



Geophysical Study in Tangi Returnee Camp, Behsud District of Nangarhar 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

The Tangi returnee camp is located in Behsud district of Nangrahar province. This area is a narrow valley surrounded by mountains and small alluvium hills. There is not accessible surface water, therefore the groundwater is the only source of drinking water, but there is unfortunately of low potential for development drinking water due to low recharge and complex hydrogeological condition. There is an urgent need to provide drinking water for the inhabitants of this returnee camp, therefore an investigation for groundwater development was conducted. On 29-30 March 2011 DACAAR/WASH Programme performed a Vertical Electrical Sounding (VES) survey in Tangi 2 and Tangi 3 areas using Shlumberger electrodes arrangement. The field data were measured by SYSCAL Pro resistivity meter and the data interpreted by IPI2 win software. The field data, interpreted data, measured and computed resistivity curves are enclosed with this report.

2. Geologic setting

The main geologic formation of the area is:

- Early Proterozoic metamorphic rocks (gneiss, shiest, amphibolites, quartzite and marble with intercalation of intrusive rocks (diorites and granodiorites)
- Late Quaternary and recent rocks gravel sand somewhat clay cobbles and boulders.

For more information consider the Geology of North Eastern Afghanistan (Fig.1)

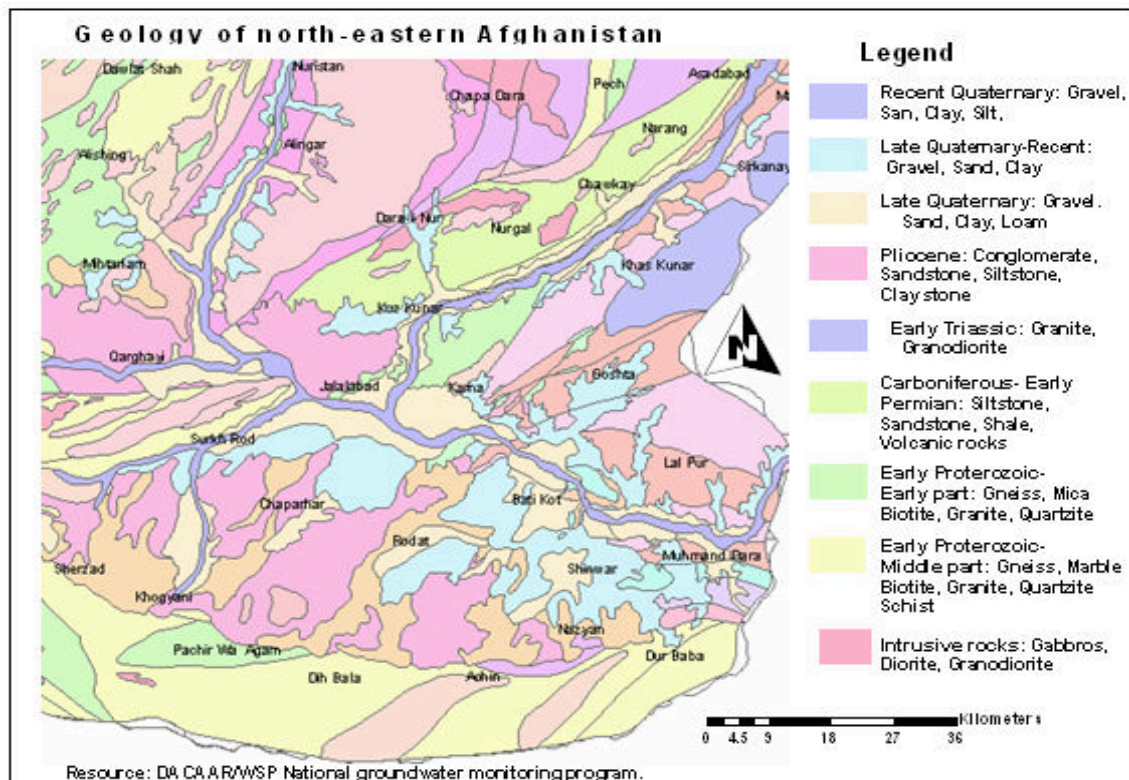


Fig. 1, Geology of North-Eastern Afghanistan

3. Hydro geologic setting

The Tangi area is mainly surrounded by mountains and alluvium small hills. The narrow valley is filled with sedimentary deposits (gravel, sand and somewhat clay, pebbles, cobbles and boulders). The sedimentary deposits are underlined by Proterozoic metamorphic rocks. The water table ranges from 45m to 75m. The discharge of wells is between 0.5-1.0 l/s.

A Tangi natural groundwater system is characterized by two hydrogeologic units:

- Early Proterozoic metamorphic rocks (Gneiss, shiest, amphibolites, quartzite and marble) with intercalation of intrusive rocks (diorites and granodiorites) as fracture water.
- Late Quaternary and Recent Rocks (deterital sediments, gravel sand somewhat clay cobbles and boulders)

Both aquifer systems have very poor groundwater possibility for groundwater development due to poor recharge and complex geologic and hydrogeological condition.

The geological structure and hydrogeological conditions of this area are illustrated in Fig.2, Fig.3, Fig.4, Fig.5 and Fig.6.

