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Identification of Aquifer Zones in the Hard Rock Region of Central Parts of Adilabad District, Telangana State; Using Electrical Resistivity Method

KEYWORDS Aquifer Zones,Hard rock terrain,Electrical resistivity method

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ABSTRACT *Adilabad district of Telangana, though, is bounded by perennial rivers like Godavari in the south, Penganga in the north and pranahita in the east has its problem of scarcity of water, in lean seasons, especially in the central hard rock region.The hard rock begins with the volcanic Deccan traps on the top and the peninsular granitic complex at the base with the quartzites etc. on the Pakhal group lying in between. The intratrappen sedimentary layer at the bottom of trap rocks, the dolomitic and phylytic shale and sandstones in the pakhal appear for the favorable for the ground water occurrence.Besides their litho groups the NW-SE treading lineaments and the NW-SW lineaments, cutting across which appear to represent structural faults might be helping occurrence and movement of ground water flow. It is in this context an area approximately150 sq.km has been related in the Deccan trap covered area located east of Utnoor. 70 Vertical Electrical Soundings (VES) were conducted with random distribution of locations with the main aim of locating bore-well points for irrigation, drinking water supply, but here we present discussion three profiles were chosen which consist of 24 VES Points. The maximum spread of current electrodes in the schulumberger survey is 120m (AB/2) , have in general revealed A&H type curves, and indicated 2, or 3 layers in the subsurface.*

Further, Resistivity and thickness values of VES points are different for each layer and it is observed that resistivity value varies from 3 ohm-m to 20 ohm-m with the thickness of 1.5m to 10m for the first layer and the second layer varies from 20ohm-m to 90ohm-m with the thickness of 15m to 70m and a final layer varies above 100ohm-m. On the basis of the resistivity and depth values together with local geology, nearly 11 VES points are suggested for drilling in the study area. The majority of drilled bore-wells are of 1000 -1500 GPH yield used for irrigation and drinking purpose.

Introduction
Adilabad district is one of the largest districts in the Telangana State with a geographical area of 16,203sq.km. The district is located in the northern most part of the State and forms border with the States of Maharashtra and Chhatisgarh.. (Fig.1), where study area lies in between North Latitude, 19.3320& 19.5960 an East Longitude 78.8090& 78.9340. The normal average rainfall for last ten years, all over the district is 1153mm, In which the Southwest monsoon rain fall is 1003mm and northeast monsoon 81mm (CGWB, 2007)

The mainrock types in the district belong to Peninsular Gneissic Complex (Archean) with enclaves of Older Metamorphics, Pakhal Supergroup, Penganga and Sullavai Groups (Proterozoic), Gondwana sediments (Upper Carboniferous to Lower Cretaceous) and Deccan Traps (Cretaceous-Paleocene).

Deccan Traps cover a vast area in the west and northwest overlying Archean-Proterozoic and Gondwana rocks and is represented by thick amygdaloidal to massive basalt flows with thin sedimentary beds (intratrappeans) at the base. The eastern margin of the Gondwana basin is faulted along NW-SE and NE-SW trending are affect the rock formations in the area, barring Deccan Traps.

The Deccan Traps form plateaus and sloping hills with escarpments. Structural/ denuded hills, valleys and plains are developed in the Proterozoic and Gondwana sedimentary domains. Archean gneiss appear around Nirmal and the Proterozoic sediments near Adilabad form the pediment/ pediplain zones. Depositional landforms such as floodplain (active and Paleo) and palaeo-channels are confined to the courses of the Godavari and Pranhita.

Geo hydrologically, the area is mainly categorized into five zones viz. Schist, granite and gneiss, Pakhal and Gondwana sediments and Deccan Trap. The eastern part of the district with highly permeable Gondawana sediments has high yield prospects, suitable for agriculture. The yield in the other areas is limited, excepting that of granite and gneiss country, which yield a moderate quantity of ground water.

