Geophysical Analysis for Deeper Groundwater Assets by using Resistivity Survey of Atal Nagar (Naya Raipur),Chhattisgarh, India

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Abstract: *:* Surface electrical resistivity surveys are focused on the theory that electrical resistivity and distribution of the surrounding soils and rocks depend on the distribution of electrical potential in the ground around a current-carrying electrode. Gradient Resistivity Profiling (GRP- 1 No.s) and Vertical Electrical Sounding (VES – 9 No.s) decipher the sub surface condition at the Nava Raipur District in formation of the time resistivity survey. For the survey, the Aqua Meter CRM-50 resistivity metre was used. Both profiling and sounding mode have been performed for the present analysis. The gradient approach for profiling has been carried out. Both the Schlumberger configuration and half the Schlumberger configuration were used for audio. 200 m (AB) for profiling and 240 m (AB) for sounding were the full spreads. By artificially energizing the subsurface and bringing measurements on the ground surface, electrical resistivity of sub-surface geological formation is calculated using Ohm's law. The contrast with the surrounding or effective presence (depending on its relative resistivity and thickness) of the resistivity value of an individual layer makes it observable. Raipur district is situated in the centre of the state of Chhattisgarh and is bounded by 81 ° 32'05 '& 82 ° 59'05" east longitudes and 19 ° 46 '35' & 21 ° 53'00' north latitudes (fig. 1) falling in the Survey of India topo sheets no 64G/12, G/16, 64H/9 & 64H/13, covering an area of 13446 sq.km. It is surrounded by the East Durg districts of Odisha State in the west, Bilaspur and Janjgir-Champa districts in the north, Raigarh and Mahasamund districts in the east. Atal Nagar (Naya Raipur) is one of Chhattisgarh's major townships, located about 17 km SE from the main town of Raipur, covering an area of about 80 square kilometres, or 8,000 hectares. It is located in Toposheet No. 64 G/12 & 64 G/16 between 21.161^0 North latitude and 81.787 ⁇ East longitude. It is part of the Chhattisgarh Super group.

Keywords: **Resistivity, Survey, Toposheet, GRP, VES, Hydrogeology, Schlumberger**

1. Introduction

In the method of electrical resistivity, a known amount of electrical current (I) is sent to the ground through a pair of electrodes (called current electrodes) and the potential (δV) produced due to the resistance provided by the subsurface is measured through another pair of electrodes (potential electrodes) planted into the ground due to the passage of this current. Depending on the spacing between the two current electrodes, the ratio between the measured potential and the corresponding current sent into the soil yields the resistance 'R' of the soil to a depth. A parameter called the apparent resistivity "ρa" is determined by multiplying this value of' R 'by ageometric factor. The knowledge on the geo-electric characteristics of the subsurface is found in both the apparent resistivity parameters ' "ρa" ' and the resistance 'R'. In practise, many configurations exist, but the Wenner and Schlumberger configurations are the most widely used. Resistivity profiling is a variation of the resistivity method in which an electrode configuration of the same dimensions is used to calculate the apparent resistivity at a number of evenly spaced identified places along a cross or profile. The current as well as potential electrode separations are held constant for all points in this form of profiling, which gives the data for approximately the same thickness of hydrogeological conditions of the subsurface. When geological formations have different resistivities in the horizontal direction, this approach is useful. Geologic formation can be distinguished on the basis of resistivity. By using various combinations of current and potential electrodes, resistivity profiling can be carried out. Wenner & gradient configurations have been used in this investigation.

