CHAPTER 5 DRILLING SURVEY

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5.1 General

A drilling survey was performed for the principal purpose of identifying the geological structure and quality of groundwater in the Study area. Drilling points, which are shown in Figure 5.1 and Table 5.1, are located in Wadi Suq, Wadi Bani Umar al Gharbi, and Wadi Lasail and its trubutary.

The drilling survey to identify the geological structure was conducted by logging the boreholes designated DH-1A, DH-1B, DH-4G, DH-15G, DH-16, DH-16A and DH-16B. The drilling survey to characterize the hydrogeological conditions was conducted by recording hydrological and water quality parameters in the boreholes designated DH-1, DH-2, DH-3, DH-4, DH-5, DH-6, DH-7, DH-8, DH-9, DH-10, DH-11, DH-12, DH-13 and DH-14. , Shallow and deep holes were independently drilled at the locations designated DH-4, DH-5, DH-6, DH-7, DH-8 and DH-12 to identify aquifers of the shallow and deep formations, respectively. In each deep borehole, the hole was sealed by solid casing pipe at least as deep as the shallow hole. Piezometers were also installed on the up gradient side of both the upper and lower part of the wadi. The arrangement of the drilling investigation is shown in Figure 5.2.

Pumping tests were performed at each hole designated DH-1～DH-14 to gather hydrogeological data . Water samples were also collected for water quality analysis twice during the study, once in July and once in November.

5.2 Geological Conditions

Geological columnar sections from each of the drilling holes for the geological investigation and the geological profile along Wadi Suq are presented in Figures 5.3 (1) to (12) and 5.4, respectively. The geology in the Study area is summarized in the following subsections of this report.

5.2.1 Upstream Area of Wadi Suq

The upstream area of Wadi Suq consists of the Effusive rocks, i.e. mainly basaltic rocks of the Ophiolite. In uppermost reaches of the wadi, tailing dam was constructed. Tailings have 30.20 to 30.65 m in thickness and Wadi Sediments can be found at the bottom of the tailings. Laminar layers are well developed in the tailings and consist of well-tightened silt to middle particle-sized sand with high pyrite content. In top the layer from 4 to 6 m of the tailings surface, porosity due to oxidation and leaching out of the pyrite can be found. However, in deeper parts, oxidized materials cannot be readily observed.

Basement rocks consist of weathered pillow lava of altered basaltic rocks with well-developed fissures. Permeability of the tailings seems to be relatively poor because they consist of well-compacted fine grained materials. On the other hand, the basaltic basement is presumed to have higher permeability

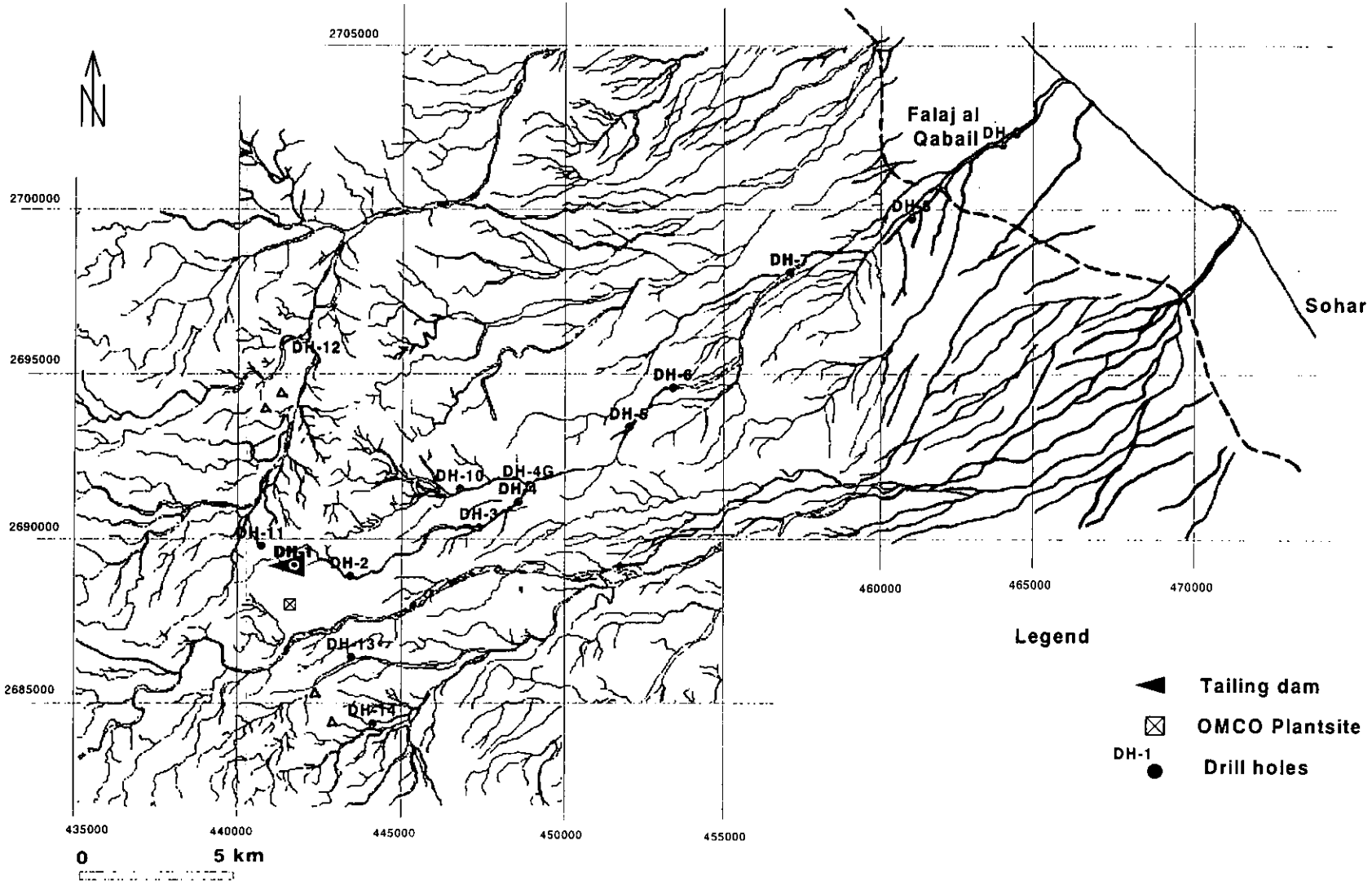


Figure 5.1 Location of Drill Holes in the Study Area

Table 5.1 Content of Drilling Survey

D.H. No. (PUL*1)		Location	Coordination (m)		Depth (m)	Pumping Test (R/R)*2	Water Sampling (Times)
			Northing	Easting			
DH-1	DH-1A	Wadi Suq (Tailing dam)	2689100	441575	50.60	R	2
	DH-1B	Wadi Suq (Tailing dam)	2689100	441525	31.50	R	2
DH-2		Wadi Suq	2688775	443410	50.00	P&R	2
DH-3		Wadi Suq	2690296	447454	30.00	P&R	2
DH-4	DH-4S	Wadi Suq	2691082	448674	18.00	R	2
	DH-4D	Wadi Suq	2691096	448688	50.00	R	2
	DH-4PUL	Wadi Suq	2691096	448688	30.00		2
	DH-4G	Wadi Suq	2691638	449025	30.00	-	-
DH-5	DH-5S	Wadi Suq	2688818	452155	18.00	R	2
	DH-5D	Wadi Suq	2693432	452170	60.00	R	2
	DH-5PUL	Wadi Suq	2693432	452170	30.00	-	-
DH-6	DH-6S	Wadi Suq	2699630	453525	30.00	R	2
	DH-6D	Wadi Suq	2699644	453545	60.00	R	2
	DH-6PUL	Wadi Suq	2699644	453545	30.00	-	-
DH-7	D-7S	Wadi Suq	2698205	457185	18.00	R	2
	D-7D	Wadi Suq	2698215	457202	60.00	R	2
	D-7PUL	Wadi Suq	2698215	457202	30.00	-	-
DH-8	DH-8S	Wadi Suq	2699852	461001	20.00	P&R	2
	DH-8D	Wadi Suq	2699866	461015	70.00	R	2
	DH-8PUL	Wadi Suq	2699866	461015	30.00	-	-
DH-9		Wadi Suq	2702145	463839	50.00	R	2
DH-10		Wadi Suq	2691505	446851	40.00	R	2
DH-11		Wadi Bani Umar	2689725	440635	30.00	P&R	2
DH-12	DH-12S	Wadi Bani Umar	2695470	442345	18.00	P&R	2
	DH-12D	Wadi Bani Umar	2695490	442342	50.00	R	2
	DH-12PUL	Wadi Bani Umar	2695490	442342	30.00	-	-
DH-13		Qadi Lasail	2686290	443455	50.00	R	2
DH-14		Wadi al Owainah	2684246	444123	50.00	R	2
DH-15		Wadi Suq (DH-6)	2694540	453627	37.50	-	2
DH-16	DH-16A	Wadi Suq (DH-7)	2698145	457370	42.20	-	-
	DH-16B	Wadi Suq (DH-7)	2697512	458170	40.50	-	-
	DH-16C	Wadi Suq (DH-8)	2699857	461016	50.10	-	-

