GEOPHYSICAL SURVEY IN SARBAND-I-HAJI TALABAI VILLAGE, SHOLGARA DISTRICT OF BALKH PROVINCE

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List of Abbreviation and Technical Terms

Roh:	Apparent Resistivity (ohm.m)
Sp:	Self Potential (mV)
Vp:	Voltage Potential (mV)
In:	Current (m A)
VES:	Vertical Electrical Sounding
DACAAR:	Danish Committee for Aid to Afghan Refugee
WASH:	Water Sanitation and Hygiene

1. Introduction

DACAAR performed geophysical survey (vertical electrical sounding) for provision of safe drinking water for Sarband-i-Haji Talabai (Mehdiha) village, Sholgara district of Balkh province. This village is located about 17 Km to the south eastern of Sholgara district center, north of Pul-i-Baraq along right course of Balkhab river. The people of this village have problems in collecting safe drinking water. The hydro geologic condition of this area is very complex for groundwater development due to deep water table and fracture water in the limestone, marl, dolomite, and sandstone and siltstone formation. The groundwater table ranges between 70 - 90 m and the water is fresh. The people are mainly collecting their drinking water from Balkhab River, which flows near the village. The water of the river is muddy during six month (winter and spring) a year and also polluted during dry seasons (summer and fall). On 16 - 17 November 2012, DACAAR performed Vertical Electrical Sounding (VES) survey in Sarband-i-Haji Talabai villages using Shlumberger electrodes arrangement (Figure 1). The field data were measured by SYSCAL Pro resistivity meter and the data interpreted by IPI2 win software.

Figure 1 Recording VES profile field data using SYSCAL Pro resistivity meter

2. Surface Geological setting of area

The surface geological formation of the survey area is:

- Recent Quaternary: Shingly and detritus sediments (gravel, sand, clay, sand, loess)
- Middle Quaternary: Shingly and detritus sediments (gravel, sand, clay, sand, loess, loam, and travertine
- Early Miocene: Read clay, sandstone, siltstone, conglomerate, and limestone
- Paleocene: Limestone, marl, dolomite, sandstone, siltstone and conglomerate

The Geological setting of the area is shown in figure 2.

