International Research Journal of Earth Sciences ISSN 2321–2527
Vol. **3(8),** 8-13, August **(2015)** *Int. Res. J. Earth Sci.*

Electrical Resistivity studies for Groundwater exploration in the some parts Chopda block of Jalgaon District, Maharashtra India

Patil.S.N[1], Kachate.N.R[1], Marathe.N.P[1], Ingle.S.T[1] and Golekar.R.B[2]
[1]School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon MS, INDIA
[2]Rajarambapu Institute of Technology, Rajaramnagar, Islampur, Dist. Sangli, MS, INDIA

Available online at: www.isca.in, www.isca.me
Received 10th July 2015, revised 22nd July 2015, accepted 20th August 2015

Abstract

A geophysical survey conducted in the Chopda and nearby the area of North-West part of Jalgaon district, Maharashtra using electrical resistivity method. A total 10 vertical electrical soundings has been taken to depict groundwater potential zone in the area under study and also understand the thickness of weathered zone/formation relevant to groundwater behaviors of aquifers in alluvium and in the trap rock. For the interpretations of VES results IX1Dv.3 software were use to generate the layered model of each sounding and also adopting curve matching techniques. A total four layer strata was obtained in the present study. The resistivity and thickness of the first layer are 2.6 ohm m to 140 ohm m and 0.2 m to 0.9 m respectively was observed. The sounding data obtained of second layer 2.1 ohm m to 29.33 ohm m. Resistivity and thickness of the third layer varies from 2.75 ohm m to 33.9 ohm m and 5.2 m to 52.2m respectively.The Fourth layer resistivity goes very high at Village Akulkhede up to 949 ohm m. KH curve type is observed in the 30 % and KQ, HK are in the 20% VES locations. The VES 2 and 8 result shows that the high resistivity value in the cross section. Pseudo cross section and resistivity cross section map were formulated by using IPI2WIN software. The resistivity results of VES 2 and 5 show that the hard compact basalts occurring at 13 and 20 m depth respectively. The resistivity results of VES 2 and 8 shows that the high resistivity zones occurring at 4 to 20 m depth. The obtained results of VES have been compared with the existing bore well and tube well logging data.

Keywords: Electrical resistivity, groundwater exploration, IX1Dv.3 software, pseudo section, cross section.

Introduction

Jalgaon is one of the districts in the northern Maharashtra region, India. In this area, water level is decreasing day by day because of fast growing of agricultural and industrial practices. Groundwater is a very important source of agricultural in the area. The areas that are prone to unnecessary withdrawal resulted in the scarcity of groundwater highlight the need for the proper estimation of available subsurface water resources and the importance of appropriate arrangement to assurance of the continuous accessibility of water. The study area with its unusual geohydrological, groundwater condition and climatic setting possesses different aquifer behavior were seen in the study area because of trap rock is seen in middle part and at the bank of Tapi river alluvium is present. Schlumberger array is used to recognize the subsurface circumstance, it is easy to function and electrodes make available for elevated signal to noise ratio, good resolution of horizontal layers and sensitivity of depth[1].

Study area: The present study area (figure-1) belongs to watersheds no. TE 30 which covers an area about 314.68 sq.km, its coordinate is latitude 21°14'N to 21°15'N and 75°10' E to 75°23'E longitude and belongs to survey of India toposheet no. 46O/3, 46O/4, 46O/7 and 46O/8. The climate of the area is dry and prone to large temperature variation with 731.80 mm average annual rainfall in Chopda taluka. In the south of study area flowing river Tapi, their exposures are noticed only 5-6 km south of river. Physiographically the study area is made up of high hill ranges on the north and alluvium in the centre. On the north, the hill ranges stretch east-west and form part of the Satpudas, the highest peak being about 262m. The maximum temperature recorded in the region is of 47°C in the month of May and minimum is of 7°C in the month of December. Soil pattern of study area is medium black soil to deep black soils.

Geology of the study area: Geologically, northern part of the study area covers the Deccan volcanic basalts (Cretaceous to lower Eocene age) and southern part covers the thick alluvium (Quaternary age) occurred along the gullies and bank of river[2,3].

