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HYDROGEOPHYSICAL EXPLORATION STUDIES IN PERIYAPATNA TALUK, MYSORE DISTRICT, KARNATAKA, INDIA.

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ABSTRACT

Geophysical exploration studies an essential role in understanding the earth subsurface groundwater conditions and natural process and its evaluation of the area. Periyapatna taluk is concerned with the major units of geomorphological and geological woks together and combination of knowledge base detailed work carried out and rectification to identify the groundwater potential zones to apply for electrical resistivity work into the ground As a result groundwater investigation has assumed top priority in recent years. Groundwater is usually held within porous soils or rock materials. People all around the world face serious water shortage because of the over exploitation of groundwater for domestic, industrial and agricultural purposes. Geophysics is highly helpful in assessing the groundwater potentiality of geological formations, estimated weathered zone thickness and bedrock topography, fractures in hard rock terrain. Geophysical study in groundwater investigation involves two stages: one in deep exploration and two shallow explorations. In deeper exploration, the exploring depths beyond the weathered zone of 100 or 200 m thickness in hard rock's where as in shallow exploration, the exploring depth is 20 to 30 m thickness.

KEYWORDS: Geomorphological, Electrical, Bedrock topography, Groundwater investigations.

1. INTRODUCTION

Water is the important component of the development of any area. The human settlement depends on a large extent on the availability of water resources. In the recent years, the consumption of water is greatly increased due to the increase in human population in the study area. Groundwater is simply water that occurs in the ground; in the pore spaces between mineral grains or in weathering, cracks and fractures in the rock mass. It is usually formed by rain water or snow melt water that sweeps down through the soil into the underlying rocks. Crystalline bedrocks, and the igneous rocks as granite and metamorphic rocks, such as, gneisses, schist, and quartzite, where the inter-granular pore-spaces are negligible and where almost all groundwater flow takes place through weathering, cracks and fractures in the rocks. The formation of the study area was accompanied by tectonic movement as fractures, joints, faulting, folds, and veins. Generally, structures play different roles in ground water quantity and quality, and variations. Collection of this information gives a rather clear picture of the subsurface geology, leading to a better understanding of various water bearing formation and distributions. Structures as hydrodynamic contacts impact on the groundwater flow pattern of an aquifer, as well as, the major structural features impacting on groundwater are fractures and folds.

2. Study Area

The study area is bounded in the north by Hassan district, in the south by Hunsur taluk, in the east by K.R.Nagar taluk and in the west by Kodagu district. Periyapatna is located at $75^{0}24^{'}00^{''}$E -$76^{0}30^{'}00^{''}$E Latitude and $11^{0}48^{'}00^{''}$N -$12^{0}36^{'}00^{''}$N Longitude with the geographical area extent of 815 km^2 covering 203 villages, (one town four Hoblies, 26 Gram panchayaths) comes under the Survey of India (SOI) toposheets nos. 57D/2, 57D/3, 57D/4, 48P/14, 48P/15, on a scale of 1:50,000. Periyapatna taluk is one of the 7 taluks of Mysuru district. Periyapatana is located at a distance of 185 Kms from Bangalore and 55 kms from the Mysuru district. It comes under the semi-arid region and good motorable road and is very well connected by Mysuru to Periyapatna and also main road of Madacare, Mangalore (**Figure 1**). A southern railway broad gauge line connects the headquarters passing through the eastern part of the study area**.** The study area falls in southern dry –agro-climatic zone (VI). The main occupation of the people in the study area depends on agriculture. The mean maximum temperature is 34°C and the mean minimum temperature is 16°C. The average annual rainfall of as recorded at Periyapatna rain gauge station has 854mm, later it has become erratic resulting in drought- prone conditions. The annual precipitation in the hydrogeological area varies from 700 mm to 810 mm. There are two rainy seasons; the long rains from March to June and a minor raining period in November and December.

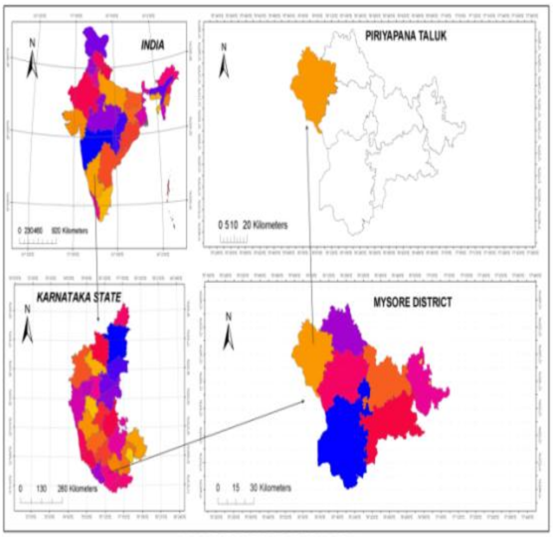

Fig. 1: Location of the Study area.

3. Geology of the area

Peninsular gneiss is grey to pink granitic gneisses and the strike of lineation in gneisses. Peninsular gneisses exposes direction of which is NW-SE with a dip towards NE, and schistose occur as an enclave within this formation. These rocks strike N10^{0}E-S10^{0}W to N30^{0}E - S30^{0}W with varying eastern dips about 60^0 to 80^0**.** Hornblende gneiss is amphibolites group of rocks. It is mainly composed of amphibole and plagioclase feldspars with little or no quartz. The physical properties of hornblende gneiss are dark grey to green in colour, heavy and weakly foliated of schistose (Flaky) structure. Amphibolite schist rocks are well exposed in the areas of sulekote, kambipura, honnapura, ambalgere. The mineral composition of amphibolite is a mixture of four molecules such as calcium, iron, magnesium and silicate. Charnockite is the blue quartz-hypersthene bearing granular suite of rocks. It is also known as Pyroxene granulite. Charnockite type of rock formations are well exposed near Muttur colony, Dodda hosur, Navalur and Beguru. Migmatites, granodiorite tonolites are well exposed and found in near Vaddarahalli hosahalli, Sal koppalu, Bylakuppe, Kodihalli and Periyapatna all most all entire part of the study area. Dolerite dykes are familier of Mysuru and Chamarajanagar district and wide spread formation of in chamarajanagar taluk but in particular study area is few of places them found near Magali, Narrlapura and Belaturu. Dolerite dykes is exploitation of commercial decorative rock type and it is also known as “Black Granite’’. But area is no quarries in commercially, They are mainly trend in the direction of NW-SE, but some also trend in different directions. Dykes are normally playing an important role in groundwater movement and storage. The upstream of the dyke normally is the storage of good amount of water, while the downstream of the dykes are the poorer storage of groundwater (**Figure 2 and Table. 1**).