2. Geological Setting

2.1 Regional Geology

Raipur is situated on the Raipur Group's Proterozoic Chandi Formation (Chhattisgarh Super Group), consisting of calcareous, shale and sandstone that is intrusive in places intruded by dolerite. Chandi Formation includes the horizontal to gently dipping member of Newari stromatolitic calcareous and Deodongar shale and sandstone. In nature, fractures, solution avities and sinkholes, exposed at Mahadevghat and Purena segment, the limestone is generally massive to thickly bedded, joined, and karstic. The calcareous rover of Deodongarmembe. The member of the Deondonger consists of khaki to purple coloured shale, intertwined with sandstone layers. Thinly laminated, light and impervious, the shales are. The ortho-quartzite sandstones with silica cement and ferruginous coating are lightweight, thin to thick beds. The sandstones are normally covered by lateritic soil and the shales are covered by soil and are bounded by 81 ° 32'05 '& 82 ° 59'05" east longitudes and 19 ° 46 '35' & 21 ° 53'00' north latitudes falling in the Survey of India topo-sheets no 64G/12, G/16, 64H/9 & 64H/13, covering an area of 13446 sq.km. It is surrounded by the East Durg districts of Odisha State in the west, Bilaspur and Janjgir-Champa districts in the north, Raigarh and Mahasamund districts in the east. Atal Nagar (Naya Raipur) is one of Chhattisgarh 's major townships, located about 17 km SE from the main town of Raipur, covering an area of about 80 square kilometres, or 8,000 hectares. It is between the northern latitude of 21.161 and the eastern longitude of 81.787. (Toposheet No. 64 G/12 & 64 G/16) (Fig. 1 Lositon Map), (Table 1: Straigraphy) It is part of the Super Group of Chhattisgarh..

2.2 Local Geology:

The region is underpinned by a thin alluvial layer belonging to the Quaternary period. The alluvial sediments are based on a dense pile of rocks belonging to the Raipur Younger Proterozoic group, consisting of limestone and sandstone. The distance is deep from a few centimetres to five metres between the joint plain and is often interconnected.

Age	Super group	Group	Formation	Lithology
QUATERNARY	Recent to sub-Recent		Alluvium and Laterite	Sand, Silt, Clay and lateritic Soil
PROTEROZOIC	Chhattisgarh Super group	Raipur Group	**Chandi Formation**	**Limestone, Sandstone & Shale**
			Gunderdehi Formation	Shale
			Charmuria Formation	Limestone & Shale
		Chandrapur Group	Kanspathar Formation	Sandstone, Siltstone, Shale & Conglomerate
			Choparadih Formation	
			Lohardi Formation	
ARCHAEAN	Basement crystallines- Granite, gneisses, granulite and Amphibolite			

Table 1. Generalized stratigraphic sequence of formation in the study area

(Lithostratigraphy as praposed by Murti 1987)

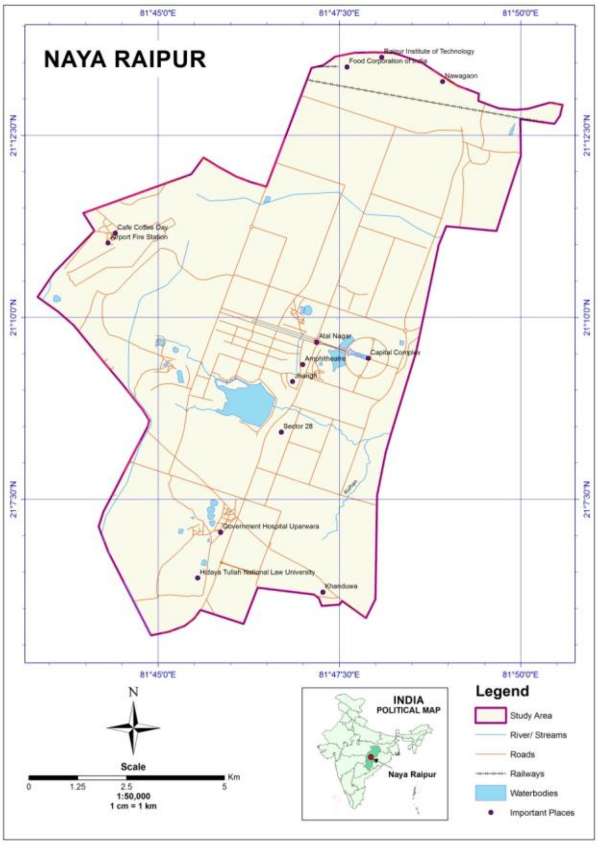


Figure 1. Location Map of study area

3. Methodology

Geophysical methods are useful in building an image of the hydrogeological conditions of the subsurface in fully untouched areas. It is based on calculating the electrical properties of the earth. The resistivity surveys were carried out in the current study using Aquameter CRM 500 (an indigenous resistivity metre based on microprocessors). The Aquameter CRM 500 is a high-power version (40Watt) that is useful for any form of soil specifically favoured for the coastal region's low-resistivity soil. It has more than 600 metres of penetration. Because of single button operation deeppenetration, accurate and consistent performance, even inadverse field conditions, it is a common instrument. The method has a self-potential calculation (SP) facility that is useful in mineral prospecting and environmental studies.

