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Vertical electrical sounding (VES) for subsurface geophysical investigation in Kanigiri area, Prakasam district, Andhra Pradesh, India

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ABSTRACT

Electrical resistivity investigation was carried out around, Kanigiri area, Prakasam district, Andhra Pradesh, India in order to study the subsurface geologic layer with a view of determining the depth to the bedrock and thickness of the geologic layers. Vertical Electrical Sounding (VES) using Schlumberger array was carried out at fifteen (15) VES stations. The field data obtained have been analyzed using computer software (IPI2win) which gives an automatic interpretation of the apparent resistivity. The VES results revealed heterogeneous nature of the subsurface geological sequence

Keywords: Vertical electrical sounding; groundwater; geoelectric section; aquifer; resistivity.

INTRODUCTION

Electrical exploration methods may be subdivided into two main groups. One group is concerned with measurement of resistivity, or conductivity, of rocks; the other group is concerned with measurement of their capacitance. The galvanic, induction, magneto-telluric, and telluric methods belong to the first group, and the induced polarization methods belong to the second group.

All resistivity methods can be applied for studying variations of resistivity with depth (depth sounding methods) or for studying lateral changes in resistivity (horizontal profiling methods). The vertical electrical resistivity sounding methods (VES) are depth sounding galvanic methods.

The electrical resistivity of rock is a property which depends on lithology and fluid content. The resistivity of coarse-grained, well-consolidated sandstone saturated with fresh water is higher than that of unconsolidated silt of the same porosity, saturated with the same water. Also, the resistivities of identical porous rock samples vary considerably according to the salinity of the saturating water. The higher the salinity of the water, the lower the resistivity of the rock.

The Vertical Electrical Sounding (VES) has proved very popular with groundwater prospecting and engineering investigations due to simplicity of the techniques. The electrical geophysical survey method is the detection of the surface effects produced by the flow of electric current inside the earth. The electrical techniques have been used in a wide range of geophysical investigations such as mineral exploration, engineering studies, geothermal exploration, archeological investigations, permafrost mapping and geological mapping.

MATERIALS AND METHODS

HYDROGEOLOGY

Geologically the Prakasam district is underlain by diverse type of rock types belonging to Archaean to recent age. The khondalite suite of rocks and charnockite group constituting the unclassified metamorphics of eastern ghat super group belonging to the Archaean age, Dharwar super group of proterozoic age, part of Gondwana sequence of Jurassic age and Cainozoic laterites and recent alluvium.. Hydrogeologically the aquifer system in Prakasam district comprises 4 groups, viz., (1) Crystalline aquifer system (2) Cuddapah aquifer system (3) Gondwana aquifers and Alluvial and laterite aquifer system.

In general ground water occurs in all the formations of the area. However, its potential depends on the nature and environment in which they occur. Ground water occurs under phreatic conditions in the weathered, fractured crystalline rocks at shallow depths and under semi confined to confined conditions in the deeper fractured crystalline rocks, Cuddapah formation and Gondwana sandstones and in the alluvial sediments of the area.

The crystalline aquifer system is represented by granite-gneiss. Hornblende-biotite-gneiss, charnockite, khondalites and schistose group of rocks. They occupy major parts of the district. The movements of ground water in these rock types depend on the thickness of weathered zone available and degree of fracturing/jointing in these rocks. The thickness of weathered zone varies from 3.0 to 15.0m and the degree of fracturing at various depths.

GEOLOGICAL SETTING

The Eastern margin of the Cuddapah basin a number of granitic bodies of Mesoproterozoic age occurs intermittently over a stretch of about 300km. They are the Vinukonda granite, Darsi granite, Kanigiri granite, Podili granite and Anumalakonda granite.

Kanigiri is located between latitude $15^{0}24^{1}30^{11}$N to $15^{0}24^{1}35^{11}$N and longitudes $79^{0}30^{1}00^{11}$E to $79^{0}30^{1}06^{11}$E and is about 86km WSW of Ongole, Prakasam district, Andhra Pradesh.Fig1 showing the location of the area.