*1 : P :Piezometer, U :Upper, L :Lower

*2 : P :Pumping test, R :Recovery test

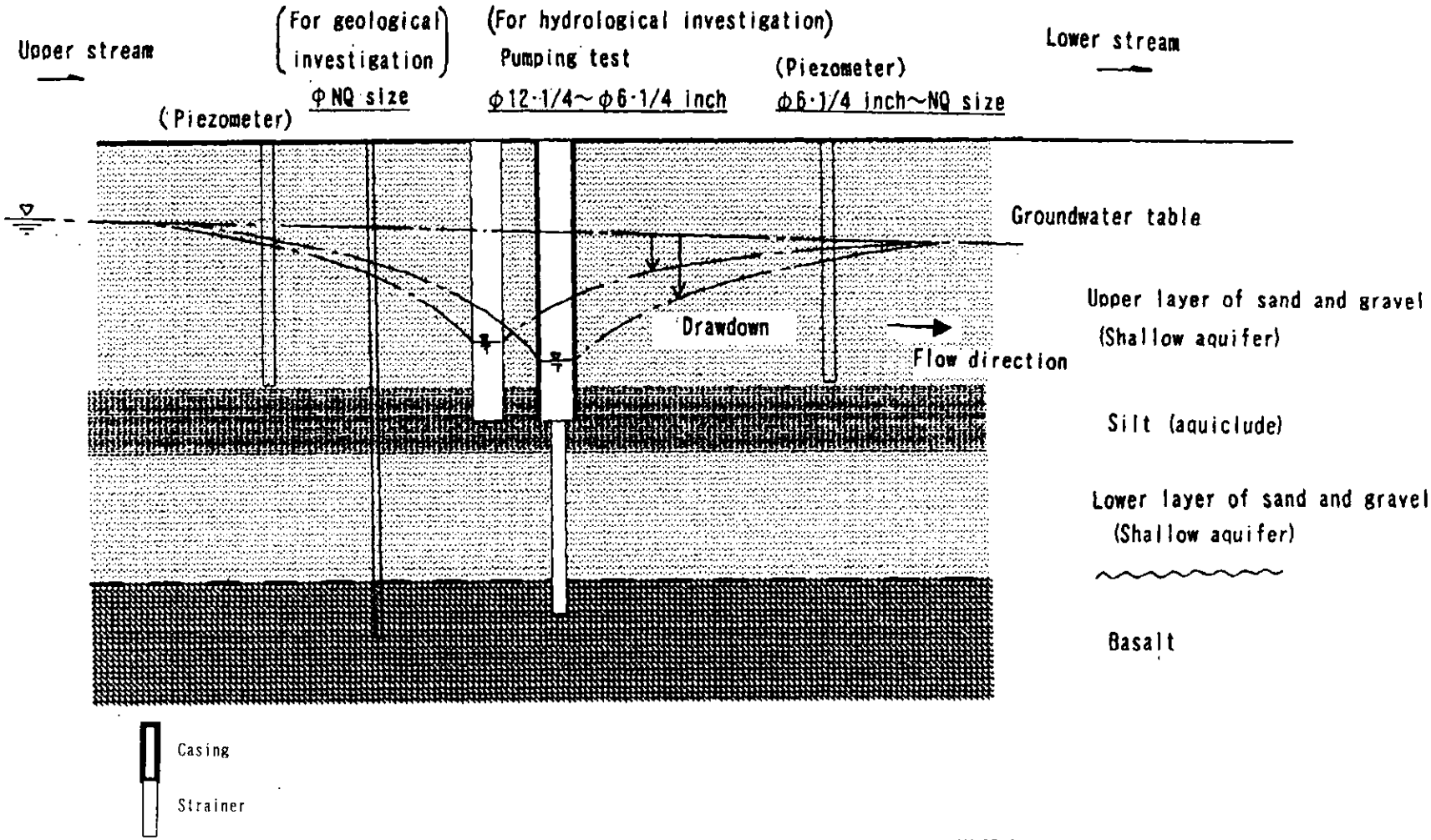


Figure 5.2 Arrangement of Shallow and Deep Drill Holes

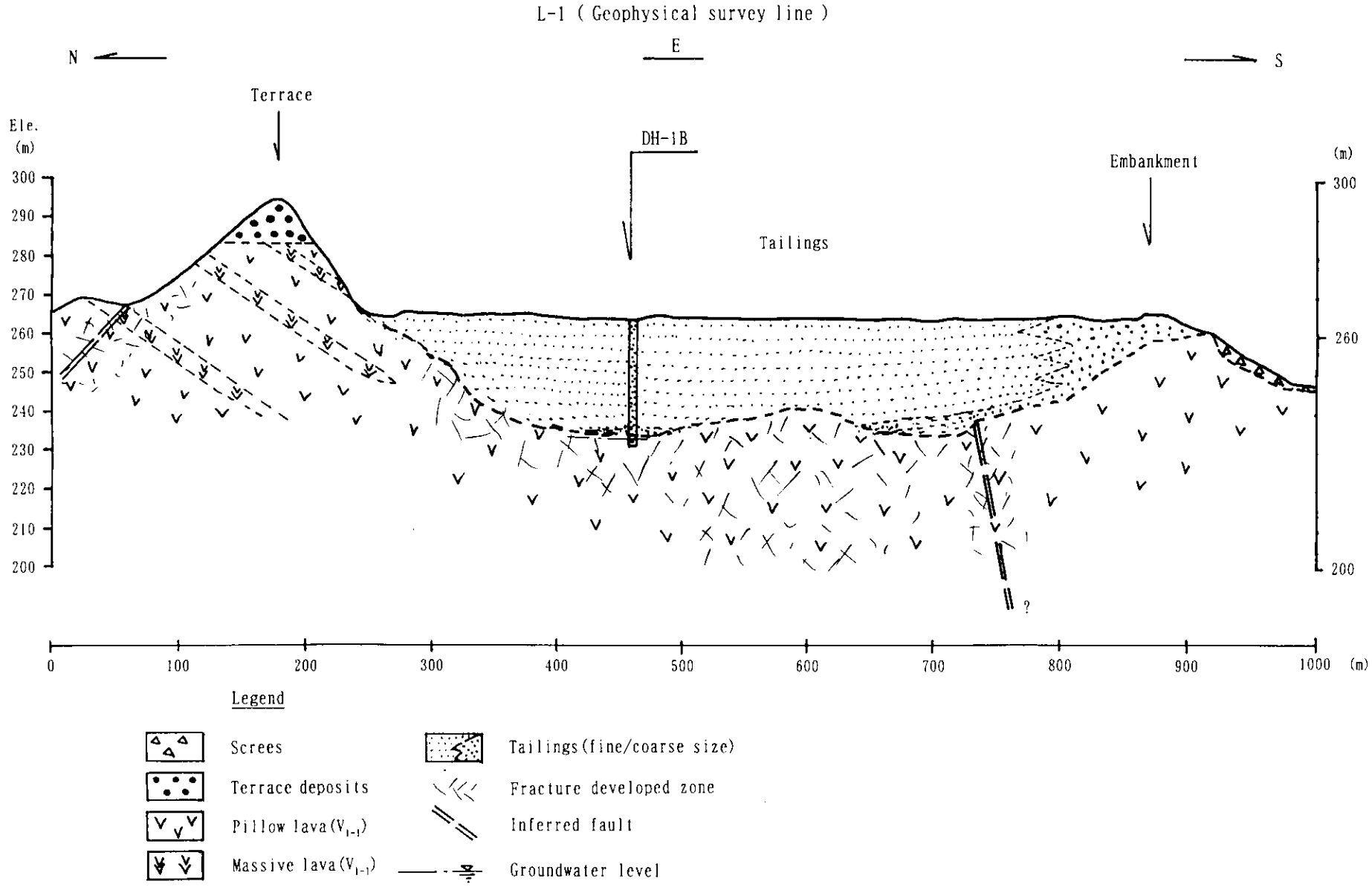
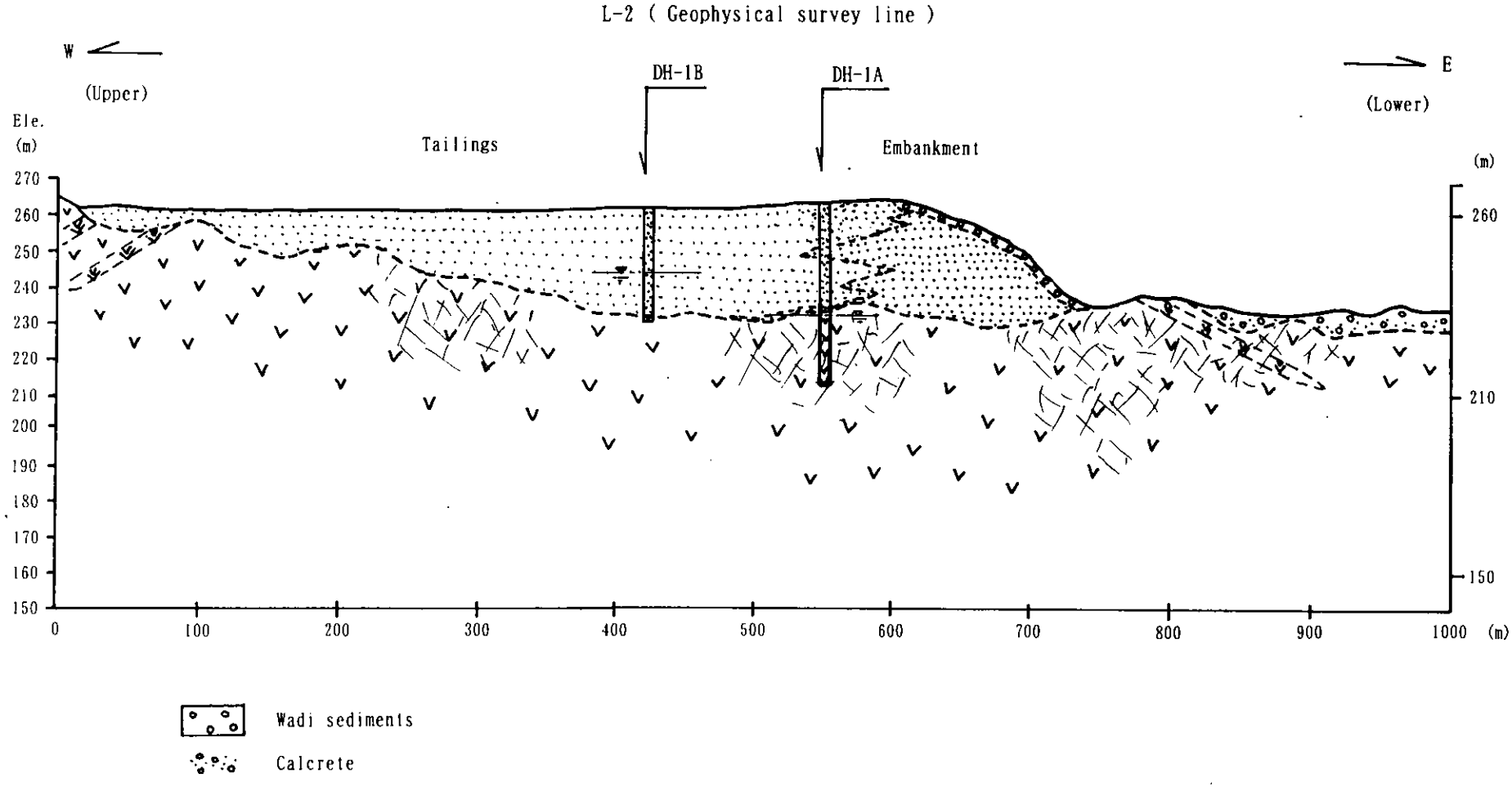
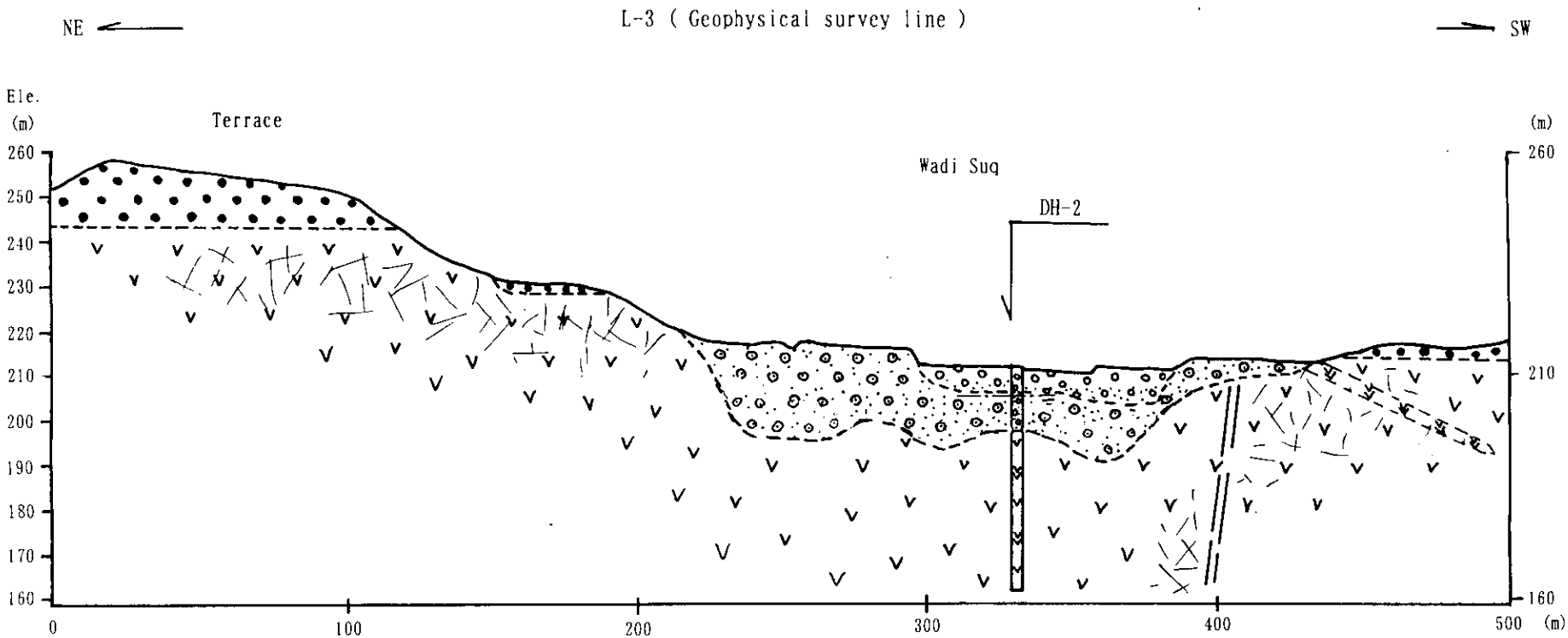