The discussion is presented here about marked three profiles, Bose and Ramkrishna (1978) have carried out surveys in the Deccan trap region in Sangli district, Rao et al. (1983) have carried out integrated geophysical surveys consisting of VES and magnetic surveys for groundwater exploration in the Deccan traps covered the Godavari– Purana basin in Aurangabad district and Kumar et al. (2010) have conducted an electrical resistivity survey to decipher potential groundwater zones in Deccan traps terrains falling under the Aurangabad district of Maharastra.

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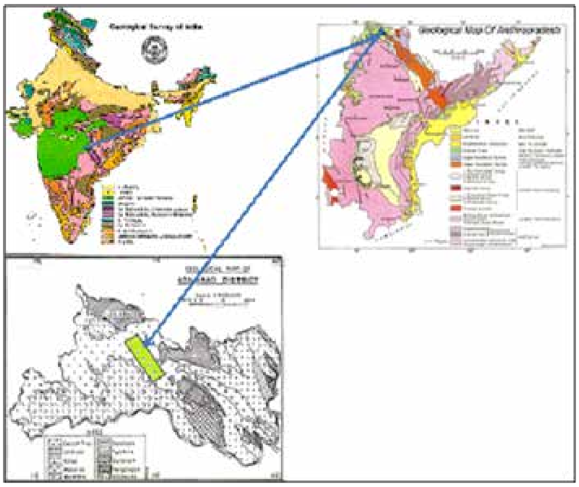

Fig-1; Study area location map (courtesy withGSI)

Study Area: -The region under study area is a part of the southeastern fringe of Deccan traps with in the Basaltic rocks, occurring in the western and central part of the district, forms the fringe of the vast Deccan Plateau of Central India. Successive lava flows resulted in a layered crystalline rock with intervening beds of clay, ash, etc. The contact zones of successive flows and between basalt together inter-trappean beds form good aquifers in addition to the top weathered zones and fractured zones. The vesicles present in the top portion of the each lava flows also form a potential zone for ground water. This unique set-up in the basaltic rocks presents a multi-aquifer system. Sometimes, this multi-aquifer system with wide variation in its compacted poses problems in constructing productive wells.

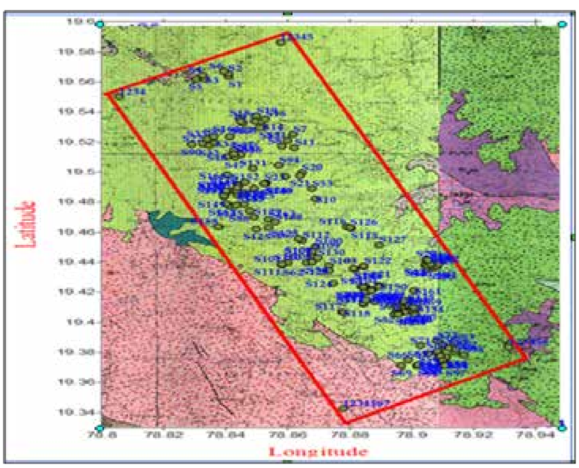

Fig-2; Study Area with VES locations

Methodology

Electrical resistivity method:

Resistivity is defined as a measure of the opposition to the flow of electrical current in a material like Deccan traps, unlike other hard rock terrains, consist of multiple layers of solidified lava flows and behave as a multi-layered aquifer system similar to a sedimentary formation. In such a geological environ, the direct current (DC) resistivity method for conducting a vertical electrical sounding (i.e. Schlumberger sounding Fig-3) is a suitable technique to map the depth distribution of litho units. Geological interpretation of these litho units leads to the delineation of aquifers at different depths. VES surveys using Schlumberger electrode configuration have been carried out by several researchers in different parts of the Deccan traps. For this study several VES points were carried out, but in the present discussion, three profiles are considered which consist of 25 VES points only.

