GEOPHYSICAL SURVEYS FOR MICRO LEVEL AQUIFER MAPPING IN PARTS OF KRISHNA RIVER BASIN OF TIPTUR AND C N HALLI TALUKS OF TUMKUR DISTRICT, KARNATAKA,

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ABSTRACT

An area of 376.2 sq.km in Krishna River basin, in parts of Tiptur and Chikkanayakanahalli of Tumkur district has been taken up for micro-level aquifer mapping. The study area is underlain by granite gneiss. In order to know the spectrum of subsurface hydrogeological disposition in the study area, integrated approach is adopted. Geophysical survey comprising of Resistivity surveys and Borehole logging, were deployed in the study area and basic information's collected through hydrogeological inventory were also utilized. In the study area, 72 Vertical Electrical Sounding(VES) in Grid pattern and Borehole logging(parameters: SP,N-16",N-64" and Natural Gamma) of 3 bore wells were conducted in determining depth and thickness and spatial distribution of subsurface hydrogeological disposition. Based on the interpreted results, contour maps of weathered layer thickness and Depth to basement have been prepared. Also, resistivity contour map of second and third layers of Geoelectric section and Apparent Resistivity contour at AB/2=25m, AB/2=100m and AB/2=200m were also prepared. The results has revealed the lateral and vertical extent of weathered zone, depth to hard rock, fractured formations and massive formations, which were demarcated based on distinct geophysical signatures. Borehole logging indicated disposition of fractured formations, especially, the natural gamma logging which showed high gamma counts against fractured zones.Thus, although the efficiency of resistivity surveys is well known for locating sites in ground water exploration, this technique in conjunction with Borehole logging (multiple parameters of electrical and natural gamma) is of great help in deciphering aquifer disposition in micro level aquifer mapping.

***Key words**: Borehole logging, Micro-level aquifer mapping, contour map, fractured zones, Tumkur district, Karnataka*

1. INTRODUCTION

During the period 20.10.2011 to 04.11.2011, Surface geophysical survey in the form of Vertical Electrical Soundings conducted for Micro Level Aquifer Mapping (MLAM) in parts of Tiptur and Chikkanayakanahallitaluks of Tumkur district. The preliminary objective of the survey is to decipher weathered layer thickness &fractured thickness, Layer resistvities of weathered, fractured and Massive formation. In addition, the surveys were aimed at computing subsurface geophysical parameters in the area. The surveys were guided by available geological / hydrogeological data of the area.

2. LOCATION

For micro level aquifer mapping in Karnataka state, a watershed has been identified in Tumkur district, which is a part of 4D3D8watershed and falls in Tiptur and Chiknayakanhallitaluks. The micro watershed is located at a distance of 5 km North of Tiptur town and starts at KupparaDoddahalli village of Tipturtaluk and extends up to Ankasandra Village in Chiknayakanhallitaluk towards North. The area covers parts of Survey of India Toposheet No.57C/7 and 57C/11 and lies between North latitudes 13° 16' 15" to 13° 38' 25" and East longitudes 76° 23' 45" to 76° 38' 25" and covers an area of 376.2 sq. km.

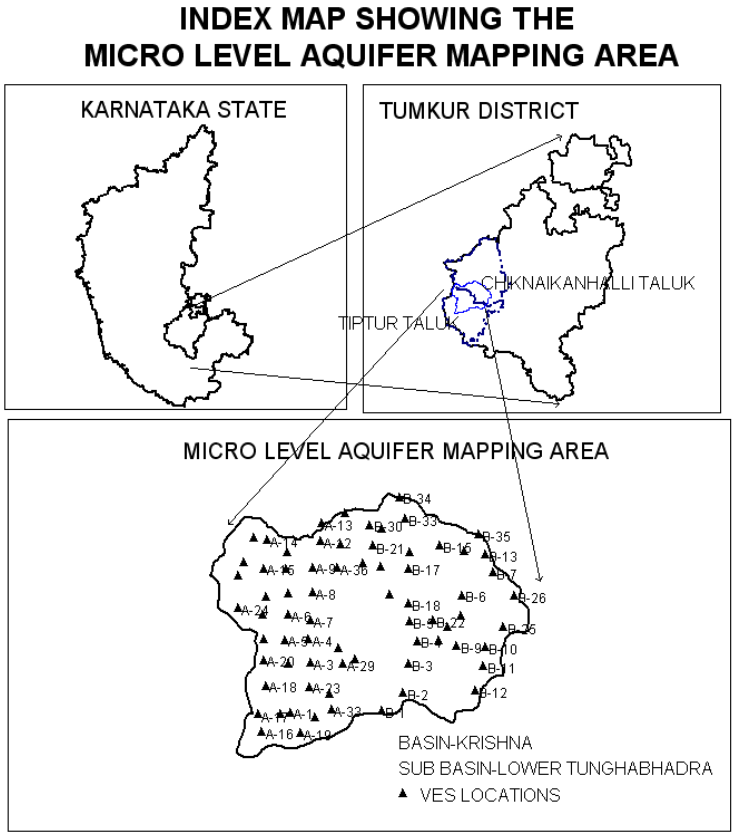

Fig-1. Location map of the study area

3. GEOLOGY

Geologically, the area mainly consists of rock types belonging to the Peninsular Gneissic Complex(PGC), Schistose rocks of Sargur group and Dharwar super group Younger intrusives (basic dykes) and in thin patches of Quaternary gravels. The Schistose rocks occupy the NW to SE in the central portion of the area. Granites and granitic gneisses occupy the North and Southern part of the area.

3.1 Description of the litho units:

The PGC occupy large areas and is represented by migmatite, tonalite-granodioritic gneiss, biotite gneiss and other granitoids. The high grade schists of Sargur group occur as continuous bands, small enclaves within the PGC, and comprise amphibolites, ultra mafics and banded ferruginous chert. The Dharwar super group is represented by Bababudan group and is exposed in NW-SE direction in the centre of the area. The younger Intrusives include basic dykes (dolerite) which are fine grained, equigranular and melanocratic. The patches of Quaternary gravel horizons contain mainly pebbles and cobbles quartz and occasionally granite and dolerite and embedded in clayey matrix. The map showing geology of the area is shown in fig.2.