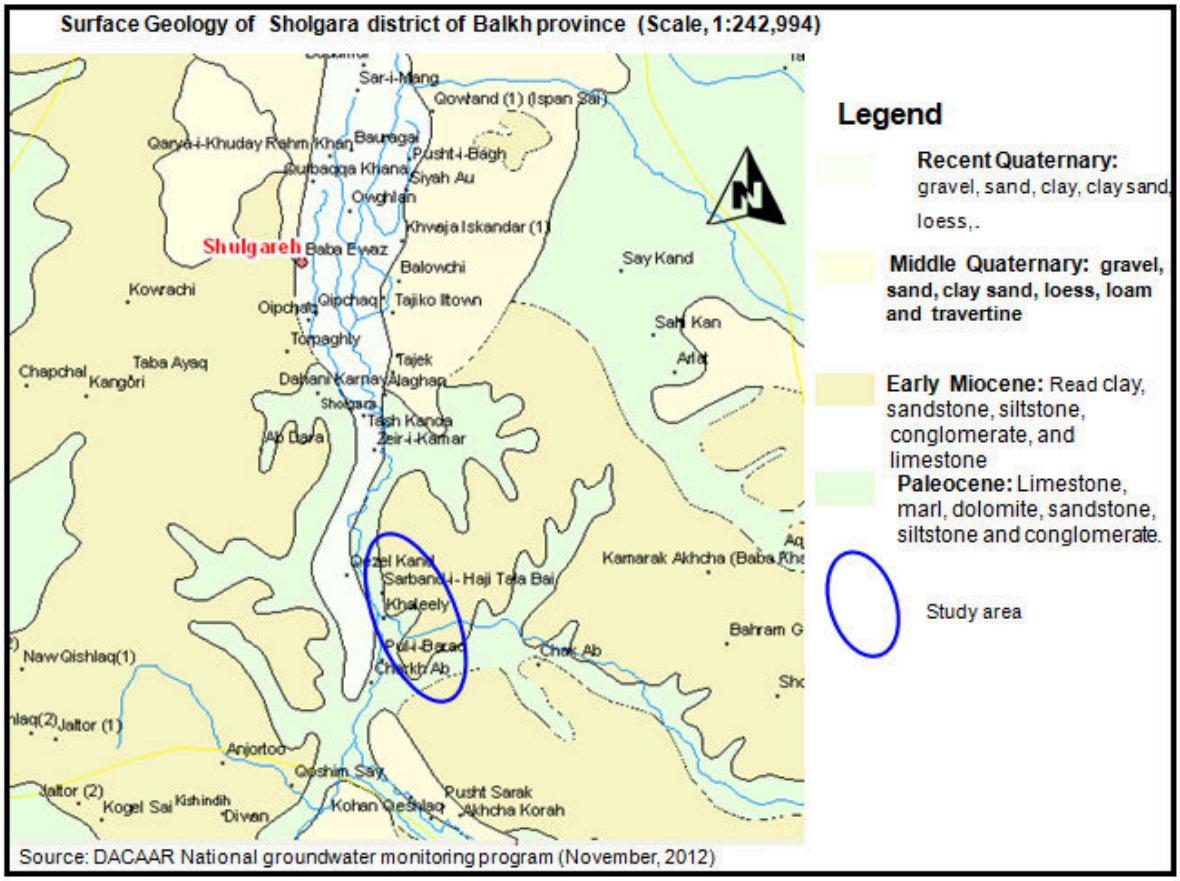


Figure 2 Surface geological setting of the survey area (Pul-e Baraq)

3. Hydro geological setting

In the survey areas the natural groundwater system is characterized by two main hydro geologic units:

- Early Miocene: Read clay, sandstone, siltstone, conglomerate, and limestone.
- Paleocene: Limestone, marl, dolomite, sandstone, siltstone and conglomerate.

Early Miocene and Paleocene formation has water in the fractures. In the survey area the water table ranges between 70 m to 90 m and the water is fresh. The figure 3 shows the location of survey area and sitting of Early Miocene and Paleocene formation.

Figure 3 Location of survey area and sitting of Early Miocene and Paleocene formation

4. Vertical electrical sounding survey

4.1 Vertical Electrical sounding method

In this method the applied Schlumberger techniques was used. Current was transmitted into the ground from DC or low frequency sources by two electrodes (A and B) and the potential difference between a second pair of electrodes (M and N) was measured.

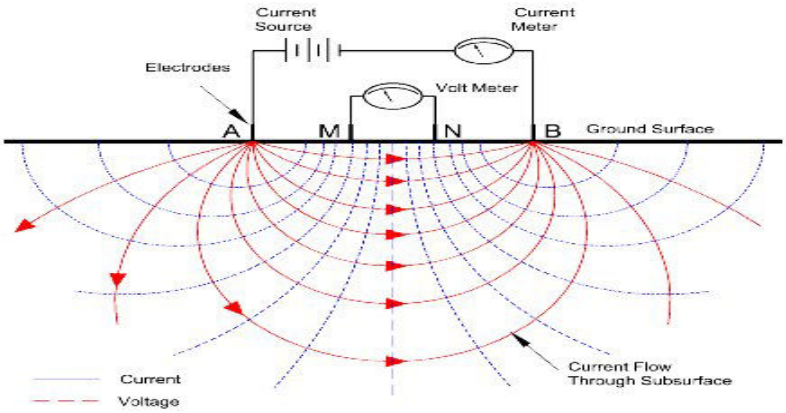


Figure 4 Vertical electrical sounding method

Apparent resistivity value is calculated:

Pa = K V / I

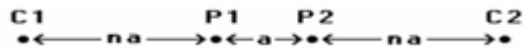
Where:

Pa is the apparent resistivity

K is the geometric factor,

V is a voltage or potential difference between a second pair of electrodes in volts
I is the current from DC or low frequency sources by two electrodes in ampere.

K = ∏n (n + 1) a



The field data interrelated according to the following resistivity scale for water and rocks.