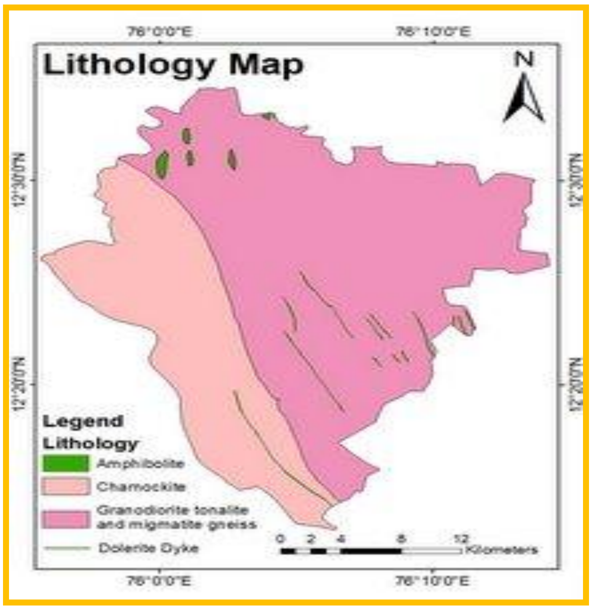

Fig. 2: Lithology of the Study area.

Table 1: Statistics of different lithological units of Periyapatna Taluk.

Lithology	Area (Sq. km.)	Percentage of area
Amphibolite	5.32	0.65
Charnockite	235.06	28.84
Granodiorite tonalite and migmatite gneiss	572.42	70.25
Dolerite Dyke	2.20	0.26
Total	**815.00**	**100.00**

4. Method and interpretation of VES data

Different types of electrical methods are commonly employed to deal with various geological problems. The majority of the groundwater problems to be solved by using the Vertical Electrical Sounding (VES) that has been conducted in 20 villages in and around Periyapatna taluk using Aquameter CRM-20 (Computerized Resistivity Meter) (**Figure 3**) employing Schlumberger electrode arrangements with AB/2 spacing range 100mts depth. It has been chosen because of its high efficiency for groundwater exploration. This Schlumberger configuration is characterized by following up the vertical variations in the subsurface layers in each VES, together with horizontal variations through compiling and correlating the measured VES's along geoelectrical profiling. During the field survey, the apparent resistivity's obtained for different electrode spacing is recorded. These apparent resistivities are plotted against current electrode spacing using IPI2 WIN software to get the field curves (**Figure 6**). The field curves are interpreted from curve matching technique. The vertical electrical field data are interpreted both qualitatively and quantitatively using simple curve shapes, semi quantitatively with graphical model curves and quantitatively with computer modeling. The field data from shorter separation tend to be more reliable than those with large separation. Various techniques of qualitative and quantitative interpretation are described by Zohdy et al. (1974); Patangay and Murali (1984) and Akos Gyulai and Tamas Ormos (1999).

4. Qualitative Interpretation

Qualitative interpretation of VES is done by analyzing the isoapparent resistivity maps, the simplest sounding curve are ascending and descending types. An ascending type curve ($\rho_{1,}\rho_2$), a compact top layer is underlain by a thick clay layer or saline water aquifer and is called conductive basement. 'A' type curve is obtained in typical hard rock terrain having a thin conductive top soil. 'Q' types are usually obtained in coastal areas where saline waters predominate or obtained along shear zones. 'H' type curves are obtained generally in hard rock terrain consisting of dry top soil of high resistivity followed by either a water saturated or weathered layer of low resistivity and then a compact hard rock of very high resistivity. The 'K' types are characteristic of basaltic areas, where compact and massive traps exist between top black cotton soil and bottom vesicular basalt. In coastal areas also these types of curves will be encountered due to the fresh water aquifer occurring in between clayey at the top and a saline zone in the bottom.

5. Quantitative interpretation

The VES curves are quantitatively interpreted by analytical and empirical methods. The two geological parameters obtained through quantitative methods are resistivity (ρ) and thickness (h) of layer. In the analytical methods, the curve matching technique is adopted. The observed sounding curve (field curve) is prepared to the same modulus as that of a set of theoretical master type curve of apparent resistivity calculated for horizontal, isotropic and homogenous earth layers for various combinations of thickness and resistivity (Orellana and Mooney, 1966; Bhattacharya and Patra, 1968; Zohdy et al. 1974; Rijikswaterstaat, 1975 etc). The field curve and master curve is then matched and the best fit position, the thickness, resistivity of the first layer is read from the master curve. The thickness and the resistivity of the second, third and fourth layer, as the case may be, are determined from the ρ_2/ρ_1, ρ_3/ρ_l, ρ_4/ρ_1 and h_2/h_l, h_3/h_l ratios given on the master curve interpretations are reliable to go away if field conditions do not conform to the assumption that form the basis for the preparation of the master curve. Different layers having different resistivity and thickness may produce same electrical field distribution on the surface. This phenomenon is known as equivalence of layers. For this reason a perfect match of data plots with the same master curve does not necessarily mean that the parameter determined are unique (Karanth, 1994).

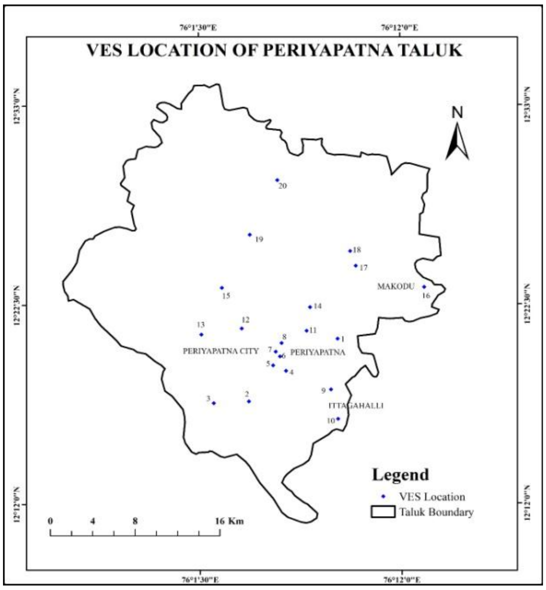

Fig. 3: VES location of the study area.

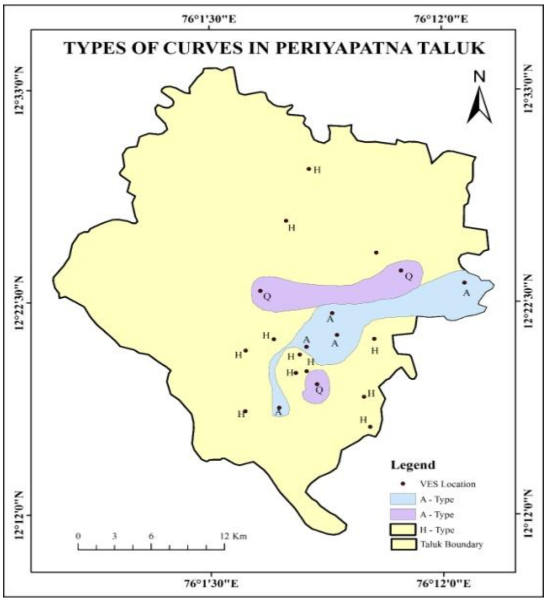

Fig. 4: Types of Curves.