3.2 Structure:

Based on the visual interpretation of IRS-ID, LISS-III satellite data, the lineament map is prepared for the study area. As per this 441 lineaments have been mapped and these are identified by straight alignment of drainage and vegetation representing surface manifestation of underlying structural features. Lineaments can be fractures, joints and dykes. In the study area, there are four sets of lineaments are interpreted and trending NE-SW, NW-SE, N-S and E-W directions. i) NE-SW trending lineament is predominantly seen in the western of the study area. This lineament is generally found in the hilly terrain formed by gneiss and schist ii) NW-SE type of

lineament is seen abundantly in eastern and southern parts of the study area. These lineaments are generally traversing in gneisses. iii) N-S direction lineament is very prominent in the central and western parts of the study area. iv) E-W direction lineaments are very prominent in the central and western parts of the study area. The minimum length of the lineament is 0.07 km and the maximum length of the lineaments is 2.47km. The total

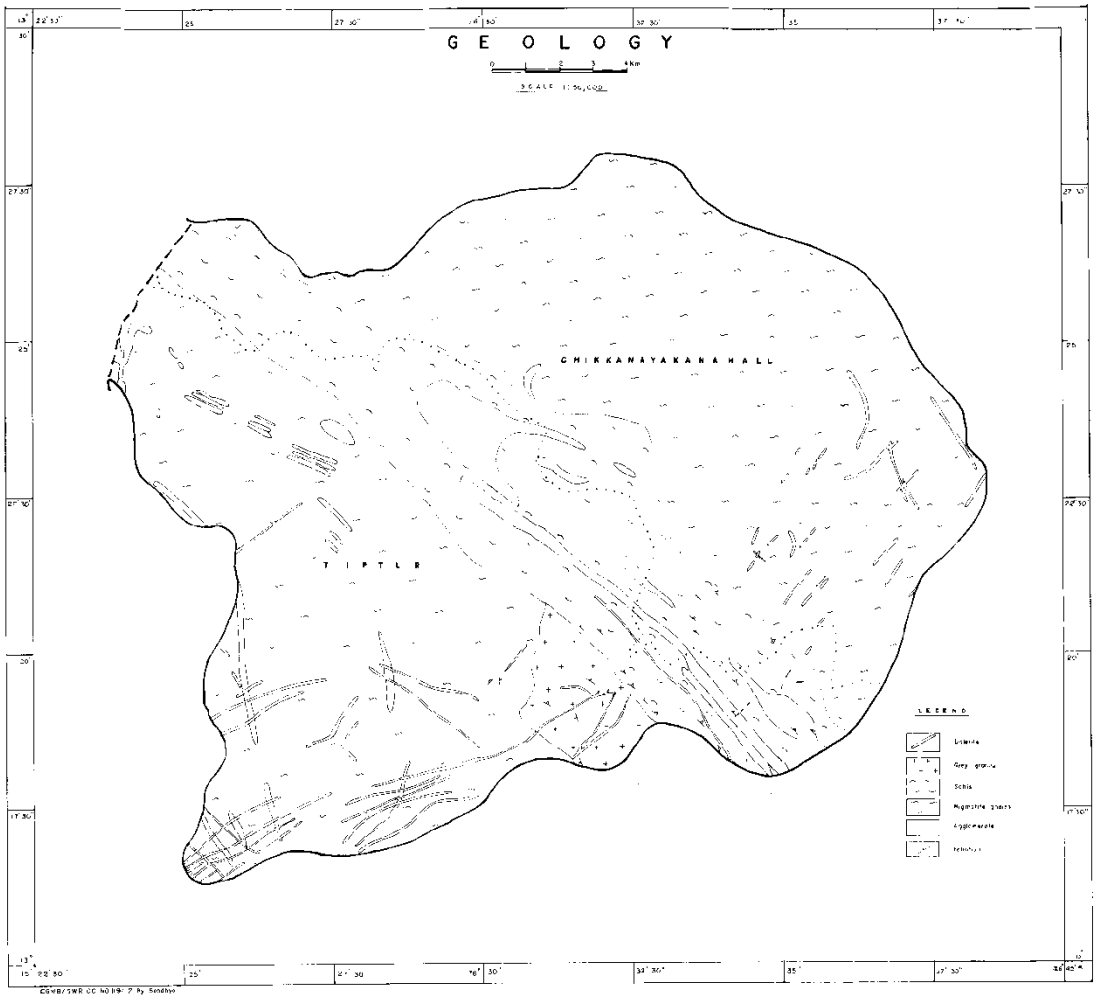

FIg2. Geology of the study area

length of the lineaments is 331.7km and the average length of the lineaments is 0.75km in the study area. The NE-SW trending lineaments are generally cutting across the schist rock formation found in the southern part of limbs where as NW-SE trending lineaments is cutting across the schist limb in the northern part. Lineaments, which are confined between schist formations occurring in the eastern parts of the study area, are considered to be good in groundwater potential for development.

4. HYDROGEOLOGY

Aquifer system exists in all the rock formations. It also exists in both weathered formation as well as fractured system down to depth of 200m. The depth of weathering varies from place to place and it varies from negligible at Banda gate village to more than 35m at Garehalli village. It shows that the depth of weathering is more than 35m in the SE part of the watershed. The depth of weathering is 20-30m in NW part and also in SE part of the basin. The depth of weathering is 10-20m in SW and other parts where as less than 10m is in the central part of the watershed.

5. DATA ACQUISITION AND INTERPRETATION

72 Vertical Electrical Soundings(VES) were conducted in the study area with station interval 2 km in grid pattern. The Indigenous IGIS Hyderabad, make ATS-SSR-MP and Mac-Ohm, OYO Japan, make Resistivity meters deployed for measuring the resistance of the ground. Schlumberger electrode spreading was used with maximum current electrode separation of AB/2=300 m. The apparent resistivity from the field plotted in a log-log graph paper shows that most of the sounding curves reflect the presence of three to four geoelectric layers A H and HA types.The initial interpretation of the VES data was accomplished using a conventional partial curve matching technique with a two layer master curve and auxiliary diagrams. Estimation of Resistivity Layers and thickness were obtained and used afterwards as starting models. The computer aided interpretation(Schum and IP2WIN) was based on optimization techniques. Dug well / Bore well information was incorporated and the layered earth models from the VES interpretation were kept as simple as possible by not allowing results with too many thin layers, The results obtained from the computer interpretation for the 72 soundings are presented in Table-1.

6. RESULTS AND DISCUSSIONS

Based on the survey results contour maps of weathered thickness, depth to basement, Apparent resistivity contour maps(AB/2=25m, AB/2=100m, AB/2=200m), Second layer resistivity and third layer resistivity maps have been prepared.

6.1 Weathered thickness contour map for MLAM in parts of Tiptur and C.N.Hallitaluksof Tumkur district:

From the Weathered thickness map it is inferred that, weathered thickness is shallow ie.,upto 10m wherever, the AB/2= 25m App.Resitivity is in the range of 100-200m. and it is 20-30m wherever, Pa is between < 100 ohm.m and greater than 30m wherever the resistivity are higher than 300 ohm.m

The weathered thickness map indicated general depth to weathered formations is around 10m. In the areas of north east and eaastern part in C.N.Hallitaluk, weathered thickness is > 30m. the range of 100-300m., weathered thickness is less than 10m.weatehred thickness is in the range of 10-20m and greater than 30m, when the resistivity is less than 100 Ohm.m(Fig-4).

