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VERTICAL ELECTRICAL SOUNDING SURVEY IN PEDDAVAGU BASIN, CHITTOOR DISTRICT, ANDHRA PRADESH, INDIA

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Abstract

The geophysical method is one of the sub-methods that are included in the category of surface survey methods. The electrical resistivity survey falls under the geophysical survey category and is carried out at twenty separate places, allowing the option of geographic dispersion. Data obtained from vertical electrical soundings (VES) can be utilised to determine the characteristics of the strata that are situated under the surface. This can be accomplished with the assistance of the findings of VES. Utilising the findings of the VES made it possible to ascertain the thicknesses of broken and weathered zones. This was something that was before impossible. When it comes to identifying the potential placements of water wells, these thicknesses are of the utmost importance.

For the purpose of gaining an understanding of the changes in thickness and resistivity of underlying layers, a method that is known as curve matching is utilised. There were three distinct lithological strata that were identified within the area that was being investigated. These strata were the top layer, weathered, and semi-weathered or fractured. The majority of the bed rock can be found in the layer that comes after the third one. The material was discovered to have an apparent resistivity that might be anywhere from 18 metres to 660 metres, and its thickness may range anywhere from 4.4 metres to 108.4 metres. There are a *number of different depths to bed rock that can be found throughout the area that is being investigated.*

Keywords: *Electrical resistivity, Vertical Electrical Soundings, Apparent resistivity, Bed rock*

Introduction

All around the world, there is a wide range of variations in both the quality and quantity of ground water, which is a very valuable natural resource. One of the reasons for the variance in the amount and quality of this natural resource is due to the fact that the rocks have different properties. This is one of the causes. Geophysical research has been utilised for hydro geophysical applications during the course of the last few decades (Butler 2005; Pellerin et al. 2009; Binley et al. 2015).

In order to evaluate the features of the rock, a resistivity survey is performed by measuring the ground surface (Mufutau Owolabi limo et al., 2023). According to Ajay et al. 2021, the resistivity approach is capable of providing accurate estimates of both the thickness and depth of a layer. According to Kirsch (2009) and Ejepe and Olasehinde (2014), the vertical electrical sounding (VES) approach is of great use in determining the vertical variation of resistivity in a particular place.

Study area:

According to the survey of India toposheets 57K11, 57K14, and 57k15, the study area encompasses a total area of 417.39 square kilometres and is located between the longitudes at 7804113411 and 7805713911E and the latitudes at 1301911211 and 1303413711N. A number of main roads and secondary roads provide excellent connectivity to the region.

The rocks that are found in the area under investigation are classed as unclassified crystalline rocks, specifically granites and granite gneisses. Over the course of the research area, the Peddavagu runs from North to South.