Table 2: Curves Types.

Curve Types	No. of sites
A	5
K	0
H	12
Q	3
Total	**20**

6. RESULT AND DISCUSSION

Electrical Resistivity method is very useful tool to investigate the formations of the subsurface to determine their in divergence of resistance to flow of electrical current and hence determine the occurrence of groundwater. The present study area was conduct 20 VES location out this were found 5 ‘A’ type Curve because of high resistivity it indicate that hard rock terrain. 12 ‘H’ type of curve and 3 ‘Q’ type of curve both of this indicate low resistivity value given Table 2 and figure 4. The resistivity values obtained from the interpretation in the study area is given in the Table 3. Out of 20 VES interpretation, 3 location were shown in 5 layer strata, 7 location were shown in 4 layer strata and 10 location were shown in 3 layer strata. The resistivity value of First and Second layers are varied from < 20m thickness > 20m thickness, with respective thickness of layers are varied from 0.617 m to 9.98 m and 0.341 m to 14.5 m respectively. In first layer the high resistivity value observed in VES location 17 and low resistivity value observed in VES location 02. In Second layer the high resistivity value observed in VES location 5 and low resistivity value observed in VES location 2. In Third layer the high resistivity value observed in VES location 2 and low resistivity value observed in VES location 14. In fourth layer the high resistivity value observed in VES location 13 and low resistivity value observed in VES location 15.The study area has identified with two sets of lineament pattern in NW-SE and NE-SW directions. NW-SE pattern density and length of lineaments are observed comparatively high in the study area. NW-SE pattern of lineaments observed in western and southwestern part. In the eastern part of the study area observed with NE-SW pattern of lineament. The river also running on the lineament course of the study area (Figure 5).

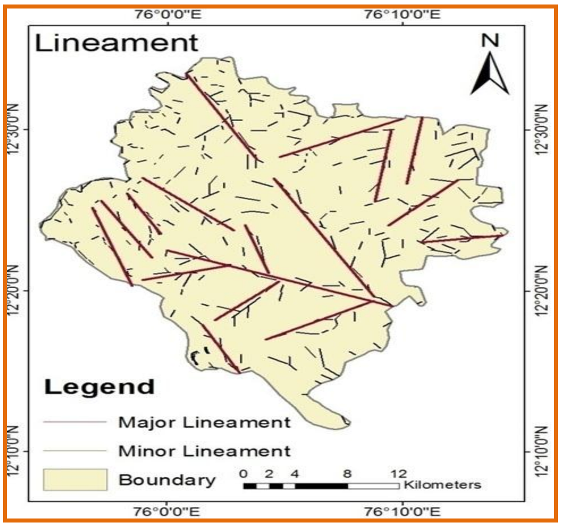

Fig. 5: lineaments of the Study area.

7. Electrical Resistivity Surveying (ERS)

In this study, twenty vertical electrical soundings were conducted to conclude a subsurface resistivity model for assessing the availability of groundwater in the area. The field work included the measurement of vertical electrical soundings using Aquameter. This is through applying the Schlumberger configuration. It has been chosen because of its high efficiency for groundwater exploration.

(i) The first geoelectrical layer

It is a layer of surface gravel, sand, silt and rock fragments, with a significant increase of silt and vary in electrical resistivity of around 15 ohm m at the bottom of this horizon (due to the increasing water content) to about 5169 ohm m in the upper parts of this layer. This is with a thickness that ranges from 6 meters to about 25 meters. The general resistivity values of this layer indicate that they are dry, in general, towards the top.

(ii) The second geoelectrical layer

Is a layer with relatively higher resistivity of about 231 ohm m (due to the effect of the upper silty layer) and also is affected by some erosional factors and reached resistivity values of more than 11000 ohm m; downwards. Originally, it is a unit of hard rock consisting of basement rocks and metamorphosed sedimentary rocks. And the depth of this horizon is starting from the depths of above 25 meters in and around some places of the study area. Fig. 7 shows the field curves and the calculated curves of these VES's along this profile. Four electrical layers in the First, second and third locations were found with different true resistivities and thicknesses as shown in (**Fig7.5, 7.6 and 7.7**).

The upper surgical part of the geological section in this area belongs to the Quaternary age and consists of Wadi deposits of gravel, sand with rock fragments followed by sand and silt intercalations. While the lower part represented the Precambrian Era composes of fractured metasediments followed downwards by hard basement rocks.

Table 3: Field Geophysical Data.

Sl. No.	Name of the Location	Resistivity ((Ωm)					Thickness of layers(m)					Curve Type
		ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	h_1	h_2	h_3	h_4	h_5	
1	Basalapura	1364	353	49.8	4958	11.2	1.88	6.11	5.81	13.9	0	H
2	Lakshmipura	8.14	1.3	14892	0	0	0.617	0.794	0	0	0	A
3	Kogilwadi	113	10.4	599	0	0	1.9	2.27	0	0	0	H
4	Ankanahalli	3736	994	26.1	19068	0	0.775	11.4	9.31	0	0	Q
5	Parekoppalu	969	6323	9.71	5175	0	1.26	1.42	7.31	0	0	H
6	Periyapatna	5882	1895	17.3	2722	0	0.97	5.08	17.5	0	0	H
7	Periyapatna City	84	10.6	171	0	0	2.04	1.33	0	0	0	H
8	Krishnapura	57.2	3.13	404	0	0	0.768	0.341	0	0	0	A
9	Sathyagala	102	20	283	0	0	0.99	3.18	0	0	0	H
10	Ittagahalli	143	14.6	4321	0	0	0.959	14.5	0	0	0	H
11	Mallahalli	49.6	396	0	0	0	4.44	0	0	0	0	A
12	Belathuru	221	12.3	10697	0	0	9.98	9.66	0	0	0	H
13	Chittenahalli	562	425	56.9	22547	0	1.77	6.01	18.5	0	0	H
14	Kagundi	17	79.4	6.77	34.3	1970	0.894	0.453	1.36	17.7	0	A
15	Neralakuppe	1821	211	1069	12.3	225	0.798	0.799	2.86	1.45	0	Q
16	Makode	111	16.1	142	1515	0	0.896	1.15	32.7	0	0	A
17	Dorekere	15203	3957	231	0	0	0.859	13	0	0	0	Q
18	Nilangala	393	87.6	28.7	6178	0	1.49	8.59	43.8	0	0	H
19	Joganahalli	566	235	26.8	918	0	0.777	4.74	4.44	0	0	H
20	Gurahalli	303	32	287	0	0	2.12	6.55	0	0	0	H