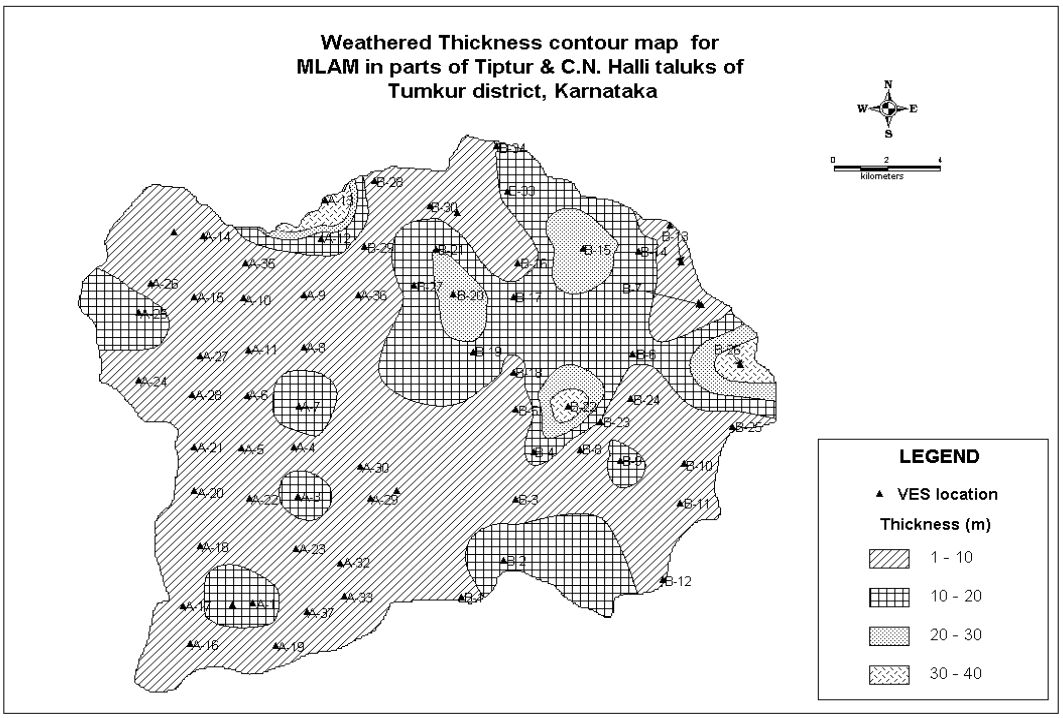

Fig. 3 Weathered thickness contour map of MLAM area

6.2 Depth to basement contour map for MLAM in parts of Tiptur and C.N.Halllitaluks of Tumkur district, Karnataka.

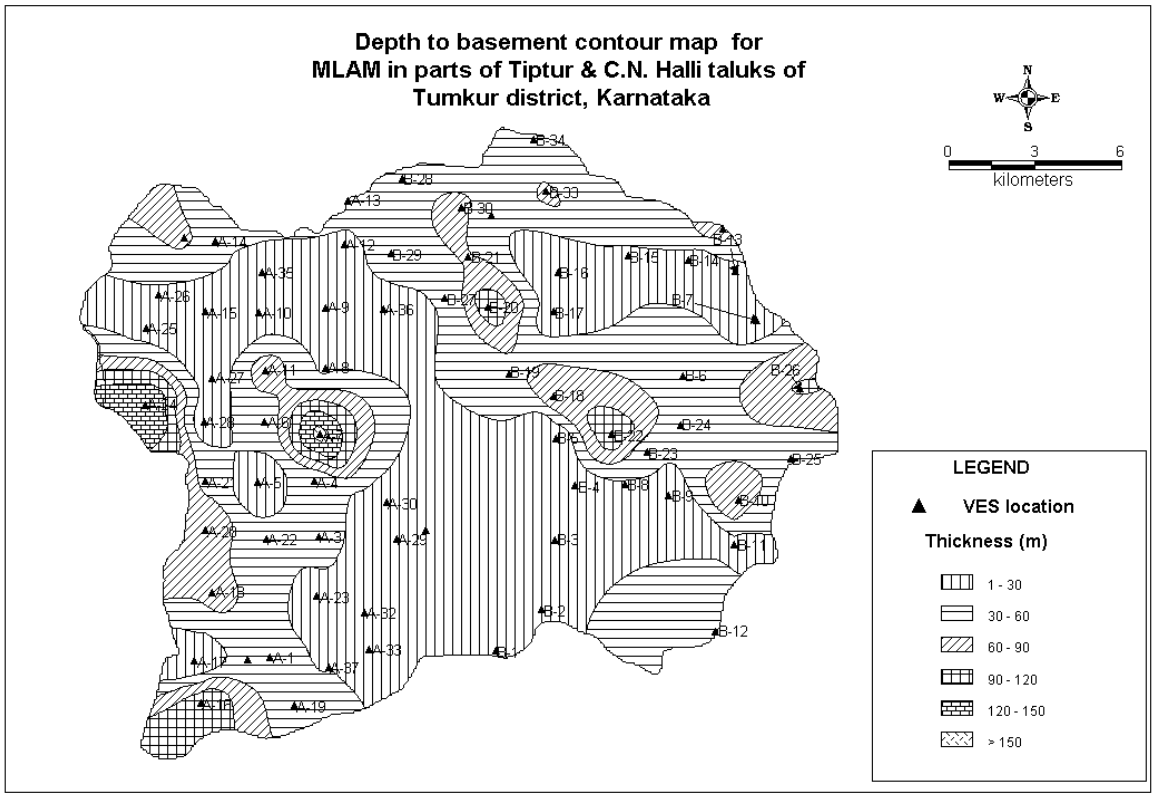

Fig 4 Depth to basement contour map of MLAM area

Depth to hard rock in general is <20-60m in the study area. In areas of schistose formations depth to hard rock is less than 30m. In areas of migmaititic gneiss it is between 30-60m. In few patches on eastern and south eastern part depth to hard rock is deeper ie.,> 100m. This zone can be demarcated as fractured wherein the resistivity is in is 200-400m.

