© 2016 IJSRSET | Volume 2 | Issue 1 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Water Quality Analysis and Subsurface Lithology Characterisation and Its Environmental Implications Using Electrical Resistivity Survey

T Dharmavathi

Dadi Institute of Engineering and Technology, Visakhapatnam, Andhra Pradesh, India

ABSTRACT

In this project, measurements of vertical electrical soundings (VES) will carry out in Rajam. The resistivity method will carry out with a view to characterize different subsurface geological units and to provide the engineering/environmental geophysical characterization of the study area. One-dimensional numerical inversion of individual DC resistivity will use to enhance the processing of the results for better achievement of the aim of the study. Models which will be obtained from the 1D inversion of each VES, together with borehole information, will use for construction of geo-electrical sections which exhibit the main geo-electrical characteristics of the geological units present in the area. In this project, it is expecting that the final interpretation of the results will help to provide the geo-electrical successions which have different layers and to decide which layer is to be the most competent for founding small to medium engineering structures and which layer is considered to be the best water bearing structure. Project also includes the assessment of quality of the ground water by analyzing the water samples which will collect from bore wells in the surveyed area.

Keywords: Hydrochemistry, Electrical Resistivity, Boreholes, Water analysis

I. INTRODUCTION

Ground water is one of the most important natural resources. In the last three decades, development of ground water has made fast strides and its exploration is ever increasing. This has been necessitated by the undependable rainfall and consequent inconsistent surface water resources. In countries like India, with vast areas underlain by crystalline rocks, ground water resources have to be necessarily explored and extracted from this hard rocks in whatever quantities available as there are no other alternative water resources in main such regions.

The electrical resistivity method involving vertical electrical sounding (VES) technique was adopted for this survey. It involves the measurement of apparent resistivity of subsurface as a function of depth or position by changing the electrode spacing interval while maintaining a fixed location for the centre of the electrode spread.

Water quality assessment is the study of physical, chemical and biological characteristics of water. Different parameters like TDS, TSS, chlorides, fluorides, sulphates, hardness, electrical conductivity, pH, alkalinity, sodium, potassium, etc. These standards are compared with the standard BIS standards and the quality assessment is done. "Determination of Lithology and Groundwater Quality Using Electrical Resistivity Survey", Muhammad Arshad1, J.M. Cheema And Shafique Ahmed[1], Department of Irrigation and Drainage, University of Agriculture, Faisalabad. A resistivity survey was carried out in order to study groundwater conditions along the Jhang Branch canal, such as depth, thickness and location of the aquifer and the type of water. "Role of Electrical Resistivity Method for Groundwater Exploration in Hard Rock Areas: A Case Study from Fidiwo/Ajebo Areas of Southwestern Nigeria."Stephen O. Ariyo and Gabriel O. Adeyemi[2], Department of Earth Sciences and Geology, Olabisi Onabanjo University, Ago-Iwoye, Nigeria."Applications of 1D and 2D Electrical Resistivity Methods to Map Aquifers in a Complex Geologic Terrain of Foursquare Camp, Ajebo, Southwestern Nigeria." Elijah Adebowale

Ayolabi[3], Ph.D. Franklin Eleyinmi, B.Sc. and Esther O. Anuyah, B.Sc. Geophysics Program, Department of Physics, University of Lagos, Nigeria. "Ground water resources management strategies for the 21st century requirements in India", S.P.Sinha[4] ray, Central Ground Water Board, Faridabad.

II. METHODS AND MATERIAL

Study Area

Rajam is a municipality and mandal headquarters located on the east coast of Srikakulam district of Andhra Pradesh, India. It is located at 18.028^0 N & 83.040^0 E. The maximum elevation is 80 m and minimum elevation is 60m. It has total geographical area is nearly 25 sq.km and average rainfall is 1086 mm.

Name of the village: Rajam				
Sl. No.	Sy. No.	Tank name	Extent	Ayacut Extent
1	67	VeerajuCheruvu	31.55	110.37
2	125	DodlappayyaCheruvu	14.36	18.23
3	135	ChinnayyaCheruvu	3.76	20.95
4	142.2, 152	AppannapatrununiCheruvu	15.29	49.23
5	165	Buddepuvanicheruvu	19.14	113.92
Total			84.10	312.70

Table 1: Surface Water Bodies in Rajam

Methodology

Three different locations were identified for borehole drilling with the help of local bore well drillers for the collection of sediment samples drilled from the bore wells from different depths. The latitude and longitude of the location were taken with the help of Global Positioning System (GPS) instrument for the respective well. The drilling process is of rotary type and air pressure of 23 kg/cm2 is used. The sediment samples drilled from the three different boreholes were analyzed and the lithological sections were prepared and the fractured zones are identified in all the three bore holes.

