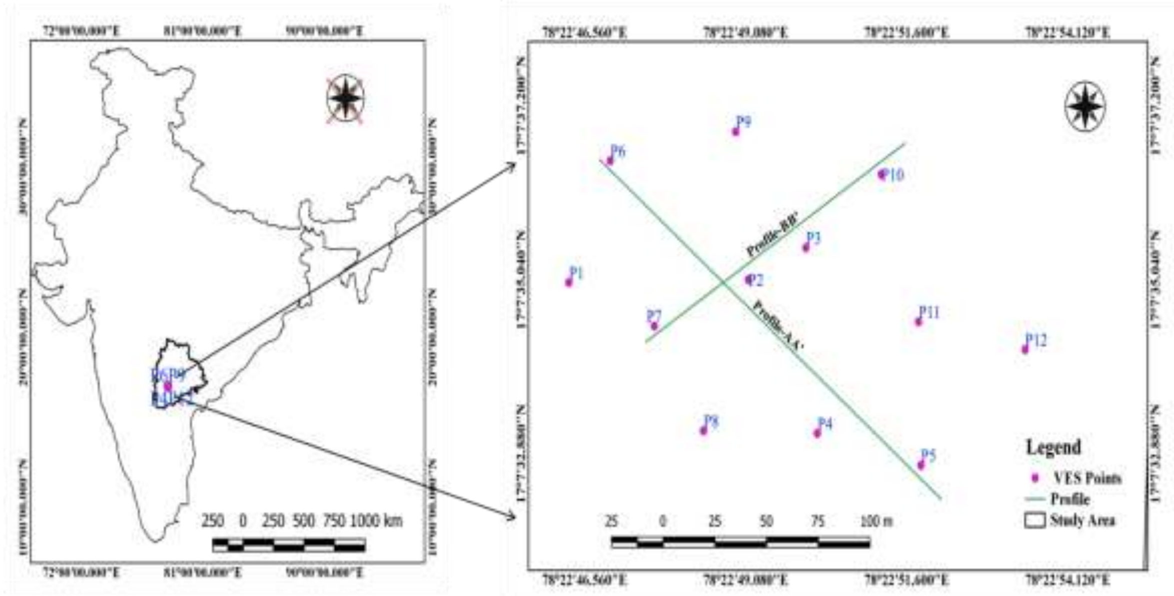


Figure 1. Location Map of the Study Area

2.1. Geology

The area is underlain by the Archaean group of rocks. The Archaean group of rocks comprises peninsular gneissic complex (PGC) and younger intrusive quartz veins. The geology normally will provide low to moderate yielding borehole to restricted amount depending on the extent of weathering zone and fractures. The depth of the weathered zone varies from 7.00m to 13.00m. Hydrogeological surveys carried out in the study area reveal that ground water occurs under water table conditions in the weathered and fractured zones.

3. Methodology

Electrical Resistivity Method is the most widely used method all over the globe because of its efficacy to detect the water bearing layers, besides being simple and inexpensive to carry out the field investigations [5]. Due to the above factors, the vertical electrical sounding surveys (VES) are still preferred to carry out for groundwater exploration. The VES measures the parameters of resistivity at various depths in the subsurface. The resistivity measurements are normally made by injecting current into the ground through two current electrodes (C1 and C2), and measuring the resulting voltage difference at two potential electrodes (P1 and P2). From the current (I) and voltage (V) values, an apparent resistivity (pa) value is calculated.

$$\rho a = G(\Delta V / I)$$

where 'G' is the configuration or geometric factor which depends on the arrangement of the four electrodes. In case of Schlumberger array it is given by:

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

Where AB is the distance between the current electrodes, MN is the distance between the potential electrodes.The VES data was analyzed with the curve matching using master curves of various ratios of absolute resistivity given [10].

