b Main Aquifers Influenced by DAD

Geological section in the downstream of DAD is inferred as shown in Figure. The proposed DAD site consists of white to pinkish limestone in general, though very thin river deposits lies along river bed. From about 1 kilo-meter downstream of DAD site, Alluvial fan composed generally of sands/gravels develops. According to test drilling, the thickness of Alluviums at the way-out from hills is 6.5 meters, and depth to water level is 2.6 meters. It is inferred that the thickness of Alluvium may be around 30 meters at maximum. They are underlain by shale in general. Miocene limestone in the area lies over the shale.

A.5 THE RESULT OF TEST DRILLING, SOIL TEST AND RESISTIVITY EXPLORATION AT PROPOSED AND EXISTING DAD SITES.

According to the results of in situ investigation in this study, the geological sections of the downstream of the priority DADs are shown in respective Figs. and described respectively as the above.

The result of Test Drillings and Soil Tests are shown in Fig.A.50 to 52.

Fig.A.50 shows Summary of Test Drilling with the result of standard penetration test.

The strength for dam foundation is enough at every dam site except at Jigda site which shows N-value of depth 4 to 8 meters less than 10. The uppermost layer of Murgi Kotal site is siltation material deposited in the reservoir area of existing Murgi Kotal DAD. Upper 10 meters of the bedrock of Kach and Iskalkoo (Gazij Shale) is weathered and its N-value shows between 10 and 20 partly.

As a result of test drilling, it is recognized that silty to clayey strata of thickness 10 to 15 meters in the unconsolidated deposit is existing. Ghutai Shera site is in the area of Subrecent deposit which is rich of silt/clay layer in this place overlain by sandy layer (river deposit) of thickness 10 meters. From depth of 30 meters at Wali Dad and from 20 meters at Dara, silty and/or clayey strata of thickness around 15 meters may be inferred Subrecent deposit.

At Murgi Kotal site, lithology is almost composed of sand and gravel except the uppermost siltation deposit. Unconsolidated deposit at dam sites of Mastung, Kalat, and Patki Shah Nawaz Sub-Basin is also composed mainly of sand and gravel.

The gradation analysis of unconsolidated deposit around respective dam site is shown in Fig. A.52. Their matrix material except sand is mostly classified low plastic silt/clay or sandy

silt/clay by Atterberg Limit Test as shown in Fig.A.51. Highly plastic soils are not existing around respective dam site.

The result of Permeability Test is as shown in Table A.3. Most part is in the range of E - 3 cm/sec. Sand and Gravel layers at dam site of Mastung, Kalat, and Patki Shah Nawaz show a little less permeability than that (in the range of E-4 cm/sec).

a Drilling

Test drilling was carried out at Delay Action Dam Sites in the phase I of this study for the purpose of the matter mentioned as under.

Number of investigation sites is 13 for the proposed DAD and 2 for the existing DAD. Study for three sites at the proposed damss are partly for the rehabilitation of the existing dams. The main purpose of the investigation for the proposed dams is to make it confirm the lithology, thickness of unconsolidated deposit and their permeability at the investigation sites, and for the existing dams are to investigate the relationship between the situation of water in the reservoir and groundwater head of the downstream, and to check the siltation material.

The purposes and the investigated locations of respective dam are briefly mentioned as the followings.

Existing dam sites

Khushab, Tirkha:

Study for the relationship between the water in the reservoir and the groundwater head of downstream.
Drilling location; center of riverbed at 50 m downstream from dam axis.

Proposed dam sites, partly as existing dams

Murgi Kotal:

To confirm the thickness of siltation material and unconsolidat-ed deposit.
Drilling location; the point showing the thickness of siltation material maximum in the reservoir area of existing dam.

Kach, Wali Dad

To confirm the subsurface lithology of the downstream area of dam.
Drilling location;
Kach; center of riverbed at the point 1.5 km far from existing dam
Wali Dad; center of riverbed at the point 1.0 km far from existing dam

Proposed dam sites

Brewary • Dara, Ghutai Shera, Arambi, Sanzali, Jigda, Sakhol, Kad Kucha, Mangi, Iskalkoo:

To confirm the subsurface lithology and the thickness of unconsolidated deposit at the center of dam axes.

Drilling location; center of riverbed along dam axes

(1) Present Conditions at the Respective Dam Sites

The present conditions at the respective dam sites for this study are mentioned briefly as under.

Proposed dam sites

Brewary:	very narrow antecedent river valley; river width is few meters; reservoir side is very deep valley. (Brewary Ls.)
Wali Dad:	upstream side is gorge; downstream side is wide alluvial fan. (Chiltan Ls.)
Ghutai Shera:	gravelly hilly area. (Subrecent dep.)
Murgi Kotal:	for the rehabilitation of existing damaged dam. left bank is linear mountain range; right bank is mountainous area. (Chiltan Ls.)
Dara:	at the apex of alluvial fan having relatively steep riverbed gradient. (Chiltan Ls. Gazij Sh.)
Kach:	the midstream area of perennial flow river within the mountains. (Gazij Sh. Urak Cg.)
Arambi:	transitional area from hilly area to mountains. (Murgha Faqirzai Sh.)
Sanzali:	hillock area. (Bostan Fm)
Jigda:	the area a little entering to hills. (Murgha Faqirzai Sh. Shaigalu Ss.)
Sakhol:	at the wide outlet from narrow valley to wide alluvial fan (Chiltan Ls.)
Kad Kucha:	the wide area a little entering from alluvial fan to valley. (Chiltan Ls. Spintangi Ls.)
Mangi:	the wide inlet from vast alluvial fan to mountains. (Shirinab Fm.)
Iskalkoo:	inside of hilly area. (Spintangi Ls.)

Existing dam sites

Tirkha: inside of hillock area. (Bostan Fm)

Khushab: the outlet of mountains. (Parh Gr.)

(2) Result of Test Drilling

Standing on the above mentioned purposes and present conditions, test drillings were carried out at respective dam sites. Besides according to lithology, standard penetration test and permeability test were carried out for confirming the bearing strength and permeability using the drilled boreholes. The results are summarized as under.

(a) Lithology and bearing strength

Khushab: 0 ~ 12.5m; river deposit; gravel. N-values are more than 50.
12.5 ~ 40+m; limestone and shale of Parh Group.

Tirkha: 0 ~ 2m; river deposit; gravel.
2 ~ 40+m; Bostan Clay. N-values are more than 50.

Brewary: 0 ~ 12m; Colluvium and river deposit; cobble, boulder, gravel, sand and silt. N-values are over than 50 except the section of depth 2 ~ 5 meters which shows 25 ~ 40.
12 ~ 40+m; tight, massive and dark grey Brewary Limestone.

Ghutai Shera: 0 ~ 11m; river deposit; uppermost 3 m is sand and silts with 1.4 m thickness and further under part is sand with silt. N- values are more than 50.
11 ~ 40+m; Subrecent dep.; alternation of around 10 m thickness of silt & clay and gravelly layer.

Wali Dad: 0 ~ 30m; alluvial fan deposit; mainly boulder and gravel, and silt partly with gravel between the section of depth 7.5 ~ 10 m. N-values are over than 50.
30 ~ 40+m; well-consolidated silty clay; may be Subrecent deposit.

Dara: 0 ~ 20m; alluvial fan deposit; surface is of boulder (deposit along flow channel), deeper parts are of silt, gravel and sand. N-values are more than 50.
20 ~ 40+m; upper 15 m is silt & clay and lower is gravel; may be Subrecent deposit.

Murgi Kotal: 0 ~ 10.5m; siltation material; low plastic silt & clay. N-values are 7 at uppermost layer and deeper parts are 15 ~ 20.
10.5 ~ 40+m; alluvial fan deposit; alternation of boulder and gravel.

Kach: 0 ~ 1m; river deposit; boulder and gravel.
1 ~ 40+m; Gazij Shale; surface layer of thickness 13 m is weathered, N-values of which are in between 25 ~ 50; deeper part is more than 50.

Jigda: 0 ~ 9.5m; river deposit; mainly of gravel and silt with gravel. N-values are partly very low (less than 10; depth between 4 ~ 7 m).
9.5 ~ 40+m;Murgha Faqirzai Shale

Sanzali: 0 ~ 2.6m; river deposits; mainly of sand-rich silty gravel.
2.6 ~ 40+m; Bostan Formation; mainly of clay, confined sand aquifer interbedded in between the depth of 12 ~ 14m. N-values are more than 50 in major part, however partly around 40.

Arambi: 0 ~ 17m; river deposit; uppermost 12 m is gravel with silt. deeper parts are silt and boulder. N-values are more than 50.
17 ~ 40+m; Shaigalu Sandstone

Sakhol: 0 ~ 40+m; alluvial fan deposit; gravel and boulder up to the depth 35 m, and the deeper sand layer. N-values are more than 50.

Mangi: 0 ~ 27m; alluvial deposit; gravel and boulder. N-values are more than 50.
27 ~ 40+m; Murgha Faqirzai Shale

Kad Kucha: 0 ~ 40+m; alluvial deposit; mainly of gravel and boulder. N-values are more than 50.

Iskalkoo: 0 ~ 6.5m; river deposit; mainly of gravel. N-values are almost more than 50, however one part 20.
6.5 ~ 40+m; Gazij Shale; uppermost layer (thickness 8 m) is weathered, N-value of which is in between 20 ~ 40.

