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Geophysical Investigations to Evaluate Potential Aquifers in Parts of Chivemla Mandal, Suryapet District, Telangana - India

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Abstract:*An attempt has been made to evaluate the groundwater potential zones using geophysical methods in hard rock terrain in Chivemla Mandal, Suryapet district, Telangana State. The iso- resistivity contour maps prepared and interpreted in terms of resistivity and thickness to their respective subsurface layers and found more appropriate in delineating the potential aquifer zones and bedrock configuration. The aquifers in the study area identified as semi confined and confined type, and are further classified as poor, moderate and good potential zones, depending on the yields of bore wells. The study reveals that the weathered, jointed and fractured portions in Granites and dykes that occur in the study area constitute the productive water-bearing zones categorized as good groundwater potential aquifers.*

Keywords: *Chivvemla Mandal, Electrical resistivity, Vertical electrical soundings, Groundwater potential aquifers.*

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I. Introduction

The demands for the water increased to many folds due to rapid growth in industrialization and to meet the needs of increasing population. The availability of surface water is unable to cope up the ever-increasing demands and the only alternative source is exploring the groundwater. Without water for few hours then living conditions in the universe. Water is one of the most is essential commodities to make the life sustainable. The modern society is entirely dependent on water for drinking and daily needs, manufacturing of various goods and for growing the crops. In order to pursue large scale development of groundwater it is essential to have a reliable estimate of groundwater potential (Singh 2002). This is possible by a systematic exploration program using modern scientific methods. Use of geophysical methods provides valuable information with respect to distribution, thickness, and depth of water bearing formations.

Location of the study area

The present area of investigation forming part of toposheet (Survey of India) no's 56O/12 and 56O/16. It is bounded by longitudes 79° 37' 30" and latitudes 17° 12' 0" with an area of 190 km^2 of Chivvemla Mandal, Suryapet district, Telangana state. (Fig.1)

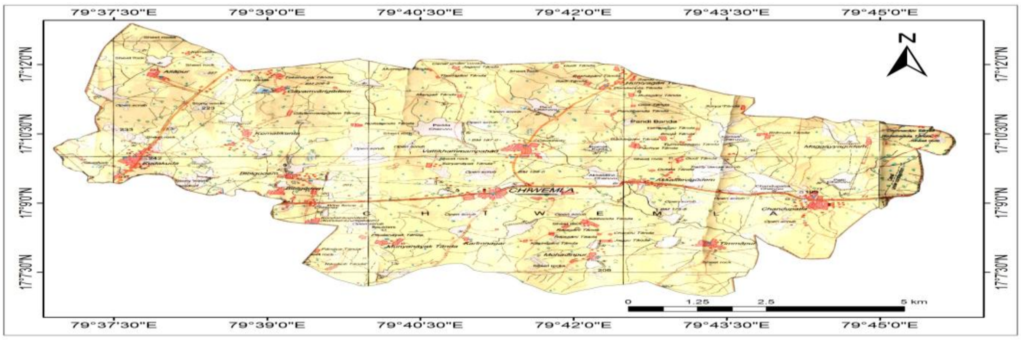

Fig.1. Location map of study area Chivvemla mandal Suryapet district, Telangana state

Climate and Rainfall

The district exhibits mixed temporal conditions, the climate of the district is generally hot and is a part of semi-arid zone. The temperature during the summer months varies from 44^{0}C – 47^{0}C and the month of May is the hottest month and the coldest months are the December and January and temperature ranges from 9^{0}C -

15^{0}C. The average annual rainfall receives the district study area is 750 mm, July, August and September months southwest monsoon in the year receives the maximum rainfall and more than 60% of rainfall received during these months only. Since last one decade the study area receives surplus rainfall in the year 2010 is 1011mm, and 1497 mm the average. The other periods experienced below average rainfall, therefore the study area categorized as drought prone area. Most part of the study are termed as dark zones, and the living conditions of men and animal are vulnerable action migration.