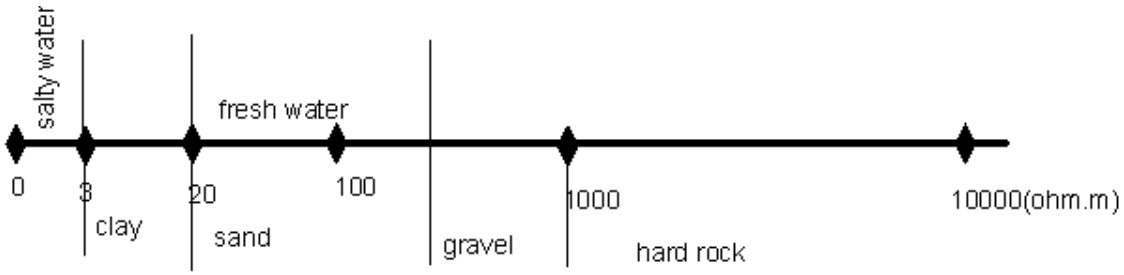


Figure 5 Resistivity scale for water and rocks

4.2 Field study

On 16 - 17 November 2012, 3 Vertical Electrical sounding (VES) profiles (VES-1, VES-2, 6 and VES-3) were performed in Sarband-i-Haji Talabai (Mehdiha) village, Sholgara district of Balkh province using Shlcumberger electrodes arrangement (Figure 4). The lengths and locations of VES profiles are indicated in Table 1 and Figure 6.

Table 1 Location of VES profiles

NO	Village	VES Profiles	LAT	LON	Elevation (m)	VES Distance (m)
1	Sarband-i-Haji Talabai	VES-1	36.2238	66.91016	648	600
2	Sarband-i-Haji Talabai	VES-2	36.22739	66.90565	647	600
3	Sarband-i-Haji Talabai	VES-3	36.22927	66.90630	650	600