(b) Permeability

The results of permeability test at respective drilling sites are shown in the following table;

According to the test, the permeability of respective lithology is as mentioned under.

- **Saturated silty gravel to boulder strata** as tested at Brewary, Khushab, Jigda shows the permeability of saturated groundwater flows as itself. Perennial groundwater flow may wash out the fine materials, and shows relatively good permeability.

  The range of coefficient of permeability is **1.5 ~ 2.5E-3 cm/sec.**

- **Unsaturated silty gravel to boulder strata** as tested at Wali Dad, Sakhol, Kad Kucha and Mangi shows the permeability of unsaturated percolating water flow. Because they lie in the unsaturated zone, the deposit may go on to shrink by arid meteorology, and contain the fine material at that sites resulting permeability reduced.

  Coefficient of permeability is **less than 1 ~ 3E-4 cm/sec**, and partly lowered in the range of E-5 cm/sec.

  However, as shown in the example tested at Dara, **the deposit almost totally washed out silt and clay situating even in the upper than groundwater level** along the river channel shows coefficient of permeability **1.5E-3 cm/sec.**

  Like as the above, even though it is the deposit lying over than groundwater level, **river deposit washed totally out the clay distributing on the base of Subrecent deposit** as tested at Ghutai Shera shows relatively high coefficient of permeability as **9.5E-3 cm/sec.**

- **Bostan Formation** as tested at Sanzali shows coefficient of permeability **1.5E-4 cm/sec.**
- The **siltation material** of Murgi Kotal existing dam shows relatively high coefficient of permeability of a fine deposit as fine deposits go due to it may be on the way to be harden. Its coefficient of permeability is **7.8E-4 cm/sec.**
- Basement rocks composed of **Gazij Shale** is impermeable showing its coefficient of permeability **in the range of E-7 cm/sec.**

As mentioned the above, the depth to bedrock or aquitards, the thickness and the lithology of unconsolidated deposits, the groundwater level (some sites are more than the depth drilled) and the permeability at respective dam site can be checked by the test drilling.

If further detail data along dam axes and of the subsurface situation of downstream may be collected by some method in the future, relatively accurate analysis of groundwater recharge may be done.

b Resistivity Exploration

(1) Purpose and Method

On the basis of the results of drilling data, geoelectrical studies for hydrogeological analyses at the priority dam sites in phase II has been carried out to check the vertical extents of aquifers after confirming the horizontal extents of aquifers in the downstream of the proposed dams sites by interpretation according to the topographical classification, including to check the geological profile along dam axis in the case dam site has the wide riverbed. The survey was meant furnish information regarding the occurrence of aquifers and aquitards in the proposed dam sites

The method of exploration is by Vertical Electrical Soundings (VES) with exploration depth up to finding out the impervious bed such as bedrock, thick silts/clay strata or, in the case these are inferred very deep, up to the depth of recharge or pumping up of groundwater concerned to which may be around 100 ~ 150 meters. Groundwater tables were also trying to make an effort to be found out as much as possible. Electrode configuration was of Schlumberger type with half current spacing ranging from 5 to 160 meters.

(2) Location

Probing points of Vertical Electrical Sounding (VES) in each dam area were arranged to grasp the aerial extents of aquifers effectively in the downstream of the priority proposed DAD in phase II study after confirming the horizontal distribution of the aquifers by topographical interpretation. Nos. of probing points at respective DAD areas are as the followings. It was

performed at 47 probing points and extra 3 points and their location is shown in Topo-Interpretation Maps.

Proposed DAD area	Nos. of Probes	Remarks
Brewary	5	
Dara	4	
Murgi Kotal	8	
Kach	3	
Jigda	6	
Sakhol	8	
Mangi	7	
Kad Kocha II	6	
Ghazlona	3	(Extra Survey)
Total	47	(and Extra 3)

(3) Result of Resistivity Exploration

The results are mentioned in the chapter 4 as the item "Main Aquifers Influenced by DAD" showing their analizing results in Figs. of Geological Sections.

Table A.1 (1) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (1) (Source; Drilling / Installation of Tubewells by WAPDA during 1985 - 89)....1/3

Date completed	Well No.	Sub-Basin	District	Benificiary	Physiography	Location		Elevation (m)	Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer					Pumping Test			Specific Capacity	Transmissivity	Specific Storage	Specific Yield	Coefficient of Permeability
						Map No.	Coordinate					Type	No.of Aquifers	Thickness (m)	Saturated Thickness (logged)(m)	Lithology	Discharge Rate (m3/d)	Static WL (m)	Draw Down(m)	(l/sec/m)	(m2/d)	(l/m)	(%)	(cm/sec)
28-06-86	PN-PAZ-2	Pishin	Qila Abdulah	Gulistan	foot slope of hill	34J/10	724 511	1490	152	34	10"	U (Bedrock)	?	?	?	SS	330	69.8	39.5	0.10	9		6	1.21E-04
																	440		51.8	0.10	9		6	1.28E-04
16-07-87	PN-PAZ-5	Pishin	Qila Abdulah	Haji Abdul Qayyum	narrow valley floor to end part of fan	34J/10	551 829	1640	137	34	10"	U	1	75	max. 43	Gv	380	29.9	40.0	0.11	10		13	6.18E-04
																	440		45.6	0.11	10		14	7.36E-04
21-02-89	GN-AKA-1	Pishin	Qila Abdulah	Gulistan	periphery of small fan	34J/10	544 745	1510	152	20	10"/8"	U	1	107	max. 47	Gv + Sd + Cl	440	60.3	24.6	0.21	18		14	7.34E-04
																	590		35.7	0.19	18		14	8.57E-04
07-03-92	Killi Saighi	Pishin	Qila Abdulah	1km South of Qila Abdulah Town	narrow valley floor of two hills	34J/10	573 844	1570	165	37	10"	U (semi C)	1	more than 94	more than 85	Gv + Sd & minor Cl, one part thin Cl lyr	160	37.2	30.5	0.06	5	8E-04	5	8.00E-05
20-09-88	PN-HMA-1	Pishin	Pishin	Killi New Majak	end part of fan	34J/10	689 839	1500	152	55	10"	U	1	62	max. 19	Gv	220	48.1	16.2	0.16	12		17	1.62E-03
24-04-86	PN-PAZ-1	Pishin	Pishin	Killi Kulak Kakoray	foot slope of hill	34J/14	736 856	1490	98	27	10"	U (semi C)	1	50	max. 49	Gv with thin Sd & Cl lyrs	1,310	27.6	13.7	1.11	101	3E-05	19	2.77E-03
09-12-87	PN-PAZ-7	Pishin	Pishin	Baezai	valley floor	34J/14	848 693	1480	137	15	10"/8"	C	5 ~ 6	24	21	Gv + Sd	1,230	16.1	12.7	1.12	101	1E-05	23	6.61E-03
																	1,830		17.6	1.20	115	1E-05	24	7.45E-03
18-10-87	PN-AF-6	Pishin	Pishin	Killi Hurumzai	midpart of fan	34J/14	805 878	1500	125	37	10"	U	1	98	max. 49	Gv	1,140	48.9	4.4	3.00	246		24	7.25E-03
																	1,230		4.9	2.91	242		24	7.22E-03
23-03-86	PN-KMT-1	Pishin	Pishin	Alizai Killi	deposit of large fan	34J/14	903 883	1560	152	29	10"	U	1	more than 152	more than 61	Gv & Sd partly with lyrs of admixture of Gv, Sd & Cl	550		4.2	1.50	114		19	2.72E-03
																	1,090	80.9	11.5	1.10	98		19	2.42E-03
																	1,230		14.6	0.97	89		19	2.26E-03
																	1,500		19.0	0.92	87		19	2.29E-03
18-09-86	PN-KMT-2A	Pishin	Pishin	Killi Khudadadzai (River Bank)	Surkhab Lora Bank	34J/14	867 725	1480	123	9	10"/8"	semi C	1	76 ~ 91	more than 76 ~ 91	alternation of Sd (partly Gv) & Cl lyrs	2,450	17.2	27.7	1.03	104	5E-05	17	1.51E-03
25-06-87	PN-KMT-3	Pishin	Pishin	Alizai Killi	end part of alluvial fan deposit	34J/14	929 861	1530	131	15	10"/8"	U	4 ~ 5	U 72	max. 40	Gv with thin Cl lys.	1,240		7.5	1.91	165	1E-05	23	6.27E-03
												partly C		C 23	23	Gv partly Sd	1,470	32.2	9.0	1.88	168	1E-05	23	6.53E-03
																	1,650		10.7	1.78	162	1E-05	23	6.40E-03
27-12-86	PN-SKP-3	Pishin	Pishin	Killi Hajizai	Pishin Lora Bank	34J/14	875 813	1490	113	15	10"/8"	U	1	99	max. 61	Gv with minor Cl	1,640		2.8	6.70	544		25	1.26E-02
																	2,180	38.5	4.0	6.24	537		25	1.24E-02
																	2,730		5.5	5.69	515		25	1.20E-02
29-11-90	Mirza Mulazai	Pishin	Pishin	Just Left Bank of Pishin Lora	Pishin Lora Bank	34J/14	917 798	1500	137	46	10"	U	1	46	?	Admixture of Gv, St, Cl but WL in Bedrock	1,300	57.0	19.8	0.76	70		17	1.77E-03
26-08-87	PN-NKT-1	Pishin	Pishin	Haji Shaukat Ali	valley floor	34J/14	894 755	1490	137	9	8"	semi C	3	25	25	lyrs of Gv, Sd, Gv+Cl	1,090	19.2	11.9	1.06	95	2E-05	22	5.22E-03
																	1,360		17.9	0.88	83	2E-05	22	4.56E-03
31-08-87	PN-NKT-2	Pishin	Pishin	Haji Abdul Wali	valley floor	34J/14	895 761	1490	134	12	10"/8"	semi C	1	29	max. 29	Gv with Sd & Cl	1,230		16.7	0.85	78	3E-05	20	3.21E-03
												C	3 ~ 4	33	33	Sd + Gv with Cl	1,640	20.7	19.6	0.96	92	2E-05	21	3.76E-03
																	1,830		23.2	0.91	89	2E-05	21	3.62E-03
09-11-92	Shadezai	Pishin	Pishin	Just Right Bank of Rokhi Lora	Rokhi Lora Bank	34J/14	747 647	1470	171	34	10"	C	3	35	more than 35	Gv	330	30.5	13.4	0.28	23	8E-05	15	9.06E-04
23-08-92	Spin Bagerzai	Pishin	Pishin	In the Flood Plain of Pishin Lora	Pishin Lora Bank	34N/2	973 836	1520	122	18	10"	C (semi)	1	46	46	Gv+Sd+Minor Cl	350	26.5	7.6	0.54	42	6E-05	16	1.25E-03
13-11-93	Khair Abad	Pishin	Pishin	North of KK Bund	periphery of piedmont plain	34N/2	20 805	1540	171	32	10"	U	1	38	30	Sd Gv	20	7.9	34.4	0.06	5		5	5.33E-05
15-10-92	Tore Shah	Pishin	Pishin	4km West of KK Bund	lower part of piedmont plain	34N/2	54 793	1565	131	76	10"	C (and U)	2	58+ 15	6 + 15	fine Sd + Coarse Sd	350	46.3	6.1	0.67	51	2E-05	22	4.59E-03
02-05-88	PN-KMT-5	Pishin	Pishin	Kamalzai	midpart of piedmont plain	34N/2	107 831	1600	137	27	10"	U	1	more than 137	more than 107	Gv with Cl lyrs	1,090	22.0	6.7	1.89	160		18	2.11E-03
																	1,230		8.2	1.73	151		18	2.01E-03
30-04-88	PN-KMT-6	pishin	Pishin	Killi Machan	periphery of piedmont plain	34N/2	958 688	1560	137	9	10"/8"	semi C to C	7	47	max. 32	Gv & Sd lyrs	1,230	29.4	22.3	0.64	60		19	2.53E-03
19-12-88	PP-HAR-1	Pishin	Quetta	Panjpai		34J/12	489 37		168	23	10"/8"	C	4	17	max. 17	Sd&Cl with Gv lyr, partly in LS	1,240	20.9	71.5	0.20	21	5E-05	17	1.63E-03
19-02-89	PP-AR-1	Pishin	Quetta	Panjpai		34J/12	502 36		152	23	10"/8"	C	1	28	28	Gv + Cl + Sd	2,450		50.7	0.56	59	3E-05	20	2.87E-03
																	1,830	29.3	37.5	0.56	57	3E-05	19	2.79E-03
																	1,240		24.1	0.59	57	3E-05	19	2.80E-03
30-03-89	PP-MKB-1	Pishin	Quetta	Panjpai		34J/12	492 46		152	23	10"	C	1	16	16	Gv +Sd + Cl	1,470	26.3	71.8	0.24	25	4E-05	18	2.11E-03
																	1,240		60.8	0.24	24	4E-05	18	2.00E-03
16-06-88	PP-BK-1	Pishin	Quetta	Panjpai	narrow valley floor	34K/5	367 937	1500	137	37	10"	C	?	?	?	SS and SH	1,240	24.0	27.7	0.52	50	1E-04	12	5.20E-04
																	1,090		23.7	0.53	50	1E-04	12	5.24E-04