Figure 5.3 Geological Section of Drill Holes (1)



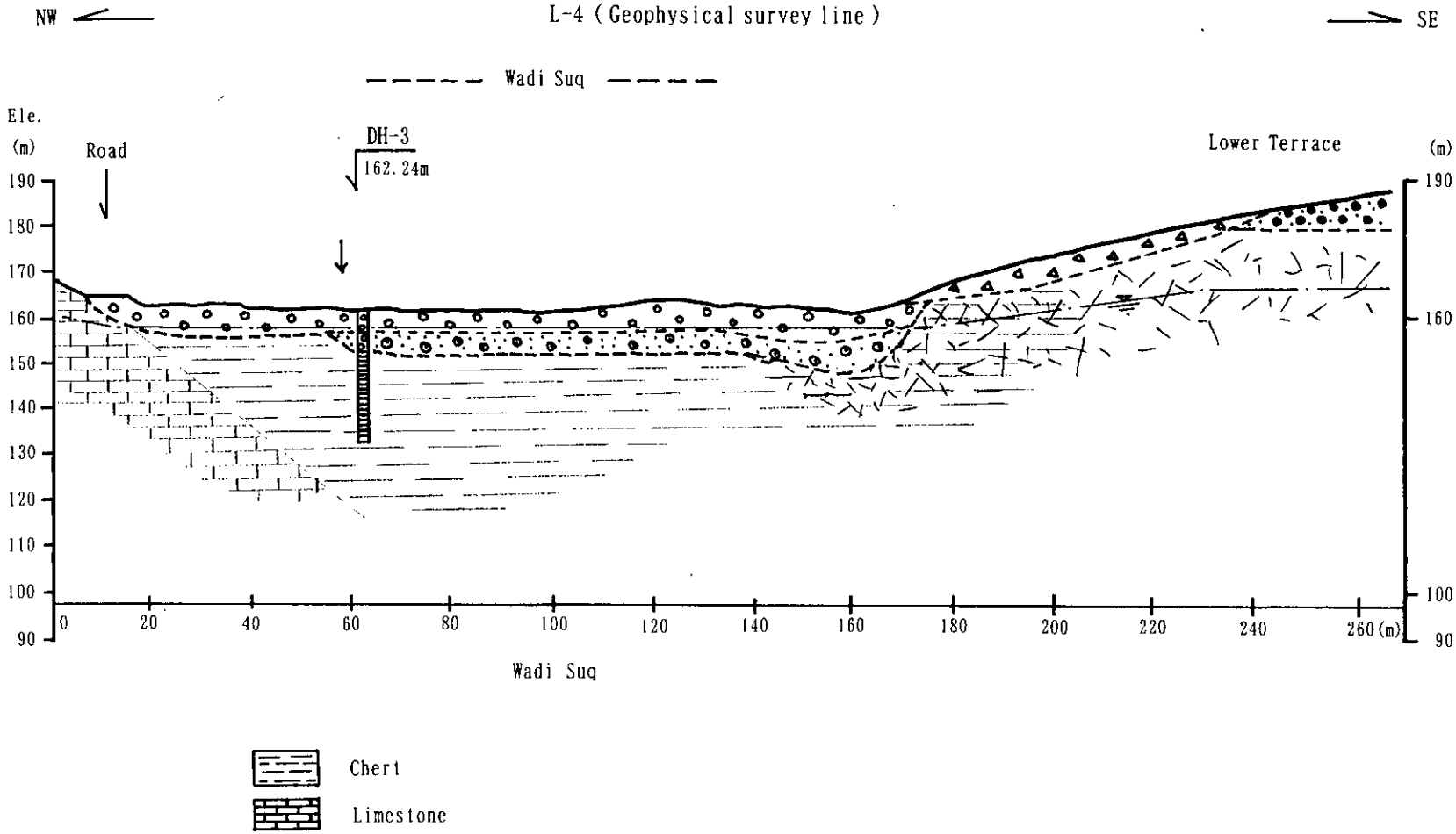
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (2)



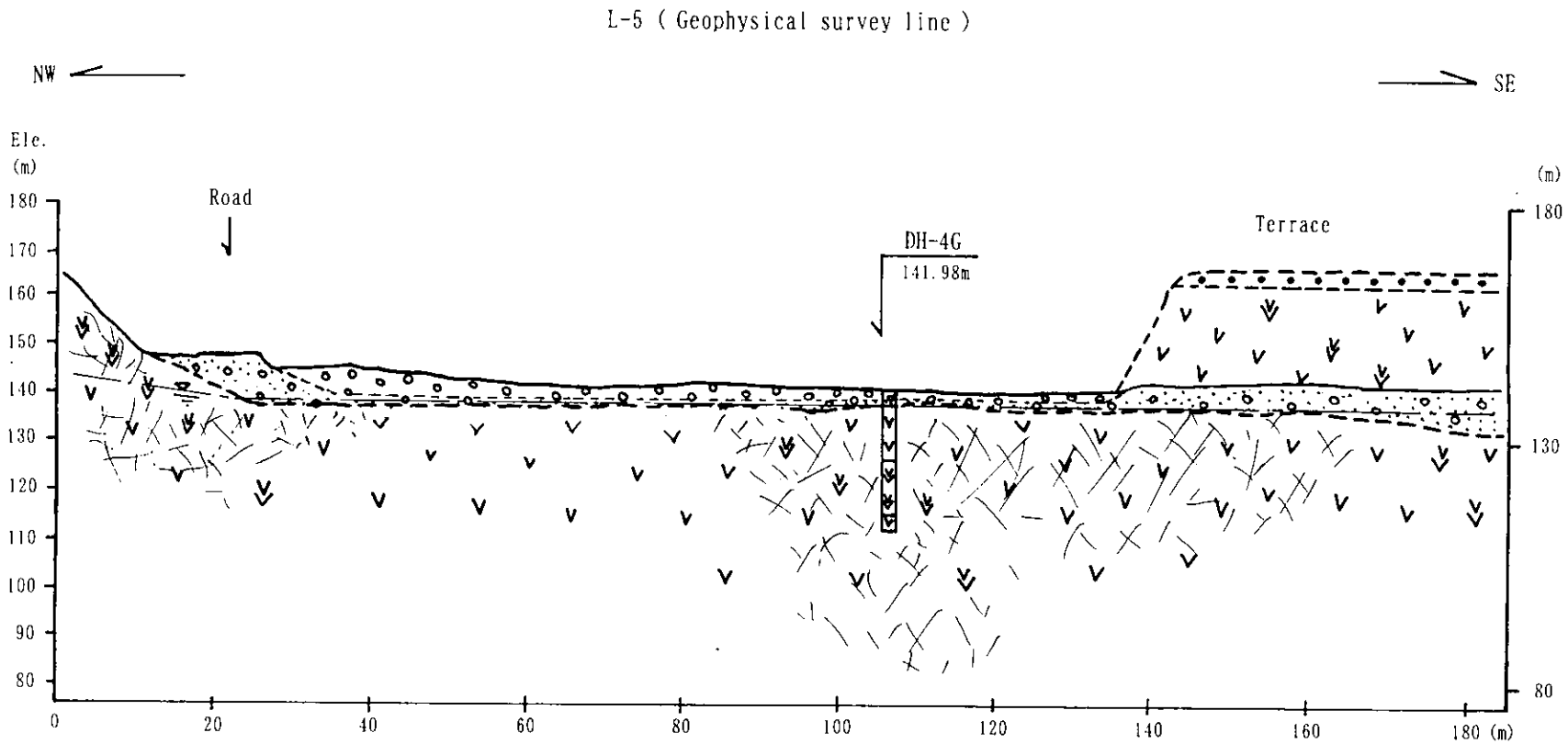
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (3)