The project work includes the Schlumberger array in electrical resistivity Survey. The basic field equipment for this study is the Electrical Resistivity Meter (SSR-MP-AT model) from ohm’s law. It is powered by two rechargeable batteries each of 12V. Other accessories includes the four metal electrodes, four Winches carrying cables for current (300m) and potential (100m) electrodes for very long spread, hammers (4), measuring tapes (2), connecting wires. In this configuration, the four electrodes are positioned in a straight line, the current electrodes on the outside and the potential electrodes on the inside. To change the depth range of the measurements, the current electrodes are displaced outwards while the potential electrodes in general, are left at the same position. IPI2win SOFTWARE is used for analysis.

Ground-water chemistry is largely a function of the mineral composition of the aquifer through which it flows. As ground water moves along its path from recharge to discharge areas, a variety of hydrochemical processes alter its chemical composition. The hydrochemical processes and hydrochemistry of the ground water vary spatially and temporally, depending on the geology and chemical characteristics of the aquifer. Interaction of groundwater with aquifer minerals through which it flows greatly controls the groundwater chemistry. The collected water samples are tested for various parameters in the chemical laboratory. Aquachem Software is used for analysis.

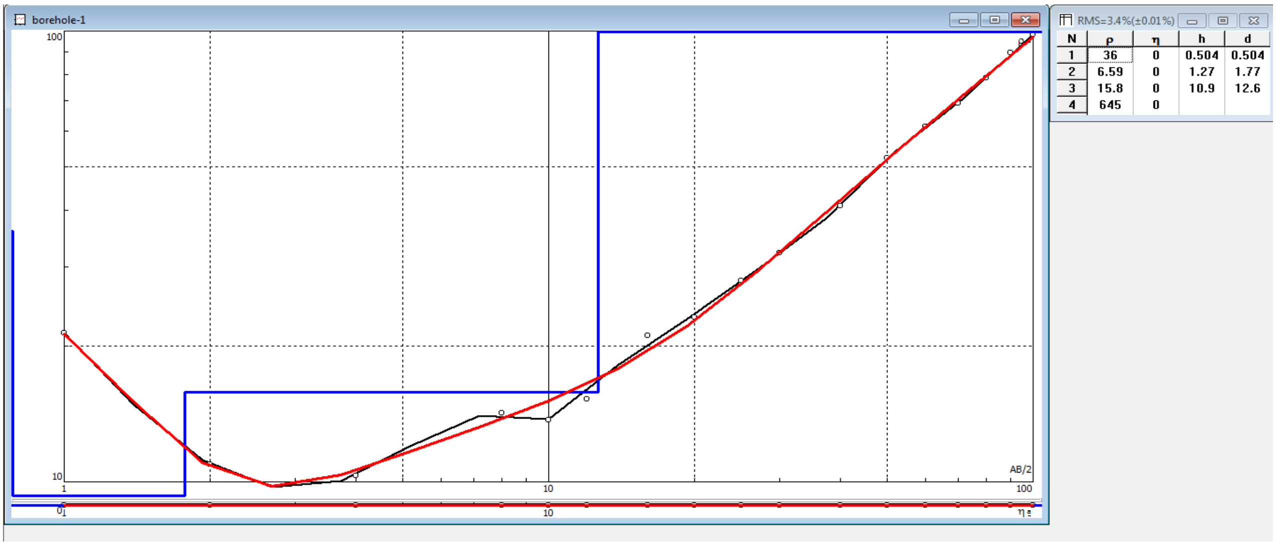

Figure 1: Curve Fitting Showing Borehole-1 Resistivity Values

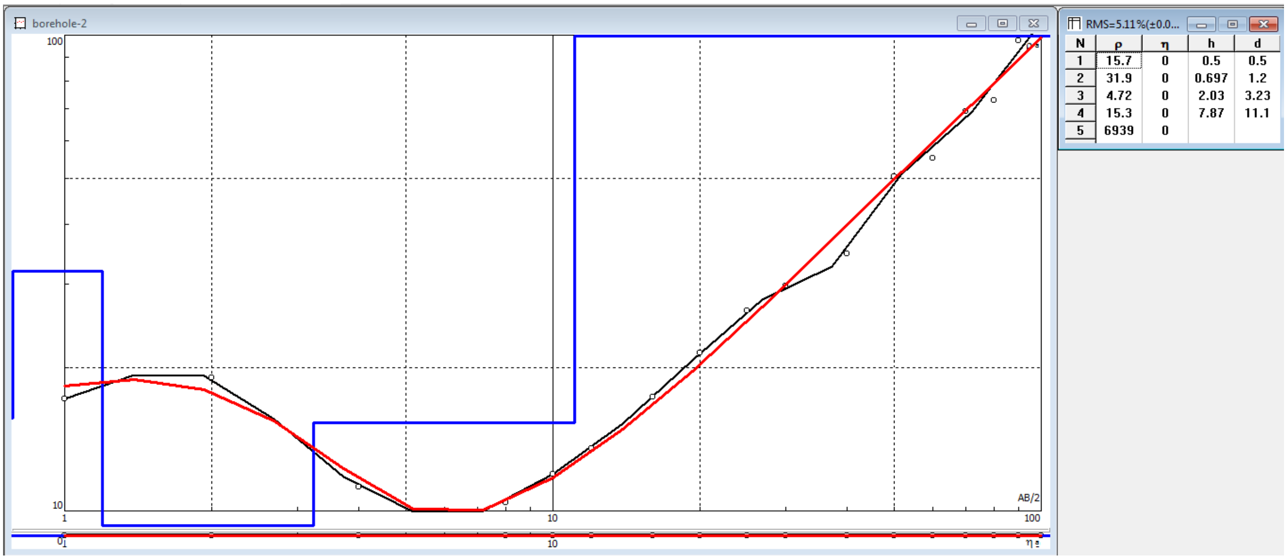

Figure 2: Curve Fitting Showing Borehole-2 Resistivity Values

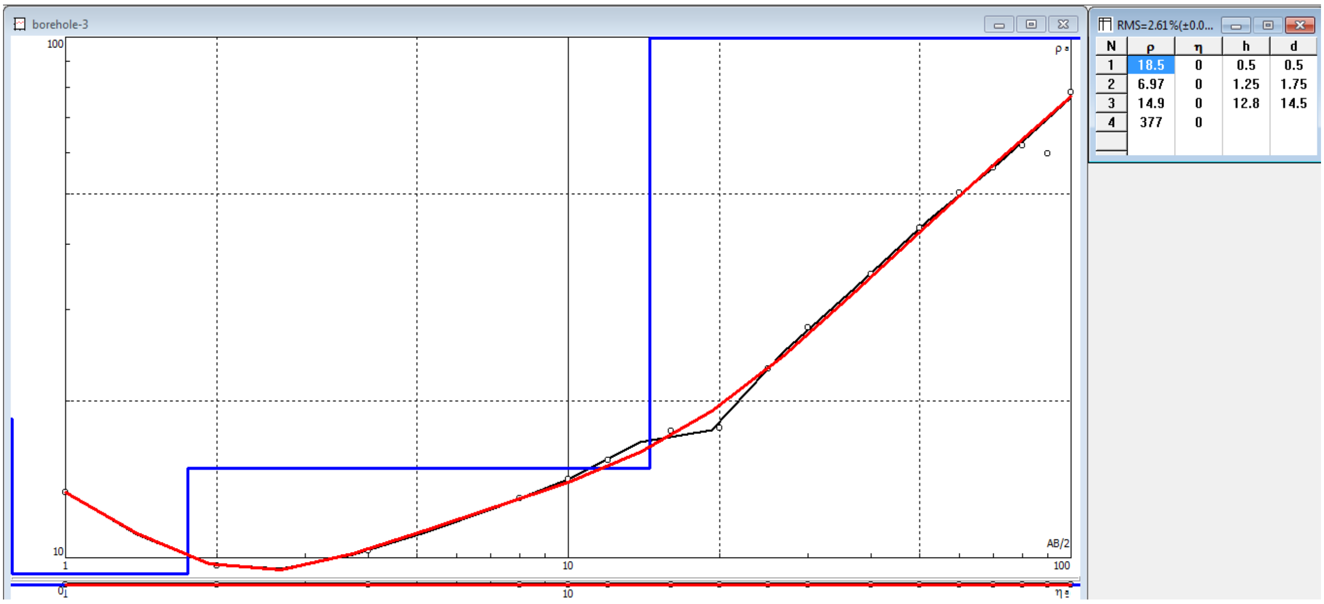

Figure 3: Curve Fitting Showing Borehole-3 Resistivity Values

S.No.	VES No.	Curve type	Resistivity in (Ωm) ρ1 (Ωm)	ρ2 (Ωm)	ρ3 (Ωm)	ρ4 (Ωm)	ρ5 (Ωm)	ρ6 (Ωm)	Thickness in m h1(m)	h2(m)	h3(m)	h4(m)	h5(m)
1	CPP ROAD	HA	36	6.5	15.8	645			0.504	1.27	10.9		
2	BUS STAND	HA	15.3	34.7	4.59	16.6	6939		0.5	0.644	2.05	8.31	
3	MALLIK ARJUNA NAGAR	HA	18.4	7.01	14.8	357			0.5	1.25	12.6		

Table 2: Results of Vertical Electrical Soundings

S.NO.	VES NO.	Total Longitudinal Conductance (C) Mho	Total transverse resistance (R) ohm-m^2	Depth to bed rock (m)	Aquifer resistivity Ohm - m	Longitudinal resistivity
1.	CPP ROAD	0.90	199	12.7	283	14.09
2.	BUS STAND	1.00	177	11.5	29.5	11.52
3.	MALLIKARJUNA NAGAR	1.06	204	14.4	125	13.58

Table 2 : Aquifer Parameters

Table 4 : Hydrochemical Analysis

TYPE	pH	EC (µs)	TDS (ppm)	TSS (ppm)	TH (mg/lit)	Ca^{++} (mg/lit)	Mg^{++} (mg/lit)	Na^{+} (ppm)	K^{+} (ppm)	Alkalinity (mg/lit)			Fl^{-} (ppm)	Cl^{-} (ppm)	SO_4^{--} (ppm)	
										p-alkali Snity	T-alkali nity					
borehole-1	7.04	2000	766	300.8	965	184	121.2	83.5	2.7	0	415		0.551	191.7	108.192	
borehole-2	7.17	1700	853	82.6	925	128	145.2	85.52	1.1	0	355		1.007	179.275	114.624	
borehole-3	7.42	1100	531	64.7	610	82	97.2	49.01	0.79	0	300		1.729	106.855	98.784	
												(P<0.5 T				