3.1 Data Analysis and Interpretation

In order to get the apparent resistivity values for each electrode spacing, the observed resistance values from the instrument have been multiplied with the geometric factor (K). The apparent resistivity values were plotted on log-log graph paper against the half-current electrode separation to get the VES curves (x axis AB/2 value and y axis apparent resistivity value). In order to obtain the VES curves (x axis AB/2 value and y axis apparent resistivity value), the apparent resistivity values were taken to the single typical potential dipole. Using software IPI2 WIN, these AB/2 and apparent resistivity data were interpreted by curve matching technique, the final result was corroborated with the knowledge of the hydrological conditions in the field.

4. Factor analysis

The method of factor analysis is used to classify fractures at depth in the hard rock region by performing VES. In this process, the apparent resistivity value for the same potential dipole (MN/2) value should be taken first and foremost. The ratio between the apparent resistivity value of that AB/2 and the sum of all the apparent resistivity values of all the previous AB/2 is the factor for any AB/2 value. If the total sum of the apparent resistivity value of a sound is in the total factor, n-1 will be the factor or the first AB/2 will be the factor. We may use the same factor value from the obtained factor values for two consecutive AB/2 readings to show the fracture zone at the respective depth. The estimated VES factor values are shown in the following table (Table No. 2) and Figure No. 2.

5. Result and Discussion

The Total Nine VES was performed using the resistivity metre at 9 different points in the same position at the Village-Tuta Aquameter CRM 500 VES. The Schlumberger and half Schlumberger configurations were used to perform the VES survey. For conducting VES, 240m(AB) was the maximum current electrode spread. On double logarithmic graph paper, to understand the true resistivity and thickness of different layers, the data is plotted and balanced with regular curves. The data is an IPI2 WIN programme interpreted by the computer to verify the results of partial curve matching. From the interpreted results of VES, Table 2 provides the resistivity and thickness of various layers.

VES-1 & 2:

For VES 1, the topmost layer with a resistivity value of 9.3 -m was used at this point for Schlumberger and half Schlumberger configuration, while the second layer can be weathered with resistivity of 18 Ω-m. The third layer may be broken limestone with a resistivity of 30 Ω-m, while massive limestone with a resistivity of 65 Ω-m may be the last layer. The thickness of the topmost layer was 1.7 m and the thickness of the second and third layers was 4.3 and 17.4 m, respectively.

VES-3:

Half the Schlumberger configuration was used for VES at this point. The topmost layer with a resistivity value of 8.6 Ω-m, while the second layer with a resistivity of 16.5 Ω-m may be weathered limestone. The third layer may be broken limestone with a resistivity of 60 Ω-m, while massive limestone with a resistivity of 140 Ω-m may be the last layer. The thickness of the topmost layer was 1.8 m and the thickness of the second layer and third layer was 7.5 and 30 m, respectively.

VES-4:

The Schlumberger configuration was used for VES at this stage. The topmost layer has a resistivity value of 10.8 m, while the second layer may be weathered with a resistivity of 8.3 m. The third layer may be broken with a resistivity of 60 m, while the last layer may have a huge resistivity of 90 m. The thickness of the topmost layer was 1.6 m and the thickness of the second layer and third layer was 4.6 and 22.6 m, respectively.

VES-5:

The Schlumberger configuration was used for VES at this stage. The topmost layer with a resistivity value of 9 m, while the second layer with a resistivity of 16 m may be weathered limestone. The third layer may be broken limestone with a resistivity of 38 m, while massive limestone with a resistivity of 95 m may be the last layer. The thickness of the topmost layer was 3 m and the thickness of the second layer and third layer were 7.6 and 22 m. Meanwhile,

VES-6:

The Schlumberger configuration was used for VES at this stage. The topmost layer with a resistivity value of 12.9-m, while the second layer with a resistivity of 18.2-m may be weathered limestone. The third layer may be broken limestone with a resistivity of 47.8 Ω-m, while massive limestone with a resistivity of 110 ?? -m may be the last layer. The thickness of the topmost layer was 1.8 m and 8 and 24.5 m were the thickness of the second layer and third layer. respectively, respectively.