Drainage

The drainage development in the study area is poor and is dendritic to sub-dendritic type which is the characteristic feature of the granitic terrain. There are four major surface water bodies dividing the area in to four micro water sheds (Fig.2). The district is drained by the River Krishna along with tributaries Musi, Aler, Dindi, Halia and Peddavagu rivers. Krishna River forms the southern boundary of the district and enters the south western part of the district and flows along the southern boundary for a distance of about 85 Kms. The directions of all the three river courses are controlled by two major lineaments in east-west and northwest-southeast directions. All other lower order streams and Nallas are controlled by minor lineaments. (Fig 3). The major river Krishna is perennial and all other rivers are seasonal and ephemeral.

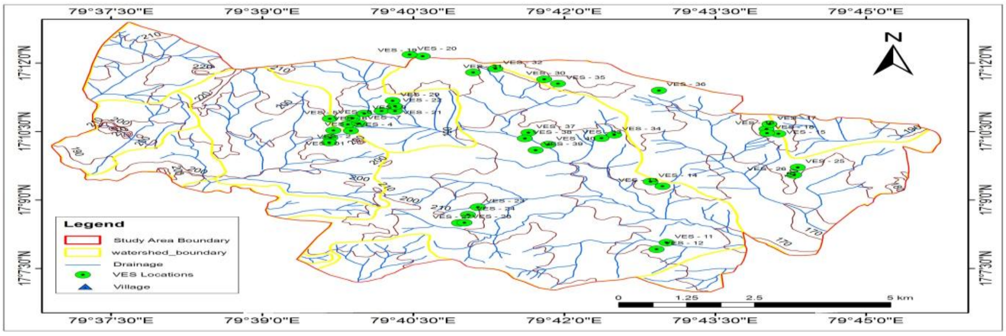

Fig.2. Drainage map of study area Chivemla mandal Suryapet district, Telangana state

Geology of the Study area

Chivvemla Mandal the study area is occupied predominantly by Archean suites of peninsular gneisses complex of oldest rocks granites of Precambrian eras with a general trend of NNE-SSW. These granites are later intruded by dolerite dykes and pegmatites veins. One major dyke traversing in NE-SW direction and others are in the NW-SE directions and are found on the Pedi Plaines of the study area. Pink and gray types of granites are distinctly occupied the entire study area (Fig.3). The granites are characterized by one major dyke traversing in NE-SW direction and others are in the NW-SE directions and are found on the study area. Fractures and fissures which are main conduits for ground water flow. The soils in the area are derived from the weathering of parent rock and varies in thickness depends on topography. Red sandy and loamy soils mostly cover the upland area and the low-lying area is dominated by black or clay soils, which are the erosional materials of red loamy soils. The topography of the area is gently sloping towards south eastern side.

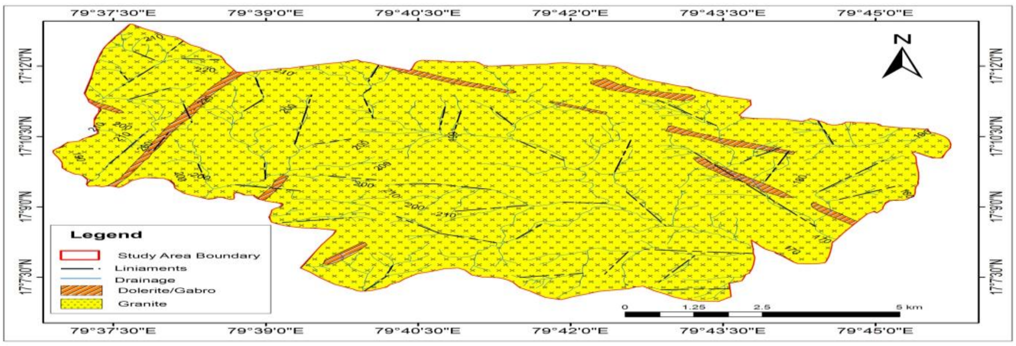

Fig.3. Geology and lineament map of study area Chivemla mandal Suryapet district, Telangana state