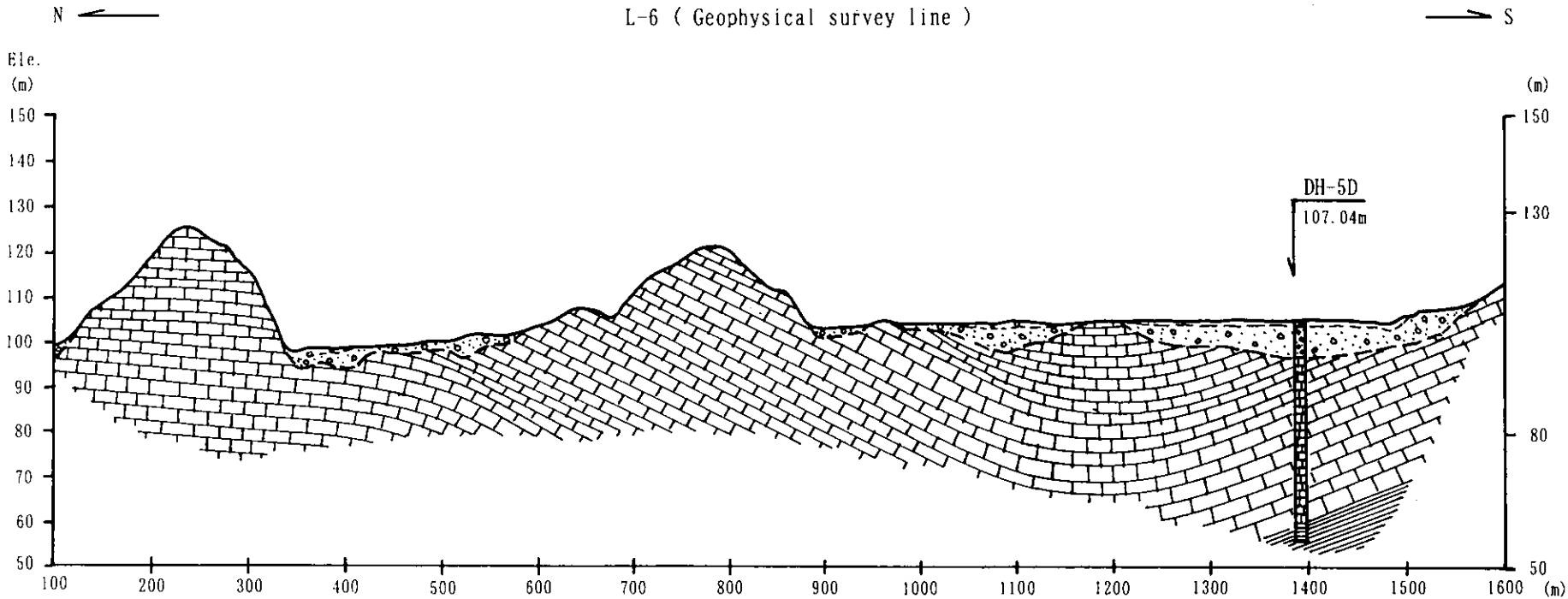
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (4)



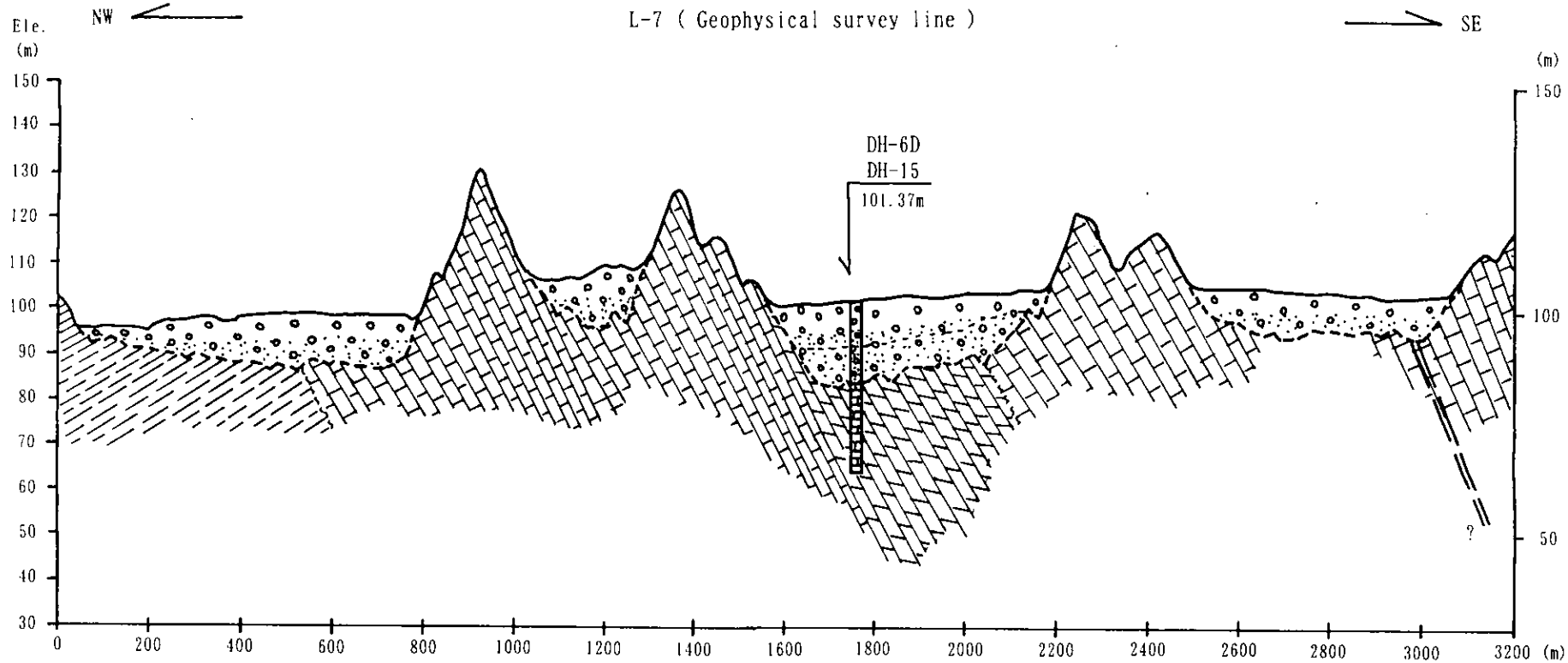
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (5)



Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (6)