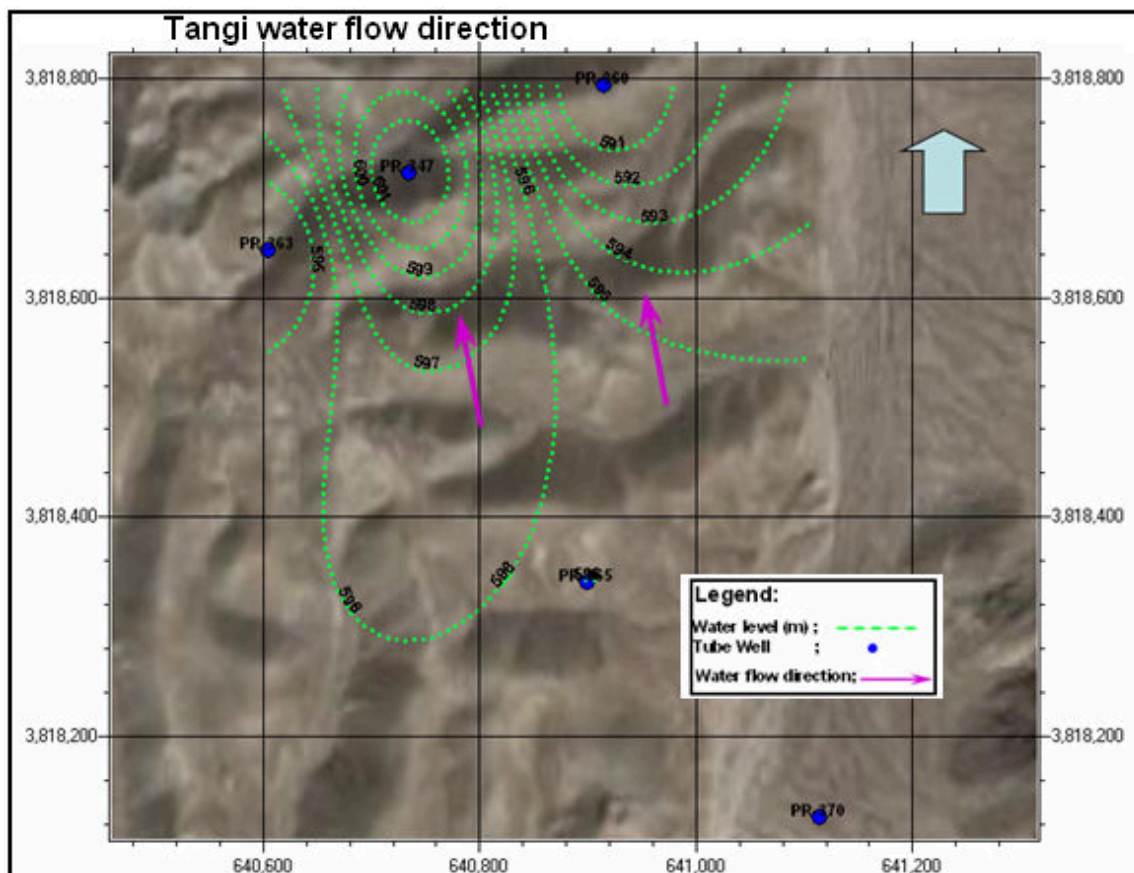


Fig.2, Water table contours and water flow direction (Tangi returnee camp)