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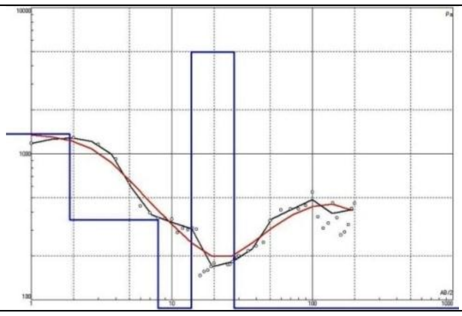
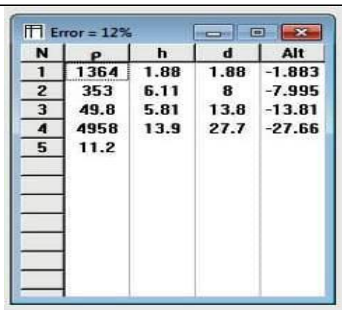
<tr><td>1</td><td>Basalapura</td><td></td><td>
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N	ρ	h	d	Alt
1	1364	1.88	1.88	-1.883
2	353	6.11	8	-7.995
3	49.8	5.81	13.8	-13.81
4	4958	13.9	27.7	-27.66
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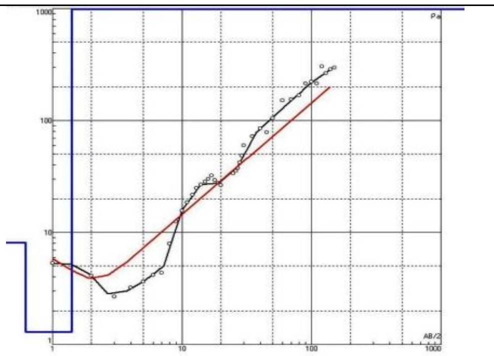
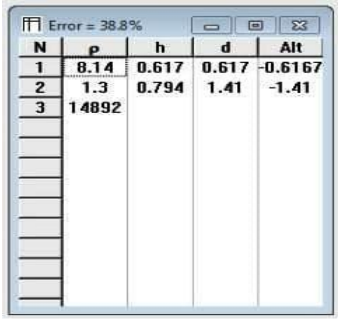
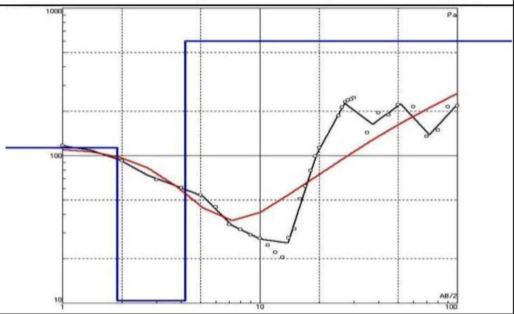
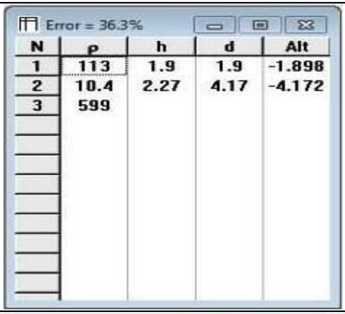
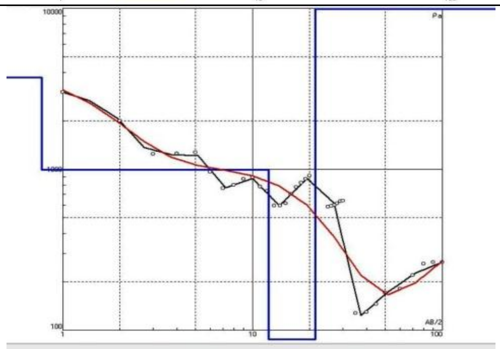
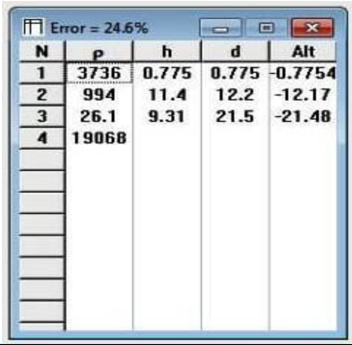
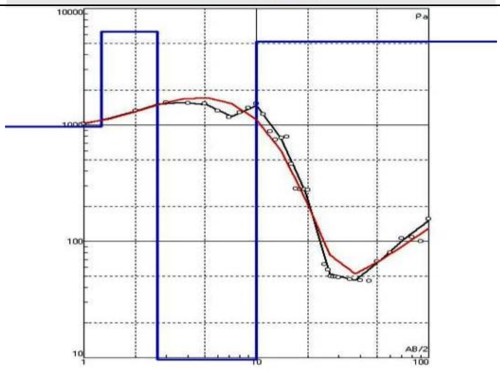
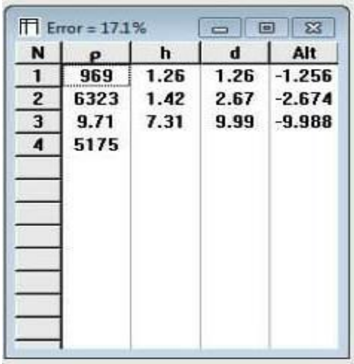
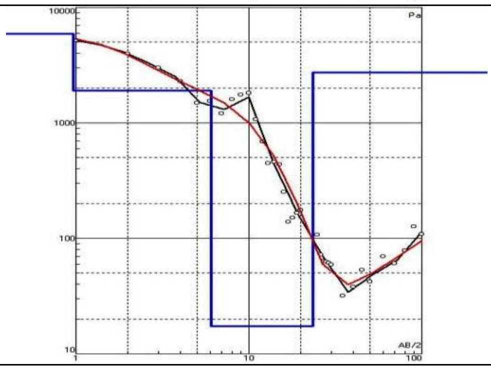
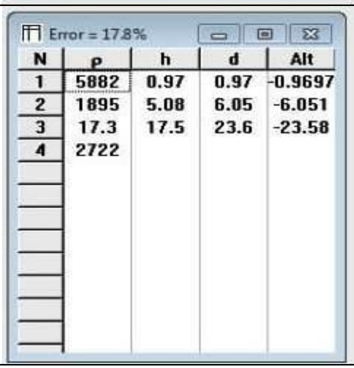
2	Lakshmipura		 Error = 38.8% N | ρ | h | d | Alt 1 | 8.14 | 0.617 | 0.617 | -0.6167 2 | 1.3 | 0.794 | 1.41 | -1.41 3 | 14892
3	Kogilwadi		 Error = 36.3% N | ρ | h | d | Alt 1 | 113 | 1.9 | 1.9 | -1.898 2 | 10.4 | 2.27 | 4.17 | -4.172 3 | 599
4	Ankanahalli		 Error = 24.6% N | ρ | h | d | Alt 1 | 3736 | 0.775 | 0.775 | -0.7754 2 | 994 | 11.4 | 12.2 | -12.17 3 | 26.1 | 9.31 | 21.5 | -21.48 4 | 19068
5	Parekoppalu		 Error = 17.1% N | ρ | h | d | Alt 1 | 969 | 1.26 | 1.26 | -1.256 2 | 6323 | 1.42 | 2.67 | -2.674 3 | 9.71 | 7.31 | 9.99 | -9.988 4 | 5175
6	Periyapatna		 Error = 17.8% N | ρ | h | d | Alt 1 | 5882 | 0.97 | 0.97 | -0.9697 2 | 1895 | 5.08 | 6.05 | -6.051 3 | 17.3 | 17.5 | 23.6 | -23.58 4 | 2722