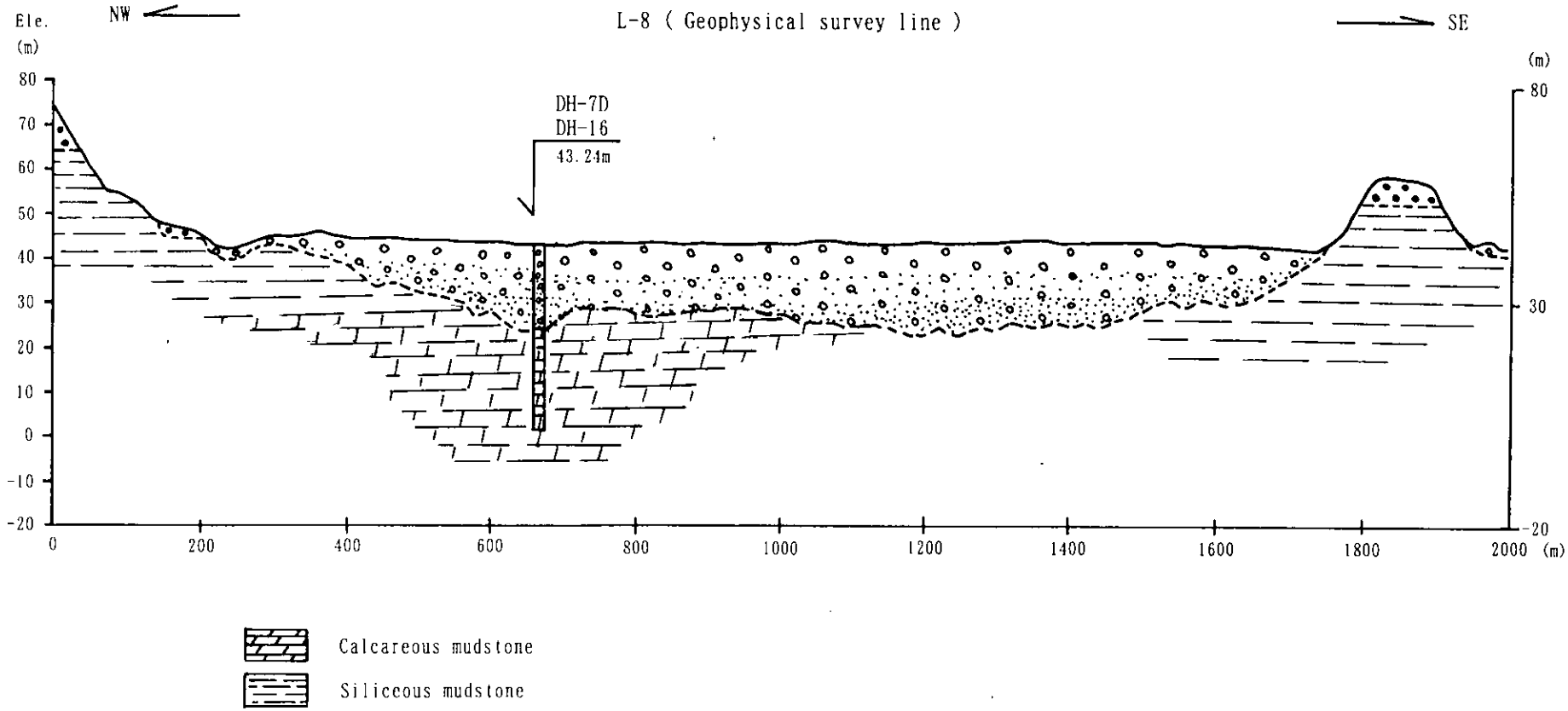
Limestone

Calcareous mudstone

Siliceous mudstone

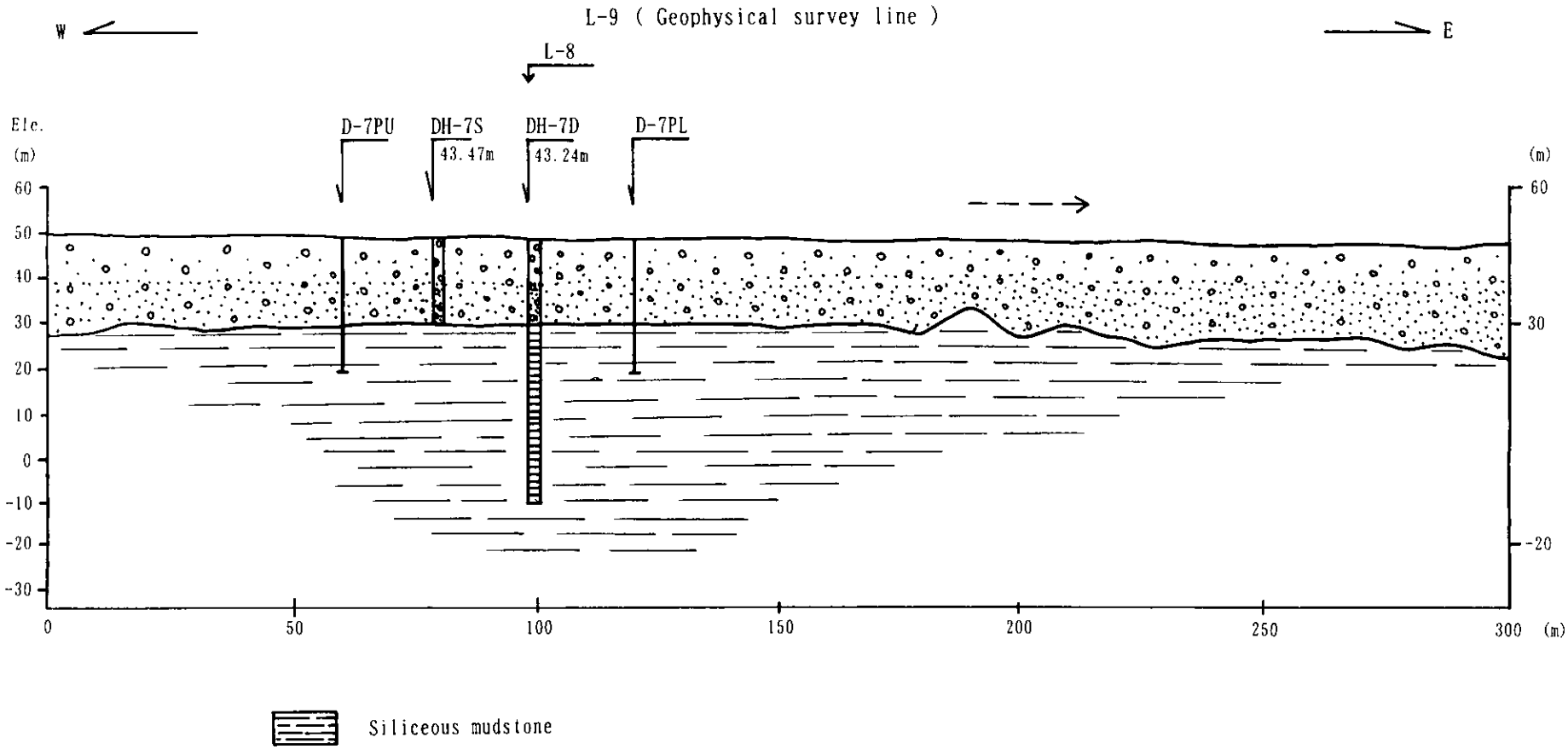
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (7)



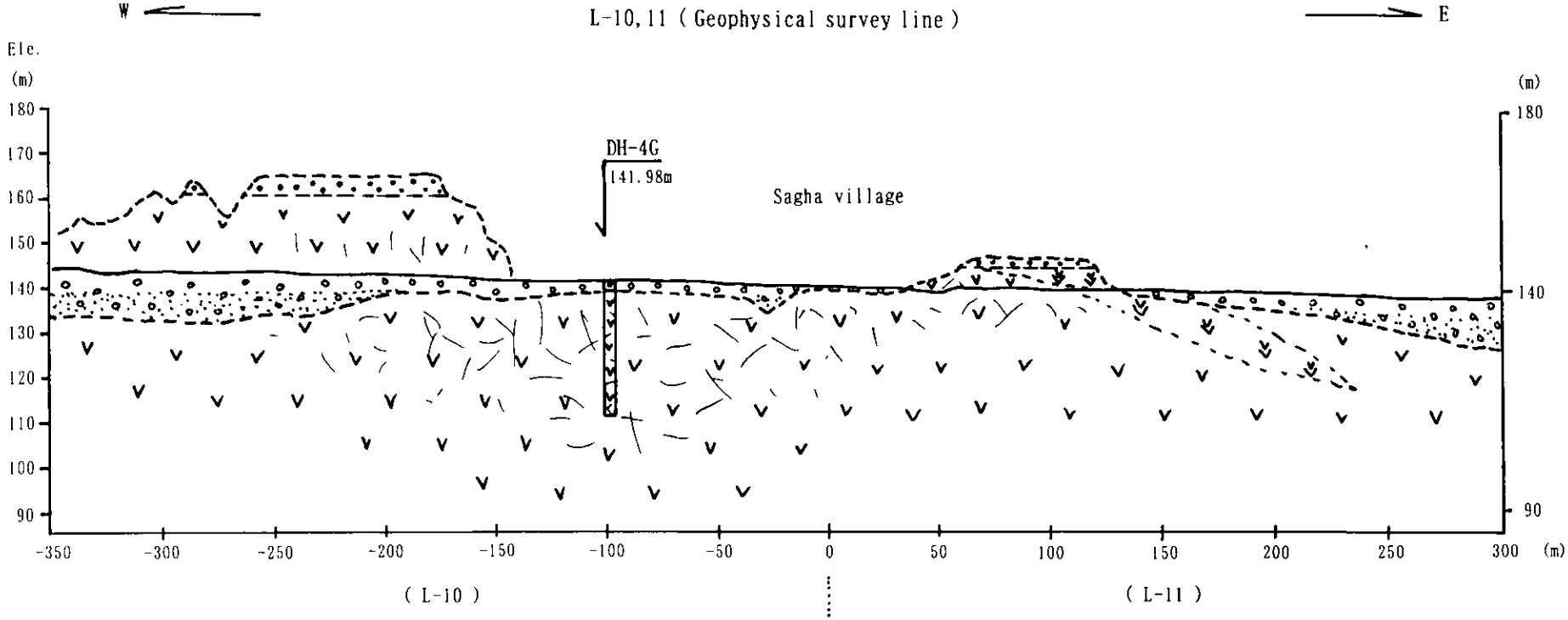
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (8)



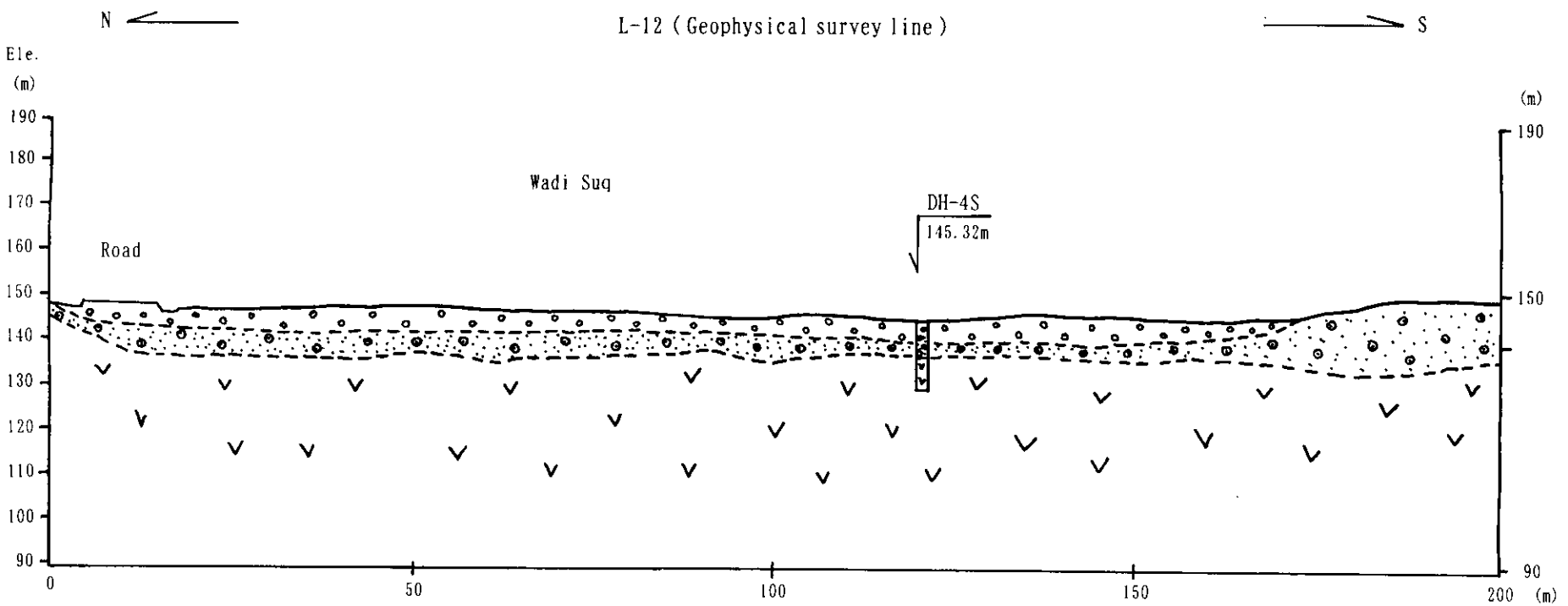
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (9)



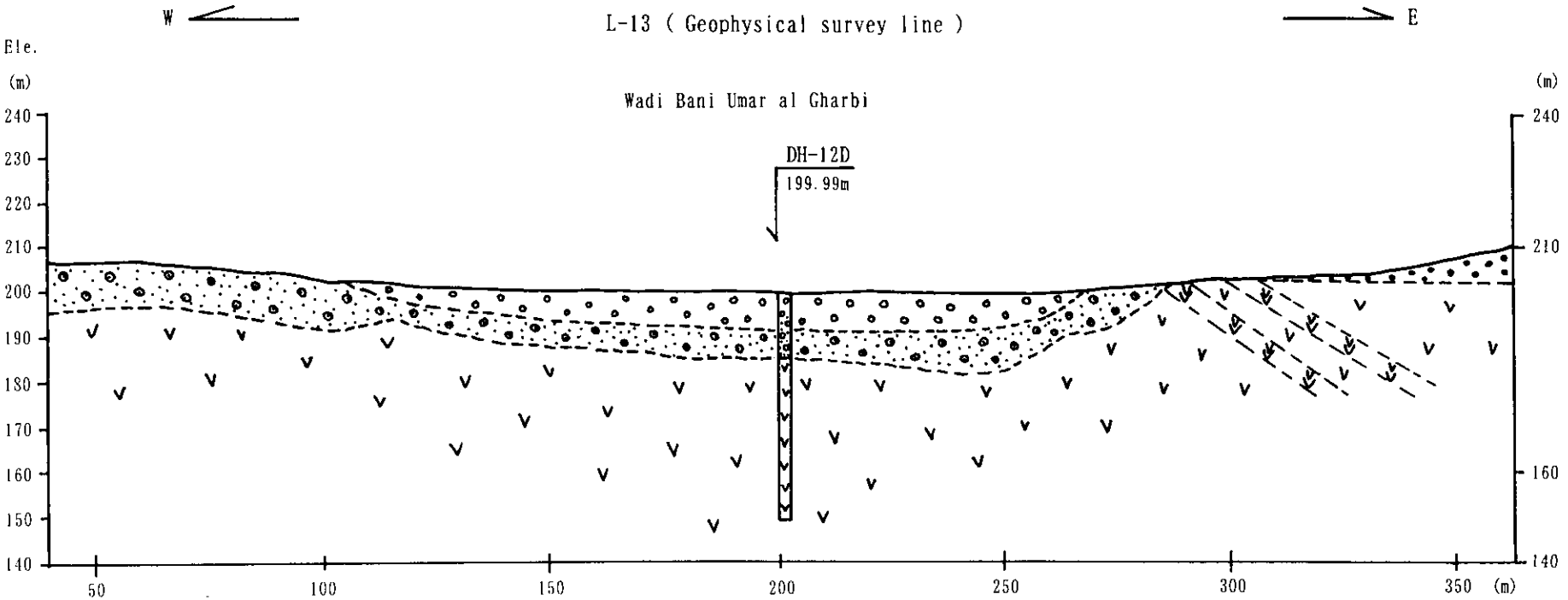
Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (10)



Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (11)



Legend is same as L-1 profile.