Fig1 Location map of the study area

MATERIALS AND METHODS

Geoelectrical investigations were carried out usually to delineate geology. Geoelectrical resistivity techniques have been extensively used in groundwater investigations all over the world[1,2]. However, in recent times these studies are also being used to alleviate groundwater quality[3,4,5].The literature available on electrical resistivity prospecting has been described by several authors [6,7,8]. The electrical resistivity method can be best employed to estimate the thickness of overburden and also the thickness of weathered/fractured zones with reasonable accuracy. Though both Wenner and Schlumberger electrode configuration methods are popularly employed, the Schlumberger electrode configuration method is more suited to the study area, ensuring better results. The method has practical, operational and interpretational advantages over other methods such as the Wenner method of electrode arrangement [1].

Vertical Electrical Soundings (VES) using Schlumberger array were carried out at twenty (20) stations. This was subsequently done on all the point data obtained for each VES station to give the set of apparent resistivity value supplied for computer program for the geoelectrical parameters.

RESULTS AND DISCUSSION

The IPI2WIN computer software was employed in the interpretation of the VES data. The result of this computer modeled curves for some selected stations are presented in figures 2 and 3. Table 1 show the following information about the various VES stations. The out put of which is used as the input for IPI2Win software (Bobachev,2003) for final layer characteristics. Further golden surfer software is used for visualization of the results.

Table 1: The results of the interpreted VES curves

VES STATIONS	LAYER1		LAYER2		LAYER3		LAYER4	
	ρ	h	ρ	h	ρ	h	ρ	h
1	60	0.75	24.1	10	157		-	
2	54.4	1.9	34.8	20.7	288		-	
3	22.7	0.75	1.06	1.21	78.3	35.4	2295	
4	122	2.19	133	16.5	3166		-	
5	687	0.75	187	5.73	72.9	8.55	2525	
6	128	2.79	30.4	12.2	1271			
7	168	0.947	25.2	16	1107			
8	162	0.75	23.6	1.33	82.1	23.4	3983	
9	124	0.957	47.2	8.16	4127			
10	15.9	1.15	3.16	1.87	221			
11	13.7	0.75	5.68	2.78	377			
12	151	1.3	36	2.48	4493	6.5	1156	
13	647	0.761	65	4.27	206	30.4	2416	
14	275	0.75	84.3	6.45	256	14.9	527	
15	73.9	3.58	262	20.6	578			
16	274	0.75	44.8	0.828	137	2.42	59.5	13.5
17	366	0.75	93.5	20.1	2558			
18	383	1.56	95.6	5.41	270	55	2245	
19	141	3.93	73.8	2.87	288	65.2	2194	
20	250	1.16	21.2	0.695	66.1	16.7	469	

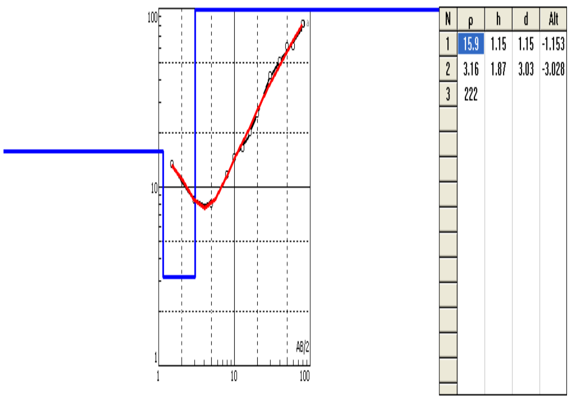


Fig2: A vertical electrical sounding curve (11) and the derived subsurface layer characteristics in Granite formation