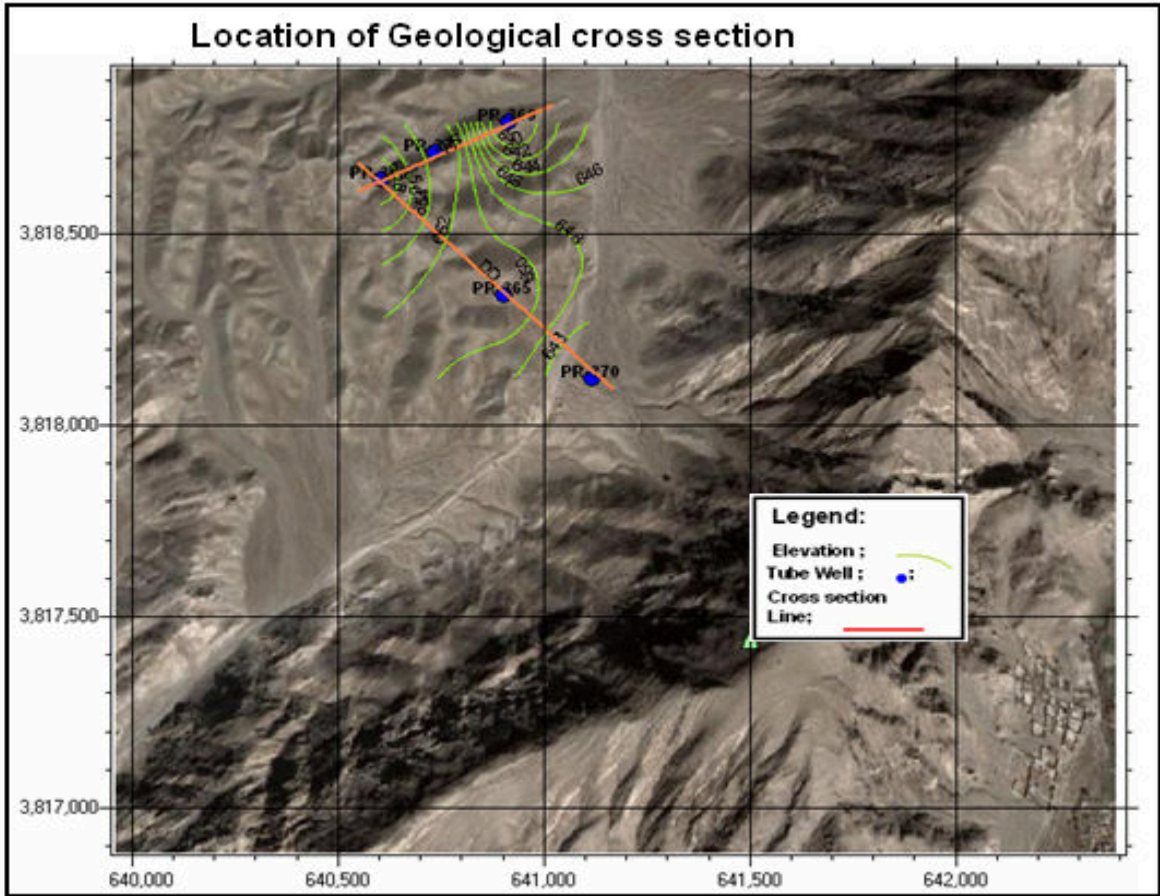


Fig.3, 1-D Geologic cross section lines and elevation contours

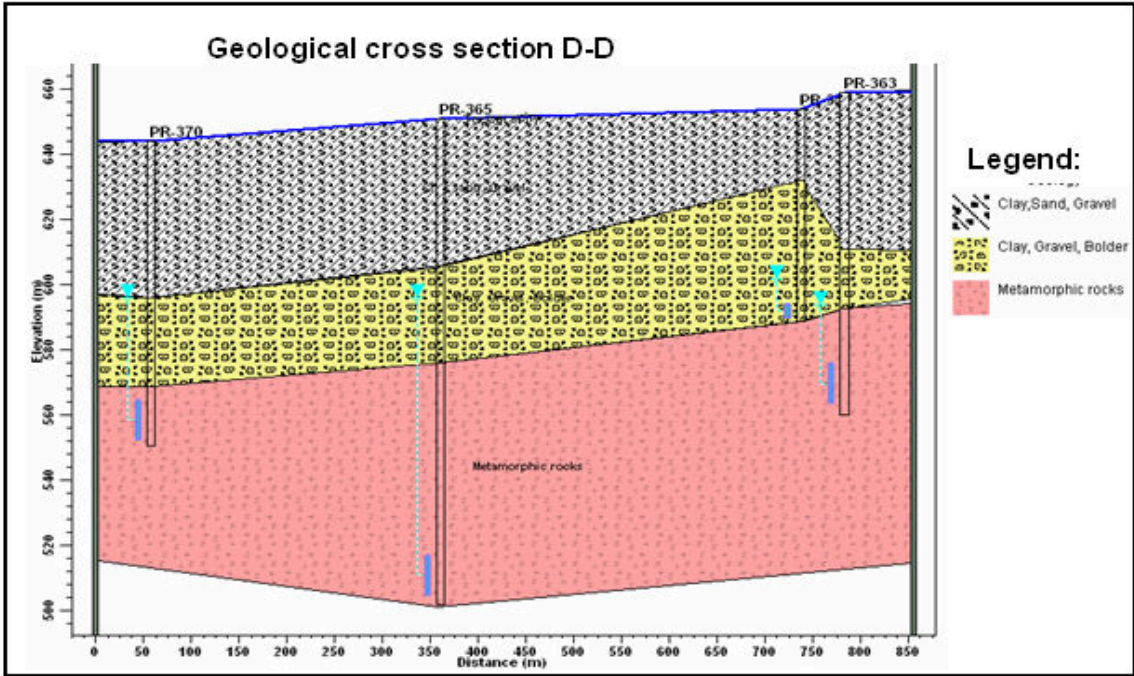


Fig.4, 1-D Geologic cross section (D-D)

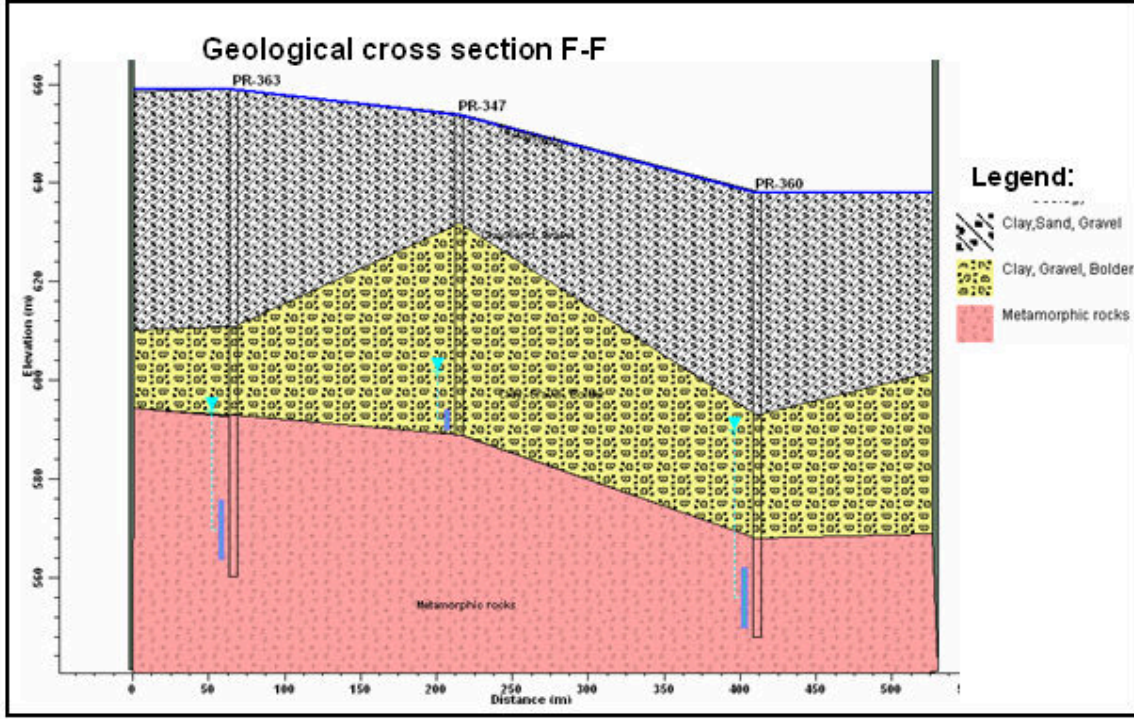


Fig.5, 1-D Geologic cross section (F-F)