6.3 Resistivity behavior of formations:

The apparent resistivity at AB/2=100m and AB/2= 200m shows the fractrured zones at shallow and deeper hard rock formations. Resistivity values of < 200 Ohm.m in schists and 200- 400 Ohm.m in gneisses in the study area indicate shallow fractures(Fig-6).Deeper fracrures are indicated in Figure-7, with in resistivity zone of 300-600 Ohm.m.A sizeable portion in south and pockets NE, East and NW fringe areas(Gandhinagar) and SE fringe area massive zones in hard rocks which are indicated by higher reistivities of morethan 400 ohm.m in Fig-6 and morethan 600 Ohm.m in Fig-7.True resistivity of second layer(weathered) and Third layer(Hard-Fractrured/massive) in Fig-8 and Fig-9 are discuuused below. Second layer resistivity contour map shows that most of the area with resistivity upto 100 Ohm.m indicates highly weathered nature, where as villages in the study area viz., Virupakshapura, Halkurke, Hulihalli, Gandhinagara and Kaimara junction, Bangarakere, SavshettihalliShettikere , Agasarahalli shows resistivity ranges more than 200 ohm m closely following massive/ fresh rock and depth to basement is shallow. Third layer shows resistivity value of < 200 and 200-400 Ohm.m in the western half of the study area, which can be attributed to fractured formations. Resitivities are higher ie., more than 600m and above in South east, north east and fringe areas of north(Gandhinagar), east and

south east indicating massive nature of rock formations.Also all the resitivity maps indicated high resitivity in the northern fringe areas near Gandhinagar ,which can be attributed to maasive formation and shallow basement