Figure 5.3 Geological Section of Drill Holes (12)

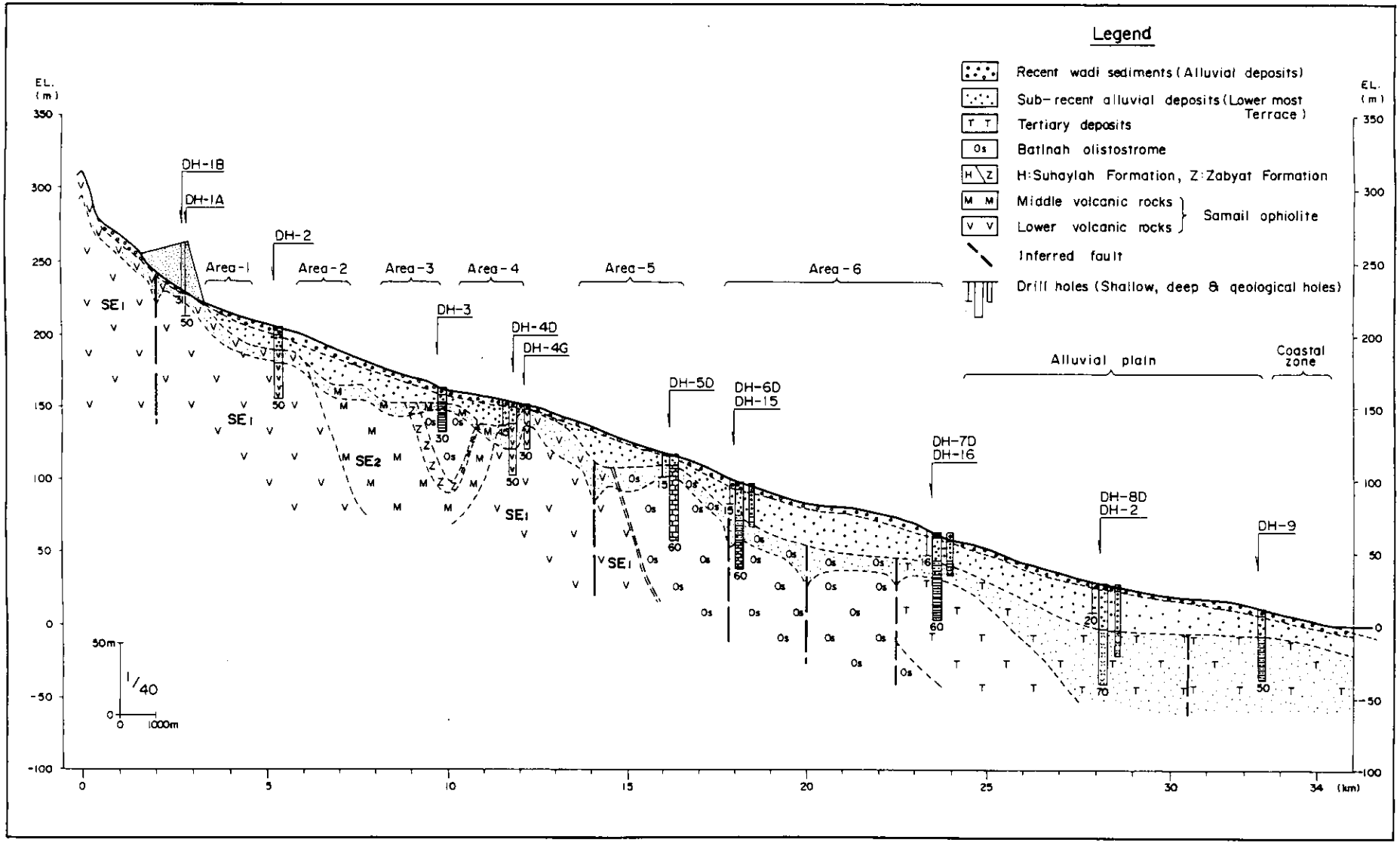


Figure 5.4 Geologic Profile along Wadi Suq

due to the well-developed fissures.

5.2.2 Middle Stream Area of Wadi Suq

The geology of the middle stream area of Wadi Suq consists of mainly basaltic rocks. Outcroppings of the Batinah Olistostrome can be seen on a small scale near the point-designated PS-2. These rocks consist mainly of limestone, red colored shale and chert. Surface layers of these rocks are strongly weathered and softened due to well-developed cracks.

Layers of riverbed sediments range in thickness from 18.60 to 19.35m and these sediments consist of sand and gravel. The top layer of -3.60 to -4.55 m is loose wadi sediments. Layers between -4 m and -19 m are calcreted sand and gravel. Layers between -10.45 to -12.30 m consist of compacted calcreted beds. The basement rocks consist of massive calcareous shale with a few fissures but softened by strong weathering.

The upper part of the wadi sediments and the slightly loose calcreted sand and gravel beds seem to be highly permeable. However, tightened calcreted sand and gravel beds exhibit low permeability.

5.2.3 Downstream Area of Wadi Suq

Wadi sediments are widely distributed in the downstream area of Wadi Suq. The thickness of the wadi sediments is 17.85 to 28.60 m and consist of sand and gravel. The top bed down to -3.00 m below the surface is loose wadi sediments. Lower beds are calcreted sand and gravel, with the lower half consisting of minute calcreted beds.

Basement rocks consist of the Batinah Olistostrome and Tertiary layers. The Batinah Olistostrome consists of mainly limestone, shale and chert.

Tertiary deposits mainly consist of calcareous and tuffaceous shale, etc. and are massive but strongly weathered and softened.

5.3 Hydrogeological Investigation

5.3.1 Groundwater Levels

Groundwater levels for each drill hole are shown in Figure 5.5 and Table 5.2. The geological profile is presented in Figure 5.4. The groundwater level in the tailing dam ranges from -18.53 to -32.64 m. Hence, it is possible that several low permeability layers consisting of fine tailings exist forming multiple perched groundwater lenses.