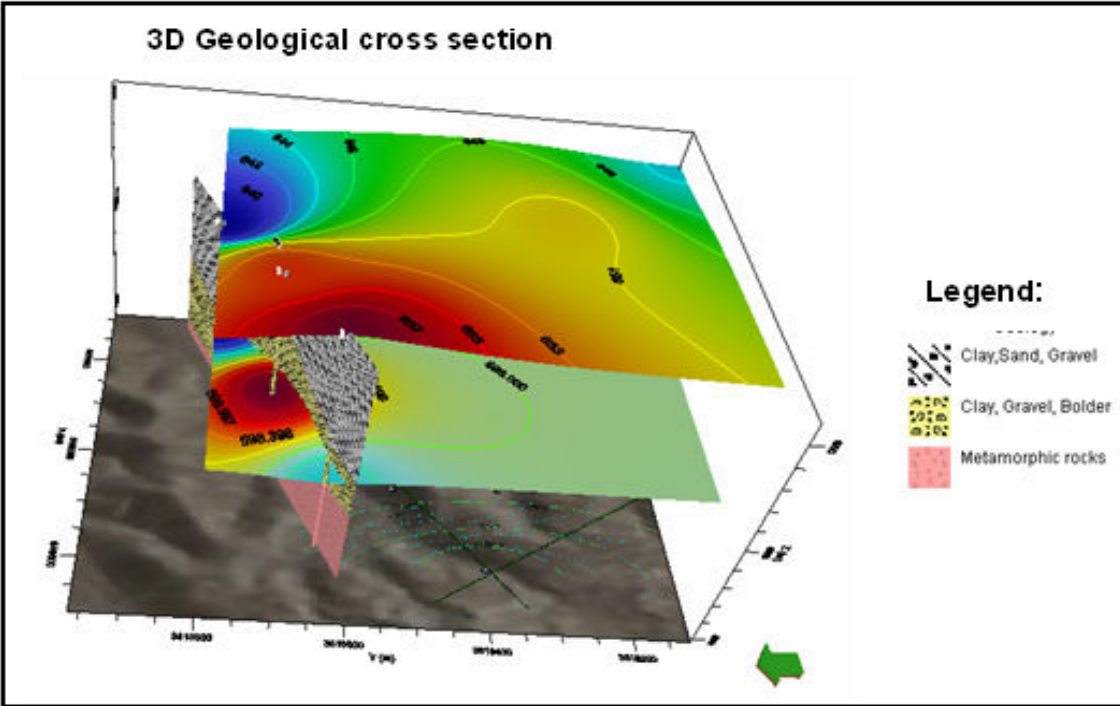


Fig.6, 3-D Geologic cross section

4. Vertical Electrical sounding Survey

On 29-30 March the Vertical Electrical sounding (VES) survey was performed in Tangi 2 and Tangi 3 returnee camps where the drilled tube wells failed. Two VES surveys were performed in Tangi 2 area. The lengths (AB) of each VES electrodes spacing were 600 m.

4 VES surveys were performed in Tangi 3 area..The maximum lengths of each VES electrodes spacing were 600 m. The locations of VES are indicated in Fig.7.



Fig.7, Location of Vertical Electrical Sounding

4.1. Measured field data

The field data were measured by SYSCAL Pro resistivity meter and the measured data are shown in Table 1, Table 2 and Table 3.

Table 1, VES-1 and VES-2 measured field data (Tangi 2)

VES-1 Tangi 2						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	211.652	6.8	528.378	15.679	13.7
2	0.5	217.908	8.6	397.518	21.491	24.7
3	0.5	216.227	9.6	222.812	28.325	56.2
4	0.5	240.32	6.4	200.535	41.29	100
5	0.5	246.795	4.2	69.592	21.927	157
6	0.5	218.049	3.5	42.631	21.958	226
8	0.5	271.304	2.1	39.562	29.207	402
8	2	190.339	12.6	82.605	20.419	99
10	2	153.998	12.7	26.871	13.155	156
12	2	114.12	13.1	9.371	9.021	225
15	2	74.726	14.1	4.917	11.439	352
20	2	43.88	16.1	3.182	22.549	627
20	5	43.755	61.5	8.451	22.772	247
25	5	30.7	44.8	1.73	10.642	389
30	5	22.443	40.6	0.981	12.003	562
40	5	20.475	33.4	1.042	25.113	1001
50	10	23.125	26.7	0.156	5.82	778
50	10	21.186	15.1	0.347	5.794	778
60	10	28.571	18.3	0.435	8.491	1123
80	10	38.131	22.1	2.328	58.797	2003
100	10	45.77	23	1.135	36.893	3134
120	10	48.188	22.1	0.315	14.028	4516
120	25	52.198	63.7	0.92	15.176	1790
150	25	57.589	70.1	0.958	22.861	2808
200	25	71.17	62.5	0.979	33.536	5007
250	25	89.00	53.8	0.625	27.433	7834
300	25	105	46.7	0.734	38.837	11290

VES-2 Tangi 2						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	178.74	5.5	2865.796	100.742	13.7
2	0.5	229.37	28.7	1492.828	76.675	24.7
3	0.5	267.66	22.8	294.255	30.221	56.2
4	0.5	256.56	14.2	182.824	35.26	100
5	0.5	253.68	15.6	149.475	45.814	157
6	0.5	235.71	12.9	77.11	36.742	226
8	0.5	200.12	15.9	42.457	42.49	402
8	2	172.74	20.6	159.997	43.648	99
10	2	134.98	43.8	81.604	45.582	156
12	2	109.34	47.6	31.451	31.627	225
15	2	75.27	47.3	22.413	51.683	352
20	2	35.47	45.1	2.358	20.676	627
20	5	44.54	20.5	7.898	20.89	247
25	5	28.26	48.4	2.691	17.95	389
30	5	22.48	48.6	2.763	33.777	562
40	5	18.67	44.6	0.974	25.808	1001
50	10	20.51	61.1	1.071	19.68	778
50	10	22.77	58.8	1.431	34.542	778
60	10	28.89	49.6	1.246	42.69	1123
80	10	49.02	34.9	2.818	89.395	2003
100	10	40.84	18	0.913	50.218	3134
120	10	37.99	16.2	2.27	51.722	4516
120	25	44.16	17.3	0.75	23.349	1790
150	25	70.91	13.3	0.14	4.873	2808
200	25	45.24	7.6	0.374	20.464	5007
250	25	42.67	7.4	0.353	32.135	7834
300	25	39.276	7.4	0.353	32.135	11290

Table 2, VES-1 and VES-2 measured field data (Tangi 3)

VES-1 Tangi 3						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	240.998				13.7
2	0.5	262.814				24.7
3	0.5	281.683				56.2
4	0.5	292.068				100
5	0.5	324.536				157
6	0.5	349.108				226
8	0.5	344.697				402
8	2	362.448				99
10	2	316.228				156
12	2	247.974				225
15	2	160.5454				352
20	2	76.91				627
20	5	88.545				247
25	5	50.982				389
30	5	32.619				562
40	5	22.831				1001
50	10	17.4				778
50	10	19.362				778
60	10	19.2				1123
80	10	17.814				2003
100	10	13.511				3134
120	10	13.67				4516
120	25	17.356				1790
150	25	14.553				2808
200	25					5007
250	25					7834
300	25					11290