Deccan Traps: Deccan traps surround almost the middle part of study area, these trap rocks are the effect of expression of enormous lava flows which extend over huge areas of western, central and southern India at the end of Mesozoic era. The some part of study area is covered by Deccan volcanic rocks of Cretaceous to Eocene age showing vesicular and mixed Basalt structures[4].

Alluvium: The southern part of the study area is underlain by Tapi alluvium. River Tapi flows from East to West and it is originate at Betul in Madhya Pradesh and meets to Arabian Sea.

On the banks of Tapi River a strip of alluvium covered lands on both sides throughout the Jalgaon district. Thicker alluvium layers are seen at the banks of river and also at the North side of Chopda taluka. Most part of study area is consisted of younger alluvium which is in quaternary age. These alluvium layers are mainly composed of sand, silt and clay as an alternating bed. Bazada (Piedmont zone) zones are seen at NW part of study area[5].

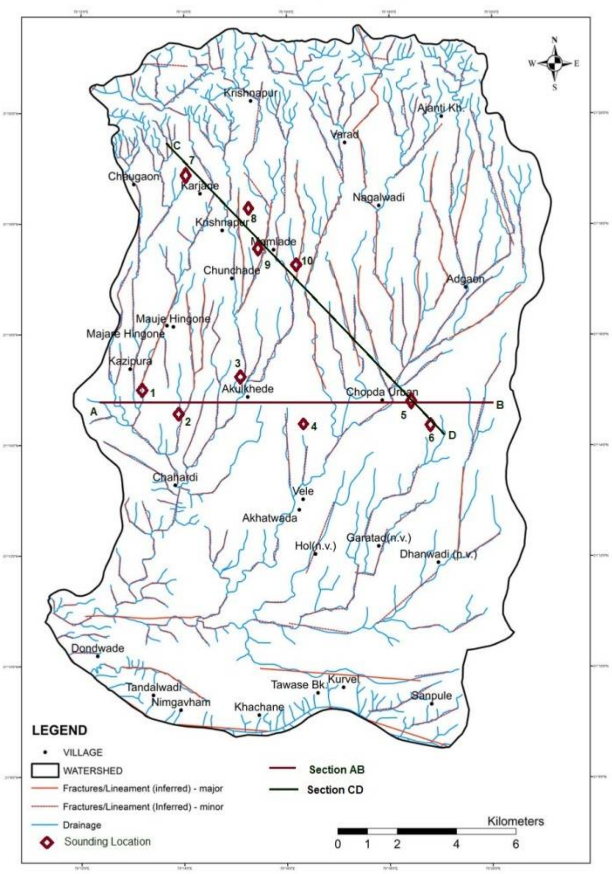

Figure-1
Location map of study area

Hydrogeology of the study area: The occurrence of groundwater in any type of terrain is largely dependent on topography, climate and geological setting. The study area includes parts of undulating piedmont plains along the foothill of Satpuda mountain ranges and flood plains along river Tapi. The general gradient is towards south. The thick pile of piedmont deposits and alluvium is predominantly composed of clay, sand and silt. In the Deccan Trap well, water level is observed at 17-18m depth in pre monsoon and rises up to the depth 12-13 m in Post-monsoon period. Geologically, central part of study area covers Deccan Trap; there is a weathered or fractured zone of basalt yields a good amount of water and in the alluvium part water level is observed at 15-17 m depth in the pre-monsoon and in post monsoon depth at 8-9.5m.