4. Results and Discussion

A total of 12 Vertical Electrical Soundings (VES) were carried out using Schlumberger Array electrode configuration. Two profiles AA1 (VES P6, P2, P4 and P5) and BB1 (P7, P2, P3 and P10) were identified in the study area. Pseudo cross sections of the two profiles were generated based on the apparent resistivity of the soundings (Fig. 4a, 4b). The geoelectric section along profile line AA1 (Figure 2a) revealed that the line is also made up of three layers the first layer is the thin resistive top soil, it has resistivity range of 20Ωm to 35Ω m and a thickness range of 8.3m to 9.72 m,. The second layer is interpreted as the weathered rock with lower resistivity value, it has resistivity range of 289 Ω m to 9864 Ω m and a thickness range of 6.9 to 67.6 m, the thickness is higher at stations 6. The third layer which is to infinity also suggests a fresh basement rock and has resistivity range of 20 Ω m to 8966 Ω m.The geoelectric section along profile line BB1 (Figure 2b) revealed that the line is also made up of three layers the first layer is the thin resistive top soil, it has resistivity range of 19Ωm to 41Ω m and a thickness range of 6.9 m to 9.3 m,. The second layer is interpreted as the weathered rock with lower resistivity value, it has resistivity range of 289 Ω m to 42971 Ω m and a thickness range of 23.6 to 131.6 m, the thickness is higher at stations 10. The third layer which is to infinity also suggests a fresh basement rock and has resistivity range of 314 Ω m to 8966 Ω m.
Two sites (VES. P6 and P7) were recommended for drilling. Drilling with Down-The-Hole Hammer (DTH) was carried out at the recommended sites down to 120 to 150m depths.

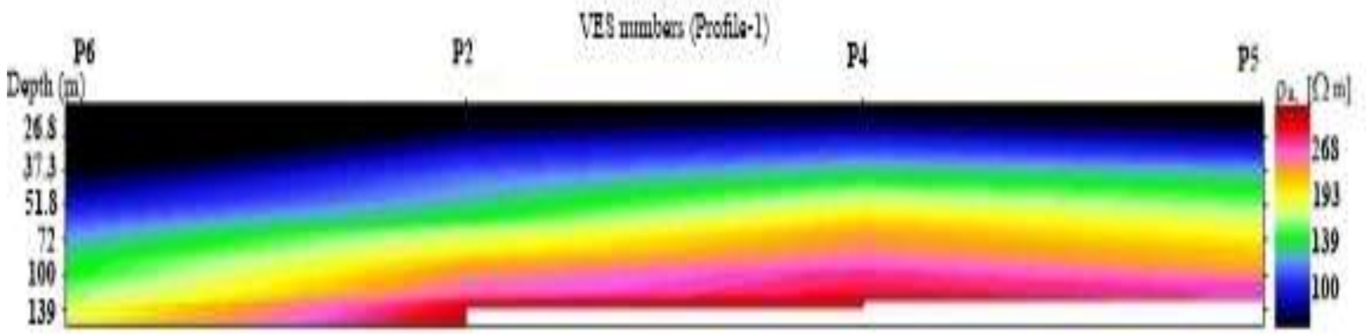
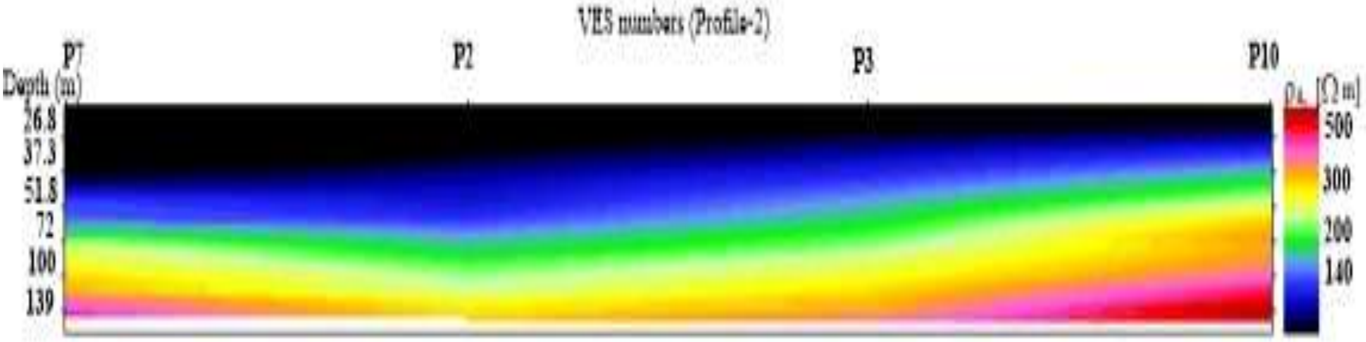


Figure. 2a. Pseudo cross sections of electrical resistivity of VES Profile-1



2b) Pseudo cross sections of electrical resistivity of VES Profile-2.