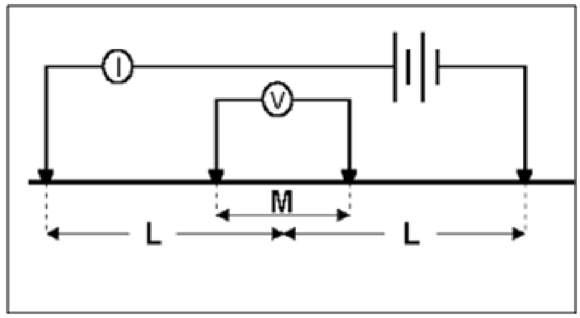

Fig-3; Schlumberger array configuration.

Result and discussion:

In the selected study area data were interpreted and processed qualitatively and quantitatively by using a partial curve matching techniques and computer to obtain the resistivity values of different subsurface layers and their corresponding thickness (Table 1) by using IPI2win 1D software. From the interpretation of VES curves, 3 to 5 subsurface layer were identified within the area. The curves are prominently of A, H and K type indicating the presence of three layers followed by combination of curves HA, KH, HK, KQ are indicating the four layers followed by a combination of curves HKQ indicating the presence of five layer sub-surface layers (Table 2) figure 8 also showing the same information. These curves were interpreted using the partial curve matching technique using two and three layer master curves and corresponding auxiliary curves to obtain the resistivity and thickness of each of the layers delineated. Here Figure3 Shows some typical example of VES curves, Figure4 shows chosen profiles and Fig 7, 8 and 9 are showing resistivity pseudo section of three profiles.

Figure-4; Map shows the selected VES Profiles.