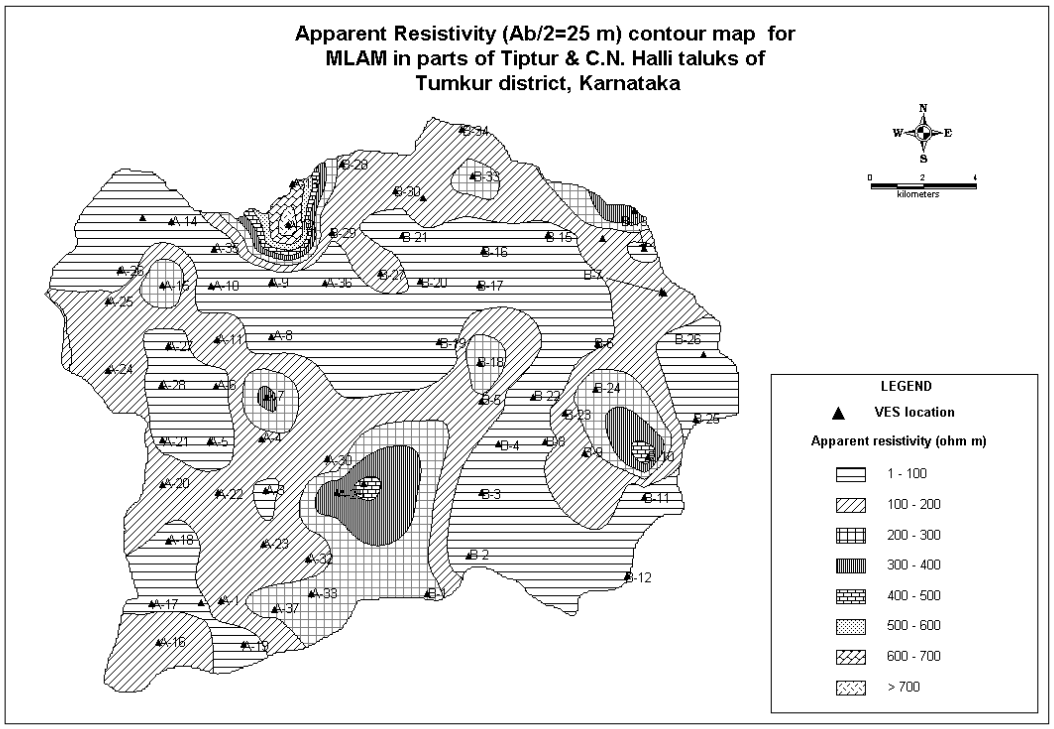

Fig 5 Apparent resistivity (AB/2= 25 m) of MLAM area

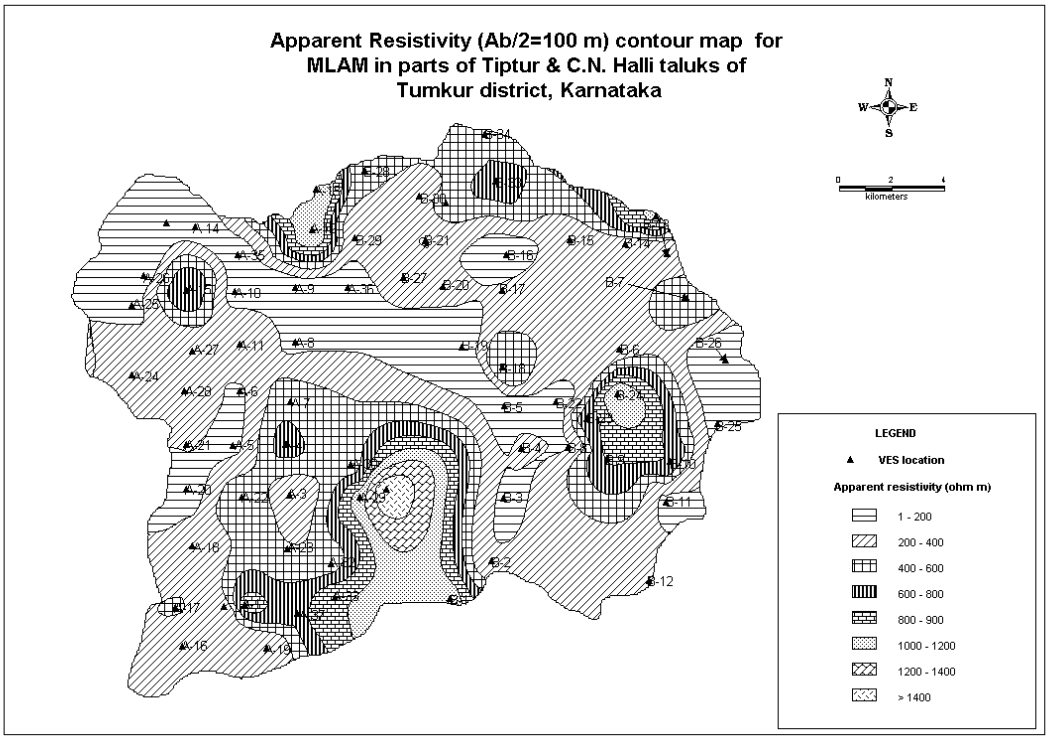

Fig 6 Apparent resistivity (AB/2= 100 m) of MLAM area

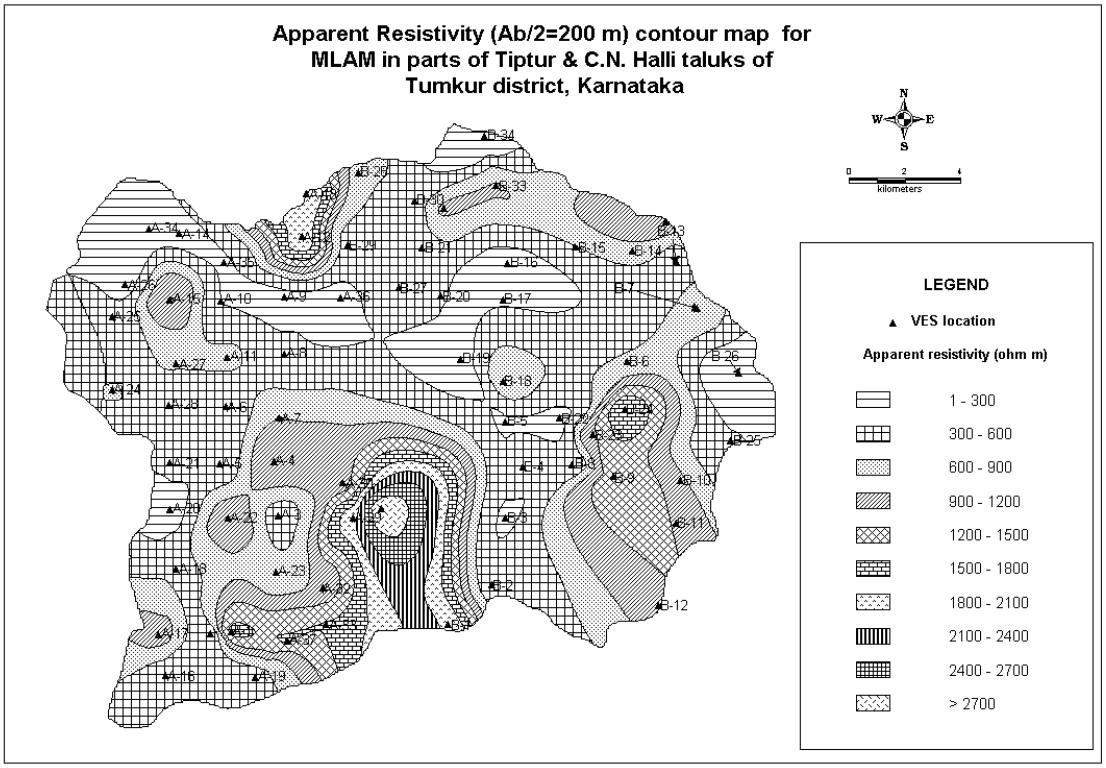

Fig 7 Apparent resistivity (AB/2= 200 m) of MLAM area

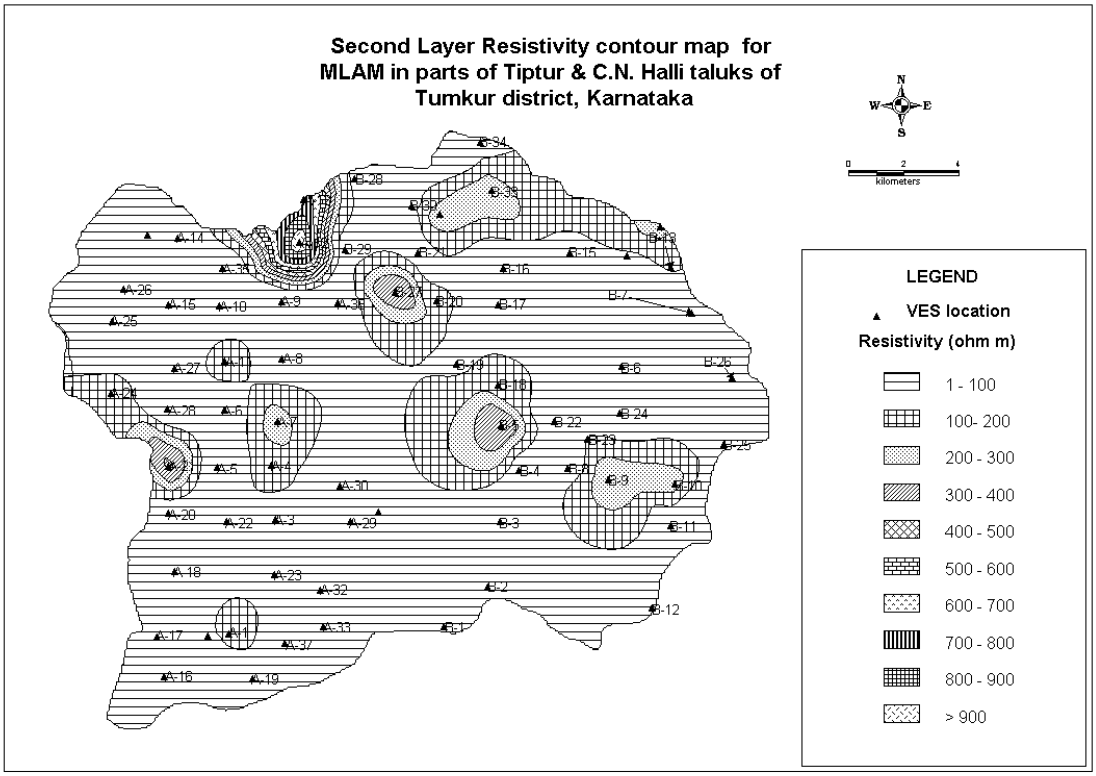

Fig. 8 Second layer resistivity contour map of MLAM area

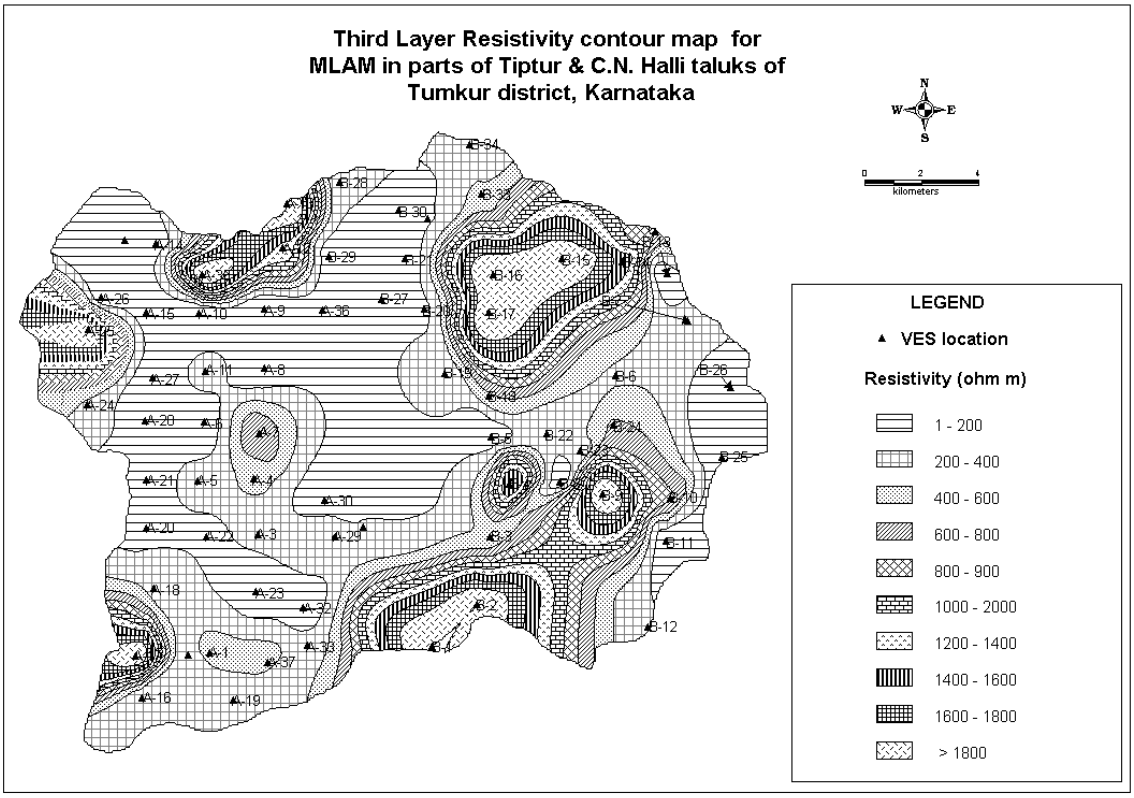

Fig. 9 Third layer resistivity contour map of MLAM area

7. BOREHOLE LOGGING

As a preliminary study three boreholes were logged(2 in Tipturtaluk in the southern and south western part and one well in the eastern part bordering C.N.Hallitaluk) logged with multiple parameters like Spontaneous potential for quality of ground water and resistivity logging with N16 &" N64" and Natural gamma for determining the fracture dispositions in the subsurface.

7.1 Khaimara junction(C.N.Hallitaluk)

Two highly fractured zones from 67-72 and 76-80mbgl were observed in all the three logs. In the gamma log, two distinct zones of gamma counts were observed viz., from 10-70 mbgl – high gamma count and generally less gamma count from 70-135mbgl.

7.2 Manakikere(Tipturtaluk)

It is observed that, natural gamma indicated high counts in the fractured zone. Also, between depths of 65-108, which is reflected as massive/hard formation in the resistivity log, has been depicted as low gamma counts in general with minor kinks in between indicating minor fractures in that depth range.

7.3 Timmarayanahhalli (Tipturtaluk)

It is observed that, natural gamma indicated high counts in the fractured zone. In normal resistivity log, greater variation of resistivity is observed below 115m Similarly, Natural gamma log also indicated grater variation in gamma counts (low as 60 to>350) below 145m depth, which may be attributed for highly disturbed formation at depth. The S.P.log indicated clear development below 90m with positive deflection against low resistivity zones reflected in Normal resistivity log.

Logging indicated shallow weathered zone at Khaimara junction in C.NB.Hallitaluk and deeper weathered zone upto 33m in Manakikere and T.R.Halli. Fractures are more frequent upto depth of 90m in all the wells and deeper fractures are encountered in Manakikere and T.R.Halli at 113-125m and 172-176m.

Natural gamma log indicated high gamma counts against resistivity lows at fractured zones. Also distinct behavior of resistivity and gamma counts were observed where greater variations of values were indicated.