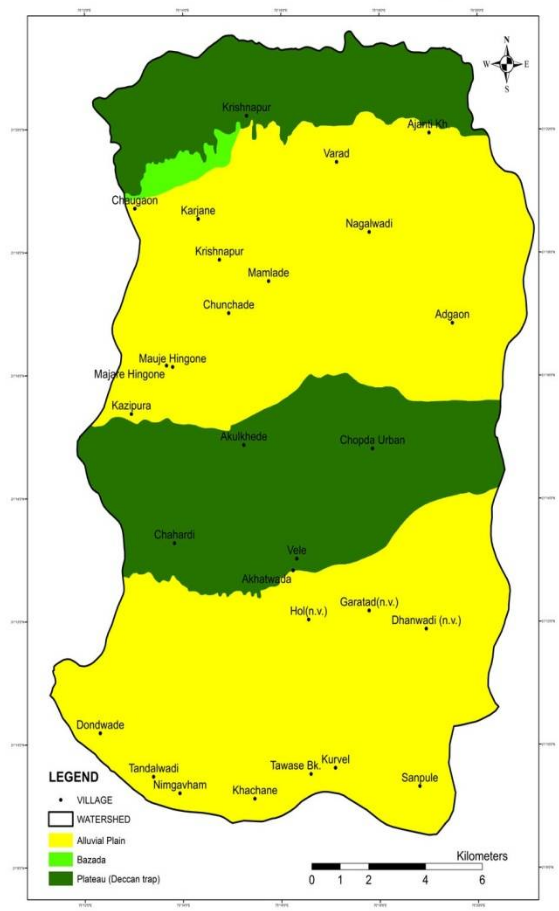

Figure-2
Geological map of the study area

Methodology

The geophysical investigations were carried by using electrical resistivity method. The VES is based on measuring the potentials difference between one electrode pair while transmitting direct current between another electrode pair[6]. The resistivity signal measurements were collected by using SSR-MP-ATS model, Make IGIS Hyderabad (India). The resistivity soundings were carried out using the Schlumberger electrode configuration with a maximum current electrode separation (AB/2) = 100m. Kearey and Brooks[7] method was used for calculation of apparent resistivity as, $\rho a=\pi\ [(L/2)^2 - (b/2)^2]/b \times V/I$ Where, L and b is the current and potential electrode spacing respectively.

The interpretation of the VES were carried out by the IX1Dv3.1 software in terms of layered resistivity model $\rho 1$, $\rho 2$, $\rho 3$ matching measured curves with a set of theoretically calculated master curves interpreted using master curves techniques[8]. The VES pseudo cross section and resistivity cross section maps were prepared by using IPI2WIN geoscientific software[9].

Vertical Electrical Sounding: The Schlumberger configuration composed of four collinear electrodes. Current and potential electrodes are placed in such a way to maintain one fifth of the spacing between the inner and outer electrode. The current electrodes are increased to a greater separation during survey while, potential electrodes remain in same position until it observes, voltage becomes too small to measure[10].

The electrical resistivity prospecting for groundwater exploration is reported by many authors[11-14]. The vertical electrical resistivity method is widely used to estimate the thickness of overburden, weathered and fractured zones. Wenner and Schlumberger electrode configuration methods are popularly employed, the Schlumberger electrode configuration method is widely used and less time consuming method, good resolution and ensuring better results[15-19]. Andrade[20] has established that VES method and 2D resistivity can be better tool in understanding the hydrological problems. The geophysical studies applied for evaluating hydrogeological conditions and management of groundwater resources in alluvial parts of Jalgaon district[19-21]. In present study three to four layer model is generated over 10 location of area. AB and CD two cross sections are drawn from West to East and NW to SE, respectively. The resistivity data obtained in the present study is compared with the Logging of Tube wells existing in the study zone[22]. The generalized ranges[21] of resistivity values of different litho units in the present study area are considered as per suggestion by earlier researchers the refereed table has shown in table-1.

Table-1
Table.1 Lithounits and Resistivity

Litho-Units	Resistivity (Ω m)
Clayey/silty layer	1-3
Medium grained sandy layer	3-5
Loose sand and gravel bed	5-7
Clay with pocket of sand	7-15
Clay with lenses of sand	15-25
Compacted clay with pebbles, cobbles, gravels	25-45
Compacted clay bed	45-60
Hard and compact rock	Over 60

Results and Discussion

The data were investigated by curve matching techniques for 10 VES locations, resistivity and thickness of geo-electrical sections presented in table-2. VES data were obtained with multiple iteration inversion using computer software IX1Dv3. In the study area 3 to 4 layer models is obtained.