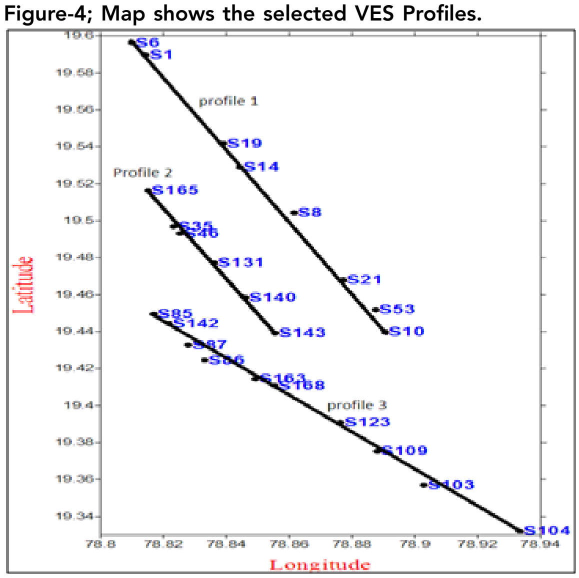

Fig-5; some typical interpreted VES curves in the study Area

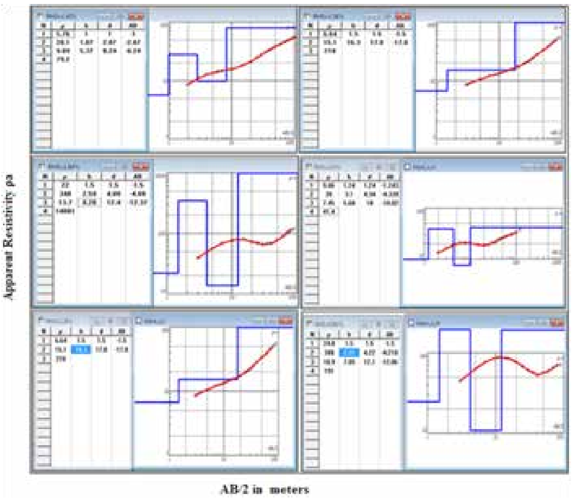

Fig-6; Map showing type of VES curves

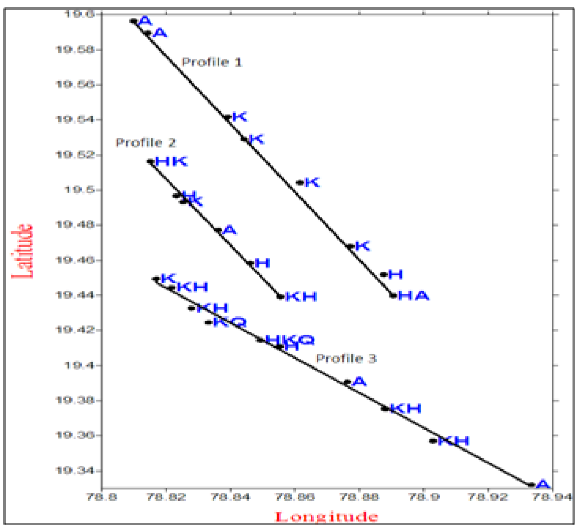

Table 1: Inter trapreted layer Parameters of VES soundings in the Study Area

S.NO.	VES Name	Resistivity layer1 ρ1 (Ωm)	Resistivity layer2 ρ2 (Ωm)	Resistivity layer ρ3 (Ωm)	Resistivity layer4 ρ4 (Ωm)	h1 (m)	h2 (m)	h3 (m)	h4 (m)	Basement depth H(m)
1	S1	19.5	108	557	0	5.2	12.6	0	0	17.77
2	S6	19.8	38.4	92.4	0	5	11.5	0	0	16.47
3	S8	11.9	249	93.2	0	1.5	17.9	0	0	19.4
4	S10	27.1	14.8	23.8	13.8	1.5	3.60	13	43	61.16
5	S14	41	109	12.2	4101	3	8.02	24	0	34.58
6	S19	161	990	20.2	0	1.5	2.36	20	0	23.86
7	S21	30	4240	74.7	0	1.5	1.85	22	0	27.35
8	S35	18.3	105	358	0	1.5	3.66	57	0	62.16
9	S46	79.1	907	0	0	4.4	10.9	0	0	15.27
10	S53	17.9	247	138	22.9	1.5	36.6	3.2	0	41.33
11	S85	153	17.7	72.7	0	2	17.6	0	0	19.59
12	S86	21.4	50.9	273	78.6	3.2	6.63	21	0	30.48
13	S87	29.2	304	3.70	0	1.5	2.90	9.5	0	13.91
14	S103	13.2	24.88	5.76	106	2.9	2.59	8.9	0	14.37
15	S104	7.85	355	52.2	0	1.5	1.22	0	0	2.72
16	S109	26.3	59.9	11.3	2373	3.6	10.5	20	0	34.15
17	S123	9.16	37	9.69	4140	2.5	7.44	12	0	21.8
18	S131	153	17.7	72.7	0	2	17.6	0	0	19.59
19	S140	3.32	631	44.5	0	1	1.8	16	0	18.8
20	S142	55.7	131	9.54	0	2.9	5.37	15	0	23.65
21	S143	7.99	174	28.3	0	1.5	5.91	29	0	36.41
22	S163	152	18.1	10781	0	2	24	0	0	26.02
23	S165	6.83	177	3.62	3271	2.2	4.22	12	0	17.87
24	S168	15	210	168	0	4	26	0	0	30

Profile-1

This profile is situated in NW-SE direction and lies in the central part of study area running from the north-west Kolamguda Narnoor mandal Kiratwada grampanchayat to South-east Ashepally Jainoor village. It has a length of 19km and oriented N270W consist of the 8 VES (S6, S1, S19, S14, S8, S21, S53, S10) the pseudo resistivity section along profile-1, (fig7) shows a thick low resistivity zone (of about 65ohm. meter) that extended from the surface to a depth corresponds to 70mtr separation. This low suggestive a conductive zone also significant lateral variation in resistivity is observed at VES S21, S19. This inferred Geo-electrical section consists of topsoil, weathered layer overlying the basement the respective thickness & resistivity of these layers are water contaminated area resistivity is up to 65 to 100 ohm-m and hard rock resistivity above >100ohm. mtr.