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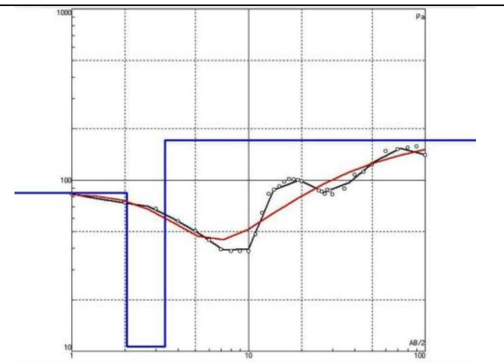
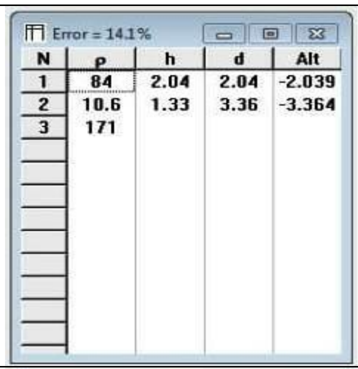
<tr><td>7</td><td>Periyapatna City</td><td></td><td>
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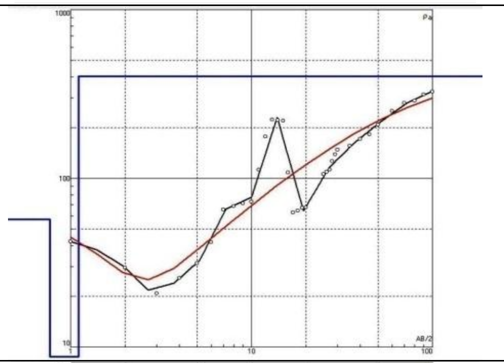
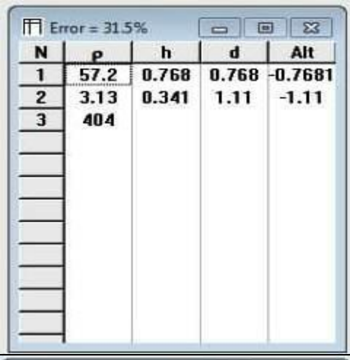
<tr><td>8</td><td>Krishnapura</td><td></td><td>
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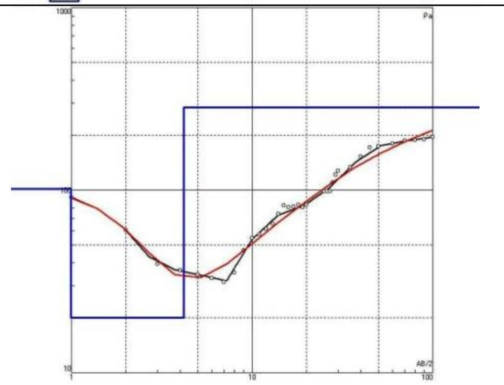
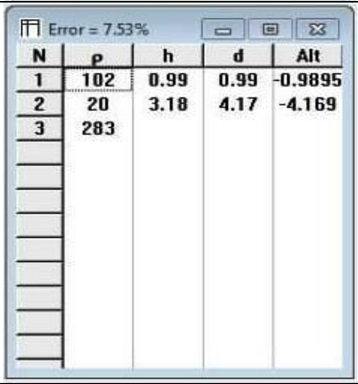
<tr><td>9</td><td>Sathyagala</td><td></td><td>
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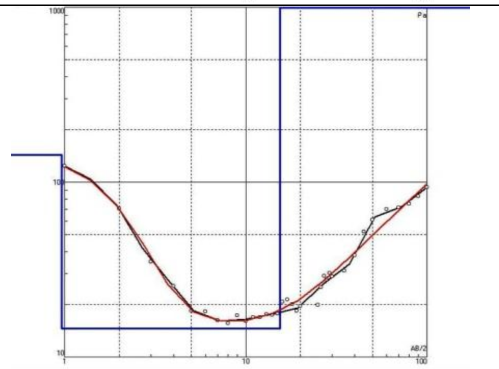
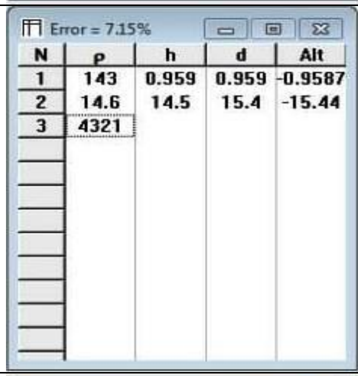
<tr><td>10</td><td>Ittagahalli</td><td></td><td>
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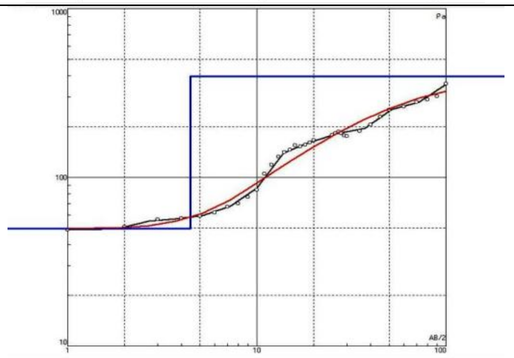
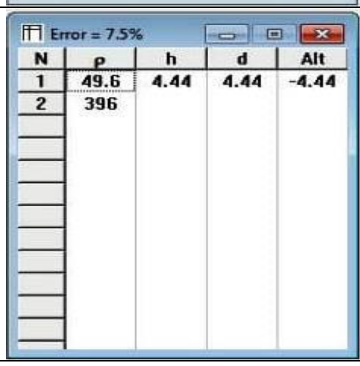
<tr><td>11</td><td>Mallahalli</td><td></td><td>
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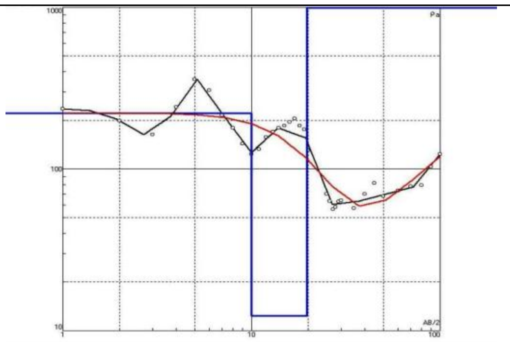
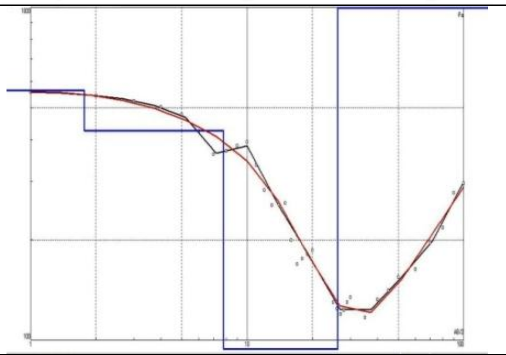
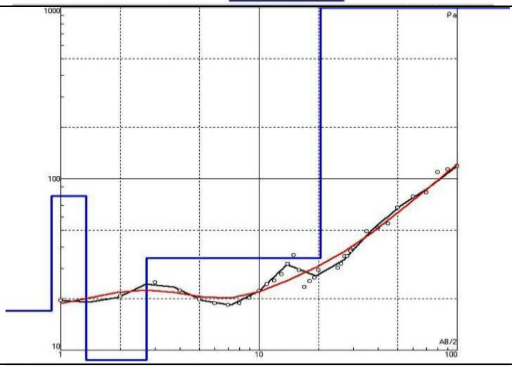
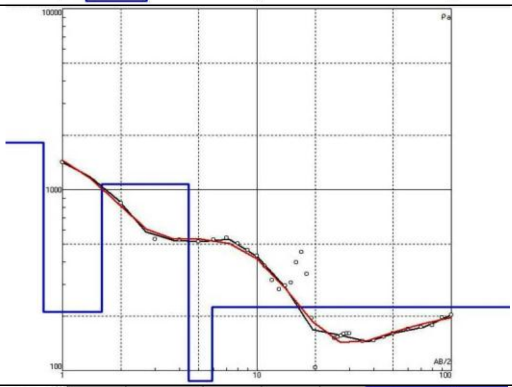
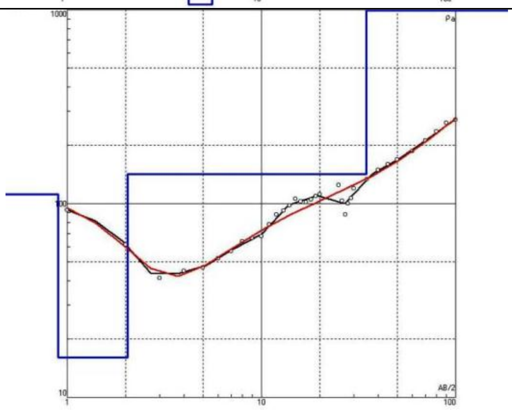
<tr><td>12</td><td>Belathuru</td><td></td><td>Error = 21.8%<table><tr><th>N</th><th>ρ</th><th>h</th><th>d</th><th>Alt</th></tr><tr><td>1</td><td>221</td><td>9.98</td><td>9.98</td><td>-9.975</td></tr><tr><td>2</td><td>12.3</td><td>9.66</td><td>19.6</td><td>-19.64</td></tr><tr><td>3</td><td>10697</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>13</td><td>Chittenahalli</td><td></td><td>Error = 4.59%<table><tr><th>N</th><th>ρ</th><th>h</th><th>d</th><th>Alt</th></tr><tr><td>1</td><td>562</td><td>1.77</td><td>1.77</td><td>-1.767</td></tr><tr><td>2</td><td>425</td><td>6.01</td><td>7.77</td><td>-7.773</td></tr><tr><td>3</td><td>56.9</td><td>18.5</td><td>26.2</td><td>-26.22</td></tr><tr><td>4</td><td>22547</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>14</td><td>Kagundi</td><td></td><td>Error = 