VES-7:

The Schlumberger configureation was used for VES at this stage. The topmost layer with a resistivity value of 340 m, while the second layer can be weathered with a resistivity of 46 m. The third layer can be broken with a resistivity of 17 m, and the last layer can be huge limestone with a resistivity of 450 m. The thickness of the topmost layer was 2.8 m and the thickness of the second layer and third layer was 10.1 m and 25.1 m. respectively, respectively.

VES-8:

At this point, the Schlumberger configuration was used for VES, the topmost layer with a resistivity value of 31.6 m, while the second layer can be weathered with a resistivity of 101 m. Fractured limestone with a resistivity of 16.7 m may be the third layer and massive limestone with a resistivity of 60 m may be the last layer. The thickness of the topmost layer was 1.5 and the thickness of the second and third layers was 3.0 m. & 14.6 respectively, respectively.

VES-9:

The Schlumberger configuration was used for VES at this stage. The topmost layer with a resistivity value of 8.5 m, where limestone with a resistivity of 15.5 m may be weathered as the second layer. The third layer can be broken with a resistivity of 55 m, while the last layer can be massive limestone with a resistivity of 115 m. The thickness of the topmost layer was 3.2 m and the thickness of the second layer and third layer was 8.5 and 21.5 m respectively.

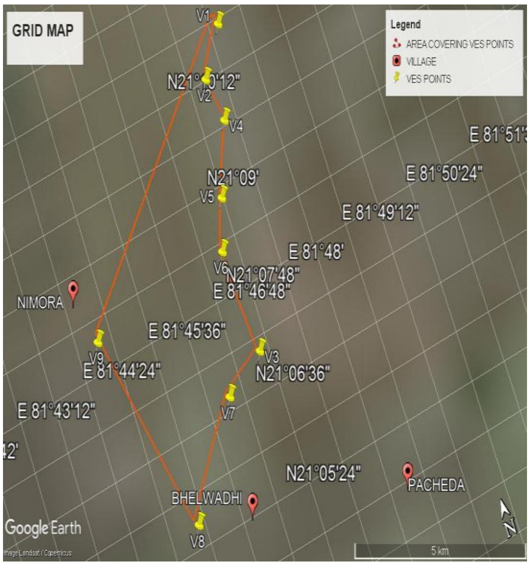


Figure 2. VES polygon showing all the points

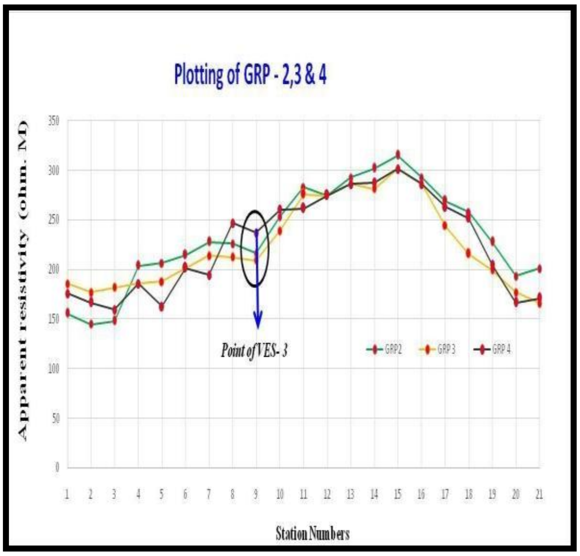