The resistivity data acquired from the study area was inputted and analyzed with suitable computer resistivity software (IPI2 WIN). And result shows that VES P1, P2, P3, P8 and P11 has curves like A type, and VES P4, P5, P6, P7, P9, P10 and P12 show K type curves respectively (Table 1) in which all the soundings shows 3 geoelectric layers. The Resistivity ranges of geological medium obtained from vertical electrical soundings correlating with well logs in the study area are shown in (Table 2).

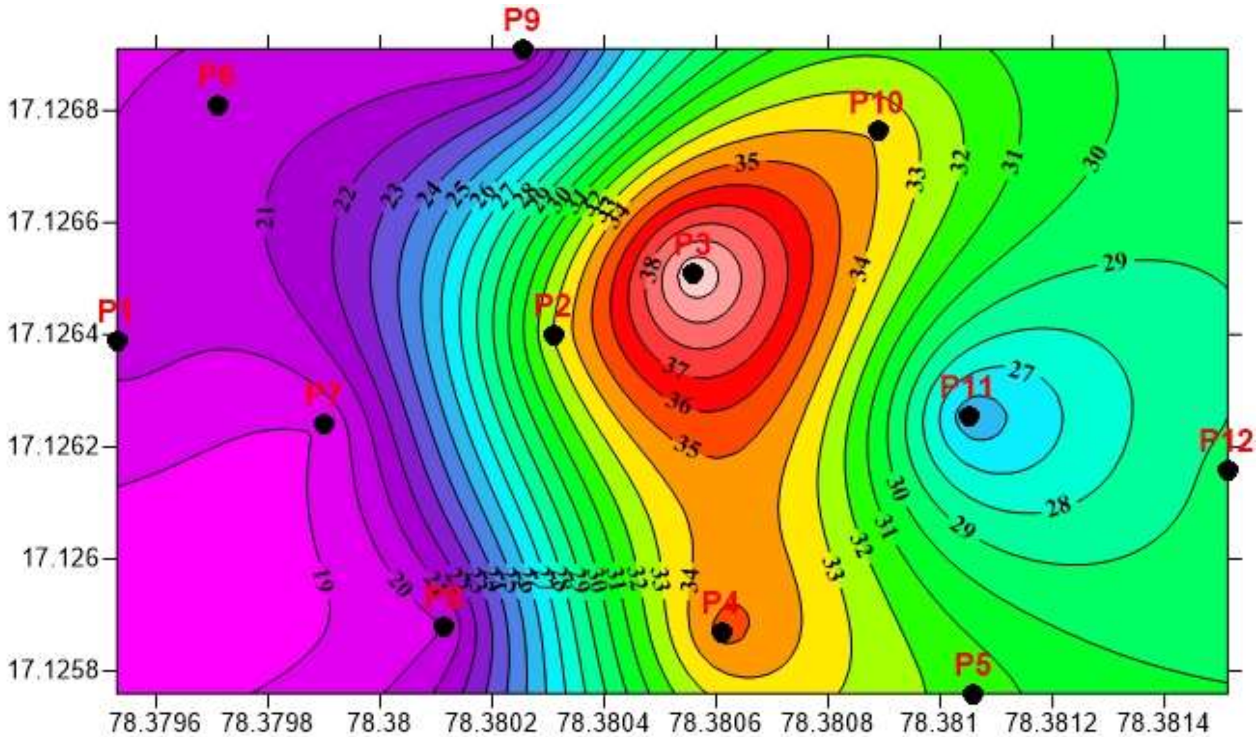
Table 1. Interpreted model geoelectric layers and curve types from the study area