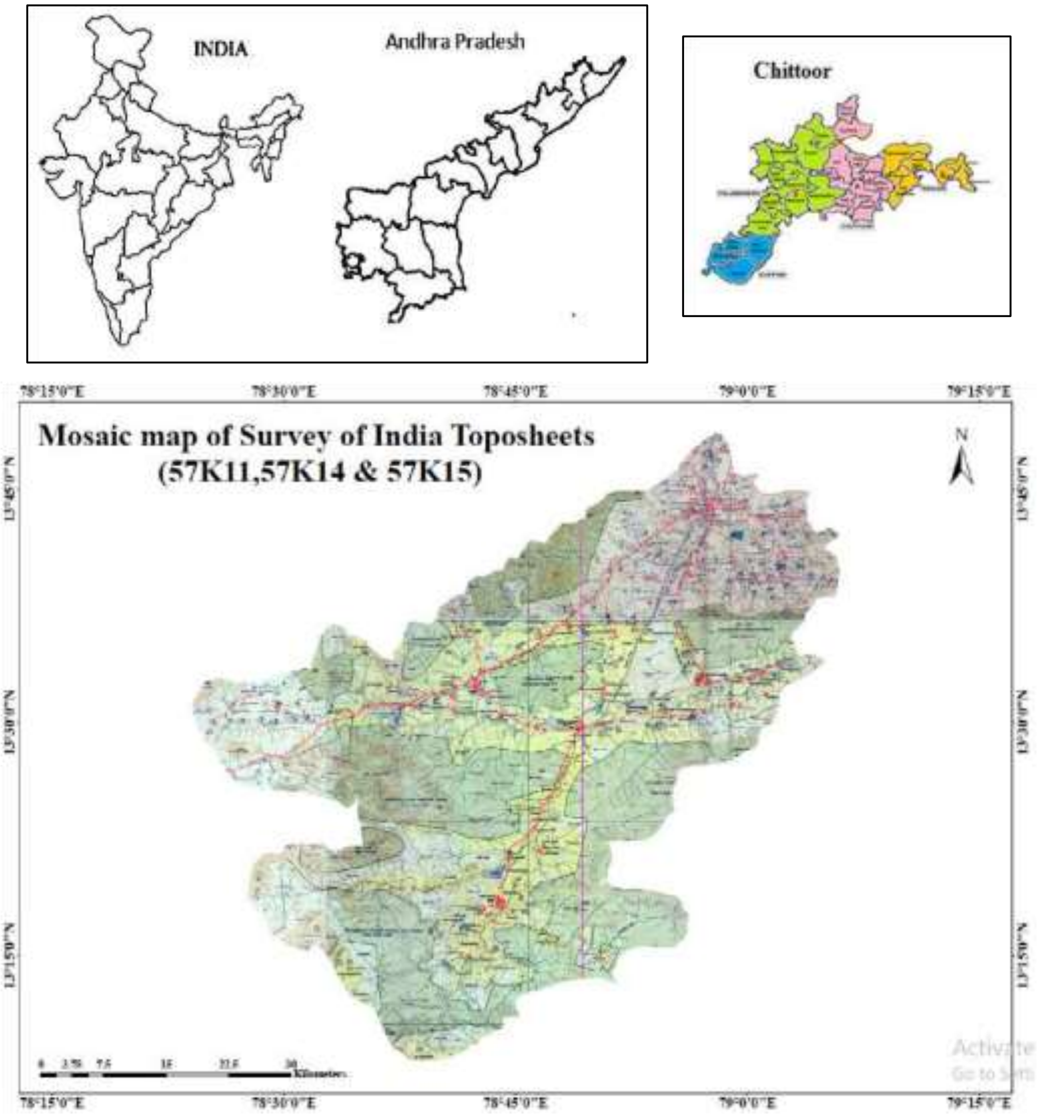

***Fig. 1**. Location map of the Study Area*

Methodology

The locational details an along with the elevation data of vertical electrical sounding is furnished (Table 1). Elevations at VES locations range between 482 meters and 686 meters. The vertical electrical sounding data is plotted on double log sheet of 62.5 mm with current electrode spacing (AB/2) on X-axis and the apparent resistivity (ρ_a) on Y-axis.

Further curve match technique was adopted by using standard two layer and three layers curves ((A: ρ1<ρ2<ρ3), (K: ρ1<ρ2>ρ3), (H: ρ1>ρ2<ρ3 and Q: ρ1>ρ2>ρ3)) of Orellina and Mooney. Electrical resistivity survey was conducted at 20 locations with electrode spacing of 80-120m using Schlumberger electrode configuration.