The first layer model having low resistivity 2.6 Ω m to 140 Ω m and a thickness of layer is 0.29 to 0.9m. VES 1 and 3 may be consisting of thick black cotton soil mixed with sand, kankars.

The second layer model has consisting of compacted clay bed at VES 5, 8 and 10 up to the depth of 1- 8.53m have a resistivity 2.1Ω m to 42.6 Ω m. VES 2, 4, 6, 7 and 9 shows low resistivity, this suggests that the presence of the clay with pockets or lenses of sand.

A maximum resistivity is of 33.9 Ω m observed in third layer model up to the depth of 52.2m having weakly fractured basalt at VES 2 and 4 whereas, at VES 7, 8, 9 and 10 have a 2.75 Ω m -22.6 Ω m resistivity, this suggest that the presence of the loose sand, medium grained sandy layer and lenses of sand.

At VES 2 and 3 have 87.7 Ω m and 949 Ω m resistivity at the depth of 90m in the fourth layer model, this suggests that the presence of hard and compact rock. At VES 5 have 53.8 Ω m resistivity at the depth of 60m, this suggests that the presence of weathered fractured basalt.

A pseudo and cross section were generated by using IPI2WIN software. The cross section AB shows that the west part of study area (VES 2) have a high resistivity value up to the depth of 8m; at the depth of 8m -20m seen a low resistivity zone and depth from 20-100m shows a high resistivity zone. VES 5 (East part of study area) clearly shows that the high resistivity zone is occurred at 30m depth. VES 1, 3, 4 and 6 show low resistivity zone at the depth of 3-60m (figure-3).

At section CD, VES 8 results shows that the high resistivity area at shallow depth (village Krishnapur is near at Satpuda ranges). It is seen in resistivity cross section VES 7, 8 and 9 has a low resistivity zone at the depth of 40m-100m having a rounded to sub rounded coarse sand which is co related with litho log data of tube well of village Mamalde (figure-4).

Conclusion

The vertical electrical resistivity helps to determine a good ground water potential zone. By studying geophysical characteristics of Deccan Trap and Alluvium showing high and low resistivity zone in different parts of study area.VES 2 (Chahardi) and VES 8 (Krishnapur) have high resistivity zone at shallow depth. It shows a presence of hard rock. Village Chahardi shows a low resistivity zone between 3-15 m it may be a good groundwater potential zone. Akulkhede and Vele have a low resistivity zone there may be a presence of clay with pocket of sand to compacted clay bed.VES 5 (Chopda) have a presence of hard rock at 26m depth. In the cross section profile CD which represent the village Karjane, Krishnapur, Mamalde and Chunchale having a low resistivity zone and identifies the loose sand, silt layered present.

The resistivity variation may be due to alternate layer of very compacted clay beds and loose or pockets of sands present in the study area. Loose or pockets of sands are good source of groundwater. The resistivity cross section confirms that the low resistivity and high resistivity zone. VES is useful for delineating a good groundwater potential zone.