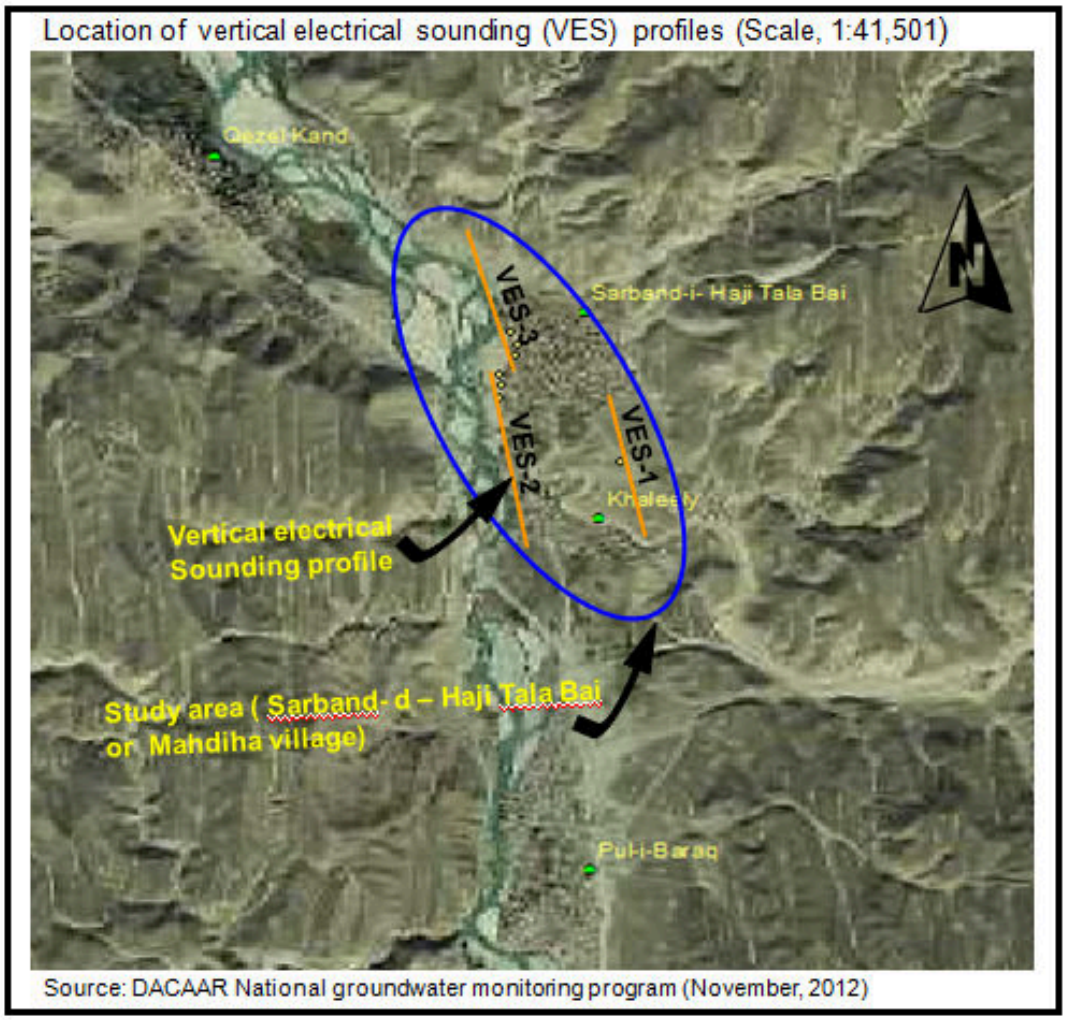


Figure 6 Location and length of VES profiles in Sarbad-e Haji Talabai village

4.3 Measured VES field data

The field data were measured by SYSCAL Pro resistivity meter and the measured data are shown in Table 2 and Table 3.

Table 2 VES#1 and VES#2 measured field data

VES#1 Pul-e Baraq (Mehdi Ha)
Lat:36.22387 Lon:66.91016 Ele:648 m

AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	183.88	51.9	2072.433	70.824	13.7
2	0.5	141.929	53.7	2056.634	70.318	24.7
3	0.5	82.454	3.7	42.556	77.419	56.2
4	0.5	57.587	3	25.21	67.645	100
5	0.5	48.003	19.4	60.833	66.5	157
6	0.5	49.322	4.8	34.706	50.01	226
8	0.5	60.395	9.5	18.32	95.895	402
8	2	60.479	6	10.685	78.312	99
10	2	76.764	11.8	29.893	77.441	156
12	2	88.526	11	26.241	97.718	225
15	2	95.483	9	14.023	83.637	352
20	2	115.015	6.6	10.614	99.161	627
20	5	107.707	5.4	5.887	84.063	247
25	5	130	9.5	31.512	76.643	389
30	5	144.74	3.6	44.518	84.55	562
40	5	172.93	2.5	34.849	99.713	1001
50	5	204.29	1.5	21.17	80.574	778
50	10	205.17	11	43.73	80.354	778
60	10	226.04	9.5	31.512	76.643	1123
80	10	262.64	10.5	16.544	62.335	2003
100	10	297.09	9.5	18.32	95.895	3134
120	10	306.49	6	10.685	78.312	4516
120	25	334.1	11.8	29.893	77.441	1790
150	25	369.09	11	26.241	97.718	2808
200	25	414.8	9	14.023	83.637	5007
250	25	416.13	6.6	10.614	99.161	7834
300	25	393.27	5.4	5.887	84.063	11290

VES#2 Pul-e Baraq
Lat:36.22739 Lon:66.90565 Ele:647 m

AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	118.18	66.4	477.057	25.362	13.7
2	0.5	110.54	71.3	161.012	17.161	24.7
3	0.5	103.95	72.8	90.017	23.804	56.2
4	0.5	120.14	72.4	59.293	24.421	100
5	0.5	142.74	74.9	45.478	24.772	157
6	0.5	170.35	72.9	43.243	28.51	226
8	0.5	216.32	71.7	40.285	37.298	402
8	2	202.71	47.3	162.91	37.872	99
10	2	246.73	19.3	149.088	45.56	156
12	2	282.52	12	116.459	45.325	225
15	2	329.93	14.1	59.357	31.227	352
20	2	379.67	15.4	229.608	188.092	627
20	5	393.24	0.8	625.529	187.402	247
25	5	439.98	24.5	75.923	32.526	389
30	5	382.47	22.9	28.375	20.394	562
40	5	356.61	27.5	28.991	40.225	1001
50	5	370.47	30.3	5.909	12.401	778
50	10	358.65	8.5	11.839	12.444	778
60	10	387.91	4.3	25.46	36.085	1123
80	10	396.27	9.9	5.207	13.002	2003
100	10	413.09	13.7	3.23	12.159	3134
120	10	419	68.6	15.328	10.943	4516
120	25	392.01	54.4	5.823	12.856	1790
150	25	345.11	56.1	1.375	5.476	2808
200	25	302.12	56.9	2.192	17.946	5007
250	25	288.2	59.1	2.8	49.818	7834
300	25	213.06	59.3	0.8	21.072	11290