VES-2 Tangi 3						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	295	60.1	1013.657	21.567	13.7
2	0.5	315.333	71.6	489.704	18.296	24.7
3	0.5	351.067	64.9	355.508	27.837	56.2
4	0.5	348.111	65.8	61.844	8.785	100
5	0.5	349.807	67.8	98.545	21.905	157
6	0.5	335.25	69.1	43.721	14.644	226
8	0.5	260.383	68.4	36.531	28.106	402
8	2	270.96	0.9	147.383	25.625	99
10	2	224.359	9.8	66.159	22.241	156
12	2	181.83	24.2	31.004	18.773	225
15	2	119.121	29.6	25.775	37.374	352
20	2	62.52	33.1	2.424	12.079	627
20	5	71.629	8.5	7.334	12.029	247
25	5	46.369	17.6	5.031	20.507	389
30	5	29.139	22.4	1.828	17.3	562
40	5	21.118	24.4	2.272	53.603	1001
50	10	20.478	24.2	0.637	24.376	778
50	10	20.743	39.6	1.375	25.063	778
60	10	21.179	39.2	1.375	36.323	1123
80	10	19.811	33.4	0.186	9.254	2003
100	10	15.421	21.8	0.072	7.97	3134
120	10	19.924	14	0.369	43.351	4516
120	25	17.844	68.8	0.915	43.669	1790
150	25	23.175	93.6	0.566	34.103	2808
200	25					5007
250	25					7834
300	25					11290

Table 3, VES-3 and VES-4 measured field data (Tangi 3)

VES-3 Tangi 3						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	228.5	66.7	1875.62	51.547	13.7
2	0.5	272.447	42.8	1015.04	43.892	24.7
3	0.5	367	45.3	250.59	18.757	56.2
4	0.5	355.074	38.7	70.368	9.806	100
5	0.5	339.707	36.5	74.891	17.141	157
6	0.5	230.811	34.8	13.754	4.819	226
8	0.5	357.77	33.2	15.81	12.995	402
8	2	210.964	37.4	60.877	13.595	99
10	2	175.51	15	36.799	15.816	156
12	2	146.477	3.7	22.447	16.851	225
15	2	98.513	4.8	9.398	16.566	352
20	2	51.292	9.9	4.825	29.28	627
20	5	58.823	71.4	15.19	30.411	247
25	5	39.575	65.5	2.867	13.647	389
30	5	25.476	59.2	1.427	15.174	562
40	5	17.48	54	0.249	6.644	1001
50	10	18.915	48.8	0.286	12.432	778
50	10	19.768	107	0.679	13.035	778
60	10	19.5	103	0.267	7.689	1123
80	10	18.93	99.9	0.113	6.008	2003
100	10	17.125	94.1	0.322	27.967	3134
120	10	18.58	82.6	0.159	20.12	4516
120	25	16.329	87	0.381	20.175	1790
150	25	19.912	61.8	0.206	14.213	2808
200	25					5007
250	25					7834
300	25					11290

VES-4 Tangi 3						
AB/2	MN/2	Rho (ohm.m)	Sp (mV)	Vp (mV)	In (mA)	K (m)
1.5	0.5	317.365	46.4	1169.609	23.155	13.7
2	0.5	340	39.2	784.593	27.179	24.7
3	0.5	370.789	45.5	93.784	6.953	56.2
4	0.5	387	42	178.723	22.819	100
5	0.5	374.869	43	61.62	12.816	157
6	0.5	353.279	42.4	65.343	20.766	226
8	0.5	316.502	36.2	24.103	14.197	402
8	2	317.16	17.9	59.701	8.87	99
10	2	245.304	35.1	55.44	16.998	156
12	2	194.134	33.5	93.658	53.044	225
15	2	126.501	32.8	7.663	10.478	352
20	2	65.289	32.9	7.02	33.311	627
20	5	76.119	21.2	21.996	34.107	247
25	5	43.577	23.2	4.084	17.652	389
30	5	30.417	24.1	3.414	30.899	562
40	5	21.494	24.7	1.431	32.861	1001
50	10	19.309	25.1	1.033	41.86	778
50	10	20.129	52.9	2.222	41.732	778
60	10	17.763	44.9	1.112	33.891	1123
80	10	18.514	36.6	0.953	51.371	2003
100	10	16.738	28	0.209	19.518	3134
120	10	13.22	20.7	0.047	7.758	4516
120	25	14	3.9	0.075	4.511	1790
150	25	18.99	8	0.095	6.869	2808
200	25	20.43	8.2	0.106	12.642	5007
250	25	20.42	6.2	0.054	9.426	7834
300	25	21.43	6.5	0.05	14.257	11290

4.2 Interpreted data

The measured field data were interpreted by IPI2 win software. The interpreted data was used to calculate apparent resistivity, thickness, depth and boundaries of layers of rocks. The interpreted data are shown in Table 4 and Table 5.