8.55%<table><tr><th>N</th><th>ρ</th><th>h</th><th>d</th><th>Alt</th></tr><tr><td>1</td><td>17</td><td>0.894</td><td>0.894</td><td>-0.8937</td></tr><tr><td>2</td><td>79.4</td><td>0.453</td><td>1.35</td><td>-1.346</td></tr><tr><td>3</td><td>6.77</td><td>1.36</td><td>2.71</td><td>-2.708</td></tr><tr><td>4</td><td>34.3</td><td>17.7</td><td>20.4</td><td>-20.4</td></tr><tr><td>5</td><td>1970</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>15</td><td>Neralakuppe</td><td></td><td>Error = 4.6%<table><tr><th>N</th><th>ρ</th><th>h</th><th>d</th><th>Alt</th></tr><tr><td>1</td><td>1821</td><td>0.798</td><td>0.798</td><td>-0.7983</td></tr><tr><td>2</td><td>211</td><td>0.799</td><td>1.6</td><td>-1.597</td></tr><tr><td>3</td><td>1069</td><td>2.86</td><td>4.46</td><td>-4.462</td></tr><tr><td>4</td><td>12.3</td><td>1.45</td><td>5.91</td><td>-5.913</td></tr><tr><td>5</td><td>225</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>16</td><td>Makode</td><td></td><td>Error = 6.22%<table><tr><th>N</th><th>ρ</th><th>h</th><th>d</th><th>Alt</th></tr><tr><td>1</td><td>111</td><td>0.896</td><td>0.896</td><td>-0.8963</td></tr><tr><td>2</td><td>16.1</td><td>1.15</td><td>2.05</td><td>-2.05</td></tr><tr><td>3</td><td>142</td><td>32.7</td><td>34.7</td><td>-34.71</td></tr><tr><td>4</td><td>1515</td><td></td><td></td><td></td></tr></table></td></tr>
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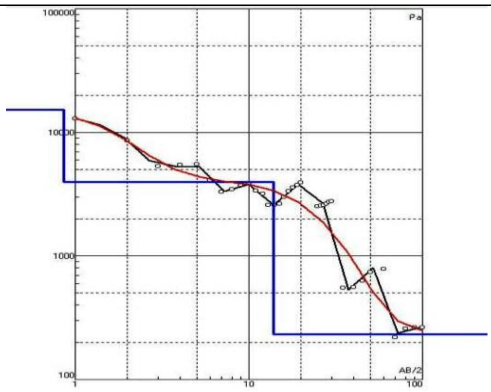
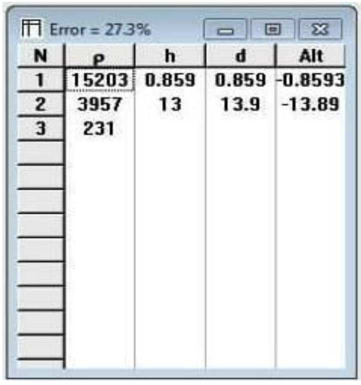
<tr><td>17</td><td>Dorekere</td><td></td><td>
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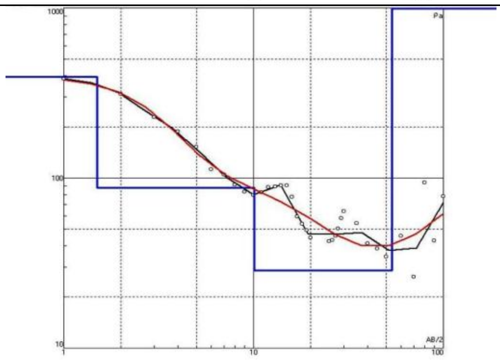
<tr><td>18</td><td>Nilangala</td><td></td><td>
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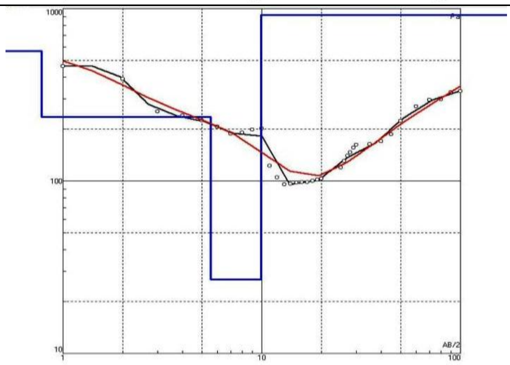
<tr><td>19</td><td>Joganahalli</td><td></td><td>
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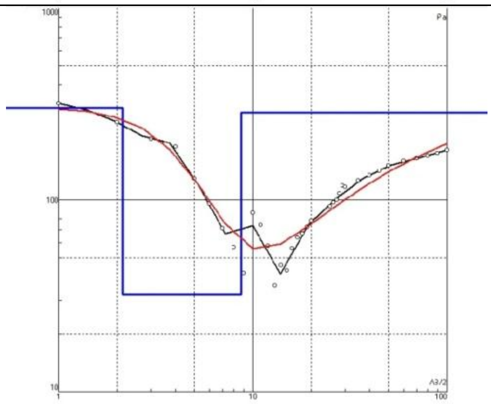
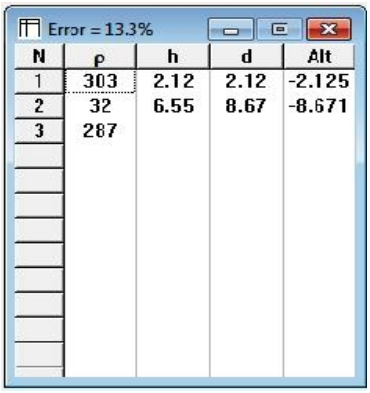
<tr><td>20</td><td>Gurahalli</td><td></td><td>
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Fig. 6: Automated Fit of Ves Curves in Periyapatna Taluk.