Table 3 VES#3 measured field data

VES#3 Pul-e Baraq (Mehdi Ha)
Lat:36.22927 Lon:66.90630 Ele:650 m

AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	129.576	27.5	756.211	36.665	13.7
2	0.5	114.486	1.1	467.059	48.063	24.7
3	0.5	108.231	5.4	186.337	47.322	56.2
4	0.5	120.205	2.3	111.997	46.107	100
5	0.5	129.268	2.5	80.413	48.389	157
6	0.5	143.577	2.6	69.985	57.549	226
8	0.5	155.356	7.3	184.052	56.554	402
8	2	156.38	0	91.843	40.036	99
10	2	172.965	1.5	25.074	14.162	156
12	2	194.954	1	53.456	39.53	225
15	2	234.621	1.1	12.347	12.215	352
20	2	315.064	45.9	33.131	12.119	627
20	5	321.132	18.4	201.298	92.919	247
25	5	408.336	10.8	153.8	90.153	389
30	5	468.728	7.2	52.038	50.347	562
40	5	511.357	2.9	31.498	57.906	1001
50	5	422.402	4.4	62.587	58.258	778
50	10	405.081	1.5	23.276	31.299	778
60	10	409.276	3	36.275	67.994	1123
80	10	488.56	7	37.435	75.827	2003
100	10	567.64	9.9	70.114	192.083	3134
120	10	580.63	17.5	26.148	101.156	4516
120	25	506.28	66.9	59.214	101.229	1790
150	25	423.87	27	23.137	75.027	2808
200	25	475.73	19.9	37.156	193.226	5007
250	25	421	14	2.349	6.649	7834
300	25	393.73	11.8	2.127	30.337	11290

4.4 Interpreted field data

The collected field data were interpreted by IPI2 wins software. The interpreted data were used to calculate apparent resistivity, thickness, depth and boundaries of layers. The interpreted data are shown in Table 4.

Table 4 VES#1, VES#2 and VES#3 interpreted data

No	VES Profiles	Vertical Electrical Sounding data interpretation results				Expected litho logy of layers
		App-Resistivity *(Ohm-m)*	Layer	Thick-ness *(m)*	Depth *(m)*	
1	VES-1 LAT: 36.22387 LON: 66.91016	248	1	1.1	1.1	Clay with sand and gravel
		20	2	1.98	3.09	Clay, silt clay
		233	3	34.8	37.9	Dry sand and gravel
		1157	4	92.5	130	Limestone without fracture water
		18.1	5	>92.5	>130	Marl and limestone with fracture water
2	VES-2 LAT: 36.22739 LON: 66.90565	154	1	0.90	0.90	Gravel, sand with clay
		38	2	0.969	1.87	Clay with sand and gravel
		3574	3	2.01	3.8	Limestone without fracture water
		190	4	16.6	20.4	Dry sandstone and siltstone
		678	5	55.7	76.1	Marl and limestone without fracture water
		96	6		>76.1	Marl and limestone with fracture water
3	VES-3 LAT: 36.22927 LON: 66.90630	115	1	5.94	0.75	Clay with gravel sand and silt
		4381	2	3.73	9.67	Marle and limestone without fracture water
		394	3		>9.67	?

4.5 Vertical Electrical sounding data Graphic interpretation

The VES -1, VES-2 and VES-3 field data (Apparent resistivity versus Electrodes distance) were interpreted by IPI2 win software as well as manually. The boundaries, thickness and depth of rocks layers were determined according to the measured and computed apparent resistivity and geo electrical model (Table 4). The rock types were specified according to the computed apparent resistivity based on the geophysical interpretation principles (Figure 5). The Apparent resistivity versus Electrodes distance curve for VES -1, VES-2 and VES-3 are shown in the Figure 7, Figure 8 and Figure 9.