Table 4, VES -1 and VES-2 interpreted data (Tangi 2)

No	Site and Direction of Surveying	Vertical Electrical Resistivity Survey in Tangi 2				Converging of evidences and geological interpretation
		App-Resistivity (Ohm-m)	Layer	Thickness (m)	Depth (m)	
1	VES -1 Tangi -2 Lat: 34.49716 Lon: 70.35748	203	1	2.05	2.05	Dry Sand, Gravel
		671	2	1.53	3.58	Dry Sand, Gravel , Bolder and somewhat silt clay and clay
		15.2	3	30.3	33.9	Sand and Gravel (Poor aquifer)
		268	4		>33.9	Metamorphic Rock (Probably Fracture water)
2	VES -2 Tangi -2 Lat: 34.49774 Lon: 70.53721	120	1	0.75	0.75	Dry Sand, Gravel
		430	2	0.406	1.16	Dry Sand, Gravel
		134	3	5.14	6.3	Gravel, Boulder , Pebble (Dry)
		10.1	4	55	61.3	Sand and Gravel (Poor aquifer)
		434	5	12	71.3	Weathered deposits (Poor aquifer)
		450	6		>71.3	Metamorphic Rock (Probably Fracture water)

Table 5, VES -1, VES-2, VES-3 and VES-4 interpreted data (Tangi 3)

No	Site and Direction of Surveying	Vertical Electrical Resistivity Survey in Tangi 3				Converging of evidences and geological interpretation
		App-Resistivity (Ohm-m)	Layer	Thickness (m)	Depth (m)	
1	VES -1 Tangi -3 Lat: 34.50367 Lon: 70.53532	378	1	1.68	1.68	Dry Sand, Gravel
		1963	2	1.72	3.39	Dry Sand, Gravel , Bolder and somewhat silt clay and clay
		27.3	3	45.6	49	Sand and Gravel (water level)
		10.3	4		>49	Weathering sediments (poor aquifer)
2	VES -2 Tangi -3 Lat: 34.50356 Lon: 70.53527	277	1	0.75	0.75	Dry Sand and Gravel
		444	2	4.63	5.38	Dry Sand, Gravel , Bolder and somewhat silt clay and clay
		19.8	3	37.7	43.1	Sand and Gravel (water level)
		4.37	4	22.7	65.7	Weathering Sediments (poor aquifer)
		1672	5		>65.7	Metamorphic Rocks(probably fracture water)
3	VES -3 Tangi- 3 Lat: 34.50303 Lon: 70.53580	110	1	0.75	0.75	Dry Sand and Gravel
		297	2	4.7	5.45	Dry Sand, Gravel , Bolder and somewhat silt clay and clay
		14.8	3	113	139	Sand and Gravel (poor aquifer)
		2802	4		>139	Metamorphic Rocks
4	VES -4 Tangi-3 Lat: 34.50367 Lon: 70.53544	349	1	0.821	0.821	Dry Sand and Gravel
		612	2	4.41	5.23	Dry Sand, Gravel , Bolder and somewhat silt clay and clay
		24.3	3	27.9	33.1	Sand and Gravel
		11	4	38.5	71.6	Sand and Gravel somewhat silt
		26.6	5		>71.6	Sand and Gravel (poor aquifer)

4.3, Vertical Electrical Sounding data Graphic interpretation

The VES 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 2). The rock types were specified according to the computed apparent resistivity based on the geophysical interpretation principles (Table 2)

4.3.1, Tangi 2 VES data Graphic interpretation

Two VES (VES-1 and VES-2) surveys were performed in Tangi 2. The measured, computed apparent resistivity and geo electrical curves show: upper parts of the rock layers consist of dry sand, gravel and somewhat silt, clay, pebbles, cobbles and boulders; the middle parts of rocks layer consist of sand and gravel; and the lower parts of rock layers consist of weathered deposits and metamorphic rocks. The water table ranges from 50m to 65 m. The possibility of groundwater is increased from the south to the north. The thickness of sedimentary aquifer is very low and has poor groundwater. For more information refer to Table 1, Table 4, Fig. 8 and Fig.9.