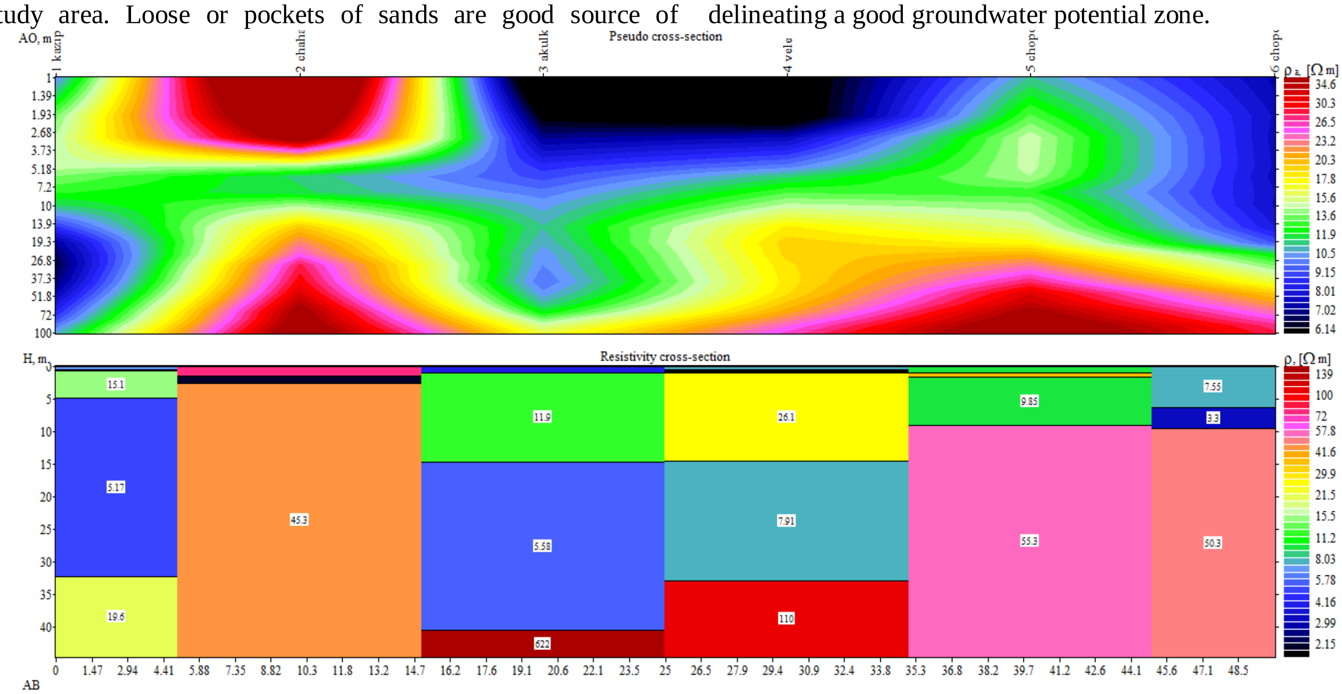

Figure-3
Profile AB resistivity cross section and pseudo cross section

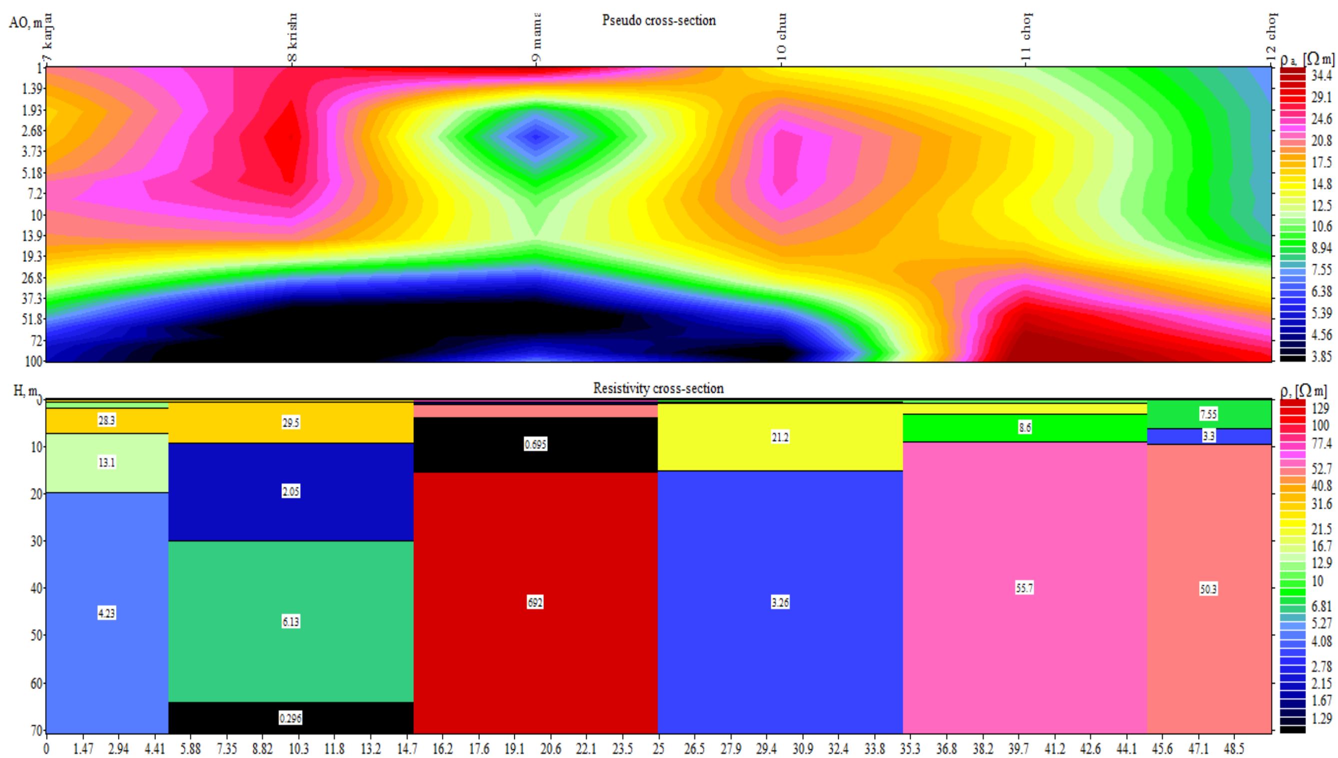

Figure-4
Profile CD resistivity cross section and pseudo cross section

Table-2
Resistivity and thickness of Geo electrical sections

Ves no.	Location	Latitude	Longitude	Elevation amsl	Resistivity (Ω m)				Thickness (m)				Curve Type
					Layer I	Layer II	Layer III	Layer IV	Layer I	Layer II	Layer III	Layer IV	
1	Kazipura	N 21.251	E 75.215	181	9.4	23.7	5.8	25	0.8	2.3	36.4	-	KH
2	Chahardi	N 20.230	E 75.237	180	140	2.1	33.9	87.7	0.9	0.6	52.2	-	HA
3	Akulkhede	N 21.252	E 75.246	199	4.1	12.4	5.5	949	1.0	12.4	25.7	-	KH
4	Vele	N 21.222	E 75.278	182	18.1	3.5	31.2	5.6	0.2	1.2	10.3	11.8	HK
5	Chopda	N 21.258	E 75.295	226	10.3	32.8	7.5	53.8	1.0	1.0	5.2	-	KH
6	Chopda-Gartad Rd	N 21.232	E 75.301	206	38.4	2.4	9.1	-	2.2	12.5	-	-	H
7	Karjane	N 21.300	E 75.245	243	25.5	5.7	22.6	4.5	0.5	0.3	12.9	-	HK
8	Krishnapur	N 21.328	E 75.254	262	22.08	29.33	2.75	-	0.29	8.53	-	-	K
9	Mamalde	N 21.286	E 75.261	227	2.6	8.5	5.6	1.3	0.8	0.8	15.1	-	KQ
10	Chunchale	N 21.268	E 75.503	240	10	42.6	21.5	3.1	0.4	0.8	13.9	-	KQ

Acknowledgment

Authors indebted to UGC-BSR (RFSMS) Government of India for the valuable research grant sanctioned to School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon. The co-operation of North Maharashtra University, Jalgaon officials is also acknowledged.