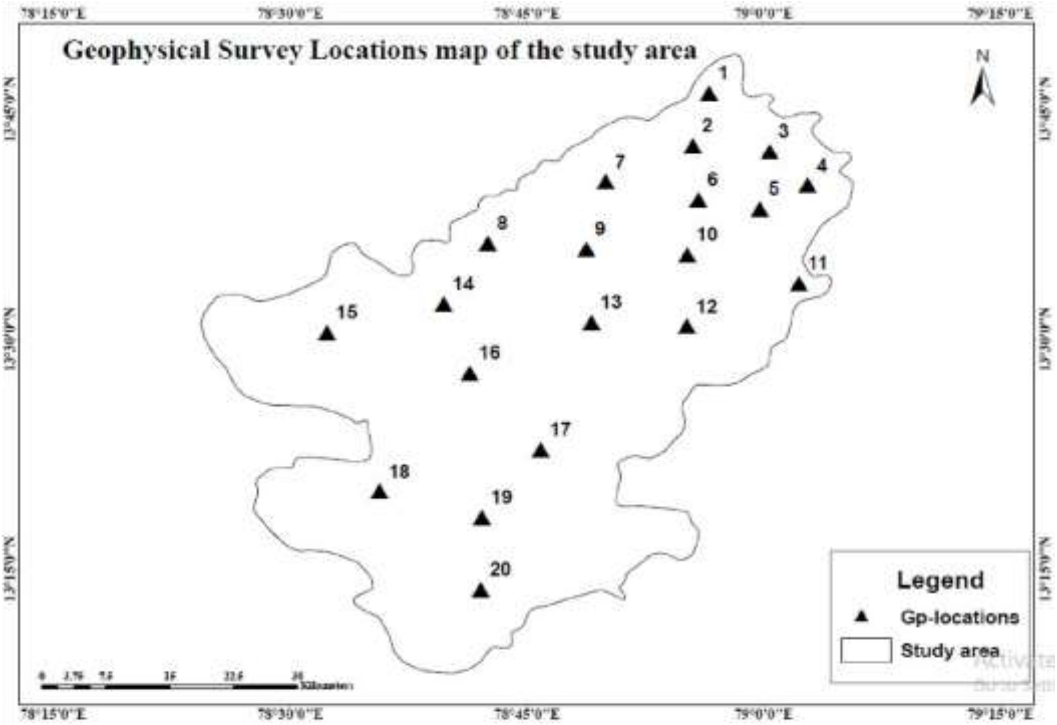

***Fig. 2** Geophysical survey locations map of the study area*

In line with the field conditions, the Schlumberger electrode configuration was utilized, featuring an electrode spacing of 80-120m. Both current and potential electrode spacing was increased outwardly from the centre where potential electrodes stay fixed at predetermined intervals and spacing of current electrodes was increased incrementally. The results of the electrical resistivity survey were given in table 2.

Table 1 Location details of the Vertical electrical soundings

VES no.	Village	Mandal	Latitude	Longitude	Elevation (m)
1	Gundluruvaripalle	Pakala	13.5624	78.9014	532
2	Ammagaripalle	Sodum	13.5396	78.8958	538
3	Cheruvumundarapalle	Sodum	13.5374	78.9274	546
4	Devadarumakulapalle	Sodum	13.5248	78.9436	582
5	Moramidapalle	Sodum	13.5135	78.9235	586

6	Nadigadda	Sodum	13.5164	78.8994	574
7	Gongivaripalle	Sodum	13.5268	78.8602	592
8	Chinnasomla	Somala	13.4983	78.8114	686
9	Surayyavaripalle	Somala	13.4974	78.8536	578
10	Kasireddivaripalle	Somala	13.4955	78.8946	586
11	M. Gollapalle	Somala	13.4812	78.9402	634
12	Chillayagaripalle	Somala	13.4648	78.8942	482
13	Nanjampeta	Somala	13.4646	78.8556	588
14	Gollapalle	Somala	13.4724	78.7948	650
15	Singarikuntapale	Chowdepalle	13.4592	78.7446	670
16	Yelkurpalle	Somala	13.4458	78.8042	660
17	Kalabandlavaripalle	Somala	13.4124	78.8356	594
18	Devalakuppam	Somala	13.3926	78.7682	674
19	Nagillivaripalle	Somala	13.3836	78.8094	666
20	Erraguntapalle	Somala	13.3578	78.8016	638

Results and interpretation

There are three unique lithological layers present in the area under investigation, according to the data obtained from the VES—as shown in Table 3. Within the top layer, it was noted that the thickness varied from 4.4 metres (at VES 4) to 10 metres (at VES 7, 17). Additionally, the apparent resistivity values varied from 18 Ωm (at VES 7) to 96 Ωm (at VES 4). These observations are depicted in Figure 3 and Figure 4. Gravel, sand, and soil are the components that make up the topmost layer, which is referred to as the weathered layer. The layer that lies underneath the first layer has apparent resistivity values that vary from 26 Ωm (at VES 6) to 369 Ωm (at VES 9). Additionally, the thickness of this layer spans from 5.2 m (at VES 6) to 24.36 m (at VES 9) (Fig. 5 & 6).

An apparent resistivity ranging from approximately 128 Ωm (at VES 13) to 670 Ωm (at VES 5) was observed in the third layer, as depicted in Figure 7 and Figure 8. The majority of the time, a layer of this sort is not broken, with the exception of instances that are brought on by regional tectonics. In areas with a relatively higher resistivity, the occurrence of weathering activity is often less common.

The information that is provided by depth to basement maps regarding the depth varia tions of the basement in the area under study is provided.

A variety of depth to bed rock values is depicted on this map, which can be found ranging fro m 53.4 metres (at VES 4) to 108.4 metres (at VES 13) (Fig 9). The VES locations were found to be of the A type and the H type, according to the information obtained from the curve matching technique. Ground Water Potential Zones that are promising have been identified in the research region. These zones are located in areas where the bedrock is deep and has a low resistivity value. On the other hand, regions that have bed rock that is shallow and high resistivity have a lower potential for groundwater.