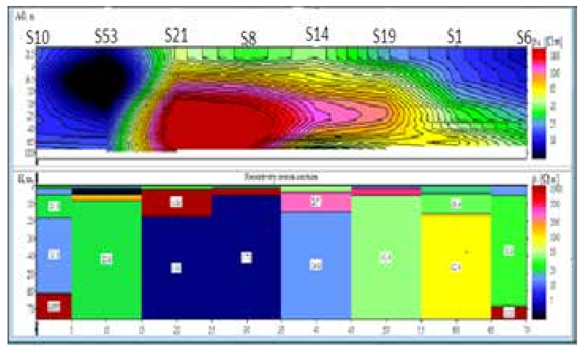

Fig-7; Pseudo resistivity section of Profile-1

Profile-2:

This profile is 10km long trends N270W same and parallel to profile-1 it consist of 6VES points (S165, S35, S46, S131, S140 & S143) fig-8 shows pseudo section of apparent resistivity values for AB/2 separation 1-100mtr. A varying resistivity low (1-15ohm. meter) is observed up to 10-15mtrs top soil and the low resistivity conductive zone between 60-100ohm-m, high resistivity gradient are seen at several points along the profile particularly S46, S140, S35. The inferred Geo electric section the low resistivity zone is up to 37-72 ohm. meter at S143&S165 these are the suitable water bearing zones, and the high resistivity is >100ohm-m at S140, S46&S35 are hard rock areas.

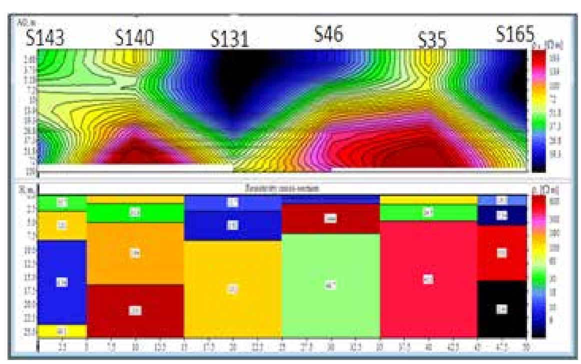

Fig-8; Pseudo resistivity section of Profile-2

Profile-3

This profile is situated below the profile 1&2 in the study area, it consists of 10VES points (S85, S142, S87, S86, S163, S168, S123, S109, S103, S104) and 18km long spread along a N440W trend. The below figure shows that the subsurface at S168, S123, S109, S104&S85 is

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characterized by low resistivity (<100ohm. meter) up to a depth corresponding to 40-70mremaining VES are showing Slightly high and high resistivity zones, which are not suitable for drilling.

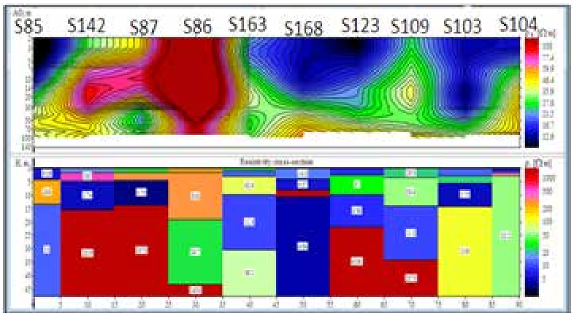

Fig-9; Pseudo resistivity section of Profile-3

Table 2: Qualitative analysis of curve types where ρ represents resistivity of the layer