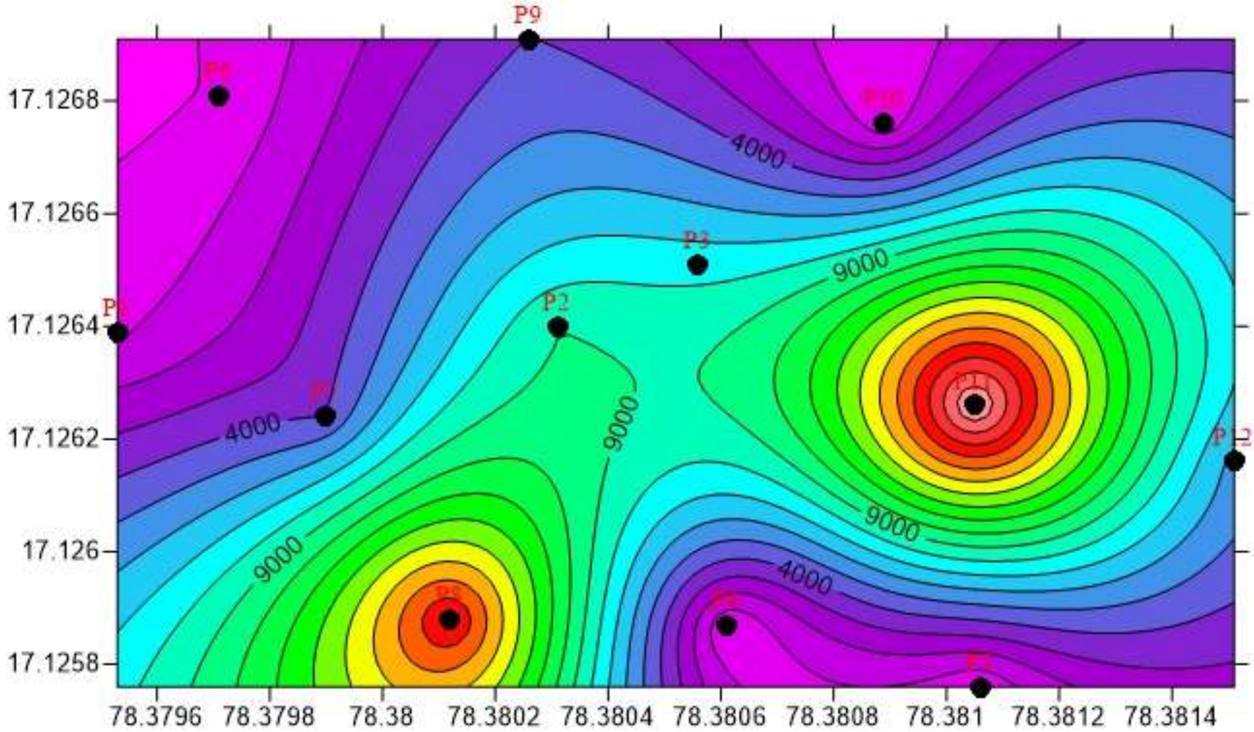
VES No.	Longitude	Latitude	ρ1	ρ2	ρ3	T1	T2	Curve Type
P1	78.37953	17.12639	20.52	471.2	844	11.95	20.91	A
P2	78.38031	17.12640	33.1	289	8966	8.32	67.6	A
P3	78.38056	17.12651	41.06	612	7550	9.39	131.6	A
P4	78.38061	17.12587	35.4	9864	20.1	9.43	7.08	K
P5	78.38106	17.12576	31.6	7392	33.6	9.27	6.93	K
P6	78.37971	17.12681	20.5	4162	112	9.72	16	K
P7	78.37990	17.12624	19.1	17829	3978	6.98	68	K
P8	78.38012	17.12588	20	3858	17289	7.19	23.8	A
P9	78.38026	17.12691	20	18067	4031	8.26	71.7	K
P10	78.38089	17.12676	33.9	42971	314	7.43	23.6	K
P11	78.38105	17.12626	25.2	4540	20349	9.76	23.1	A
P12	78.38151	17.12616	29.3	25484	5686	8.99	66	K

Table 2: Resistivity ranges of geological medium obtained from VES correlating with well logs

Resistivity range (Ωm)	Geological Medium
0-20	Clayey layer
20-50	Hard murram
50-120	Semi-weathered to fractured rock
100-350	Fractured rock
>350	Hard rock

The iso-resistivity values are drawn for the 3 geoelectric layers selected along X, Y coordinates of the locations. The iso-resistivity maps are prepared by using surfer software incorporating all the twelve VES data in the study area. These resistivity contours were helpful in delineating the lateral variation in the sub-surface geology of the area. Low resistivity denotes good conductors and high resistivity values are poor conductors (Fig. 3a, 3b and 3c).