Table 2 Results of the Vertical Electrical Soundings

VES no.	**r1 (ohmmeters)**	**h1 (meters)**	**r2 (ohmmeters)**	**h2 (meters)**	**r3 (ohmmeters)**	**h3 (meters)**	**H = h1+h2+h3 (meters)**	**Type of Curve**
1	36	3.7	54	5.6	164	26	35.3	A
2	46	5.2	124	8.4	284	40	53.6	A
3	72	6	56	9.58	134	38.24	53.82	H
4	96	4.4	124	6.2	660	22.8	33.4	A
5	94	4.2	64	7.46	484	48	59.66	H
6	34	3.8	26	5.2	184	42	51	H
7	18	5.4	38	8.25	290	34	47.65	A
8	86	4.8	148	5.24	660	46	56.04	A
9	57	3.8	165	14.36	412	38.4	56.56	A
10	48	5.2	184	16.42	386	46.84	68.46	A

11	92	4.5	60	13.44	264	42.68	60.62	H
12	76	5.8	174	8.84	482	28	42.64	A
13	38	6.8	58	18.6	128	28	53.4	A
14	78	4.4	56	5.4	480	34.26	44.06	H
15	40	6.4	30	7.2	276	46	59.6	H
16	64	5.6	32	7.8	146	44.24	57.64	H
17	26	7.4	48	8.4	245	52	67.8	A
18	74	4.2	54	14.25	476	48.4	66.85	H
19	66	6.2	234	18	440	54	78.2	A
20	54	7.2	220	8.6	318	32.4	48.2	A