Hydrogeological Conditions

The occurrence of groundwater around the Chivemla mandal area is confined to the secondary porosity like fractures, fissures, joints in the deeper levels. Weathering in the area very profuse and limited to a certain depth. The iso-resistivity contour maps are clearly revealed the weathered zone thickness with its unconsolidated formations. Granite being the hard and compact formation with the least porosity and permeability, and the groundwater in this area occurring in the deeper zones of jointed and fractured zones. Groundwater is the main source for the agricultural activities, results depletion of ground water levels and scanty availability of water in the shallow depth. The present area weathering is extending to a depth of 2-15 mts, particularly this may be due to denser drainage and lineaments are the main features supporting in percolation and development of groundwater potentiality.

II. Materials and methodology

Electrical Resistivity Survey

Among geophysical methods of exploration, electrical resistivity method is the one which can be used for evaluation of subsurface information. This method is more practical, fast and cost effective. For the present Schelumberger configuration is used to measure the electrical resistivity, because the area under investigation is a hard-granitic heterogonous terrain (Zhdanov 1994). An indigenous portable D.C. (IGIS Hyderabad) resistivity meter is used for the present study, with a maximum current electrode (AB/2) separation of 100 m and with potential electrode separation as 10 m and is more sufficient to the hard terrain (Bhattacharya, et. al 1968). Vertical electrical soundings were conducted in the Chivvemla mandal in a systematic manner during the pre-monsoon period, when the surface is dry and easily approachable and collected the data. After obtaining the VES data is processed and interpreted both manually and with the software. The manual interpretation is done using the master curve (E. Orellana, et, al 1966) and also compared using IPI2 WIN software for qualitative and quantitative assessment. The VES data interpreted are resembling to H, A, and HA type, which are more typical to the hard rock terrain of granitic region. Majority of the curves surveyed are showing A and A type, and are the show with shallow basement, the aquifer characters and parameters were addressed in the present study in chivvemla mandal to deduce the groundwater potential zones for future groundwater exploration. Further suitable groundwater recharge structures in the area are recommended for sustainable development. The primary objectives of conducting vertical electrical soundings are to transform the field data into subsurface geology or hydrogeology and this can be achieved by adopting suitable interpretation techniques. Depending upon the details required the field data can be interpreted by qualitative and quantitative methods (zondy et. at 1974). Qualitative methods help in be learning the general preparing information about the geological structures and the changes in the geoelectrical section of an area. Interpretations are done by iso resistivity maps transverse resistance and longitudinal conductance maps. The results abstained after interpretation using curve matching method are tabulated and shown in (table -1).

Table. I VES analyses conducted in the study area.