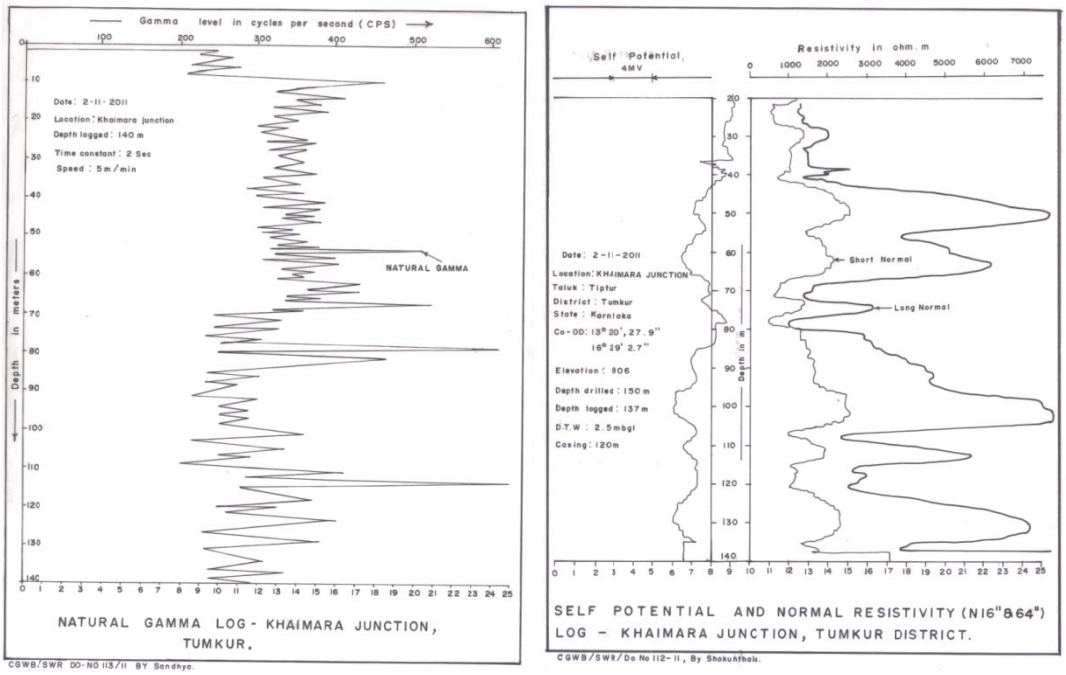

Fig 10. Gamma, SP and N16"- N64"logging at Khaimara Junction

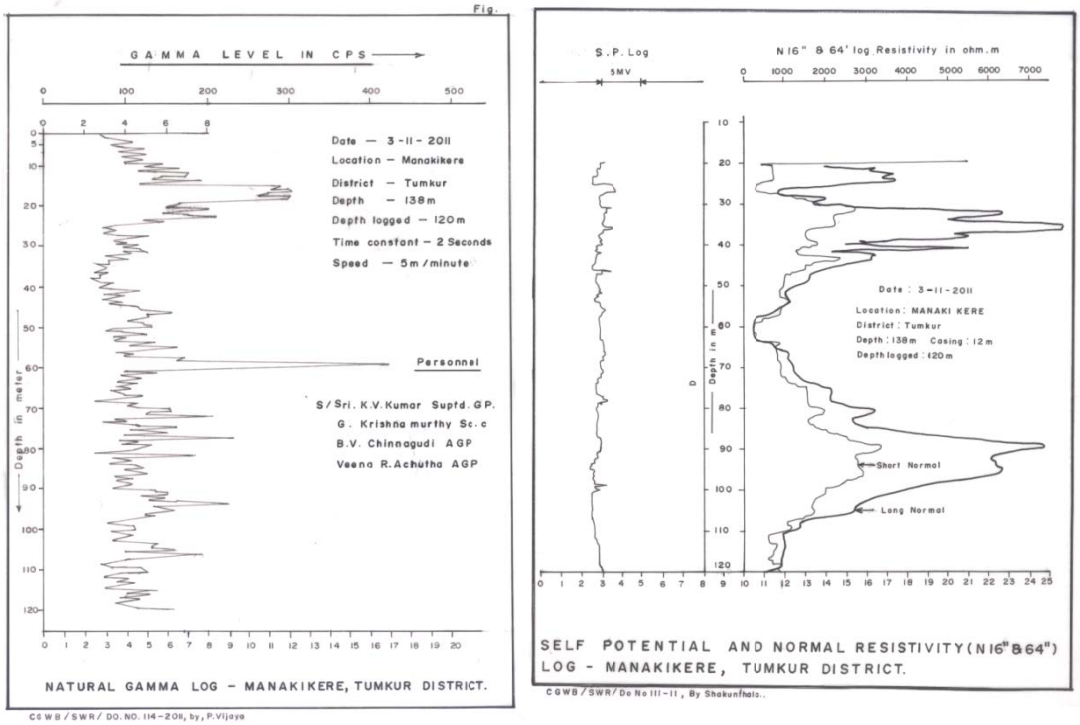

Fig 11. Gamma, SP and N16"- N64"logging at Manakikere

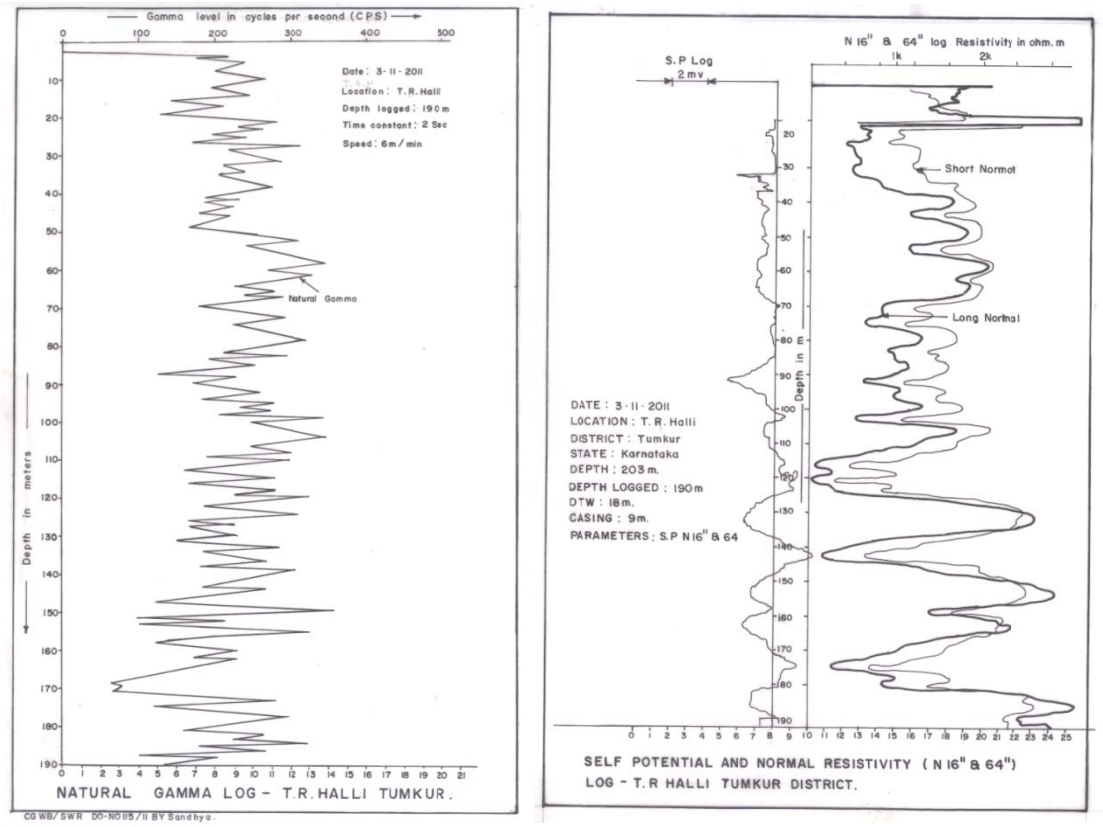

Fig 12. Gamma, SP and N16"- N64"logging at Timmarayanahalli

Table .Interpretted VES results of Microlevel aquifer mapping area in parts of Tiptur and C.N.Hallitaluks of Tumkur district.

Sr. no.	VES no.	Village	Layer parameters							
			Resistivity in ohm m				Thickness in m			
			ρ1	ρ2	ρ3	ρ4	h1	h2	h3	H
1	A-1	Bhairanayakanahalli	95	143	480		0.5	15	18	33.5
2	A-2	Alur	27	64	250		1.75	16	20	37.75
3	A-3	Manakinakere	106	53	238		1	15	19	35
4	A-4	Bhairapura	60	150	450		3.75	6	35	44.75
5	A-5	Ghatakanakere	50	6	238		1	4	8	13
6	A-6	MuddenahalliTanda	85	16	100		1.5	4	41	46.5
7	A-7	H. Muddenahalli	176	236	767		1.5	17	137	155.5
8	A-8	Basavarajapura	101	21	41		1.3	6	19	26.3
9	A-9	Kodigehalli	25	4.5	16		0.75	1.5	9	11.25
10	A-10	Marisiddaiahnapalya	10	8	14		1	2	9	12
11	A-11	Gandanakatte cross	112	150	263		1.5	8	60	69.5
12	A-12	Gandhinagara	1200	946	1359		0.5	15		15.5
13	A-13	Kairara Junction	400	750	9999		1.75	56		57.75
14	A-14	kamalapura	17	5	113		1.5	3.75	35	40.25
15	A-15	Rangapura	*		--					
16	A-16	Kupparadoddahalli	150	95	226		0.75	3	100	103.75
17	A-17	Harachanahalli	21	23	9999		0.75	5.5		6.25
18	A-18	Paruvagondanahalli	129	30	333		1.25	7.25	58	66.5
19	A-19	T.M. Manjunathanagar	89	25	265		0.5	7	40	47.5
20	A-20	Nelagondanahalli	52	45	146		1.75	2	76	79.75