References

1. Stanley H. Ward., Resistivity and induced polarization methods, *Geotechnical and Environmental Geophysics, Society of Exploration Geophysicists*, (**1**) 147-190 **(1990)**
2. District Resource Map Jalgaon district, *Geological Survey of India*, Maharashtra **(2001)**
3. Golekar R. B, Baride M.V. and Patil S. N., Human health risk due to trace elements contamination in groundwater from Anjani and Jhiri river catchment of Northern Maharashtra, India., *Earth Science Research Journal* **17, (1)** 17-23**(2013)**
4. Deshpande G. G., Geology of Maharashtra, *Geological society of India*, Bangalore. **(1)** 129-160 **(1998)**
5. Patil S. N., Studies of hydrology and watershed characters of Yawal taluka, Dist. Jalgaon (MS) India, *Unpublished Ph.D Thesis, North Maharashtra University, Jalgaon* **(2005)**
6. Gautam Gupta, Vinit C. Erram, Saumen Maiti, Nandkishor R. Kachate and Sanjay N. Patil., Geoelectrical studies for delineating Seawater intrusion in parts of konkan coast, *International Journal of Environment and Earth Sciences* **1(1)** 62-79 **(2010)**
7. Kearey, P. and Brooks, M., An introduction to geophysical exploration, *ELBS Blackwell Scientific Publication, Oxford*, (**3)** 296 **(1988)**
8. Orellana E. and Mooney H. M. Master tables and curves of vertical electrical sounding over layered structures. *Interciencia Madrid Spain* 150-166 **(1966)**
9. Bobachve.A, Resistivity Sounding Interpretation IPI2WIN, Version 3.0.1, a 7.01.03. *Moscow State University* **(2003)**
10. Sharma Prem V., Environmental and Engineering Geophysics, *Environmental and Engineering Geophysics*, **1(1) (1997)**
11. Bhattacharya P. K. and Patra H. P., Direct current geoelectric sounding principles and interpretation.
12. Methods in geochemistry and geophysics, Elsevier, New York, (**1)** 135**(1968)**
13. Karanth K. R.., Ground Water Assessment, Development and Management, *Tata Mc Graw Hills Publications Company Limited, New Delhi*, (**27)** 449-460 **(1987)**

14. W.M. Tellford, L.P. Geldart and Sheriff R.E., Applied Geophysics, *Cambridge university press, New York*, 522-577**(1990)**
15. Debabrata Nandi, Ipsita Mohanta and Sandeep Ranjan Mishra., Delineation of Groundwater Prospective Zones by Schlumberger electrode array in Bangriposi block of Odisha, *International Research Jour. of Earth Sciences* **3(4**) 5-11**(2015)**
16. Duraiswami R.A. Dykes as potential groundwater reservoir in semi-arid areas of Sakri Taluka, Dhule District, Maharashtra, *Gond. Geol.Magz*, **21(1),** 1-9 **(2005)**
17. Singh R P and Jamal A., Dykes as groundwater loci in parts of Nashik District, Maharashtra, *J. Geol. Soc. India,* **59(2),** 143–146 **(2002)**
18. Erram V. C, Gupta. G, Pawar J. B, Gupta Suyashkumar and Pawar N. J., Potential groundwater zones in parts of Dhule District, Maharashtra a joint interpretation based on Resistivity and Magnetic data, *J. Ind. Geol. Cong.*, **2(1)** 37-45**(2010)**
19. Gupta G,Erram V. C, and Gupta Suyashkumar, Temporal geoelectric behavior of dyke aquifers in northern Deccan Volcanic Province, India, *Jour. Earth Syst. Sci*., (**121)** 723–732**(2012)**
20. Golekar R. B,Baride M. V and Patil S. N., 1D resistivity sounding geophysical survey by using Schlumberger electrode configuration method for groundwater explorations in catchment area of Anjani and Jhiri river, Northern Maharashtra (India), *Journal of Spatial Hydrology*, **12(1),** 22-35 **(2014)**
21. Andrade R., Intervention of electrical resistance tomography in resolving hydrological problems of a semi arid granite terrain as Southern India, *Jour. Geol. Soc. India*, (**78),** 337-344 **(2011)**
22. Patil S. N. and Baride M. V., Geophysical investigation for ground water in Yawal taluka of Jalgaon district, Maharashtra, *ISEG Jour Engg. Geol.*, **36(1),** *1-4* **(2009)**
23. Logging of tube well, Unpublished report, *Ground water Survey and Development Agency Jalgaon,* **(2002)**