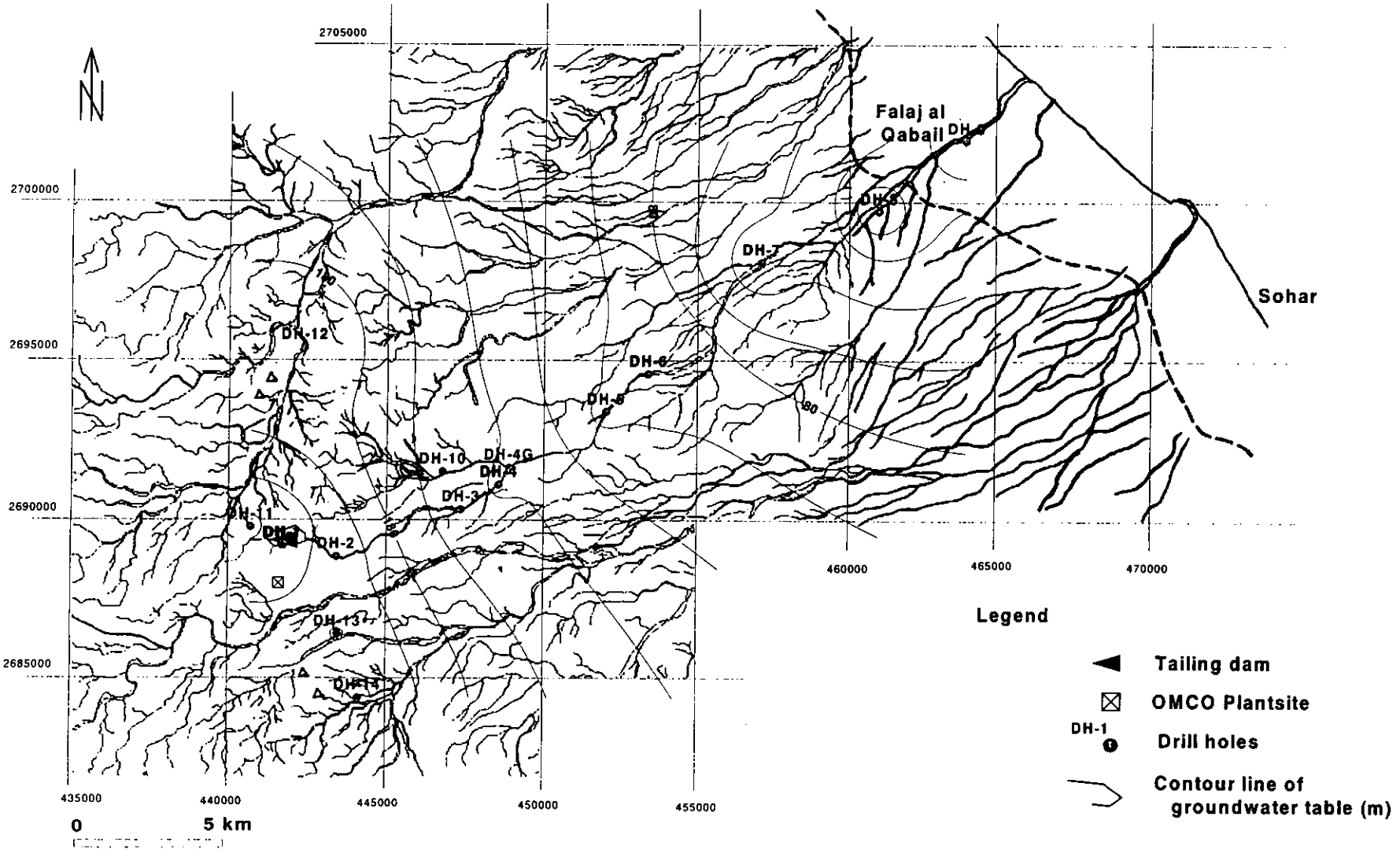


Figure 5.5 Groundwater Table in the Drill Holes

Table 5.2 Groundwater Level in Drill Holes

Drill hole №	July, 2000 Depth (m)	Nov., 2000 Depth (m)	Drill hole №	July, 2000 Depth (m)	Nov., 2000 Depth (m)
DH-1A	-32.70	-32.50	DH-7D	-10.20	-9.35
DH-1B	-17.79	-17.53	DH-8S	-16.36	-15.31
DH-2	-7.37	-6.60	DH-8D	-16.16	-15.24
DH-3	-3.45	-2.51	DH-9	-8.22	-7.57
DH-4S	-6.59	-5.61	DH-10	-7.62	-6.85
DH-4D	-5.88	-4.98	DH-11	-10.33	-9.58
DH-5S	-10.64	-9.90	DH-12S	-5.88	-5.20
DH-5D	-8.40	-8.07	DH-12D	-5.87	-5.36
DH-6S	-11.41	-10.54	DH-13	-9.21	-7.85
DH-6D	-11.61	-10.78	DH-14	-9.47	-8.70
DH-7S	-10.19	-9.42			

Groundwater levels near the KM 2 point are at approximately -7 m. However, from KM 2 to KM 14 near Sagha Village, groundwater is generally shallower than - 4 m. This zone of shallow groundwater seems to be derived by a dam created by a narrow constriction in the natural topography near KM 14. Down stream of the Sagha village, the lower the wadi reaches, the deeper the groundwater level becomes, presenting –8.07 to –16.36 m. Seasonal fluctuation ranging between 20 and 90 cm were observed in all the boreholes during the study.

Both shallow and deep holes were drilled for points of DH-4, DH-5, DH-6, DH-7, DH-8, and DH-12 in order to identify and differences in the shallow and deep groundwater.

The differences groundwater levels in each shallow and deep drill hole are presented in Table 5.3.

Deep groundwater in DH-4, DH-5 and DH-8 appears to be slightly confined. Minute calcreted sand and gravel layers are the probable cause of the confining beds. Groundwater levels in each the shallow boreholes DH-6, DH-7 and DH-12 is almost the same indicating that the deep groundwater is not confined.

5.3.2 Field Pumping Tests

Field pumping tests were carried out by submerged pump for drill holes of 12-1/4 in diameter. The pump tests consisted of stage tests, continuous tests, and recovery tests. In the drill holes with diameters of 6-1/4 inch, recovery tests were conducted after continuous pumping tests by air lift pumping. The results of the field pumping tests are given in Figure 5.6 (and refer to Appendix-5) and Table 5.4.

Referring to pumping, flow rates of 30 to 350 L/min could be obtained at DH-2 and DH-3 in the upstream reaches of Wadi Suq and DH-9 in a tributary of Wadi Bani Umar al Gharbi.

Table 5.3 Level Difference of Groundwater in Each Shallow and Deep Drill Hole

Location	Drill hole No.	Groundwater level		Difference*3
		July, 2000	Nov., 2000	Deep - Shallow
DH-4	DH-4S*1	-6.59	-5.61	+0.71
	DH-4D*2	-5.88	-4.98	+0.63
DH-5	DH-5S	-10.64	-9.90	+2.24
	DH-5D	-8.40	-8.07	+1.83
DH-6	DH-6S	-11.41	-10.54	-0.20
	DH-6D	-11.61	-10.78	-0.24
DH-7	DH-7S	-10.19	-9.42	-0.01
	DH-7D	-10.20	-9.35	+0.07
DH-8	DH-8S	-16.36	-15.31	+0.20
	DH-8D	-16.16	-15.24	+0.07
DH-12	DH-12S	-5.88	-5.20	+0.01
	DH-12D	-5.87	-5.36	-0.16

*1:Shallow hole, *2: Deep hole,

*3: Level difference= (WL in deep well) - (WL in shallow well)

Flow rates in all other bore holes, were less than 30 L/min. Permeability coefficients ranging between 10^{-3} to 10^{-6} cm/sec were obtained by the field pumping tests. The observed permeabilities are rather low because the tests were mostly conducted in calcreted sand and gravel zones and in bedrock.

DH-8 and DH-9 in the downstream reaches of Wadi Suq and DH-12 at Bayda village showed high permeability on the order of 10^{-3} cm/sec. Permeabilities obtained in the upstream to middle stream reaches of Wadi Suq were relatively low, ranging from 10^{-4} to 10^{-6} cm/sec. Generally speaking, the shallow portion of each bore hole showed higher permeability than the deep layers.

5.4 Result of Water Quality Analysis

Groundwater samples for water quality analysis were collected twice during the study, once in July 2000 during first field investigation, and once in November 2000 during the second field investigation. The results of field water quality measurements and water quality analysis are presented in Table 5.5 (1)~(2). The results of electric conductivity, Cd, Pb, Cu, SO_4, and Cl analysis for shallow groundwater during the second investigation are presented in Figure 5.7 (1)~(6) and refer to Appendix-6.

5.4.1 Characteristics of Water Quality

Water quality in the drill holes is characterized as follows:

- Temperature of groundwater ranges from 27.8 to 33.7°C, indicating 1°C higher temperature of upstream area than that of downstream. And the groundwater temperature obtained in November shows lower tendency ranging from 1 to 3°C than July.

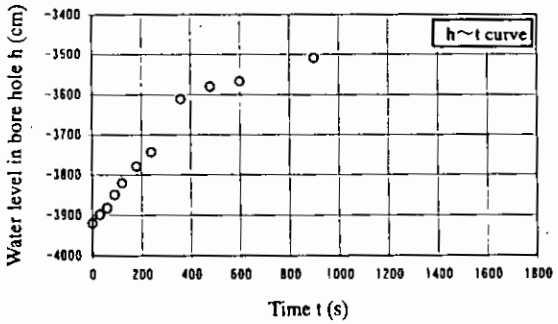
Based on JGS 1314	Permeability Test using drill hole (Unstationary Method)

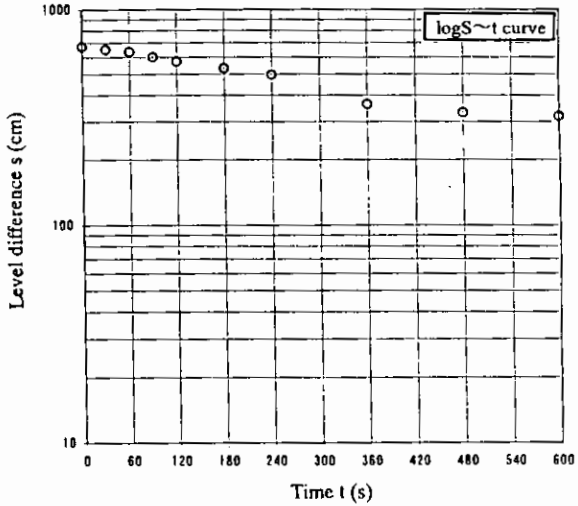
Subject: The Feasibility Study on Mine Pollution Control in Sohar Mine Area, Sultanate of Oman — Date tested: 06/07/2000

Name of drill hole : DH-1A — Measured by: mrc

Test method	Recovery test	Sectional length : L (cm)	1810	Classification of aquifer	Unconfined
Section tested (m)	32.50～50.60	Groundwater level : h_0 (cm)	-3250.0		
Pipe inner diameter : d (cm)	6.35	Diameter of drill hole : D (cm)	9.75	Ground level (m)	262.72
Slope of linear part of log～t curve : m (S^{-1})	7.68E-04	Permeability Coefficient : k (cm/s)	**2.90E-05**	Weather	Fine

Elapsed time : t(s)	Water level in hole : h (cm)	Level difference between original GWL: S (cm)
0	-3920.0	670.0
30	-3899.0	649.0
60	-3883.0	633.0
90	-3850.0	600.0
120	-3821.0	571.0
180	-3780.0	530.0
240	-3744.0	494.0
360	-3612.0	362.0
480	-3581.0	331.0
600	-3568.0	318.0
900	-3510.0	260.0





Remarks :

Equations used for permeability test

$$k = \frac{0.66d^2 \log(2L/D)}{L} \cdot m \qquad \left[m = \frac{\log(s_1/s_2)}{t_2 - t_1} \right]$$

Figure 5.6 Site Pumping Test

Table 5.4 Result of Site Pumping Test

Drill Hole No.	Location (m)		Elevation (m) *1	Depth of hole (m)	Groundwater		Pumping volume (L/min)	Permeability coefficient (cm/sec)	
	Northing	Easting			Depth (m)	Elevation (m)		Pumping test	Recovery test
DH-1A	2689125	441695	262.72	50.60	-32.50	230.22	< 30	-	2.90E-05
DH-1B	2689133	441635	261.39	31.50	-17.50	243.89	< 30	-	5.49E-05
DH-2	2688775	443410	211.49	50.00	-7.49	204.00	90	9.15E-05	5.38E-05
DH-3	2690296	447454	162.24	30.00	-3.27	158.97	540	1.70E-05	6.28E-04
DH-4G	2691638	449025	141.99	50.00	-3.81	138.18	< 30	-	4.22E-05
DH-4S	2691082	448674	145.32	18.00	-6.60	138.72	< 30	-	7.76E-04
DH-4D	2691096	448688	144.72	50.00	-6.44	138.28	< 30	-	1.08E-05
DH-5S	2693418	452155	107.56	18.00	-8.07	99.49	< 30	-	7.42E-05
DH-5D	2693432	452170	107.04	60.00	-9.90	97.14	< 30	-	7.57E-06
DH-6S	2694630	453525	101.80	18.00	-10.50	91.30	< 30	-	5.04E-04
DH-6D	2694644	453545	101.37	60.00	-10.80	90.57	< 30	-	5.85E-05
DH-7S	2698205	457185	43.47	18.00	-10.30	33.17	30	-	6.60E-05
DH-7D	2698215	457202	43.24	60.00	-10.30	32.94	< 30	-	5.70E-05
DH-8S	2699852	461001	22.31	20.00	-15.30	7.01	60	2.33E-04	3.57E-04
DH-8D	2699866	461015	22.22	70.00	-16.20	6.02	< 30	-	4.61E-03
DH-9	2702145	463839	8.00	50.00	-8.40	-0.40	624	-	2.80E-03
DH-10	2691505	446851	167.50	40.00	-7.71	159.79	< 30	-	2.69E-05
DH-11	2689725	440635	255.64	30.00	-11.50	244.14	30	2.91E-04	8.55E-05
DH-12S	2695470	442345	200.10	18.00	-5.87	194.23	60	1.69E-03	4.06E-03
DH-12D	2695490	442342	199.99	50.00	-5.98	194.01	< 30	-	4.67E-05
DH-13	2686290	443455	228.57	50.00	-7.85	220.72	< 30	-	2.84E-04
DH-14	2684246	444123	230.95	40.00	-8.70	222.25	< 30	-	1.10E-05