VES	Curve type	Curve Characteristics	No. of Geo-Electric layers
S168,S140, S35, S53	H	ρ1>ρ2< ρ3	3
S123, S131, S6,S1, S104	A	ρ1<ρ2<ρ3	3
S85,S45,S19, S14,S8, S21	K	ρ1<ρ2>ρ3	3
S142,S87, S109, S103, S143	KH	ρ1<ρ2>ρ3<ρ4	4
S86	KQ	ρ1<ρ2>ρ3>ρ4	4
S165	HK	ρ1>ρ2<ρ3>ρ4	4
S10	HA	ρ1>ρ2<ρ3<ρ4	4
S163	HKQ	ρ1>ρ2<ρ3>ρ4 <ρ5	5

Conclusion

This work showed that in a Deccan Trap environment, Vertical Electrical Sounding (VES) has proved to be very reliable for groundwater studies and therefore the method can be used for shallow and deep groundwater geophysical Resistivity investigation. The suggested places of the study area consist of good quality of a groundwater because the study area is dominated by the H-type curve. The top layer is the black and red mixed soil and it is followed by a weathered zone which is underlain by basement rock.By using these pseudo resistivity sections understand the water bearing capacity of a particular location within the study area.The most appropriate suitable layer which acts as the good aquifer of selected area of Adilabad districts is the second layer which consists of the weathered rock formations at the depth between 65 to 100m. table-2 shows the distribution of resistivity curve types within the study area.

REFERENCE

1. Bose R N and Ramkrishna T S 1978 Electrical resistivity surveys for groundwater in the Deccan trap country of Sangli district, Maharashtra; J. Hydrol. 38 209–221. | 2. CGWB 2007 Groundwater resources and development potential of Adilabad district, Andhra Pradesh; Report, Central Region, Hyderabad,. | 3. Chakravarthi V, Shankar G B, K, Muralidharan D, Harinarayana T and Sundarajan N 2007 An integrated geophysical approach for imaging subset sedimentary basins: Case study of Jam River basin; Geophysics 72 (6) B141–147. | 4. Ekine, A S., Osobonye., (1996), Surface geo-electric sounding for the determination of Aquifer characteristics in parts of Bonny local government area of river state. Nigeria journal of physics, 85, pp 93-97. | 5. Fetter, C.W., (1994), Applied hydro- geology, fourth ed. Prentice-Hall, NJ, pp 543-591. | 6. Gnanasundar D. Elango L., (1999), Groundwater assessment of a coastal aquifer using Geoelectrical techniques, Journal of environmental hydrology, 7, Paper 2. | 7. Muthuraj D., Srinivas Y.and Chandrasekar N., (2010), Delineation of groundwater potential areas - a Case study from Tirunelveli District, TamilNadu, India, International journal of applied environmental sciences, 5, pp 49-56. | 8. Olorunfemi,M.O.,M.A.Dan-Hassan and J.S.Ojo., (1995), Scope and limitations of the electromagnetic method in groundwater prospecting in a precambrian basement terrain J.Afr.Earth Sci., 20, pp 151-160 | 9. Orellana, E. and Mooney, H.M., (1966), Water table and curves for vertical electrical sounding over layered structures, Interet encia Madrid, Spain | 10. Patra, H.P., Nath, S.K., (1999), Schlumberger geoelectric sounding in ground water: | 11. Principles, Interpretation and applications. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, p 153. | 12. Rai S N, Thiagarajan S and Ratnakumari Y 2011 Explo-ration of groundwater in the basaltic Deccan traps terrain in Katol taluk, Nagpur district, India; Curr. Sci. 101(9) 1198–1205. | 13. Rao T G, Athavale R N, Singh V S, Muralidharan D and Murthy N N 1983 Geophysical exploration for groundwater in Deccan traps of Godavari–Purna basin, Maharashtra; NGRI technical report no. GH 18-GP10. | 14. Vander Velpen B P A and Sporry R J 1993 RESIST– a computer program to process resisitivity sound-ing data on PC compatibles; Comput. Geosci. 19(5) 691–703. |