Figure 7: Interpretations of Vertical Electrical Sounding Field Curves.

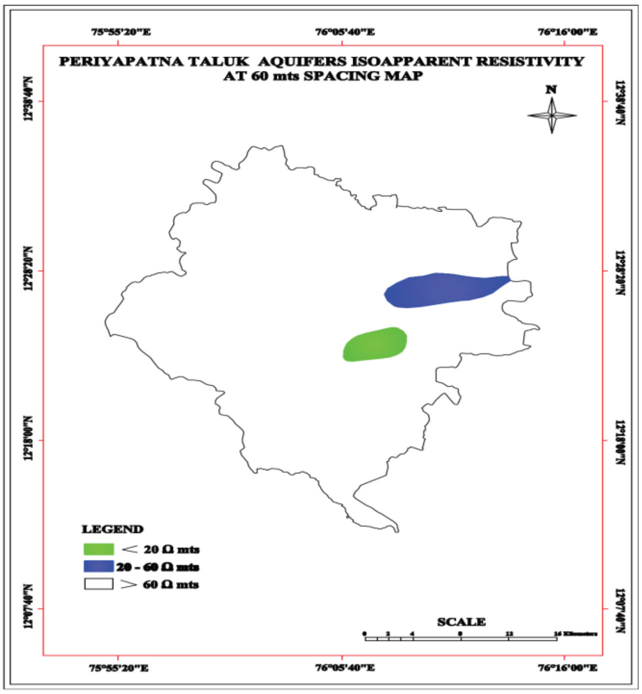

Fig. 7.1: Iso apparent resistivity at 20mts Spacing.

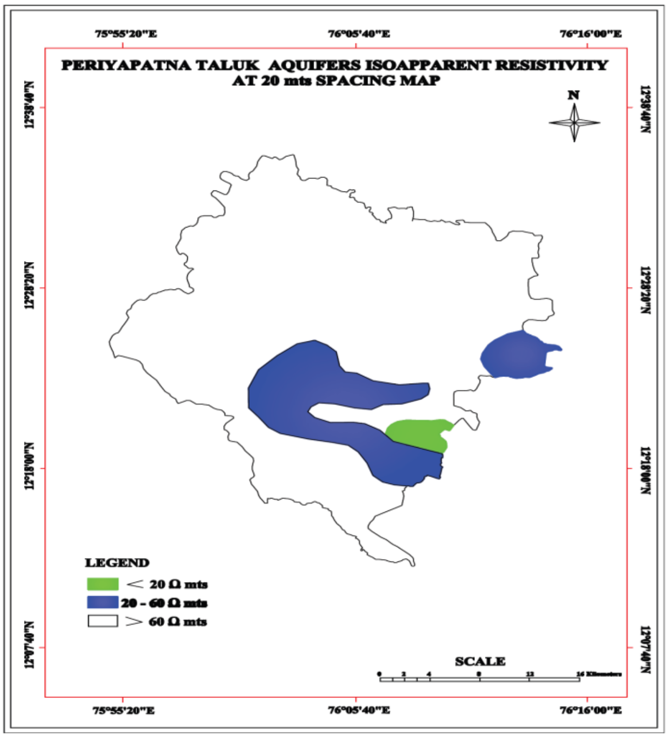

Fig. 7.2: Iso apparent resistivity 45 mts Spacing.

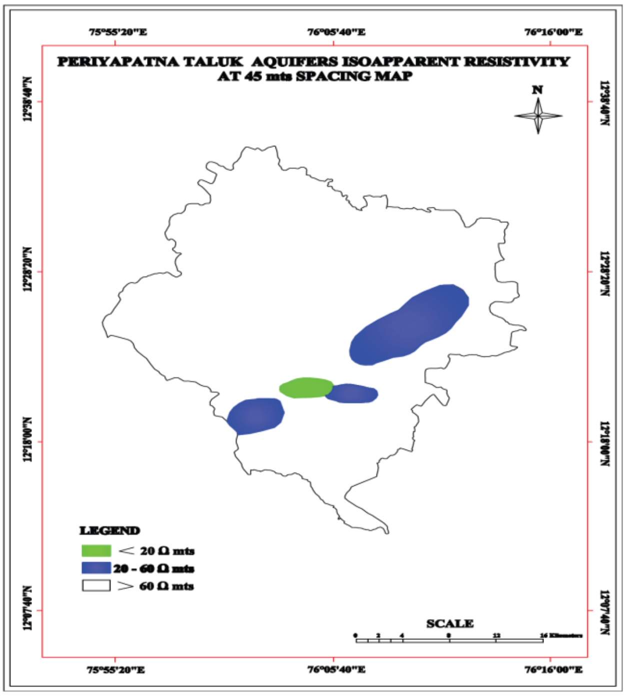

Fig. 7.3: Iso apparent resistivity at 60mts Spacing.