*1 : Elevation of ground at the hole

- PH value ranged from 4.00 to 9.98. In DH-13 and DH-14 in downstream area of Lasail mine showed acidic pH of 4 to 5 in July but changed to neutral pH of 7 to 8. This change of water quality is believed to depend on change of water level. In DH-12 in downstream area of Bayda mine, pH showed weakly alkaline of 9.49 to 9.98. All other areas showed neutral pH ranging from 6 to 8.
- Oxidation-Reduction-Potential (ORP) values range from -247 to -209 mV. DH-2 and DH-3 in upstream of Wadi Suq and DH-12 in Wadi Lasail showed oxidizing state, while other area showed reducing state.
- Electric Conductivity (EC) values range from 0.07 to 8.15S/m. Tailing impoundment showed 7 to 8 S/m, while its downstream to Sagha village was 0.9 to 3 S/m. Middle and down stream of the Wadi Suq showed 0.1 to 3 S/m and about 0.1 S/m, respectively.
- Mercury (Hg) concentrations range from 0.0003 to 0.0035 mg/L with the higher concentrations being obtained from seepage out of the tailings dam. All other samples indicated lower values not exceeding the standard of 0.001mg/L stipulated in Omani drinking water and waste water discharge regulations.
- Cadmium (Cd) concentrations range from 0.001 to 0.112 mg/L with the higher concentration of 0.1mg/L being obtained from seepage out of the tailings dam. The downstream area to the DH-5 bore hole and the area near Aarja and Bayda mines showed slightly higher values. All other samples, however, indicated lower value not exceeding the standard of 0.01mg/L stipulated in Omani drinking water and waste water discharge regulations.
- Chromium (Cr) concentrations range from 0.006 to 1.12 mg/L with the higher concentration of 0.1 mg/L being obtained from seepage out of the tailings dam. The downstream area to DH-5 bore hole and area near Aarja and Bayda mines showed slightly higher values.
- Arsenic (As) concentrations range from 0.004 to 0.013 mg/L with slightly higher concentrations being obtained from seepage out of the tailings dam. But all other samples indicated lower values not exceeding the standard of 0.05mg/L stipulated in Omani drinking water regulations.
- Lead (Pb) concentrations range from 0.01 to 1.17 mg/L with slightly high concentrations being obtained from seepage out of the tailing dam, including the downstream area to borehole DH-5 and near the area of Aarja and Bayda mines. All other samples, however, indicated lower values not exceeding the standard of 0.1mg/L stipulated in Omani drinking water and waste water discharge regulations.
- Copper (Cu) concentrations range from <0.01 to 1.48 mg/L with the higher concentrations being obtained from seepage out of the tailings dam. All other samples indicated lower values not exceeding 0.1 mg/L.
- Manganese (Mn) concentrations range from <0.01 to 5.03 mg/L with slightly higher concentrations being obtained from seepage out of the tailings dam, including DH-6 and DH-7. All other samples indicated lower values not exceeding 0.1 mg/L.
- Iron (Fe) concentrations range from 0.05 to 78.24 mg/L with the higher concentrations being obtained from seepage out of the tailings dam, including DH-6 and DH-12. All other samples indicated lower values.

Table 5.5 Measurements and Analysis Results of Water Quality (1)

Sample Number	Temp. (C.)	pH	ORP (mV)	E.C. S/m	Hg mg/L	Cd mg/L	Cr mg/L	As mg/L	Pb mg/L	Cu mg/L	Mn mg/L	Fe mg/L	Ni mg/L	Zn mg/L	SO_4 mg/L	Cl mg/L
DH-1A	30.4	6.95	-8	7.27	0.0027	0.108	1.090	0.011	0.52	0.39	5.03	42.50	0.055	0.66	1483	31005
DH-1B	31.1	6.68	1	8.14	0.0032	0.112	1.080	0.013	0.44	1.48	3.03	77.48	0.058	1.19	1435	33565
DH-2-S	32.3	6.94	83	3.33	0.0006	0.046	0.702	0.007	0.78	0.11	0.10	0.35	0.039	0.13	971	12402
DH-2-D	32.0	6.79	89	3.35	0.0005	0.044	0.663	0.005	0.79	0.10	0.19	0.30	0.038	0.10	953	12944
DH-3-S	33.3	7.57	120	1.86	0.0004	0.016	0.272	0.006	0.33	0.07	0.11	0.20	0.034	0.14	653	6536
DH-3-D	32.5	7.50	118	1.90	0.0005	0.012	0.291	0.009	0.47	0.10	0.11	0.88	0.033	0.11	607	6634
DH-4S	33.2	4.27	-16	1.85	0.0008	0.020	0.212	0.008	0.30	0.06	0.03	0.27	0.033	0.08	584	6388
DH-4D-1	33.4	6.23	-33	0.97	0.0007	0.009	0.101	0.007	0.12	0.06	0.18	0.34	0.032	0.32	479	3012
DH-4D-2	33.5	8.54	-54	0.96	0.0007	0.006	0.042	0.008	0.14	0.06	0.15	2.03	0.032	0.19	477	2973
DH-5-S	33.4	5.31	-28	0.23	0.0004	0.006	0.031	0.007	0.03	0.08	0.01	0.20	0.030	0.10	341	287
DH-5D-1	33.5	7.45	-220	1.36	0.0005	0.031	0.912	0.008	1.17	0.10	<0.01	0.19	0.035	0.07	364	4449
DH-5D-2	33.7	5.52	-102	3.57	0.0004	0.041	0.463	0.008	0.59	0.12	0.05	1.60	0.038	0.11	667	13633
DH-6S	32.3	4.00	-18	1.06	0.0006	0.003	0.032	0.006	0.17	0.07	<0.01	0.21	0.032	0.06	370	3445
DH-6D-1	32.2	8.86	-21	0.78	0.0007	0.013	0.013	0.009	0.23	0.07	0.92	4.10	0.031	0.17	299	2392
DH-6D-2	31.7	7.90	-20	0.81	0.0006	0.012	0.014	0.010	0.14	0.09	0.99	31.67	0.042	0.16	294	2510
DH-7S	33.5	7.42	-36	0.59	0.0005	0.011	0.042	0.008	0.06	0.06	<0.01	0.13	0.030	0.05	973	1161
DH-7D-1	33.3	8.06	-76	0.59	0.0003	0.007	0.051	0.009	0.07	0.06	0.32	0.42	0.030	0.08	973	1270
DH-7D-2	32.4	7.81	-61	0.61	0.0004	0.009	0.011	0.007	0.04	0.06	0.24	0.44	0.031	0.06	1011	1299
DH-8S	32.6	7.80	-50	0.17	0.0004	0.004	0.022	0.005	0.02	0.01	<0.01	0.33	0.030	0.04	114	396
DH-8D-1	32.2	8.12	-56	0.17	0.0006	0.005	0.021	0.004	0.01	<0.01	<0.01	0.14	0.007	0.15	135	335
DH-8D-2	32.0	7.93	-50	0.17	0.0005	0.004	0.034	0.004	0.03	0.01	<0.01	0.21	0.007	0.10	143	348
DH-8D-3	31.6	7.85	-47	0.22	0.0003	0.002	0.008	0.004	0.01	0.01	<0.01	0.17	0.005	0.11	281	394
DH-9-S	30.7	8.26	-17	0.07	0.0004	0.002	0.006	0.007	0.02	0.01	<0.01	0.51	0.021	0.09	58	112
DH-9-D	31.9	8.15	-62	0.07	0.0004	0.005	0.007	0.006	0.02	0.01	<0.01	0.23	0.024	0.03	52	110
DH-10-S	32.7	8.33	118	0.23	0.0003	0.006	0.042	0.005	0.04	0.07	<0.01	0.11	0.032	0.09	397	402
DH-10-D	32.6	7.99	125	0.24	0.0004	0.008	0.022	0.005	0.02	0.08	<0.01	0.85	0.031	0.09	442	433
DH-11-S	32.4	8.01	146	1.44	0.0004	0.022	0.121	0.012	0.25	0.09	0.06	0.37	0.033	0.38	502	4626
DH-11-D	32.1	7.75	-179	1.48	0.0005	0.021	0.193	0.008	0.21	0.09	0.41	0.37	0.033	0.10	533	4971
DH-12S	32.9	7.47	144	0.35	0.0003	0.003	0.064	0.004	0.03	0.06	<0.01	0.06	0.030	0.05	318	874
DH-12D-1	32.6	8.55	67	1.00	0.0005	0.030	0.313	0.007	0.03	0.11	0.03	2.94	0.035	0.10	864	2973
DH-12D-2	32.4	9.98	15	1.01	0.0006	0.026	0.262	0.008	0.28	0.09	0.02	2.83	0.037	0.19	888	3032
DH-13-S	33.1	4.44	-55	0.11	0.0004	0.002	0.034	0.008	0.01	0.08	<0.01	0.27	0.030	0.39	266	97
DH-13-D	32.5	4.10	-50	0.11	0.0003	0.001	0.017	0.009	0.02	0.08	<0.01	1.37	0.030	0.42	264	94
DH-14-S	31.8	5.20	-56	0.08	0.0030	0.005	0.007	0.005	0.01	0.02	<0.01	0.27	0.007	0.34	141	47
DH-14-D	32.0	4.80	-45	0.08	0.0004	0.004	0.008	0.004	0.02	0.02	0.01	1.46	0.008	1.42	145	49
Minimum	30.4	4.00	-220.0	0.07	0.0003	0.001	0.006	0.004	0.01	<0.01	<0.01	0.06	0.005	0.03	52	47
Maximum	33.7	9.98	146.0	8.14	0.0032	0.112	1.090	0.013	1.17	1.48	5.03	77.48	0.058	1.42	1483	33565
Average	32.5	7.10	-9.5	1.32	0.0007	0.019	0.206	0.007	0.21	0.11	0.60	5.02	0.030	0.23	528	4720

Red color : Exceeding Omani standard of discharge