Table A.1 (2) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (1) (Source; Drilling / Installation of Tubewells by WAPDA during 1985 - 89)....2/3

Date completed	Well No.	Sub-Basin	District	Beneficiary	Physiography	Location			Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer					Pumping Test		Draw Down(m)	Specific Capacity (l/sec/m)	Transmissivity (m2/d)	Specific Storage (l/m)	Specific Yield (%)	Coefficient of Permeability (cm/sec)
						Map No.	Coordinate	Elevation (m)				Type	No.of Aquifers	Thickness (m)	Saturated Thickness (logged)(m)	Lithology	Discharge Rate (m3/d)	Static WL (m)						
13-10-88	PP-HAN-1	Pishin	Quetta	Panjpai	valley floor	34K/5	393 929	1480	183	21	10"/8"	semi C	2	10	7	Sd	1,830	12.2	30.4	0.70	70	2E-05	22	4.77E-03
												C	2	20	20	Gv	2,450		41.3	0.69	72	2E-05	22	4.84E-03
07-07-89	QT-PHED-2	Pishin	Quetta	Panjpai	hillock area	34K/5	402 878	1510	91	23	10"/8"	semi C	?	?	?	Gv , SS and SH	1,240	9.5	15.1	0.95	87	6E-05	16	1.33E-03
																	1,360		8.7	1.81	160		20	3.04E-03
21-03-87	[illegible] MGTW-1	Kuchlagh	Pishin	Kan Mehtarzai	lower part of fan	34N/6	459 847	2205	122	29	10"	U	1	more than 122	more than 76	Gv with Cl	1,830	32.0	12.1	1.75	163		20	3.15E-03
																	2,450		18.0	1.58	155		20	3.10E-03
02-03-93	Khasai	Kuchlagh	Pishin	Right Flank of Bostan Lora	lower part of large fan	34N/3	80 576	1680	168	37	10"	U	1	98	52	Gv with minor Sd	350	46.3	9.1	0.45	35		15	1.03E-03
																	440		20.5	0.25	21		13	5.84E-04
15-02-88	KLC-HM-3	Kuchlagh	Pishin	Khasai	Bostan Lora flood plain	34N/3	554 72	1640	137	18	10"/8"	U	1	107	max.61	Gv with Cl	550	43.3	27.9	0.23	20		13	6.03E-04
24-09-88	BN-AH-1	Kuchlagh	Pishin	Bostan	periphery of fan	34N/3	12 497	1590	152	20	10"	U (semi C)	1 (4 ~ 5)	39 (77)	max. 30 (77)	Gv (Sd with Gv + Sl)	1,830	26.0	27.2	0.78	77	1E-05	23	6.32E-03
																	1,240		17.0	0.84	78	2E-05	22	5.00E-03
														more than	more than		1,240		3.7	3.88	315		22	4.88E-03
18-07-88	BN-AKP-1	Kuchlagh	Pishin	Bostan	lower part of fan	34N/3	964 648	1600	152	39	10"	U	1	152	91	Gv	1,830	59.0	6.0	3.50	308		22	4.74E-03
																	2,450		8.6	3.29	304		22	4.74E-03
														more than			1,360		13.5	1.17	107	4E-05	18	1.82E-03
10-05-87	KLC-SKP-6	Kuchlagh	Quetta	Kuchlagh Railway Station	periphery of small fan	34J/15	895 408	1565	107	34	10"	semi C	1	79	max. 79	Gv with few Cl	1,830	19.8	19.9	1.07	103	4E-05	17	1.74E-03
																	2,450		29.1	0.98	99	5E-05	17	1.66E-03
																	1,640		17.7	1.07	101	1E-05	23	6.83E-03
20-03-87	KLC-AF-3	Kuchlagh	Quetta	Sahibzada	valley floor	34J/15	911 426	1555	122	12	10"/8"	C	3	20	20	Gv	2,180	4.0	26.6	0.95	95	1E-05	23	6.29E-03
																	2,450		33.4	0.85	87	1E-05	23	5.79E-03
																	2,730		39.4	0.80	84	2E-05	22	5.56E-03
11-01-88	QA-PAZ-8	Kuchlagh	Quetta	Aghberg	periphery of fan	34J/16	769 241	1580	107	19	8"	C	3	28	23	Gv with Cl	440	30.6	8.7	0.58	47	3E-05	20	2.93E-03
																	650		19.1	0.40	35	4E-05	18	2.12E-03
21-07-86	BM-BKB-1	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	83 713	1640	168	49	10"	U	1	more than 152	more than 61	Gv with Sd & Cl	1,230	58.1	38.1	0.37	37		16	1.20E-03
06-09-86	BM-BKB-2	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	108 712	1640	168	29	10"	U	1	more than 152	more than 61	Gv with Sd & Cl	820	65.4	25.6	0.37	34		15	9.77E-04
06-11-87	BM-CKD-1	Kuchlagh	Mastung	Basham	midpart of fan	34J/16	712 91	1645	168	30	10"	U	1	more than 168	more than 61	Gv partly with Gv + Sd + Cl lyrs	1,640	63.8	41.8	0.45	46		17	1.57E-03
30-12-87	BM-PGA-8	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	718 87	1645	168	30	10"	U	1	more than 168	more than 61	Gv with Sd & Cl	650	75.1	22.9	0.33	30		14	8.21E-04
																	930		30.6	0.35	33		15	9.99E-04
06-05-87	BM-HBB-3	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	704 56	1630	168	34	10"	U	1	mre than 168	more than 91	Gv with very thin Cl lyr	2,450	66.0	7.9	3.61	332		22	5.12E-03
23-05-87	BM-HBB-4	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	712 75	1635	168	15	10"/8"	U (partly C)	1 (5 ~ 6)	more than 168	more than 61	Gv with some thin Cl lyrs	350	64.5	37.1	0.17	16	1E-04	12	5.16E-04
														more than	more than	Gv partly with Gv	1,280		3.0	4.98	397		23	6.15E-03
16-07-87	BM-HBB-5	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	709 61	1640	183	30	10"	U	1	183	91	+ Sd+ Cl lyrs	1,850	73.1	5.1	4.25	368		23	5.63E-03
																	2,450		8.5	3.34	309		22	4.81E-03
09-01-87	BM-FYJ-1	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	63 703	1625	168	34	10"	U (partly C)	1 (5 ~ 6)	more than 168	more than 300	Gv with some thin Cl lyrs	2,450	54.5	18.1	1.57	154	3E-05	19	2.51E-03
05-03-87	BM-FYJ-2	Kuchlagh	Mastung	Basham	periphery of fan	34J/16	692 48	1615	183	18	10"/8"	U (partly C)	1 (7 ~ 8)	more than 168	more than 61	Gv with some thin Cl lyrs	550	49.1	64.6	0.10	9	1E-04	12	4.66E-04
13-02-88	BM-AF-8	Kuchlagh	Mastung	Basham	lower part of fan	34J/16	703 50	1630	156	35	10"	U	1	more than 156	more than 76	Gv with minor Sd & Cl	2,450	67.9	4.8	5.92	522		25	9.64E-03
																	1,830		3.2	6.63	551		25	1.01E-02
24-02-88	BM-AF-9	Kuchlagh	Mastung	Basham	midpart of fan	34J/16	707 38	1640	171	29	10"	U	1	more than 171	more than 76	Gv with minor Cl	1,830	65.9	10.7	1.98	182		20	3.49E-03
																	2,450		18.0	1.58	155		20	3.10E-03
17-04-89	QT-BM-1	Quetta(N)	Quetta	Basharabad	lower part of fan	34N/4	959 269	1670	152	23	10"	U	1	more than 152	more than 76	Gv with minor Sd & Cl	650	61.9	18.4	0.41	36		14	7.39E-04
18-12-85	QA-CGY	Quetta(N)	Quetta	Christian Graveyard	lower part of fan	34N/4	971 235	1700	77	20	10"	U	1	more than 62	more than 15	Gv	1,120	25.5	16.2	0.80	73		25	1.46E-02
06-09-86	QA-FA-1	Quetta(N)	Quetta	Parsi Colony	valley floor	34N/4	956 207	1680	76	9	10"/8"	C	2	12	12	Gv	650	14.8	2.5	2.98	219	2E-05	25	2.63E-02
24-10-86	QA-FA-2	Quetta(N)	Quetta	Parsi Graveyard	periphery of fan	34N/4	950 232	1670	78	12	10"	semi C	1	more than 50	more than 40	Gv with Sd & Cl	820	21.8	16.1	0.59	52	4E-05	18	1.80E-03
24-11-86	QA-PGA-4	Quetta(N)	Quetta	Satellite Town	valley floor	34N/4	948 173	1700	92	15	10"	semi C	1	more than 62	more than 46	Gv with some Cl	720	23.8	27.5	0.31	28	9E-05	14	8.23E-04