*** Not interpretable**

Sr. no.	VES no.	Village	Layer parameters							
			Resistivity in ohm m				**Thickness in m**			
			ρ1	ρ2	ρ3	ρ4	h1	h2	h3	H
21	A-21	D.Manjunathanagar	38	410	133		0.5	2	52	54.5
22	A-22	Mavinahalli	57	73	172		0.75	1.5	35	37.25
23	A-23	Virupakshapura	64	69	102		0.75	1.5	24	26.25
24	A-24	Baluvaneralu	225	120	377		0.5	2	138	140.5
25	A-25	B. Muddenahalli	87	40	9999		1.5	20		21.5
26	A-26	Muddanayakanapalya	19	4	62		1.5	3	23	27.5
27	A-27	Bommanahalli	187	14	55		1	2	18	21
28	A-28	Dasanakatte	170	18	38		1	1.5	15	17.5
29	A-29	L.Gollarahatti	306	20	401		1.5	2.5	4	8
30	A-30	H.Gollarahatti	35	12	87		1	2	13	16
31	A-31	Timmarayanahalli	162	53	208		1	1.5	10	12.5
32	A-32	Kalkere	263	67	88		1	4	16	21
33	A-33	Doddamarappanahalli	101	84	271		0.75	2.75	23	26.5
34	A-34	KamalapuraTankbed	23	13	128		1.25	5.75	57.5	64.5
35	A-35	Daggenahalli	85	3	9999		1.75	4		5.75
36	A-36	Tammadihalli	9	3	145		1.75	4	6	11.75
37	A-37	Misethimmanahalli	92	45	450		1.5	4	24	29.5
38	B-1	Bandegetu (18.6 km stone)	114	72.4	9999		1	6.33		7.33
39	B-2	Irlagere gate	69.2	30	9999		1.63	18.4		20.03
40	B-3	Gopalanahalli (bet 13 & 14 km stone)	29.3	11	461		2.45	4.62		7.07
41	B-4	Gopalanahalli (11 km stone)	44.5	38.5	1620		1.67	14.5		16.17
42	B-5	Malavalli (temple)	134	372	105		0.82	1.23	10.6	12.65
43	B-6	Dugadihalli	87.8	53.3	383		2.12	11.1	32.9	46.12
44	B-7	Kodigehallipalya (1 km stone)	90.5	54	284		1.78	3.51	13.2	18.49
45	B-8	Sasalu	37.4	23.6	103		0.99	4.02	24.3	29.31
46	B-9	Agasarahalli	37.2	248	9999		2.8	11		13.8
47	B-10	Agasarahalli	222	224	816	9999	1	7.5	79	87.5
48	B-11	Gerahalli	331	23	86		1.2	5.7	19	25.9
49	B-12	Jakkanahalli	69.7	51.3	219		1.3	8.66	43.4	53.36

50	B-13	Melanahalli (1 km stone)	25	103	53		0.6	1.36	21.7	23.66
51	B-14	Marasandra	23	93	1549		0.94	14.3		15.24
52	B-15	Navule	30.2	66.6	9999		0.73	26.8		27.53
53	B-16	Kuppulu (8 km stone)	3	26	9999		1.9	3.07		4.97
54	B-17	Hesarahalli	31.8	44	5595		1.96	16.5		18.46
55	B-18	Settikere	92	145	562		1.25	8	70	79.25
56	B-19	Madihalli	18	90	259		1.5	19	30	50.5
57	B-20	Marchahalli	96	112	175		1.5	25	75	101.5
58	B-21	Abhujahalli	25	58	131		0.5	20	40	60.5
59	B-22	Kalubhavipalya	15	48	250		0.5	35	65	100.5
60	B-23	Tittigoranapalya	176	101	275		1.5	10	32	43.5
61	B-24	Kodalagara	41	47	618		1.25	3	34	38.25
62	B-25	Vaddarahatti	48	25	46		1.5	5	31	37.5
63	B-26	Kadenahalli	241	44	46	17	1	35	55	91
64	B-27	Tammedihalli	36	400	47		0.25	12.5	25	37.75
65	B-28	Chattasandra	143	88	246		0.5	5	46	51.5
66	B-29	Madapur	106	71	118		3	8.5	42	53.5
67	B-30	BanjraTanda	111	83	153		1.5	8	54	63.5
68	B-31	Berinahalli	11	250	30		0.85	6.5	16	23.35
69	B-32	Ballenahalli	40	250	347		1.25	5	34	40.25
70	B-33	Aralikere	70	256	461		2	11	50	63
71	B-34	Ankasandra	123	56	212		0.5	10	21	31.5
72	B-35	Maligehalli	29	218	786		0.5	6	60	66.5

7. CONCLUSION

The results has revealed the lateral and vertical extent of weathered zone, depth to hard rock, fractured formations and massive formations, which were demarcated based on distinct geophysical signatures. Borehole logging indicated disposition of fractured formations, especially, the natural gamma logging which showed high gamma counts against fractured zones. Indication of fractured zones in the western half of the study area from resistivity behavior and deeper fractures indicated from logging at Manakikere and T.R.Halli is well correlated with hydrogeological features such as lineaments and intrusions in the western part of the study area.

Thus, although the efficiency of resistivity surveys is well known for locating sites in ground water exploration, this technique in conjunction with Borehole logging (multiple parameters of electrical and natural gamma) is of great help in deciphering aquifer disposition in micro level aquifer mapping. The geophysical surveys revealed the thickness of weathered formation in the study area which is highly useful in knowing whether the area is suitable for construction of dug wells for domestic and irrigation purposes. It also reveals the length of casing to be lowered in construction of bore wells and the cost of casing thereon. The geophysical surveys reveals the vertical extension of the fractured aquifers in massive formation i.e., below the weathered formation .It is very useful for the owner of the bore well to what depth the bore well can be drilled to get high yields and minimize the cost of construction of bore wells.

8.ACKNOWLEDGEMENT

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