S.No	p1	h1	p2	h2	p3	h3	p4	H
1	9.79	1.5	68.3	8.18	160	19.9	601	29.5
2	36.8	1.5	73.8	1.68	190	28.6		31.78
3	3.00	1.68	29.73	2.25	44.25	19.5		23.43
4	5.08	1.66	31.5	4.33	521	12.9	538	18.89
5	14.7	4.97	171	7.43	208	15.6		28
6	9.6	3.1	9.28	8.1	12.7	22.1		33.3
7	68.8	7	383	11.5	383			18.5
8	26.5	3.1	396	15.65	398			18.75
9	28.4	1.13	28.8	1.84	399	17.6	396	20.57
10	37.8	5.01	447	17.52	477			22.53
11	24.7	1.5	1.79	25.9	5.7			27.4
12	8.4	3.21	242	4.81	242	11.1	578	19.12
13	3.17	1.5	488	1.6	710.5	17.05	1167	20.15
14	7.69	2.43	299.5	3.54	299.5	8.96	2356	14.93
15	18.6	1.76	293	8.86	72.9	5.6	146	16.22
16	6.05	1.75	346	2.63	346	6.56	1348	10.94
17	21.7	3.01	72.7	4.49	120	11.6	1465	19.1
18	64.6	6.2	754	11.3	745	22.7	7544	40.2
19	20.7	1.4	359.5	12.6	349.5	9.9	3495	23.9
20	20.6	9.23	568	13.8				23.03
21	15.7	3.34	362.6	6.35				9.69
22	44.4	3.1	213.5	15.3	1026			18.4
23	26.3	1.9	116.4	3.85	758	8.5	1643	14.25
24	24.1	1.93	136.2	7.32	433	18.53	1116	27.78
25	2.8	1.5	514.3	22.25				23.75
26	19.5	6.88	708	10.3	906			17.18
27	21.1	1.91	870	2.86	1231	14.1	8704	18.87
28	16	2.82	1003	14.8	79.8			17.62
29	22.9	3.1	575	10.96	304			14.06
30	3.78	1.87	4.38	15.33	460			17.2
31	30.7	10.8	142.4	5.68	1998			16.48
32	12.9	1.5	136.3	13.89	3586			15.39
33	12.9	1.5	510.3	15.1	3756			16.6
34	31.9	2.09	288	16.2	286	4.71	288	23
35	11.2	1.5	212	12.6	1068			14.1
36	8.79	1.76	128.3	10.8	3551			12.56
37	5.15	1.5	55.7	15.4	1715			16.9
38	19.4	1.5	10.9	15.7	1860			17.2
39	21.4	1.5	16.8	5.01	251	10.25	2510	16.76
40	23.3	3.23	72.01	8.71	251.3	2.85	239	14.79

S.No	Lon.Con (mho) (S)	Trans.Res (Ωm^2) (T)	Anisotropy aquifer (λ)
1	0.198165	3757.379	5.023948
2	0.068981	5613.184	3.490534
3	0.654475	934.8075	5.110006
4	0.382656	6865.728	11.7932
5	0.391054	4588.389	8.005148
6	0.901063	385.598	3.230151
7	0.138298	4886.1	6.043699
8	0.132598	6279.55	6.663965
9	0.081857	7107.484	5.318247
10	0.154251	8020.818	7.410416
11	1.161875	83.411	1.880685
12	0.416994	3877.184	9.195576
13	0.479742	12899.58	17.52484
14	0.333724	3762.437	9.170619
15	0.185458	3036.956	5.892732
16	0.301323	3190.328	9.374001
17	0.208261	1783.74	4.410146
18	0.114018	25832.22	8.559624
19	0.079138	8018.73	5.152837
20	0.464308	8028.538	12.72256
21	0.22195	2354.948	7.344402
22	0.087361	3266.55	3.938175
23	0.093416	6891.14	6.721238
24	0.10527	9066.987	5.861613
25	0.538631	11447.38	16.11264
26	0.362538	7426.56	12.51869
27	0.094597	19885.6	9.984397
28	0.2144	14889.52	13.46014
29	0.15096	6372.99	8.271984
30	0.925715	74.214	1.998561
31	0.43304	1140.392	5.474095
32	0.127702	1912.557	3.983709
33	0.119618	7724.88	7.460877
34	0.080082	6079.331	4.600776
35	0.142409	2688	5.210424
36	0.214441	1401.11	4.890973
37	0.319067	865.505	4.042334
38	0.215741	200.23	1.584771
39	0.165355	2689.018	5.150731
40	0.196335	1418.671	4.339656

Table II. Total thickness (H)