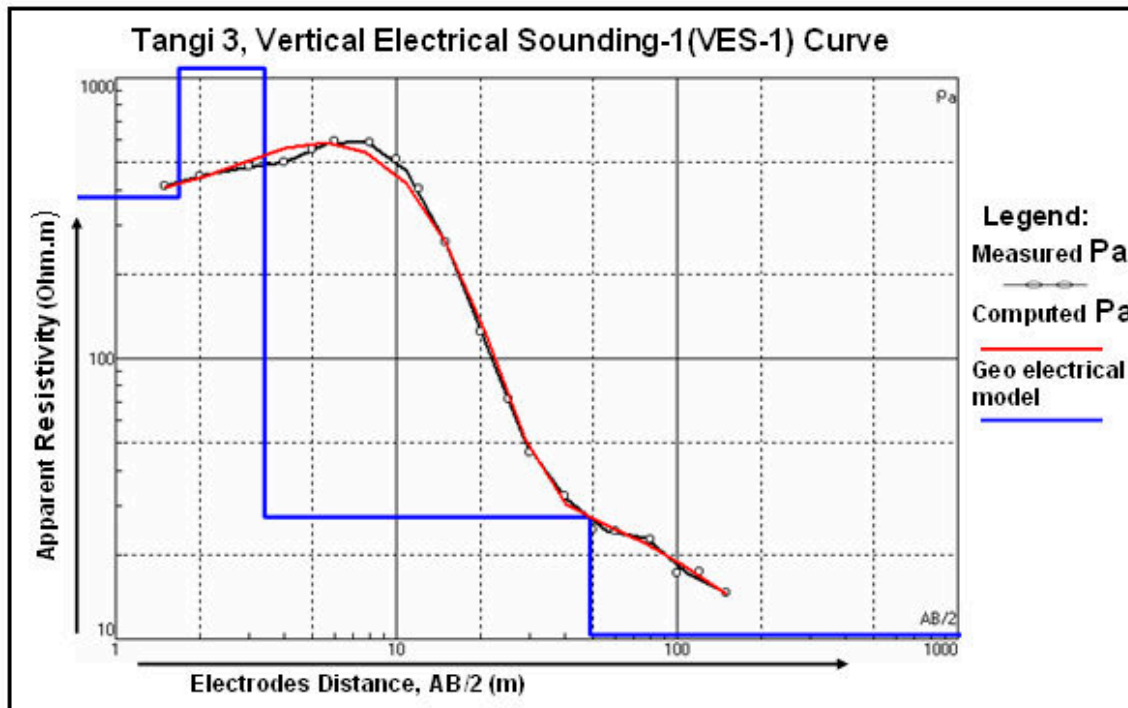


Fig. 8, VES-1 Curve

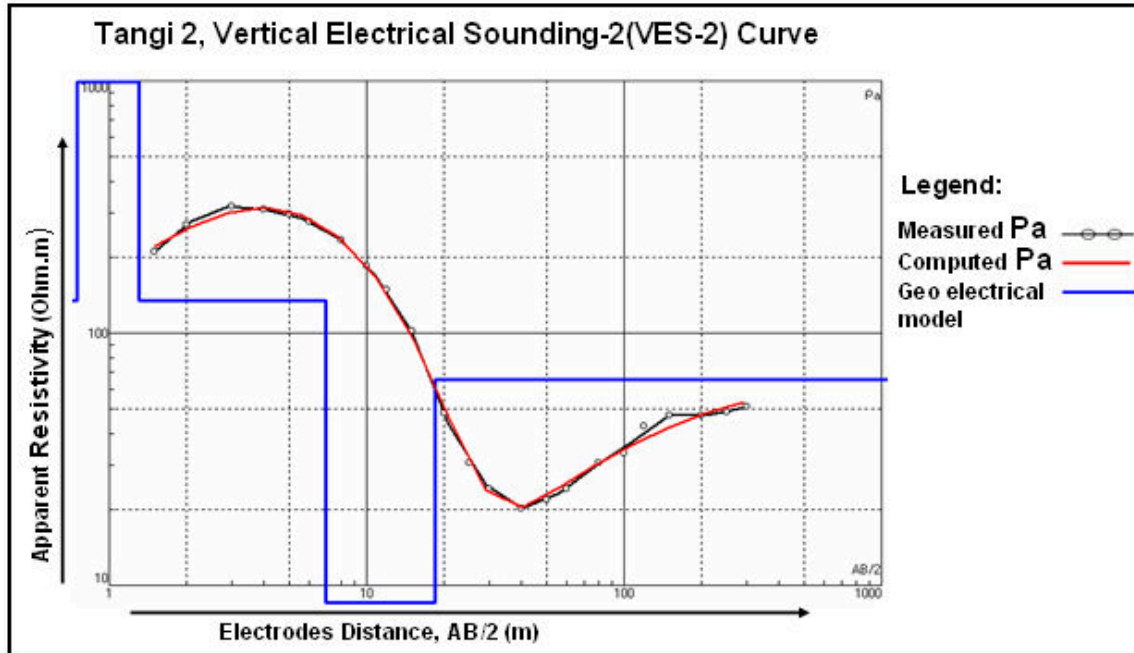


Fig. 9, VES-2 Curve

4.3.2, Tangi 3 VES data Graphic interpretation

4 VES surveys (VES-1, VES-2, VES-3 and VES-4) were performed in Tangi 3. The measured and computed apparent resistivity and geo electrical curves show: upper parts of the rock layers consist of dry sand, gravel and somewhat silt, clay, pebbles, cobbles and boulders; the middle parts of rocks layer consist of sand and gravel; and the lower parts of rock layers consist of weathered deposits and metamorphic rocks. The water table ranges from 40m to 55 m. The possibility of groundwater is increased from the north-west to the north-east. The thickness of sedimentary aquifer ranges from 25m to 40m and has poor groundwater. Tangi 3 has relatively better groundwater development possibility than Tangi 2. For more information refer to Table 2, Table 3, Fig. 10, Fig.11 and Fig.12.