P9
P6
P10
P3
P1
P2
P7
P11
P12
P8
P4
P5
17.1268
17.1266
17.1264
17.1262
17.126
17.1258
78.3796
78.3798
78.38
78.3802
78.3804
78.3806
78.3808
78.381
78.3812
78.3814


P9
4000
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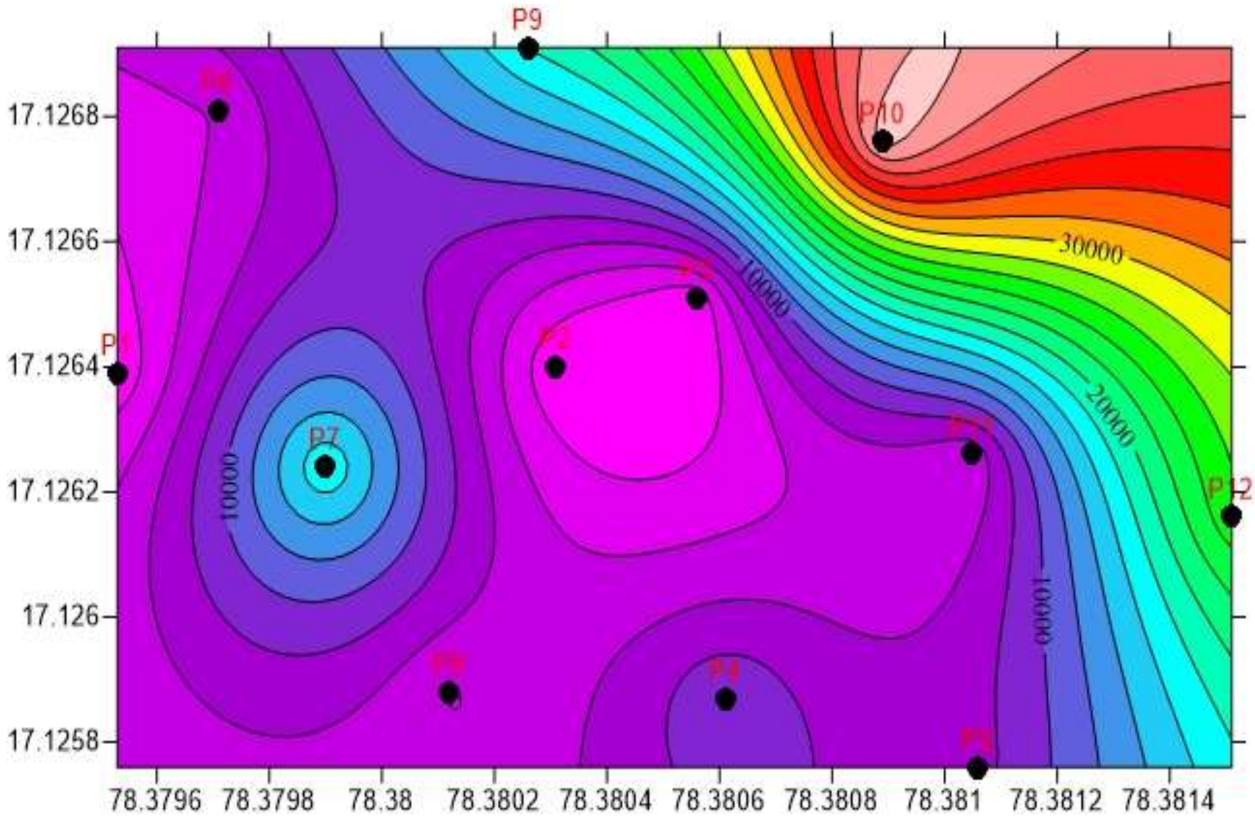

Figure 3 Isoresistivity Curves a) Layer 1 charectristics b) Layer 2 characteristics and c) Layer 3 characteristics of the vertical electrical soundings

5. Conclusion

The results of the interpreted data and the lithologic logs from boreholes indicate three geoelectric layers. The VES P6 and P10 represented by low resistivity contours in the range of 20 to 350 Ωm, indicating fractured granite as an aquifer. Majority of resistivity curves are falling in 'K' type. The prominent low resistivity anomalies observed in and around (VES P6 and P10), have been represented in all the iso-resistivity contour maps, indicating a weaker zone or lineament favorable zone for targeting groundwater. From the study, it is recommended that VES P6 and P10 boreholes to be drilled upto 120 to 150m to harness potable water within the 2nd aquifer. These VES results matched well with the test soundings carried at the drilled bore well resistiviites. The yields of bore wells vary from 3000 to 5000 liters per hour (lph).

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