Figure 3. Plotting of GPR-2,3 & 4 field curves

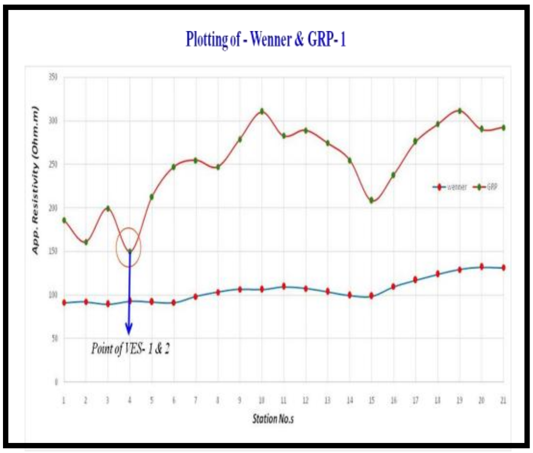
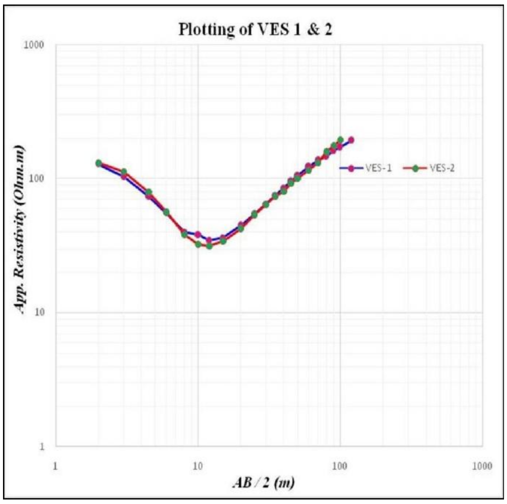


Figure 4. Plotting of Werner and GPR-1 field curves



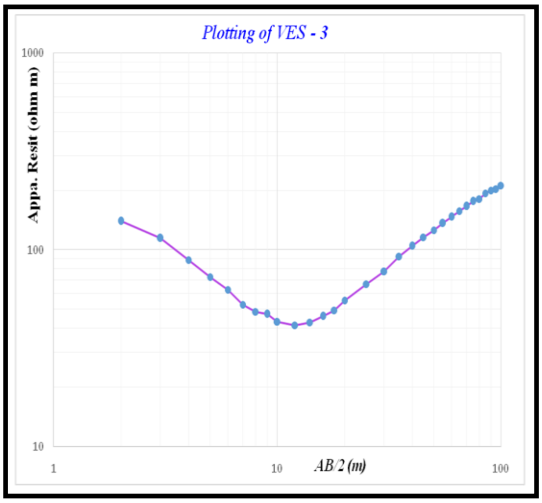


Figure 5 and 6 Plotting of VES 1, 2 & 3 fiels curves

Sounding No.	ρ1 (Ω-m)	ρ2 (Ω-m)	ρ3 (Ω-m)	ρ4 (Ω-m)	h1 mts.	h2 mts.	h3 mts.	Probable Fracture Zone (m)
VES-1 &2	9.3	18	30	65	1.7	4.3	17.4	25-30 & 60-65
VES-3	8.6	16.5	60	140	1.8	7.5	30.0	35-40, 80-85 & 110-120
VES-4	10.8	8.3	60	90	1.6	4.6	22.6	20-30,40-45 & 95-110
VES-5	9	16	38	95	3.0	7.6	22.0	25-30,45-50 & 90-100
VES-6	12.9	18.2	47.8	110	1.8	8.0	24.5	30-35, 70-75 & 95-100
VES-7	340	46	17	450	2.8	10.1	25.1	
VES-8	31.6	101	16.7	60	1.5	3.03	14.6	
VES-9	8.5	15.5	55	115	3.2	8.5	21.5	

Table 2 Interpreted parameter of VES 1, 2 & 3

6. Conclusion

From the interpretation of resistivity survey we got the following outcome :

The thickness of topsoil varies from 1.5 meter to 3.0 meters with resistivity range from140 Ω-m to 158Ω-m.

The thickness of weathered formation varies from 9.21 meter to 11 meters and the range is 21.7 Ω-m to 33.4Ω-m.

Third layer mostly indicates fracture zones and the thickness of this layer varies from 5 meters to 9.13 meters and resistivity range is 128 Ω-m to 350Ω-m.

The last layer is massive formation which shows high electrical resistivity with the range of 883 Ω-m to 973Ω-m..

Acknowledgments

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7. References

7.1.1. Journal Article

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