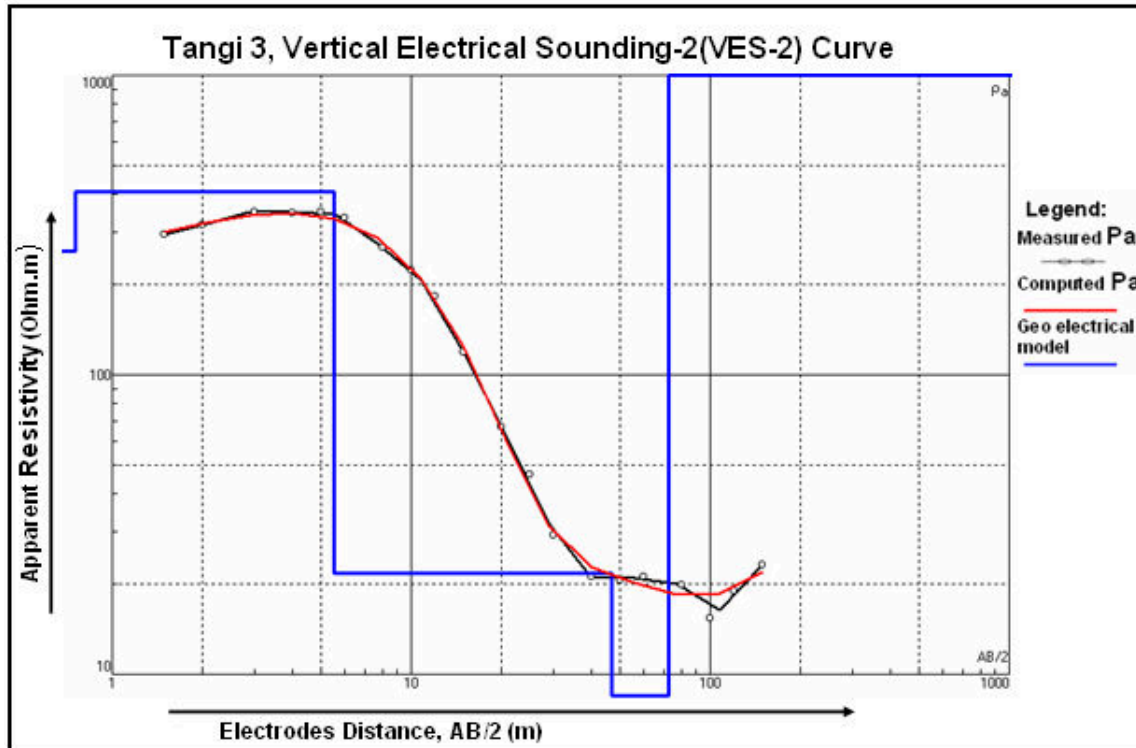


Fig. 10, VES-2 Curve

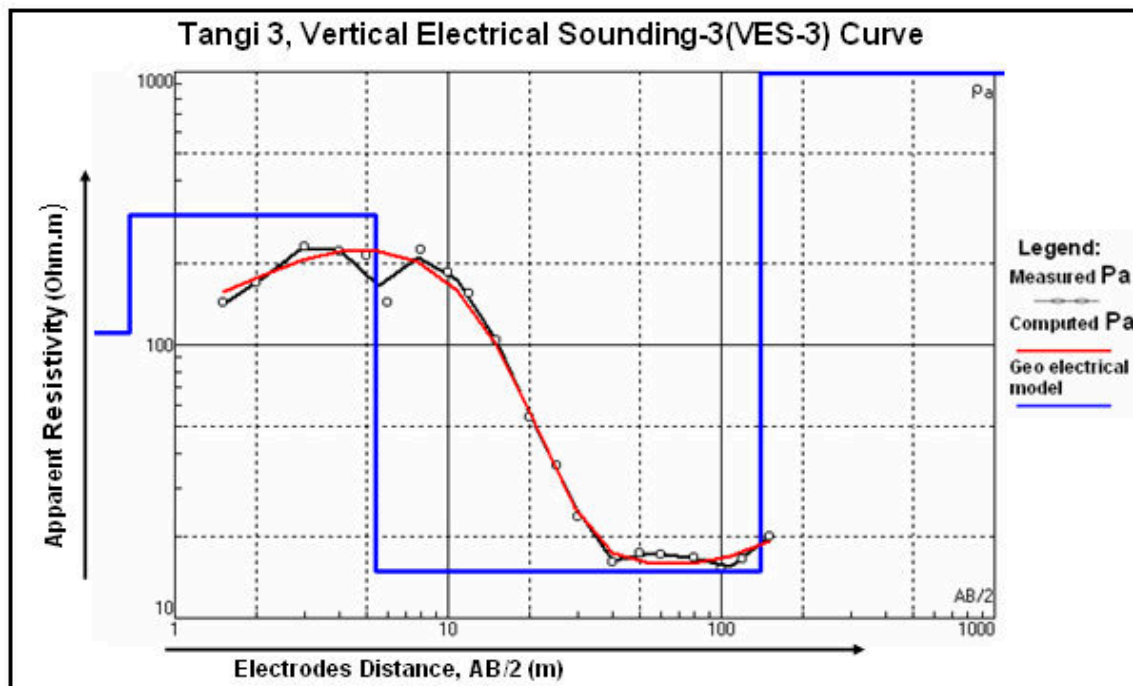


Fig. 11, VES-2 Curve

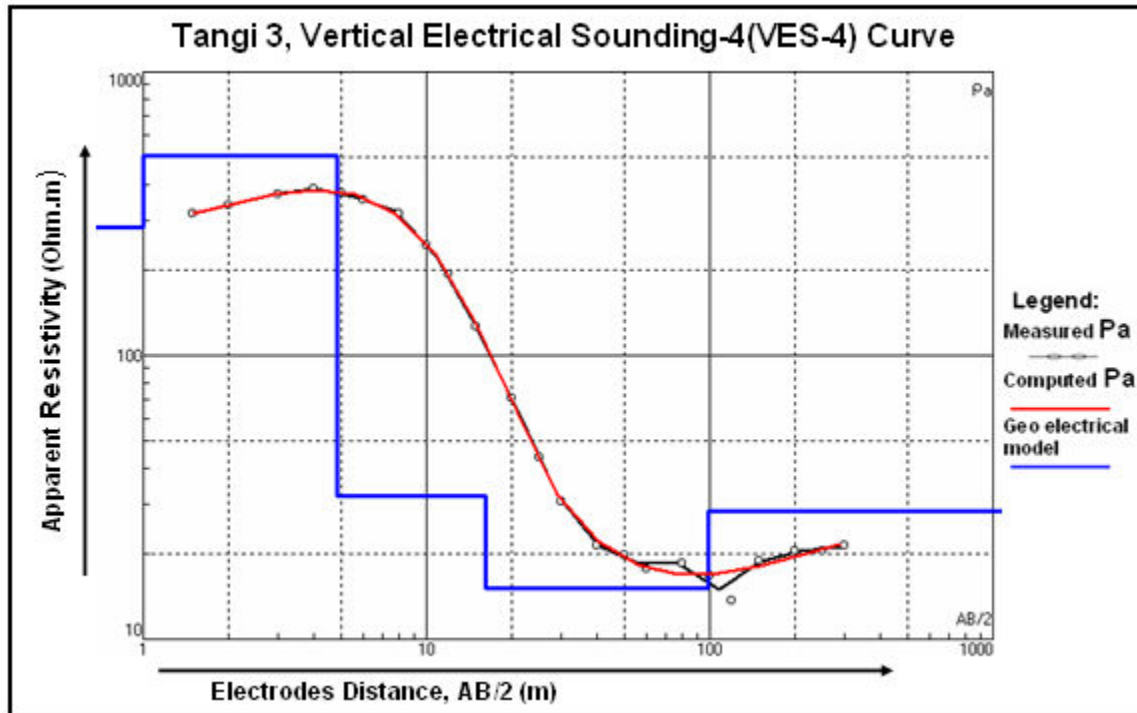


Fig. 12, VES-2 Curve

Conclusion

1. In Tangi 2, the measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:
 - The water table ranges from 50m to 65m.
 - The possibility of groundwater is increased from the south to the north.
 - The aquifer media is sedimentary deposits and metamorphic fractured rocks.
 - The thickness of sedimentary aquifer is very low and has poor groundwater.
 - The tube wells should be drilled 50m south of the failed drilled tube wells.
 - The maximum drilling depth of well should be 120m.
2. In Tangi 3, the measured apparent resistivity, computed resistivity and geo electrical model data interpretation show:
 - The water table ranges from 40m to 55m.
 - The possibility of groundwater is increased from the north-west to the north-east.
 - The aquifer media is sedimentary deposits and metamorphic fractured rocks
 - The thickness of sedimentary aquifer is very low and has poor groundwater.
 - The tube wells should be drilled to the north of the failed drilled tube wells.
 - The maximum drilling depth of well should be 120m.