Table A.1 (3) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (1) (Source; Drilling / Installation of Tubewells by WAPDA during 1985 - 89)...3/3

Date completed	Well No.	Sub-Basin	District	Beneficiary	Physiography	Location Map No.	Location Coordinate	Elevation (m)	Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer Type	Aquifer No.of Aquifers	Aquifer Thickness	Aquifer Saturated Thickness (logged)(m)	Aquifer Lithology	Pumping Test Discharge Rate (m3/d)	Pumping Test Static WL (m)	Pumping Test Draw Down(m)	Specific Capacity (l/sec/m)	Transmissivity (m2/d)	Specific Storage (1/m)	Specific Yield (%)	Coefficient of Permeability (cm/sec)
10-11-85	QA-SYN-1	Quetta(N)	Quetta	Sardar Yaqoob Khan Nasir	valley floor	34N/4	952 222	1670	61	15	10"	C	1	18	18	Gv with minor Sd & Cl	980	9.6	4.1	2.80	224	9E-06	25	1.69E-02
23-03-86	QA-SYN-1A	Quetta(N)	Quetta	Sardar Yaqoob Khan Nasir	valley floor	34N/4	952 222	1670	70	6	10"/8"	C	2	9	9	Gv	1,060	8.1	8.2	1.49	129	1E-05	25	1.85E-02
10-05-88	QA-MCZ-5	Quetta(N)	Quetta	Lady Dufferin Hospital	valley floor	34N/4	969 213	1680	91	15	10"/8"	C	2	20	20	Gv with some Cl	1,230	22.3	2.8	5.08	401	2E-05	25	2.81E-02
13-04-87	QA-MGZK-3	Quetta(N)	Quetta	Prom School	periphery of fan	34N/4	949 193	1700	92	9	10"/8"	C to semi C	2	33	max. 33	Gv with some Cl	330	13.2	29.0	0.13	11	1E-04	12	4.77E-04
02-04-88	QA-ANK-6	Quetta(N)	Quetta	Yazdan Khan High School	lower part of fan	34N/4	983 203	1730	107	15	10"/8"	U to semi C	2 - 3	79	max. 66	Gv with Sd & Cl	660	12.8	31.1	0.25	23	1E-04	12	4.65E-04
06-05-86	QA-SNA-1	Quetta(N)	Quetta	Marriabad	fan deposit	34N/4	985 200	1750	98	37	10"	U	1	more than 98	more than 67	Gv with minor Cl	2,440	19.7	8.0	3.56	327		23	7.01E-03
08-12-86	QA-SNA-2A	Quetta(N)	Quetta	Marriabad	fan deposit	34N/4	987 196	1770	119	-	8 1/2	U	1	37	7	Gv, LS	2,730	62.2	4.3	7.26	642		25	2.03E-02
01-09-92	Darwash Abad	Quetta(N)	Quetta	Samungli	valley floor	34J/16	876 268	1595	155	34	10"	C	6	52	52	Gv	30	18.9	21.3	0.17	14	7E-04	4	2.98E-05
06-02-87	QA-ANK-1	Quetta(N)	Quetta	Brewery	midpart of fan	34J/16	910 203	1660	122	32	10"	U	1	more than 122	more than 76	Gv	930 1,230 1,830	26.0	16.3 18.4 21.9	0.68 0.77 0.97	61 72 96		16 17 18	1.22E-03 1.47E-03 1.95E-03
25-10-87	QA-ANK-2A	Quetta(N)	Quetta	Samungli Air Base	periphery of fan	34J/16	894 263	1590	73	9	10"/8"	semi C	2	14	9	Gv with some Cl	760	20.5	17.3	0.51	45	1E-05	23	6.71E-03
19-03-88	QA-ANK-3	Quetta(N)	Quetta	Killi Kamaloo	valley floor	34J/16	902 103	1690	175	12	10"/8"	semi C	2	9, more than 9	?	St+Sd, LS	1,240	19.4	55.2	0.26	26	2E-05	20	3.33E-03
22-03-88	QA-ANK-4	Quetta(N)	Quetta	Killi Nek Mohammad	valley floor	34J/16	933 175	1685	152	12	10"/8"	semi C	5	49	27	Sd + Gv with Cl	460	34.6	35.5	0.15	14	1E-04	13	6.71E-04
22-03-88	QA-ANK-5	Quetta(N)	Quetta	Killi Alizai	lower part of fan	34J/16	944 139	1730	152	12	10"/8"	semi C	5	77	max. 67	Sd + Gv	560	25.7	29.7	0.22	20	2E-04	11	4.02E-04
31-10-88	QA-ANK-7	Quetta(N)	Quetta	Muslimabad	valley floor	34J/16	943 272	1645	122	12	10"	semi C	3	58	max. 58	Gv + Sd	440	22.8	15.7	0.32	27	1E-04	13	6.48E-04
25-01-89	QT-NGS-1	Quetta(N)	Quetta	Haji Ghulam Sarwar	valley floor	34J/16	933 198	1670	107	21	8"	semi C	6	26	max. 26	Sd + St	300 240	15.8	63.9 46.7	0.05 0.06	5 5	3E-04 2E-04	9 10	2.65E-04 2.82E-04
17-12-85	QA/PGA(FR)	Quetta(N)	Quetta	Kirani	piedmont plain	34J/16	894 144	1695	122	27	10"/8"	semi C	2 - 3	more than 93	max. 93	Gv + Sd with Cl	1,360	13.2	20.8	0.76	72	7E-05	15	1.07E-03
26-10-86	QA-AGHA-PGA-3	Quetta(N)	Quetta	Killi Lalabad	midpart of alluvial fan	34J/16	875 69	1750	135	34	10"	U	1	more than 135	more than 61	Gv with Sd & minor Cl	1,910	32.5	36.8	0.60	61		18	1.95E-03
20-06-87	SZ-BKB-2	Mastung	Mastung	Sorgaz	lower part of fan	34K/13	816 845	1710	122	15	10"/8"	U	1	more than 122	more than 61	Gv	1,230 1,830 2,450	42.3	5.4 8.7 13.4	2.63 2.43 2.12	221 220 204		22 22 22	5.21E-03 5.27E-03 5.06E-03
10-04-88	MST-KN-2	Mastung	Mastung	Karez Noth	valley floor	34K/13	738 754	1620	207	15	10"/8"	U & C	1 1	94 102+	max. 82 102+	Sd + Cl(or St)	890	11.5	87.6	0.12	12	4E-04	7	1.57E-04
08-11-91	Pilot School	Mastung	Mastung	Pilot School	valley floor	34K/13	781 742	1670	241	27	10"	C	2	more than 40	more than 40	Gv & Bd with Cl	160	23.2	109.7	0.02	2	9E-04	4	5.25E-05
02-08-86	KB-BKB-1	Pado Shah Nawaz	Kalat	Kirdagab	river flood plain	34K/6	259 398	1600	130	29	10"	U	1	more than 130	more than 84	Gv with Cl	160	42.8	56.4	0.03	3		4	7.15E-05
02-03-86	KKL-PGA(A)	Kalat	Kalat	Kohing	valley floor	34K/12	502 834	1990	62	12	10"/8"	U (semi C)	1	more than 61	more than 15	Gv with some Cl lyrs	1,170	4.1	33.5	0.41	39	2E-05	20	3.45E-03
24-05-86	KKL-PGA(B)	Kalat	Kalat	Kohing	valley floor	34K/12	512 830	1990	107	41	10"	C (semi C)	1	53 +	53 +	Gv, LS	3,270	2.1	3.9	9.80	870	1E-05	28	2.21E-02
16-07-86	SB-AKZ-1	Kalat	Kalat	Daahl(Surab)		34L/6	402 795		61	12	10"/8"	U	1	42	max. 25	Gv with Cl	380	25.7	6.4	0.69	53		20	3.39E-03
06-11-86	KL(BTU)-PGA-2	Kalat	Kalat	Mouza Bitagu		34L/6	540 741		126	38	10"	U	1	63	max. 45	Gv with Cl	2,450 2,700 3,000	21.6	6.5 7.5 9.6	4.38 4.18 3.63	397 386 344		25 25 25	1.29E-02 1.28E-02 1.16E-02