well-1	8.32	2400	867	97.5	255	40	37.2	459.15	8.8	25	200	CO_3 =50 HCO_3=	0.418	52.54	96.192	
												T-				
												2P=150)				
												(P<0.5 T				
well-2	7.92	3000	1243	240.6	315	52	44.4	503.2	10.2	55	240	CO_3=11 0 HCO_3=	0.589	96.915	113.76	
												T-				
												2P=130)				
well-3	7.67	1200	104	321.4	505	126	45.6	86.48	5.24	0	265		1.292	94.075	123.36	
well-4	7.43	1400	585	483.2	525	140	42	131	26.1	0	250		0.703	173.95	189.69 6	
well-5	7.59	3400	1678	169.6	715	96	114	363.7	5.8	0	305		2.014	113.24 5	136.41 6	
well-6	7.52	1800	692	323.1	470	80	64.8	181.35	102.5	0	255		0.646	115.37 5	116.25 6	
well-7	7.26	1700	872	519	825	180	90	95.5	13.55	0	325		2.28	186.37 5	122.01 6	

III. RESULTS AND DISCUSSION

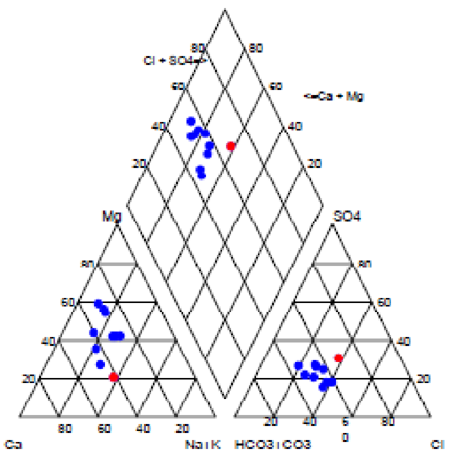

Figure 4: Piper Representation

The water quality variation and geochemical evolution of groundwater has been studied by using the Piper‘s diagram. The water quality data of groundwater are plotted in the Piper diagram. The cation plots in the diagram reveal that majority of the samples lie in the no dominant, calcium and magnesium type. The anion plot in the diagram reveals that samples fall under the Ca, Mg-CO3, HCO3 facies (piper diagram). This variation implies that recharge area of the ground is same but small variation may be due to the ground dynamics. Presence of Ca, Mg-CO3, HCO3 facies in the lake via recharge area acquires their initial chemical characteristics by contact with lower and middle rocks.