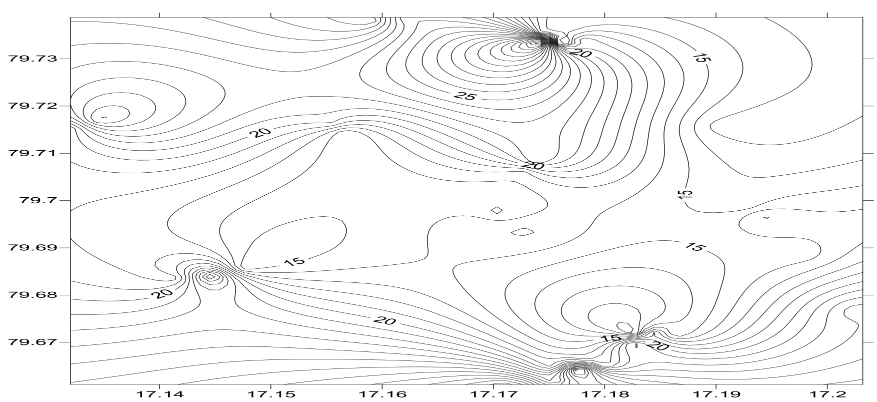

Fig.4. Iso-resistivity map showing the basement (H)

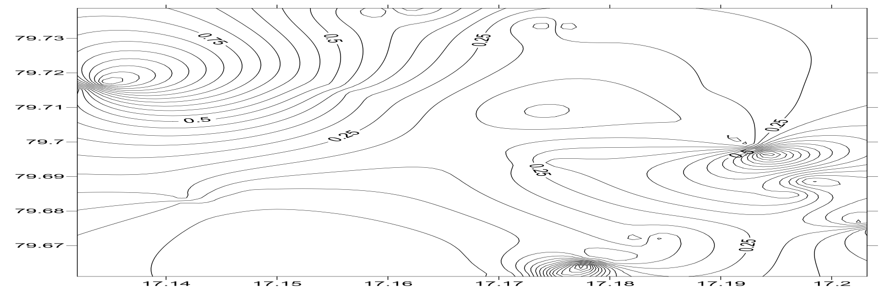

Fig.5. Contour map showing longitudinal conductance

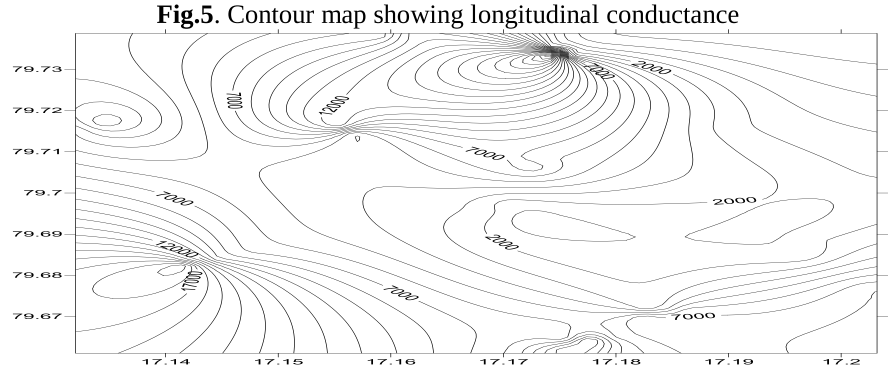

Fig.6. Transverse resistance map of the study area

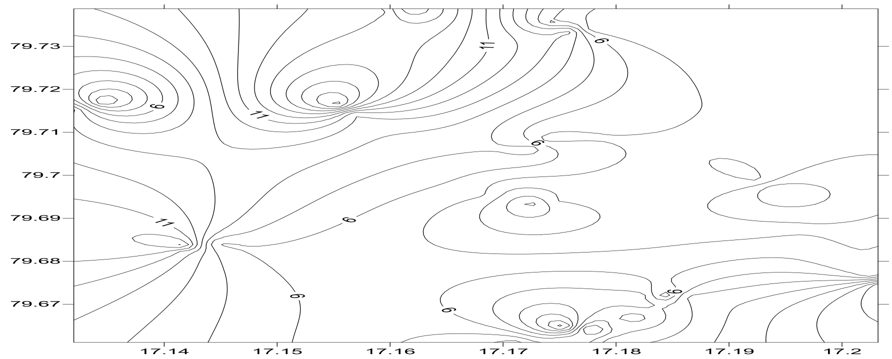

Fig.7. Anisptropism **map of the study area**

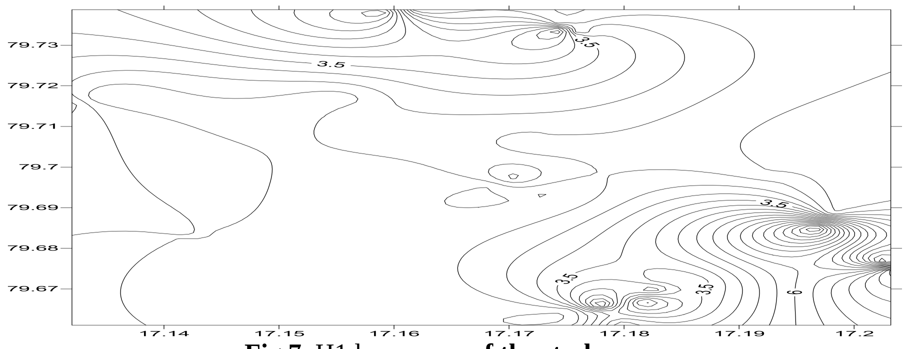

Fig.7. H1 layer **map of the study area**

III. Results and discursions

Numerous geophysical investigations have carried in various locations over the globe to demarcate ground water potential zones, thick and low resistivity horizons are considered as favorable for development. Based upon geoelectrical surveys. (Yonk - Hee Park et. al 2007), have delineated different lithological layers in alluvium formations. (Akankpo. O and Igboekeoe. M.U .2011) have identified hard rock impervious layers to proposed to delect ground water contaminations. In igneous and crystalline rocks, groundwater usually can be tapped from weathered zones and these are found at comparatively shallow depths. Such zones and pockets have lower resistivity values compared to more compact and fresh rocks and can be easily be located by resistivity surveys. C Prasad 1984 and Sharma et, al (1986). Table (1) shows the apparent resistivity and thickness of the different layers as interpreted from the analysis of the resistivity soundings curves of the VES data from 40 locations in part of the Chivvemla Mandal. These results have been transformed to sub surface geological details as thickness of topsoil, weathered layers and jointed layers and shown in table (1). The maximum topsoil thickness of 2.0 