Note:

Aquifer Type: U ; Unconfined Aquifer, C ; Confined Aquifer, semi C ; Semiconfined Aquifer

Lithology: Gv; Gravel, Sd; Sand, St; Silt, Cl; Clay, LS; Limestone, SS; Sandstone, SH; SHale lyr; layer

Table A.2 (1) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (2) (Source; UNDP Groundwater Studies in Selected Area of Balochistan) 1/3

Year installed	Well No.	Sub-Basin	District	Physiography	Location				Elevation (m)	Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer			Lithology	Pumping Test			Specific Capacity (l/sec/m)	Transmissivity (m3/d/m)	Specific Storage (l/m)	Specific Yield (%)	Coefficient of Permeability (cm/sec)
					Map No.	Coordinate	Latitude	Longitude					Type	No.of Aquifers	Thickness (m)		Discharge Rate (m3/d)	Static WL (m)	Draw Down(m)					
1972 - 1974	PLV-7	Pishin	Qila Abdullah	periphery of fan	34J/10	651 823	30°41'45"	66°42'44"	1470	93	100	12"/9"	U	1	84	Gv	1744.1	40.1	1.4	14.82	1382		25	1.93E-02
1972 - 1974	9	Pishin	Qila Abdullah	lower part of fan	34J/10	547 718	36'24"	36'50"	1485	100	79	12"/9"	semi C U	11	121	Gv	2169.3	41.2	2.2	11.49	1130	6E-06	25	1.08E-02
1972 - 1974	12	Pishin	Qila Abdullah	periphery of fan	34J/10	535 655	33'28"	36'12"	1470	87	56	12"/9"	U semi C	2	22	Gv,Sd,St	1722.3	12.6	13.7	1.45	160	1E-05	24	8.45E-03
1979	UN-PLV-1	Pishin	Qila Abdullah	hillock area	34/J/10	530 870	44'15"	35'43"	1770	102	115	10"	C	3	48	Gv, SS		46.3						
1972 - 1974	2	Pishin	Pishin	river flood plain	34N/2	56 850	43'30"	06'02"	1530	85	99	12"/9"	U,C	2	47	Gv,Sd	2180.2	35.7	10.5	2.40	264	1E-05	23	6.54E-03
1978	KLG-1	Kuchlagh	Pishin	periphery of fan	34N/3	962 500	25'54"	67°00'40"	1565	73	65	10"	U C	1	30	Gv	2452.7	5.4	9.7	2.92	317	7E-06	25	1.23E-02
1978	2	Kuchlagh	Pishin	valley floor	34J/15	911 460	23'45"	66°58'00"	1530	67	60	10"	C	2	20	Gv	469 (artesian)	5.6				1E-05	23	6.53E-03
1978	3	Kuchlagh	Pishin	foot slope of hill	34N/6	255 746	38'06"	67°17'16"	1910	119	200	10"	U C	3	238	Gv with Sd + Cl	2043.9	21.0	2.3	10.14	989	2E-05	22	4.81E-03
1978	4	Kuchlagh	Mastung	valley floor	34J/16	693 48	03'18"	40'55"	1610	64	48	10"	U	1	15	Gv	626.8	40.2	16.8	0.43	44		24	7.93E-03
1978	5	Kuchlagh	Quetta	valley floor	34J/16	726 222	12'02"	47'22"	1590	98	135	8"	U,C	2	69	Gv	408.8	31.9	10.0	0.47	47	9E-05	14	7.89E-04
1978	6	Kuchlagh	Pishin	valley floor	34N/3	993 525	26'50"	67°02'03"	1585	85	115	8"	U	1	53	Gv + Sd with Cl	692.2	12.2	19.4	4.14	44		16	1.21E-03
1978	7	Kuchlagh	Quetta	lower part of fan	34J/16	709 115			1625	116	180	10"	U C	2	90	Gv		45.4						
1978	8	Kuchlagh	Pishin	valley floor	34N/3	964 484	25'03"	00'50"	1600	125	170	10"	U	1	114	Gv + Sd + Cl	2452.7	40.5	4.2	6.62	690		24	7.15E-03
1978	9	Kuchlagh	Pishin	lower part of fan	34N/2	153 591			1740	128	180	10"	U	1	87	Gv with Cl & St		68.5						
1978	10	Kuchlagh	Quetta	valley floor	34J/15	865 372	19'33"	55'12"	1555	93	95	8"	C	3	51	St + Sd + Cl		12.2						
1978	11	Kuchlagh	Quetta	valley floor	34J/15	820 310	16'25"	52'47"	1575	137	?	?	Aquitard	0	0	?		(Artesian)						
1978	13	Kuchlagh	Quetta	valley floor	34N/6	278 705	36'05"	67°18'40"	1925	101	88	10"	C	1	104	Gv with Cl		19.5						
1969 - 71	UN-QA-27	Kuchlagh	Quetta	outflow area of basin	34J/15	878 300			1580	104	170	8"/6"	C	9	56	Gv with minor Cl	659.5	12.5	4.1	1.86	186	2E-05	21	3.84E-03
1969 - 71	31	Kuchlagh	Quetta	outflow area of basin	34J/15	878 303			1580	94	140	2"	C	4	54	Gv with minor Cl		11.0						
1969 - 71	32	Kuchlagh	Quetta	outflow area of basin	34J/15	878 302			1580	79	80	2"	C	4	56	Gv		11.0						
1969 - 71	33	Kuchlagh	Quetta	outflow area of basin	34J/15	880 303			1580	99	60	2"	C	3	52	Gv		11.0						
1969 - 71	34	Kuchlagh	Quetta	outflow area of basin	34J/15	878 303			1580	93	100	2"	C	2	57	Gv with minor Cl		11.0						
1969 - 71	35	Kuchlagh	Quetta	valley floor	34J/15	835 310			1560	98	105	8"	C	1	50	Gv with Sd	790.3	11.9		0.01				
1969 - 71	QA-5	Quetta	Quetta	alluvial fan	34N/3	970 320	17'05"	00'20"	1685	113	146		U, C	5	57	Gv		47.2						
1969 - 71	9	Quetta	Quetta	lower part of fan	34J/16	886 85	03'22"	66°56'30"	1695	69	90		U, C	6	98	Gv + Cl		25.9						
1969 - 71	10	Quetta	Quetta	lower part of fan	34N/4	981 219	12'03"	67°01'53"	1690	60	40		U, C	9	68	Gv with Cl		32.6						
1969 - 71	20	Quetta	Quetta	lower part of fan	34J/16	894 166	03'17"	6656'58"	1690	75	90		C	2	315	Gv	1635.1	15.8						
1969 - 71	24	Quetta	Quetta	center of fan	34J/16	902 208	11'37"	66°57'43"	1690	99	130		semi C	1	114	Gv		36.6						