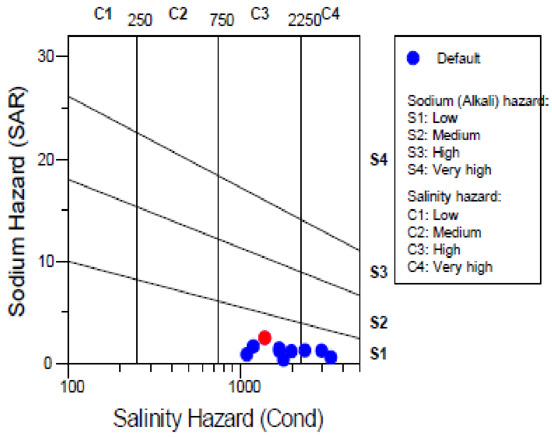

Figure 5: Salinity Hazard

The chemical characteristics of ground water of Rajam have been studied on the basis of chemical analysis. The pH values show that the water is of neutral in nature.

The concentration of Calcium and magnesium in 80% samples are below the prescribed limits (200 and 100 ppm respectively). Sodium and potassium found to be exceeding the limit (200 ppm and 10 ppm respectively) in 20% of the samples, majority of the water samples are exceeding the prescribed limits (600 ppm) of total hardness.

IV. CONCLUSION

- The ground water potentially varies depending on the thickness and depth of the fresh/massive rock. On the basis of present investigations the specific values inferred for the area are as follows
- The water bearing aquifer lies between 3.73 to 13.9 m with a resistivity varying from 10 to 17.5 ohm-m
- The resistivity of the highly fractured system are varying between 10 to 12.5 ohm-m with a varying thickness of 5.18 to 13.9 m
- The hard rock is occurring at a depth of 72 to 100 m, with resistivity values ranging from 75.5 to84.5 ohm-m
- The study has shown that the fluoride concentration exceeds the prescribed limit (1.5ppm) in three samples. Therefore wells which will fall above and below the range 0.6 to 1.5 ppm are not suitable for drinking purposes and need to apply suitable public health measures to bring the fluoride level within the range. The sulphate and chloride content of all the samples are below the prescribed range (400 and 1000 ppm respectively).
- The results of piper diagram have shown that, the majority of wells are falling under Ca+2, Mg+2, HCO3

V. REFERENCES

[1] "Determination of Lithology and Groundwater Quality Using Electrical Resistivity Survey", Muhammad Arshad1, J.M. Cheema And Shafique Ahmed.

[2] "Role of Electrical Resistivity Method for Groundwater Exploration in Hard Rock Areas: A Case Study from Fidiwo/Ajebo Areas of SouthwesternNigeria."Stephen O. Ariyo and Gabriel O. Adeyemi, Department of Earth Sciences and Geology, OlabisiOnabanjo University, Ago-Iwoye, Nigeria.

[3] "Applications of 1D and 2D Electrical Resistivity Methods to Map Aquifers in a Complex Geologic Terrain of Foursquare Camp, Ajebo, Southwestern Nigeria."

[4] Elijah AdebowaleAyolabi, Ph.D. Franklin Eleyinmi, B.Sc. and Esther O. Anuyah, B.Sc. Geophysics Program, Department of Physics, University of Lagos, Nigeria.

[5] Bureau of Indian standards, Doc. WRD03(457) August 2007, “Geophysical surveys for Hydrogeological studies”.

[6] "A new and faster algorithm for 1D VES data inversion called Recursive Ant Colony Optimization (RACO) "YogeshArora*1, Deepak Kumar Gupta1, Jai Prakash Gupta2 and Upendra K. Singh-Indian School of Mines (ISM), Dhanbad, India, 2-Indian Institute of Technology (IIT), Kharagpur, India.

[7] Bernstone, C. & Dahlin, T. (1996). 2D resistivity survey of old landfills. Proceeding of 2nd European Environmental and Engineering Geophysics Meeting, 188 – 191.

[8] Kelly, W.E. (1976). Geoelectric sounding for delineating groundwater contamination. Groundwater, 14, 16 – 10.

[9] Koefoed, O. (1979). Geosounding principles Resistivity sounding measurement. Amsterdam: Elsevier.