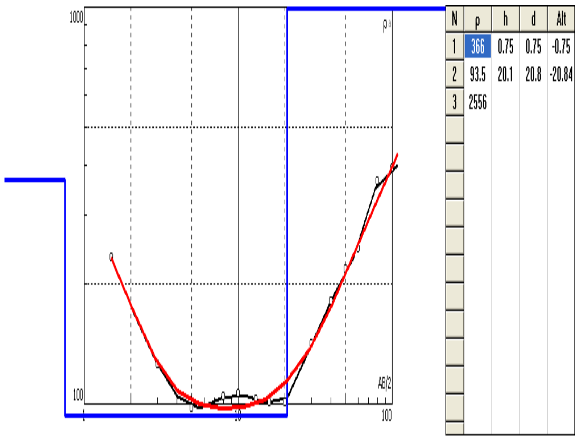


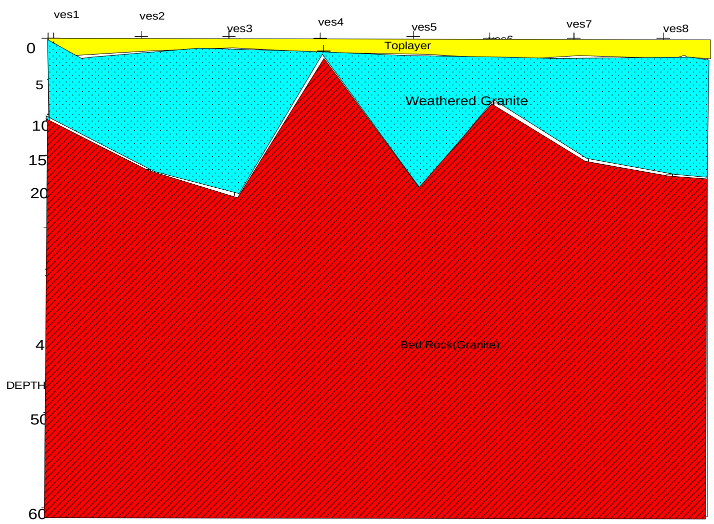
Fig3: A vertical electrical sounding curve (18) and the derived subsurface layer characteristics in Granite formation

Based on the various layer characteristics obtained in the study area, the range of resistivity values corresponding to different lithological units present in the area are shown in the table 1.2. The geological parameters at the drilled site correlated with lithology. Using these correlation signatures as the basis, lithology was inferred at other sounding locations for the delineation of surface lithology. The analysis of the data indicates that the resistivity of the weathered zone ranges from 10-90Ωm while its thickness from 2-60m.

Table 1.2 Resistivity ranges and layer thickness of subsurface lithologic units

S. No	Subsurface lithological units	Thickness in m
1	Top Soil	0.5-2
2	Weathered granite	2-6
3	Semi weathered granite	6-45
4	Hard rock	45-80

For better understanding, the layer parameters obtained from geoelectrical studies are utilized to prepare the geoelectrical cross section along profiles AB and CD(Fig4,5).



Geoelectric cross section of profileAB

Fig4: Geoelectrical cross section along AB

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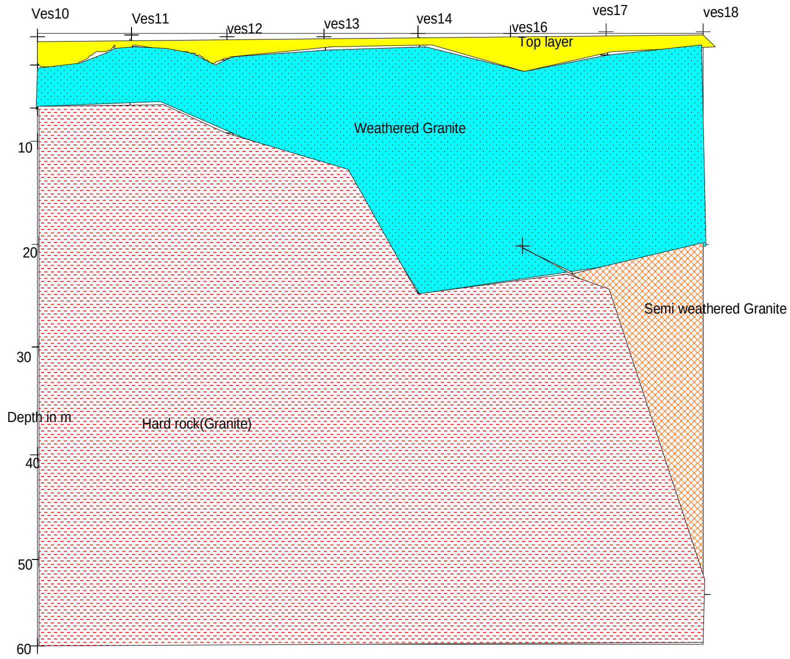

Geoelectric cross section of profile CD

Fig5: Geoelectrical cross section along CD

CONCLUSION

Groundwater potential aquifers producing zones have been delineated through investigation conducted by the electrical resistivity survey. Weathered and fractured horizons have been identified in the study area underlying VES stations, and all of these constitute the aquifer zones.

This research has provided information on the depth to the groundwater and the thickness of the aquifer unit in the study area. This information is going to be relevant to the development of an effective water scheme for the area. Based on all the findings made in the interpretation of the VES data.

The thickness and resistivity of the aquifers at these VES stations indicates medium potential for groundwater. Conclusively, the study area has a high potential for groundwater development.

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