Table A.2 (2) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (2) (Source: UNDP Groundwater Studies in Selected Area of Balochistan) 2/3

Year installed	Well No.	Sub-Basin	District	Physiography	Location				Elevation (m)	Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer			Lithology	Pumping Test			Specific Capacity (l/sec/m)	Transmissivity (m3/d/m)	Specific Storage (l/m)	Specific Yield (%)	Coefficient of Permeability (cm/sec)
					Map No.	Coordinate	Latitude	Longitude					Type	No.of Aquifers	Thickness (m)		Discharge Rate (m3/d)	Static WL (m)	Draw Down(m)					
1970 - 71	UN-QA-1	Quetta	Quetta							82		8"			12			18.9			46		21	4.36E-05
1971 - 71	3	Quetta	Quetta		34O/1	14 861			1595	183		12"/10"			143		327.0	56.7			9		4	6.94E-05
1969 - 71	4	Quetta	Quetta	valley floor	34J/16	931 168	30°09'32"	66°59'06"	1905	87	40	10"	semi C	2	73	Sd + Cl + St		100.3		0.19		5E-04	6	1.36E-04
1969 - 71	28	Quetta	Quetta	Hanna River bank	34N/4	989 279			1720	134	20	2"	U	1	83	Gv		100.6						
1969 - 71	29	Quetta	Quetta	alluvial fan	34N/3	0 307			1715	137	20	2"	U	1	83	Gv + Sd + Cl		6.4						
1972 - 76	BL-7	Quetta	Quetta	valley floor	34J/15	909 285			1605	75	65	9"	C	5	30	Gv + Cl		24.7						
1972 - 76	8	Quetta	Quetta	valley floor	34J/16	938 269			1635	58	50	9"	C	4	23	Gv		4.3						
1972	9	Quetta	Quetta	valley floor	34J/16	922 235			1660	94	55	9"	C	4	17	Gv with minor Cl		36.0						
1972	QESCO	Quetta	Quetta	valley floor	34N/4	964 234	30°12'45"	67°00'52"	1690	66	54	12"/9"	U, C	2	28	Gv		14.9						
1972	GSP	Quetta	Quetta	valley floor	34J/16	943 182			1700	137	324	9"/10" /8"/10"	C	3		Sd with Gv		18.9						
1969 - 78	Recorder-2	Quetta	Quetta	valley floor	34N/4	953 174			1710	45	15	4"/1.25 "	C	5	6	Gv with Cl		34.1						
1969 - 78	Police H.Q	Quetta	Quetta	valley floor	34N/4	975 221			1695	91	110	10"	U, C	2	45	Gv						1E-05	23	5.73E-03
1970 - 78	EME-2	Quetta	Quetta								125	12"/10 "					381.5	75.8	14.6	0.22	25		21	3.93E-03
1971 - 78	Staff College	Quetta	Quetta								123	10"			63		190.8	57.9	20.1	0.10	9		13	6.12E-04
1975	Artillery Mess	Quetta	Quetta	alluvial fan	34N/4	995 217	30°11'57"	67°02'40"	1735	104	154	10"	U, C	7	47	Gv		16.5						
1975	Air Force (base)	Quetta	Quetta	foot slope of hill	34J/16	896 263	14'10"	66°57'00"	1610	79	100	10"	C	4	30	Gv + Cl		28.0						
1975	Animal-husbandary-1	Quetta	Quetta	valley floor	34J/16	914 209	11'33"	58'08"	1660	119	250	10"/8"	semi C	5	76	Gv with Cl & Sd	1580.6		17.1	1.08	121	4E-05	18	1.84E-03
1975	3	Quetta	Quetta												83		1537.0	39.2	8.5	2.07	186		25	2.87E-02
1978	Airport	Quetta	Quetta	outflow area of basin	34J/16	894 278			1595	73	70	10"	C	3	34	Gv with minor Cl		15.8						
1978	University -1	Quetta	Quetta	valley floor	34J/16	941 173	30°09'43"	66°59'34"	1700	79	66	12"/10 "	C	2	37	Gv	599.5	20.7				2E-05	21	4.06E-03
1978	Killi Umer	Quetta	Quetta	river flood plain	34N/4	954 267			0	121	104	10"	U	1	68	Gv + Sd	1444.4	52.5	25.2	0.66	74		17	1.57E-03
1975 - 76	UN-MST-1	Mastung	Mastung	valley floor	34K/13	800 835	29°52'58"	66°51'52"	1685	320	20	3"	C	1	4	Gv + Cl	32.7	Artesian						
1974 - 77	3	Mastung	Mastung	valley floor	34K/10	638 470	34'45"	42'48"	1745	99	50	10"/8"	C	5	18	Gv	621.3	31.1	16.2	0.43	47	3E-05	20	2.97E-03
1975 - 76	4	Mastung	Mastung	sand dune	34K/13	835 805	51'29"	53'50"	1735	61	10	2"	U	1	23	Gv		43.6						
1974 - 77	4-A	Mastung	Mastung	foot slope of hill	34K/13	825 926	57'26"	53'12"	1735	138	162	10"	U	1	78	Gv	1389.9	44.0	16.9	0.95	104		17	1.73E-03
1974 - 77	5	Mastung	Mastung	valley floor	34K/14	753 675	44'58"	49'18"	1690	97	40	8"/6"	C, U	7	43	Gv	267.1	2.5 (artesian)	49.1	-	7	3E-04	8	1.91E-04
1975 - 76	6	Mastung	Mastung	valley floor	34K/10	582 676	40'18"	45'25"	1725	239	50	4"	C	2	17	Gv + Cl		17.4				1E-04	13	6.00E-04
1974 - 77	6	Mastung	Mastung	sand dune	34K/13	785 822	52'12"	51'06"	1645	320	85	10"	Aquitarde	0	32	Gv	245.3	42.5 (artesian)	-	-		8E-04	1	4.45E-05

Table A.2 (3) Well Data used for the Analysis of Hydrogeological Properties in The Study Area (2) (Source; UNDP Groundwater Studies in Selected Area of Balochistan) 3/3

Year installed	Well No.	Sub-Basin	District	Physiography	Location				Elevation (m)	Depth (m)	Total Screen Length (m)	Dia. (inc.)	Aquifer			Lithology	Pumping Test			Specific Capacity (l/sec/m)	Transmissivity (m3/d/m)	Specific Storage (l/m)	Specific Yield (%)	Coefficient of Permeability (cm/sec)
					Map No.	Coordinate	Latitude	Longitude					Type	No.of Aquifers	Thickness (m)		Discharge Rate (m3/d)	Static WL (m)	Draw Down(m)					
1974 - 77	10	Mastung	Mastung	periphery of fan	34K/13	826 837	53'03"	53'22"	1730	227	20	4"	C	7	119	Gv + Cl		26.4						
1974 - 77	11	Mastung	Mastung	periphery of fan	34K/14	711 578	40'00"	46'58"	1740	146	266	8"	U, C	5	105	Gv	588.6	30.4	7.6	0.90	89	8E-05	15	9.82E-04
1974 - 77	12	Mastung	Mastung	valley floor	34K/10	654 529	37'42"	43'42"	1725	218	40	4"	C	2	88	Gv + Cl		18.8						
1974 - 77	13	Mastung	Mastung	alluvial fan	34K/14	781 670	44'48"	50'51"	1750	183	70	4"	U, C	3	46	Gv with Cl	218.0	43.5				1E-04	12	5.53E-04
1975 - 76	KDK.1	Mastung	Mastung	river bank	34K/10	630 425			1770	73	100	12"/10"	U	1	48	Gv		54.9	13.7					
1975 - 76	2	Mastung	Mastung	river bank	34K/10	625 421			1785	114	100	12"/10"	U	1	63	Gv		60.4	8.2					
1974 - 77	3	Mastung	Mastung	river bank	34K/10	633 432			1770	105	100	12"/9"	U	1	56	Gv	1651.5	51.8	5.4	3.53	364		24	7.87E-03
1974 - 77	4	Mastung	Mastung	river bank	34K/10	630 421			1775	102	85	11"/9"	U	1	46	Gv + Cl		59.4	9.1					
1974 - 77	5	Mastung	Mastung	valley floor	34K/10	628 435			1765	82	65	12"/9"	U	1	33	Gv + Cl	1280.8	47.2	11.1	1.33	142		23	6.01E-03
1976 - 78	UN KL-1	Kalat	Kalat	valley floor	34K/8	371 920	07'24"	28'18"	1820	79	90	11"	U	1	11	Sd + Cl with Gv		65.8						
1976 - 78	3	Kalat	Kalat	valley floor	34K/8	396 35	29°13'03"	66°29'30"	1795	143	180	8"	U, C	2	108	Gv + Sd	697.7	46.7	4.3	1.90	183	4E-05	18	1.97E-03
1976 - 78	4	Kalat	Kalat	valley floor	34K/12	410 927	07'36"	30'24"	1850	192	170	9"	U, C	2	105	Gv	147.2	53.9	10.4	0.17	15	4E-04	7	1.63E-04
1976 - 78	5	Kalat	Kalat	valley floor	34K/12	495 828	03'24"	35'24"	1985	70	100	10"	C	1	62	Gv	545.0	13.8	1.6	4.49	374	1E-05	23	6.93E-03
1979	UN-PS-3	Pishi Shah Nawaz	Mastung	valley floor	34K/6	278 488	35'28"	22'29"	1565	79	75	8"	semi C C	2	26	Gv	790.3	16.8	1.4	6.21	567	1E-05	29	2.56E-02
1979	6	Pishi Shah Nawaz	Kalat	valley floor	34K/7	254 377			1605	122	180	8"	semi C	1	86	Gv		36.3						