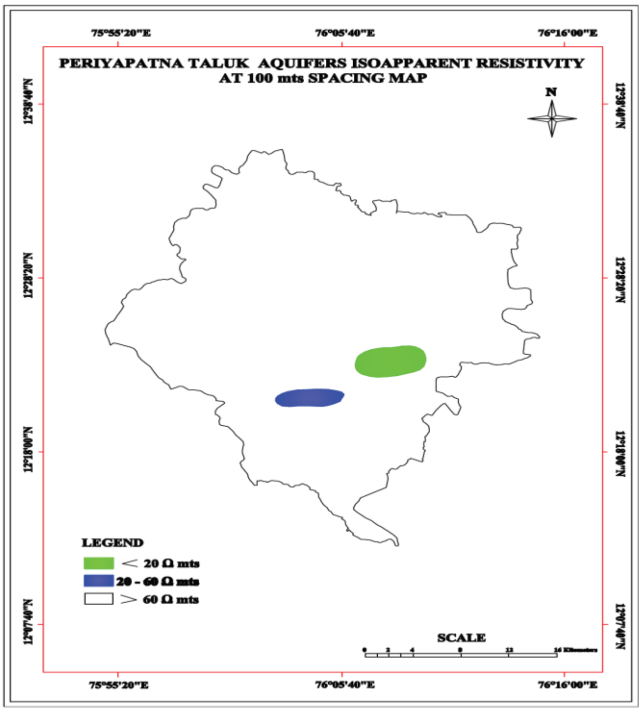

Fig. 7.4: Iso apparent resistivity 100 mts Spacing.

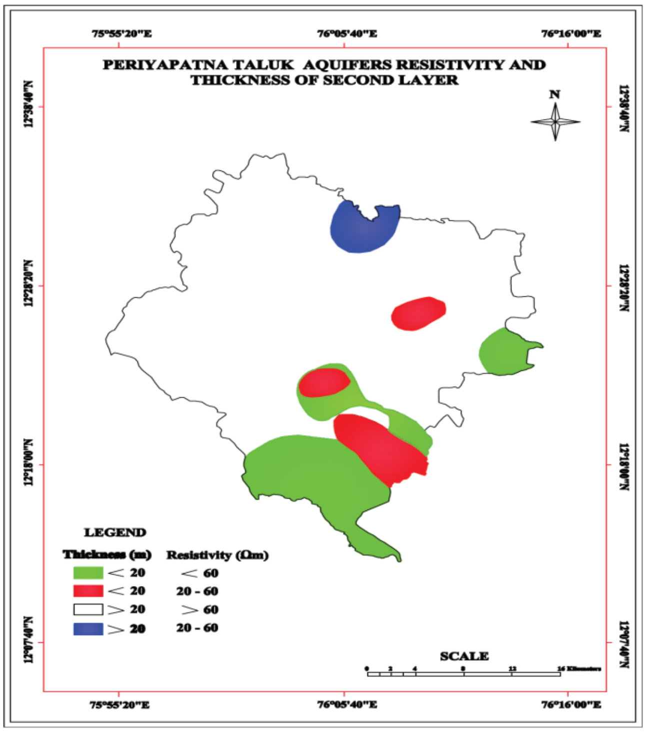

Fig 7.5: Aquifers resistivity and thickness of First Layer

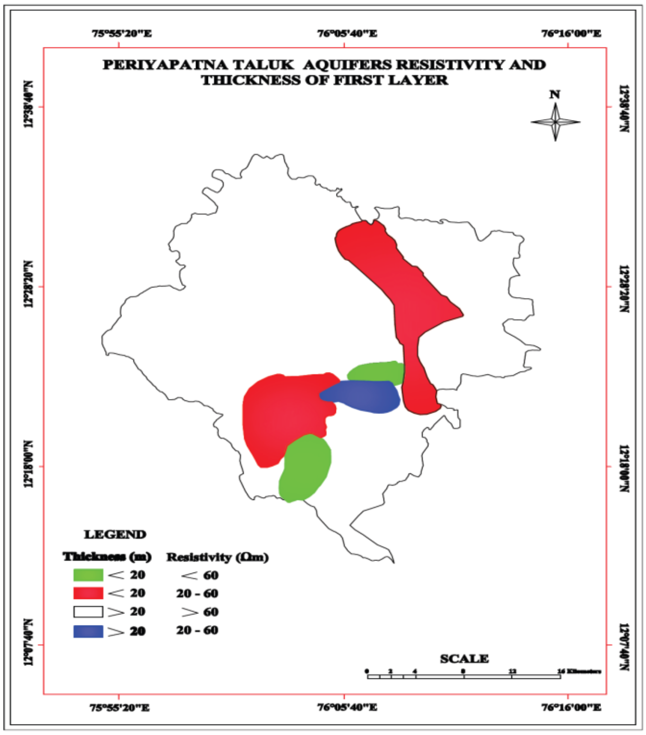

Fig 7.6: Aquifers resistivity and thickness of Second Layer

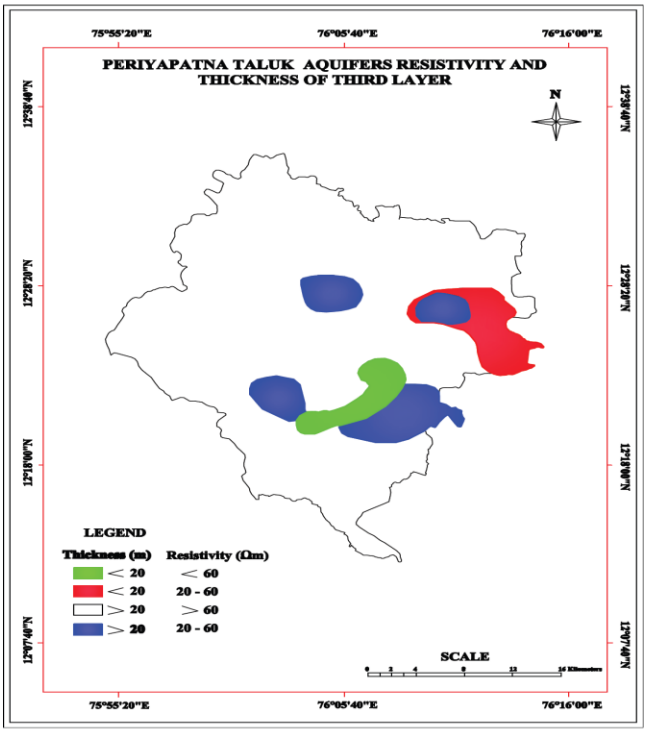

Fig. 7.7: Aquifers resistivity and thickness of Third Layer.

CONCLUSIONS

Several geological, hydrogeological and geophysical methods are employed to target the groundwater potential zones. The interpretation of satellite images and aerial photographs also help more in this process. Groundwater exploration is a very unique exercise. As it is a hidden resource, various indirect methods are attempted to identify the points. The success in the groundwater targeting lies in experience of understanding the geological conditions, structural conditions and hydrogeological conditions which favor the occurrence of groundwater. The modern tools like remote sensing and aerial photography also provide a lot of spatial data for a quick understanding of the domain for a better decision-making

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