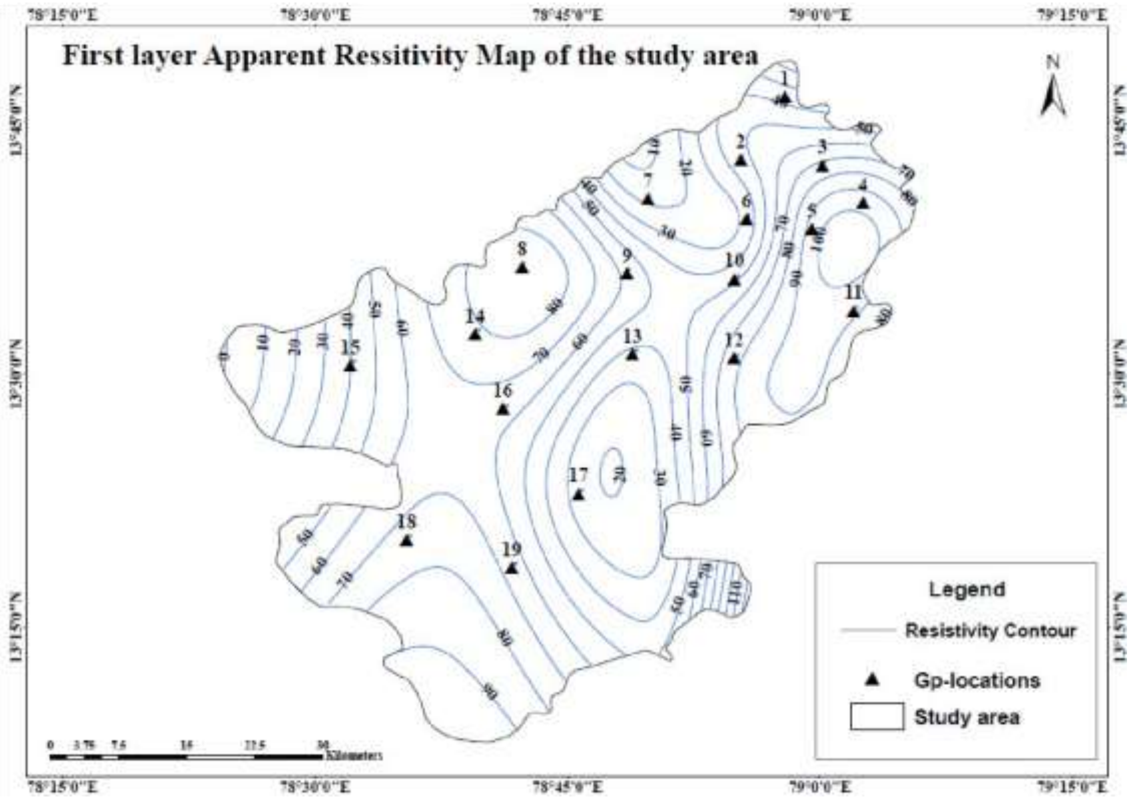

***Fig. 3** First layer Apparent resistivity map of the study area*

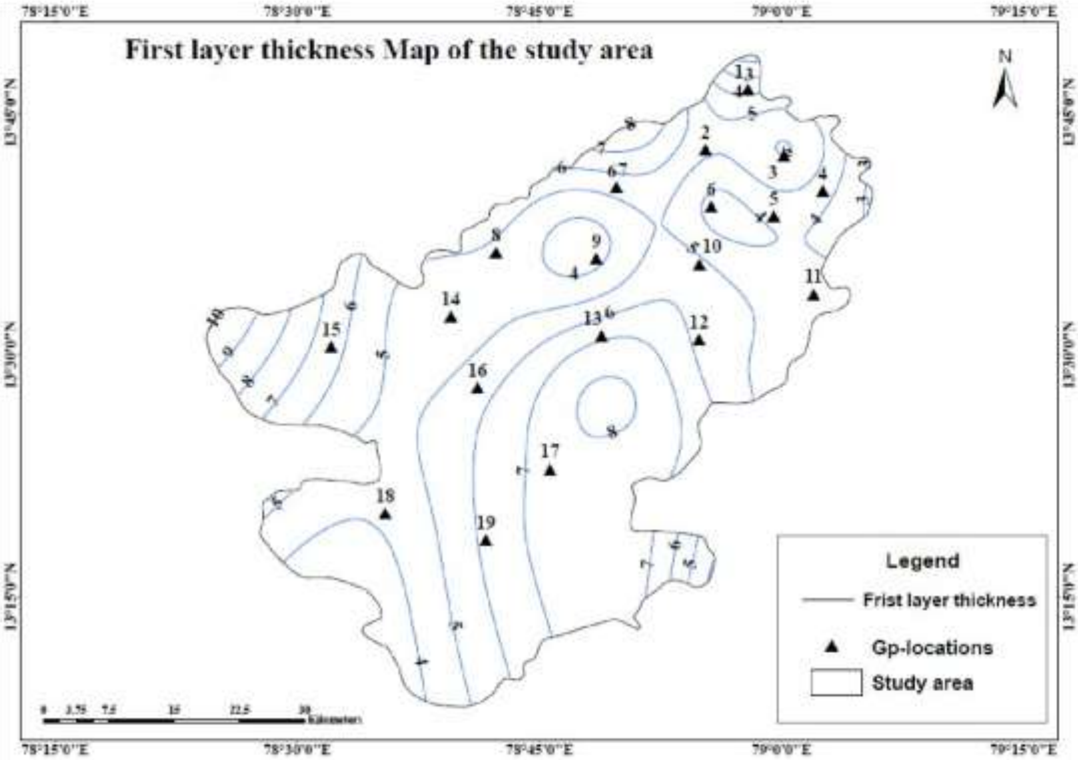

Fig. 4 *First layer thickness map of the study area*

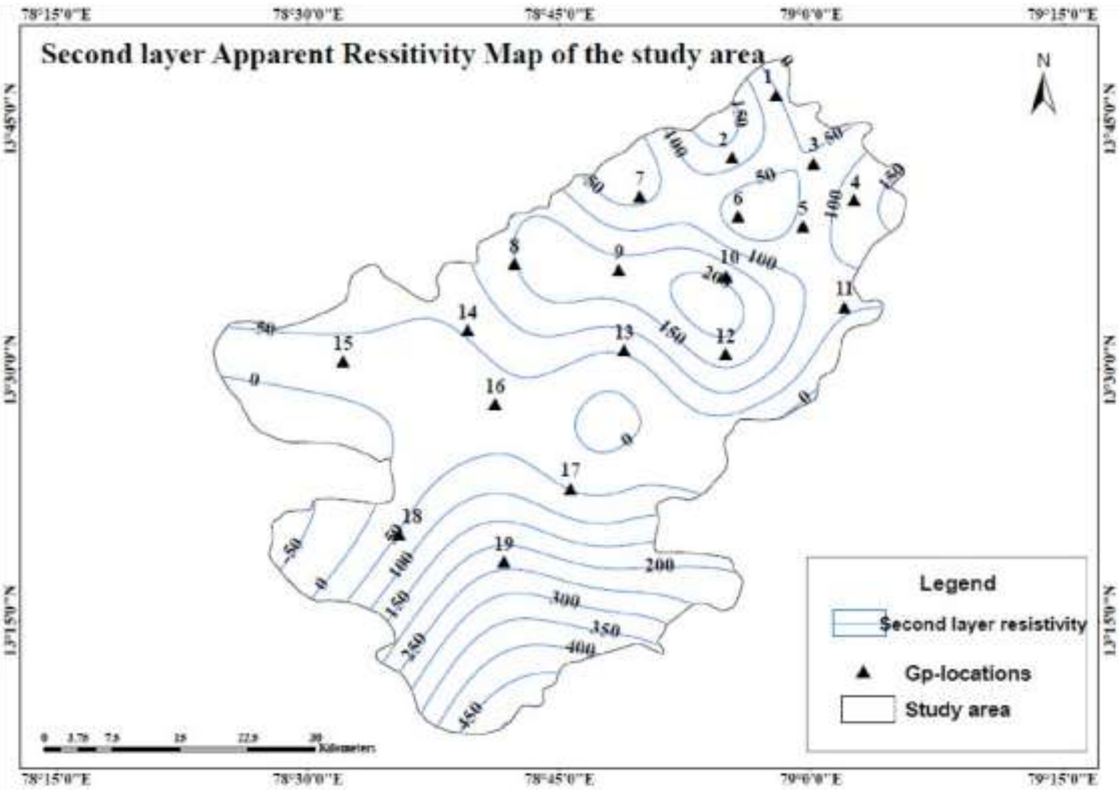

Fig. 5 *Second layer apparent resistivity map of the study area*

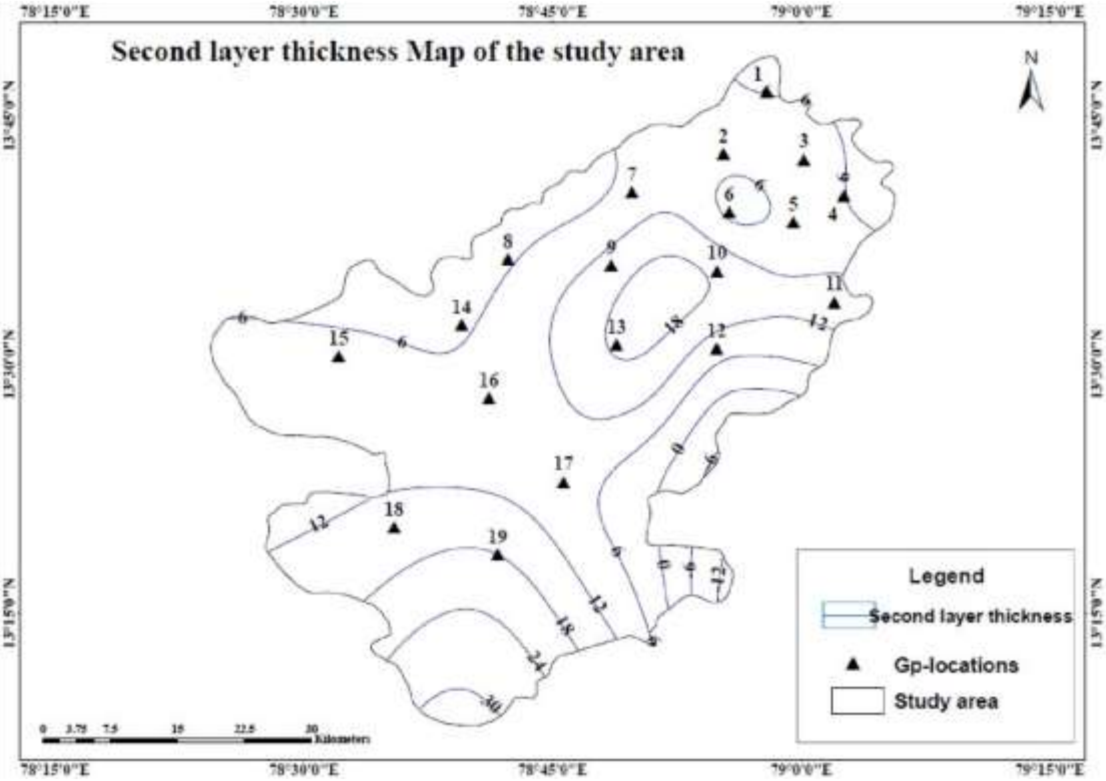

Fig. 6 *Second layer thickness map of the study area*