Note:

Aquifer Type: U ; Unconfined Aquifer, C ; Confined Aquifer, semi C ; Semiconfined Aquifer

Lithology: Gv; Gravel, Sd; Sand, St; Silt, Cl; Clay, LS; Limestone, SS; Sandstone, SH; SHale lyr; layer

Table A.3 The Result of In Situ Permeability Test at Drilling Sites

Test Method; Falling Head Method by Casing

Name of Drilling Site	Test Depth (GL.-m)	Depth to Water Table (GL.-m)	Depth (m) to Bedrocks or Aquitard	Name or Compo - sition of Bedrocks or Aquifer	Lithology at Testing Section	Coefficient of Permeability (cm/sec)
Khushab	8.10	6.40	12.5	Limetone & Shale (Parh Gr.)	Silt,Sand,Gravel	1.42E-03
Tirkha	2.00	0.20	2.0	Bostan Clay	Gravel Sand (River dep.) / Bostan Clay	8.50E-04
Brewary	6.24	1.82	12.0	Brewary Limestone	Boulder Gravels	2.50E-03
Ghutai Shera	2.77	5.33	11.0	Sandy Silt (Subrecent dep.)	Silty Sand	9.50E-03
Walidad	2.00	Nil	30.0	Clayey Silt (Subrecent dep.)	Cobble/Gravel	1.26E-04
Dara	3.00	Nil	20.0	Silt with Clay (Subrecent dep.)	Gravel	1.49E-03
Murgi Kotal	2.60	Nil	40+	-	Siltation Material	7.82E-04
Kach	2.50	1.05	1.0	Gazij Shale	Gazij Shale	3.50E-07
Jigda	8.00	6.10	9.5	Murgha Faqirzai Shale	Gravel,Sand	1.50E-03
Sanzali	20.00	2.50	2.5	Bostan Clay	Bostan Fm.	1.54E-04
Arambi	9.00	7.75	17.0	Shaigalu Sandstone	Creyey Gravel	2.07E-04
Sakhol	3.70	Nil	40+	-	Gravel,Sand,Silt	3.06E-04
Mangi	3.00	Nil	27.0	Murgha Faqirzai Shale	Cobble,Gravel,Silt	1.06E-04
Kad Kucha II	2.55	Nil	40+	-	Gravel,Sand,Silt	3.18E-05
Iskalkoo	16.00	2.60	6.5	Gazij Shale	Gazij Shale	1.03E-04

Table A.4 Topo-Scale and Hydrogeological Properties of Aquifers Distributing in the Downstream of Priority DADs.

Name of DAD Sites	Topo-Type of Aquifers	Topo-Scale of Aquifers		Hydrogeological Properties		Basement Rocks
		Horizontal Dimensions	Topo-Gradient & Thickness	Coefficient of *Permeability*	Others (T : Transmissivity, Sy : Specific Yield)	
Brewary	Alluvial Fan deposits	Radius app. 3km Radial angle app.100deg. Area app. 8km2	Gradient app. 1/50 Thickness more than 100 m	Uppermost-Stream Area 2.5E-3cm/sec Center of Fan 1.2 to 1.9E-3cm/sec	T : 60 to 120m2/d Sy : 18 to 25%	Brewary Limestone
Dara	Alluvial Fan deposits	Radius 2 to 3km Radial angle app. 60deg. Area 5 to 6km2	Gradient 1/20 to 1/40 Thickness 150 to 200 m	Uppermost-Stream Area 1.5E-3cm/sec	T : 40 to 80m2/d	Chiltan Limestone
Murgi Kotal	Alluvial Fan deposits (Kuchlagh Side)	Radius 1.5 to 2km Radial angle app. 100deg. Area app. 2km2	Gradient app. 1/25 Thickness 150 to 200 m	In the order of E-3cm/sec	T : 90 to 100m2/d Sy ; a little more than 20%	Chiltan Limestone
	Alluvial Fan deposits (Quetta Side)	Radius app. 3km Radial angle app. 60deg. Area app. 6km2	Gradient app. 1/25 Thickness app. 150m	In the order of E-3cm/sec	T : 90 to 100m2/d Sy : a little more than 20%	Chiltan Limestone
Kach	River dep. & Fan dep.	Radius app. 5km Radial angle app. 30deg. Area 4 to 5km2	Gradient less than 1/50 Thickness up to 200m	1 to 2E-3cm/sec	T : 40 to 80m2/d Sy : more than 20%	Gazij Shale
Jigda	River dep. & Fan dep.	Radius 5 to 6km Area 12 to 13km2	Gradient app. 1/45 Thickness up to 200m	Uppermost-Stream Riverbed 1.5E-3cm/sec Alluvial Fan 6 to 7E-3cm/sec	T : 160 to 70m2/d Sy : 23%	Murgha Faqirzai Shale
Sanzali	River deposits	Widness of Riverbed Some Tens to Hundred & Some Tens of Meters	Gradient 1/40 to 1/80 Thickness 2.5 to 10m	approximately 1E-3cm/sec	T : 3 to 3m2/d Sy : 15 to 20%	Bostan Formation
	Fan dep. & Valley Floor dep.	Influenced Radius app. 3km * 3km	Gradient 1/50 to 1/60 Thickness Silty Sands up to 30m, Silts & Clay up to 150m	a little less than 1E-3cm/sec	T : 70 to 80m2/d Sy : app.15%	Bostan Formation
Sakhol	Sand Dune deposits	Widness Several km	Gradient app. 1/100 Thickness 20 to 30m	In the order of E-4cm/sec	T : 2 to 3m2/d Sy : 10 to 15%	Chiltan Limestone
Mangi	Alluvial Fan deposits	Area 14 to 15km2	Gradient app. 1/100 Thickness 70 to 80m	In the order of E-3 to E-4cm/sec	T : 5 to 500m2/d	Shirinab Formation Murgha Faqirzai Shale
Kad Kocha II	Alluvial Fan deposits	Area 3 to 4km2	Gradient 1/30 to 1/40 Thickness up to 200m	approximately 1E-3cm/sec	T : 90m2/d Sy : 15%	Chiltan Limestone
Ghaziona	River deposits	Widness of Riverbed 40 to 200m	Gradient 1/50 to 1/60 Thickness 10 to 30m	In the order of E-3cm/sec	T : app. 5m2/d	Murgha Faqirzai Shale