mts has been inferred at Rollabanda Thanda. The maximum weathered thickness of 15 mts is found at Thimmapur village. In all 40 VES locations 22 % of sites have weathered zones with thickness of 5 mts. About 75 % of VES locations have fractured and jointed formations attached the thickness of more than 15.0 mts and are located at Maggayagudem and Pandibanda Thanda.

The total longitudinal conductance (S), the total transverse resistance (T) and the aquifer anisotropy for the area under study have been computed and shown in table (2). It could be seen that the values of S, T and (ʎ) from to Mhos to Ohm mts^2 and respectively. The transverse resistance map (Fig.4) of study area indicates that the North-West West and South-East part Akkaladevigudem and SaibandaThanda respectively are suitable for having deep bore wells. Considering the longitudinal conductance map shows that moderate to high the longitudinal conductance values are characteristic of deeper basement topography in certain part of the study area.

IV. Conclusions

Geoelectrical method proved to be useful in demarcating groundwater potential zone especially in hard rock terrain. Fractured and jointed horizons have been identified in the study area constitute good aquifer zones. Good prospect therefore exists for ground water development where the depth to basement is relatively thick and has favorable low resistivity values. While those thin bed rock thickness and high resistivity zones have a lower aquifer potential. Moderate to high longitudinal conductance values are of characterization of deeper basement topography and are suitable potential aquifer zones.

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