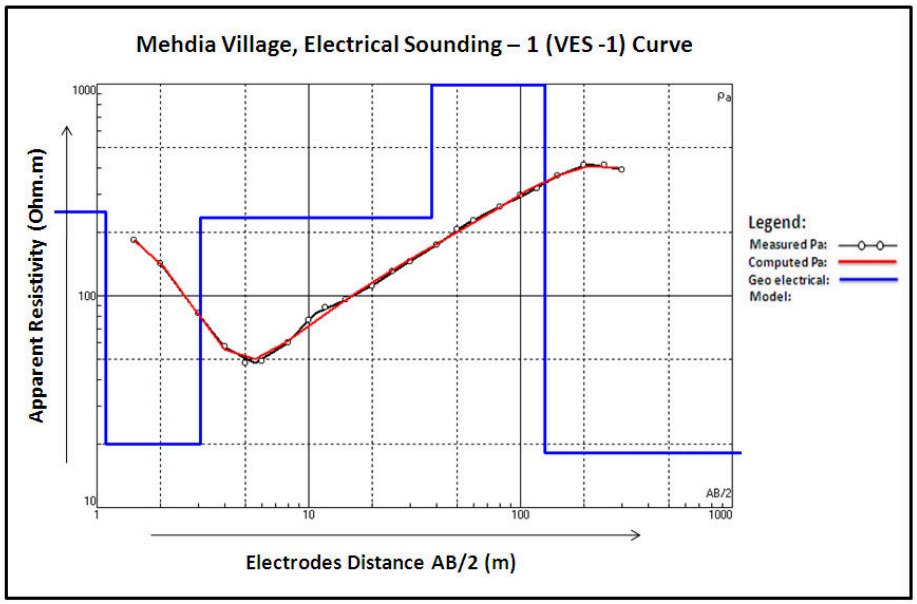


Figure 7 VES#1 Curve

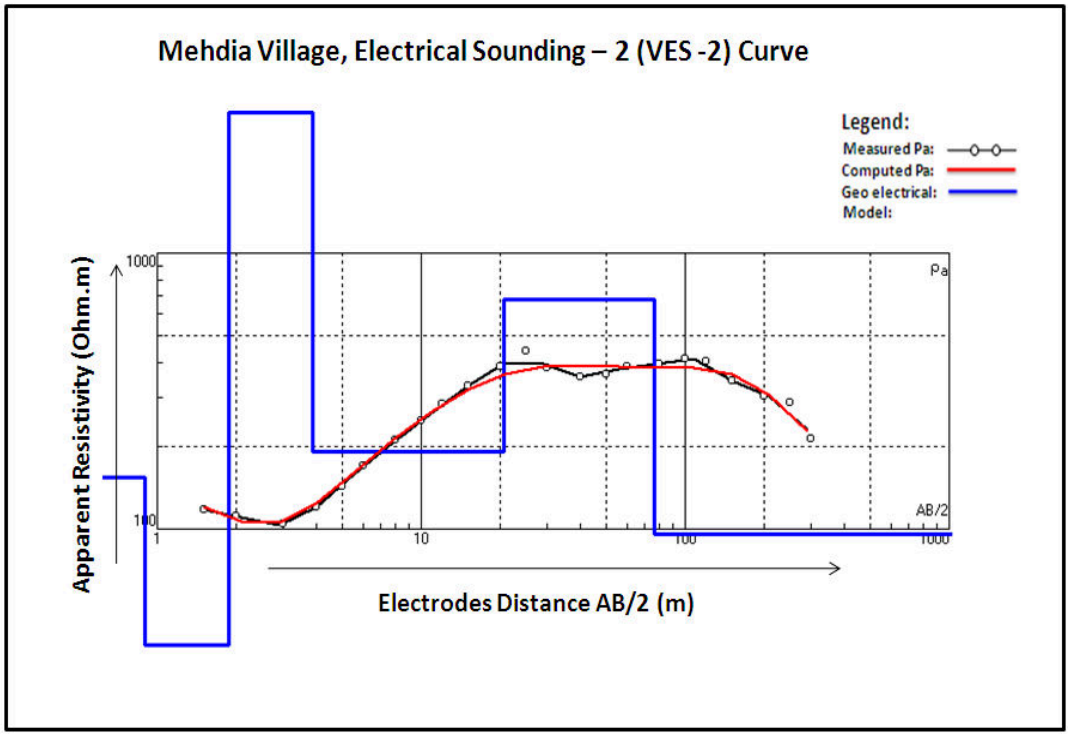


Figure 8 VES#2 Curves

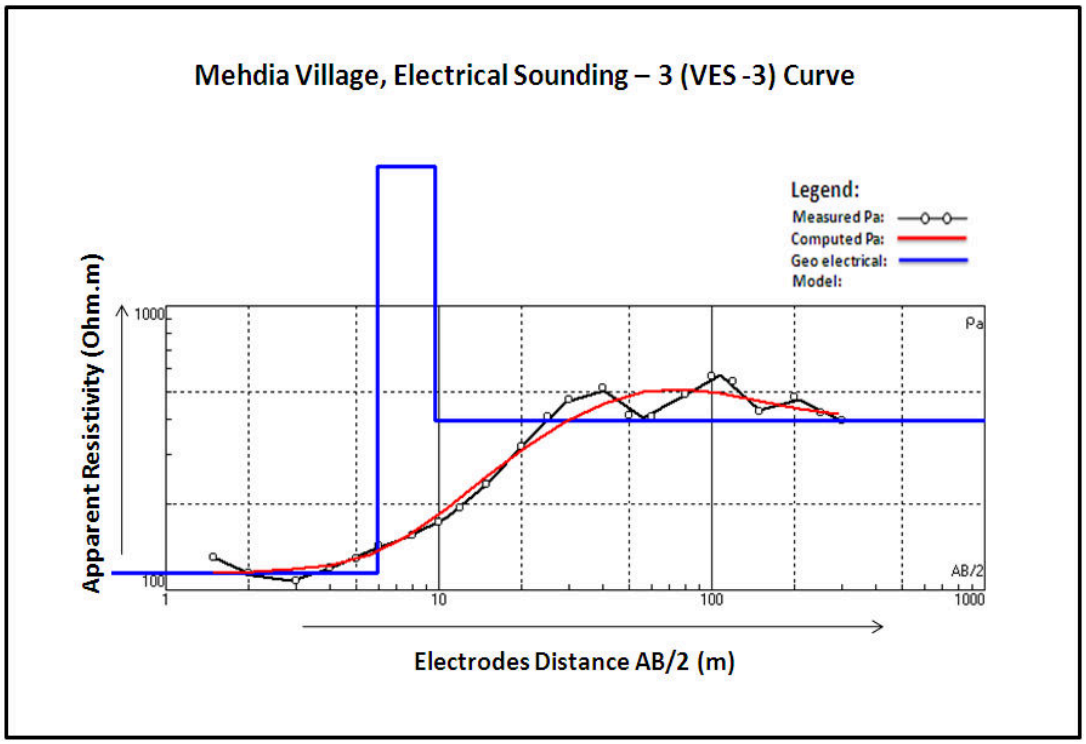


Figure 9 VES#3 Curves

5. Conclusion

The measured, computed apparent resistivity and geo electrical curves show:

- The field data graphic interpretation of profiles VES-1 and VES-2 show that the marl and limestone formation has fracture water. The water table ranges between 76 - 92m. The water is fresh for drinking (table 4).

- The field data graphic interpretation of profiles VES-1 shows that the upper part and deeper part of formation don't have water (table 4).

6. Recommendation

- The Sarband-i-Haji Talabai village (study area) is one of problematic area due to having deep fracture groundwater and hard strata (see VES 1 in table 4). There is no possibility to for an easy solution and therefore this area is not suitable for a tube well.
- In VES 2 table 4 of the same area the water table ranges between 76-92m and the water is fresh according to the field data graphic interpretation (table 4 and figures 7, 8 and 9).
- The discharge of groundwater couldn't be determined by this study (Geophysical survey). We couldn't find any information about hydraulic properties of groundwater in this area.
- The discharge of a well can be determined after construction of a tube well and thereafter performing a pump test. In this village no tube well is available for provision of safe drinking water and therefore the geophysical investigation results cannot be correlated. At present the people are mainly collecting their drinking water from Balkhab River which flows near to this village. The water of this river is muddy during winter and spring and polluted during summer and fall.
- It is suggested to drill an observation well to the depth of 135m then to make a pump test before installation of pipe and screen, if the well produces enough water for serving a pipe scheme then install pipe and screen.