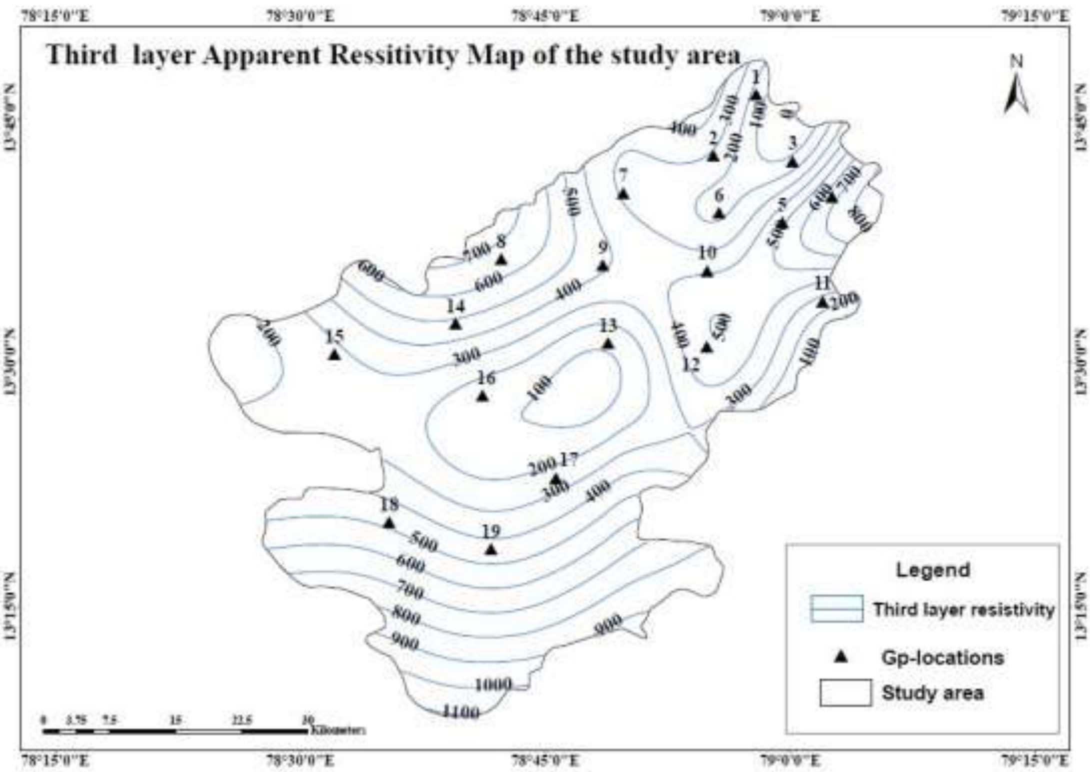

Fig. 7 *Third layer apparent resistivity map of the study area*

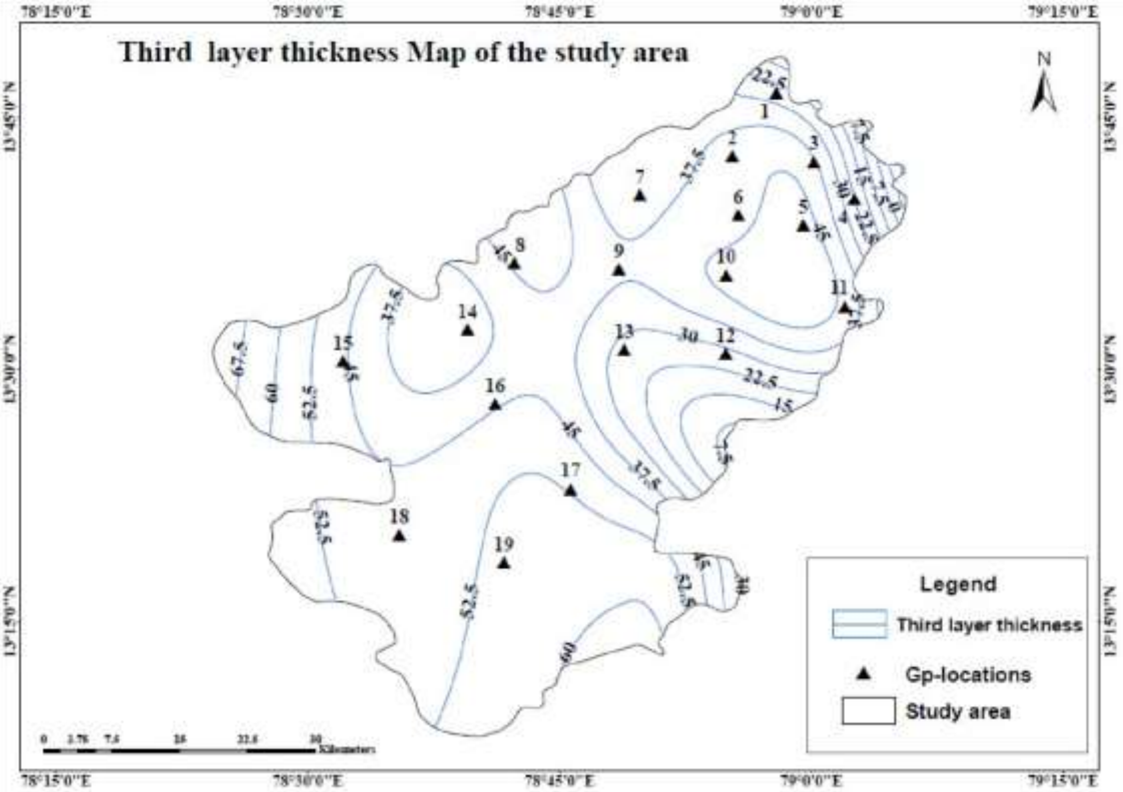

Fig. 8 *Third layer thickness map of the study area*

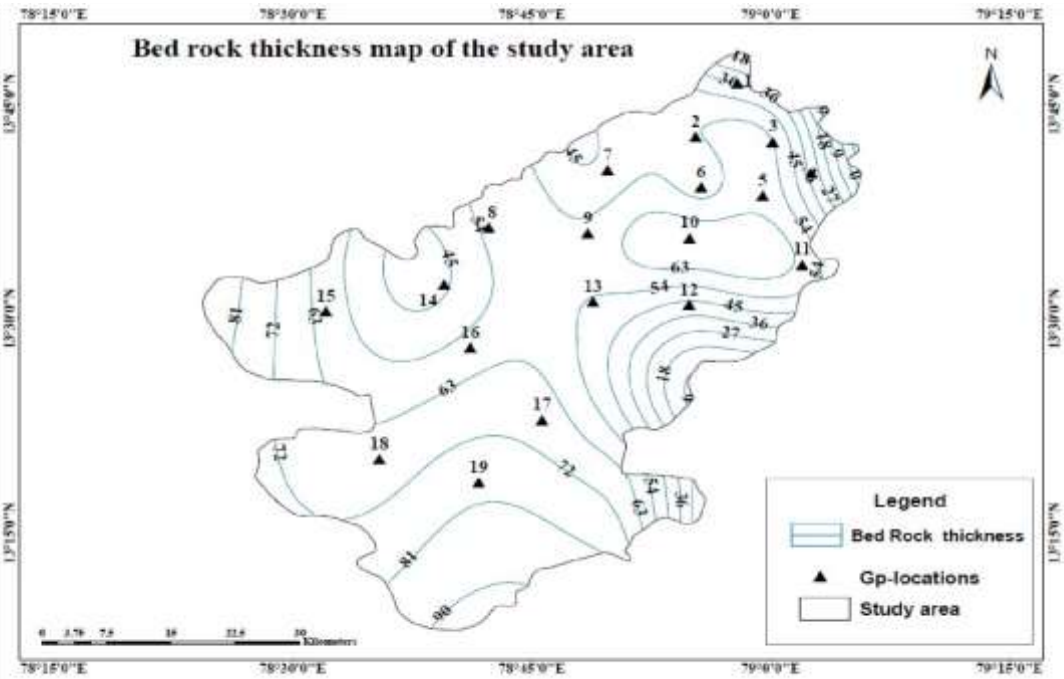

Fig. 9 *Bed rock thickness map of the study area*

Conclusion

The resistivity and thickness data of subsurface layers is highly useful in integrated studies to delineate groundwater potential zones. In the present study, vertical electrical resistivity data indicates that the soil cover also varies from one meters to 4 meters.

A thickness spanning between 4.4 m and 10 m, apparent resistivity values ranging from 18 Ωm to 96 Ωm, was observed in the top layer. The second layer showed apparent resistivity values ranging from 26 Ωm to 369 Ωm with a thickness spanning between 5.2 m to 24.36 m The third layer has apparent resistivity ranges 128 Ωm to 670 Ωm with a thickness ranges fom 42 m to 82 m. Depth to basement shows a range of from 53.4 m to 108.4 m. Based on the curve matching technique, it observed that the VES locations belong to A type and H type.

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