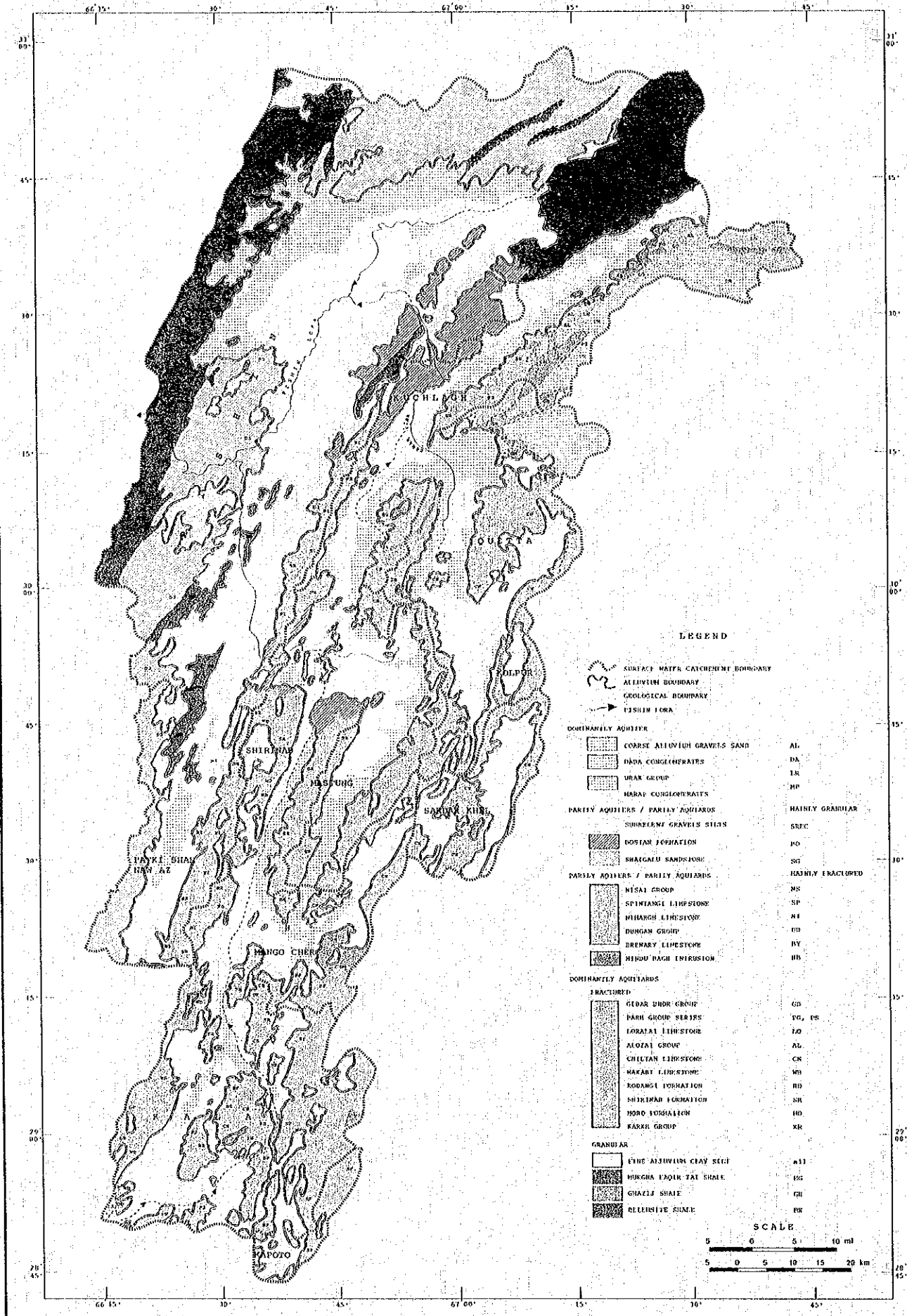

Fig.A.1 AQUIFERS AND AQUITARDS PISHIN LORA BASIN

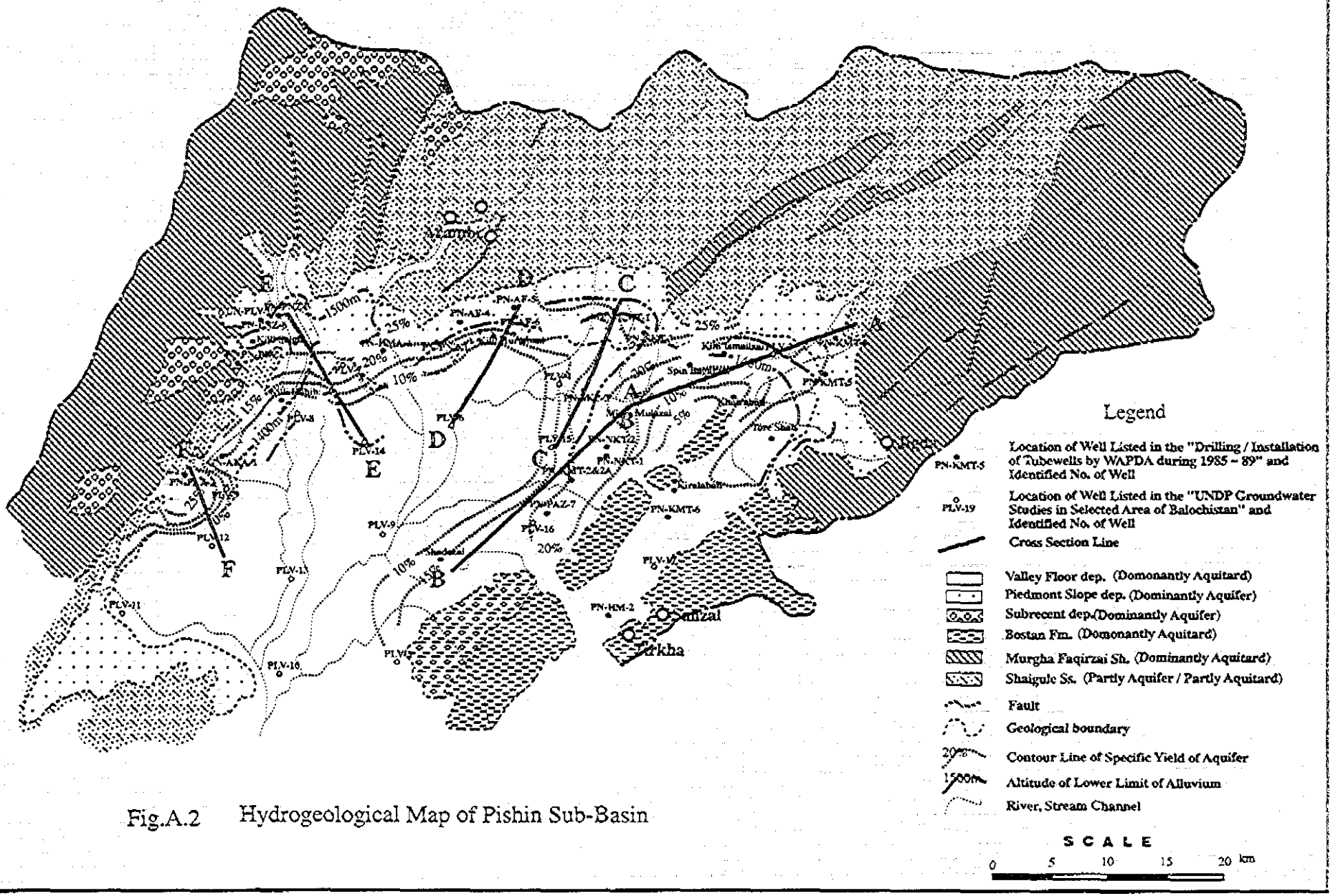

Fig.A.2 Hydrogeological Map of Pishin Sub-Basin

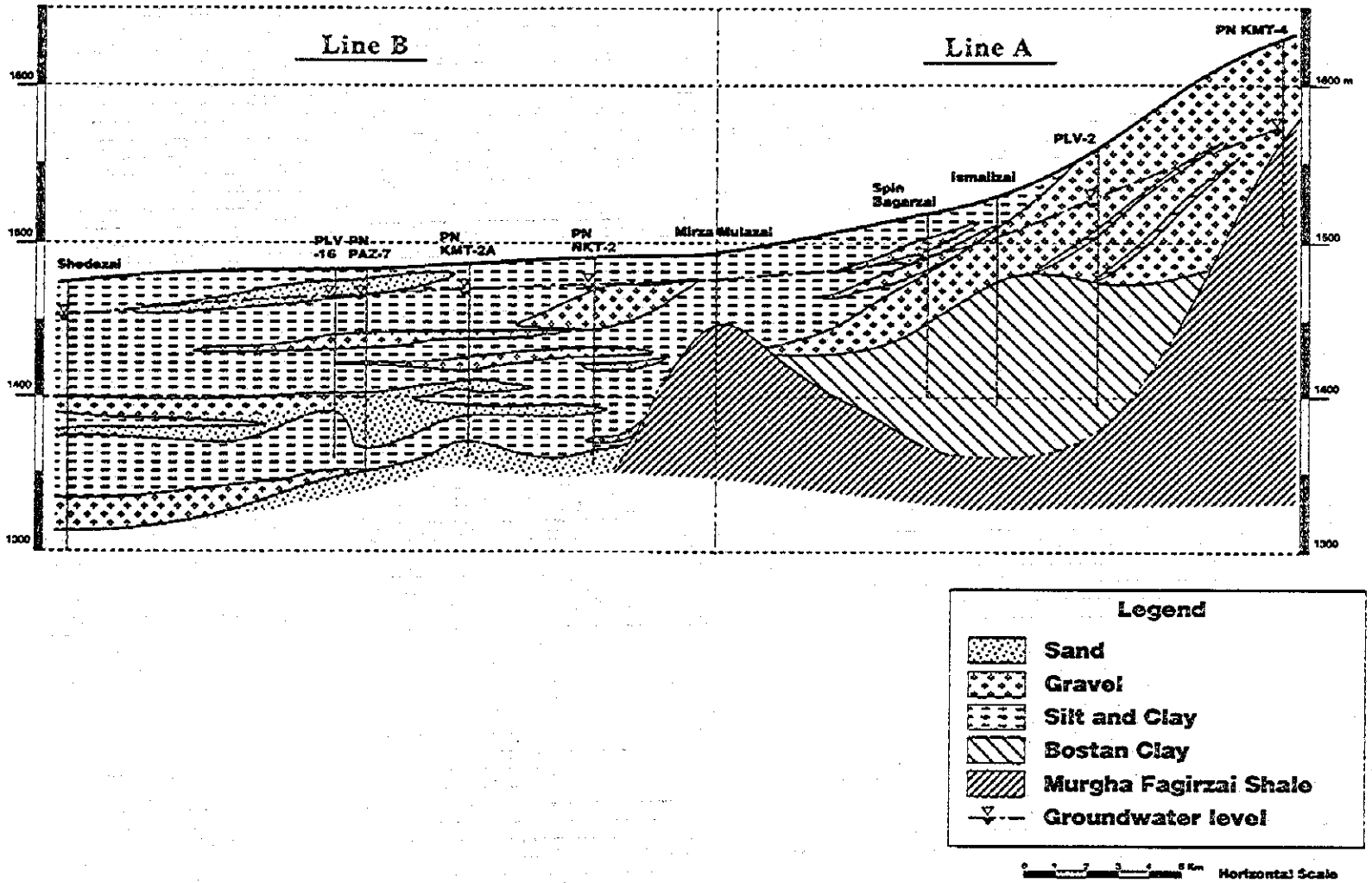

Fig.A.3 Geological Profiles of Pishin Sub-Basin (1)

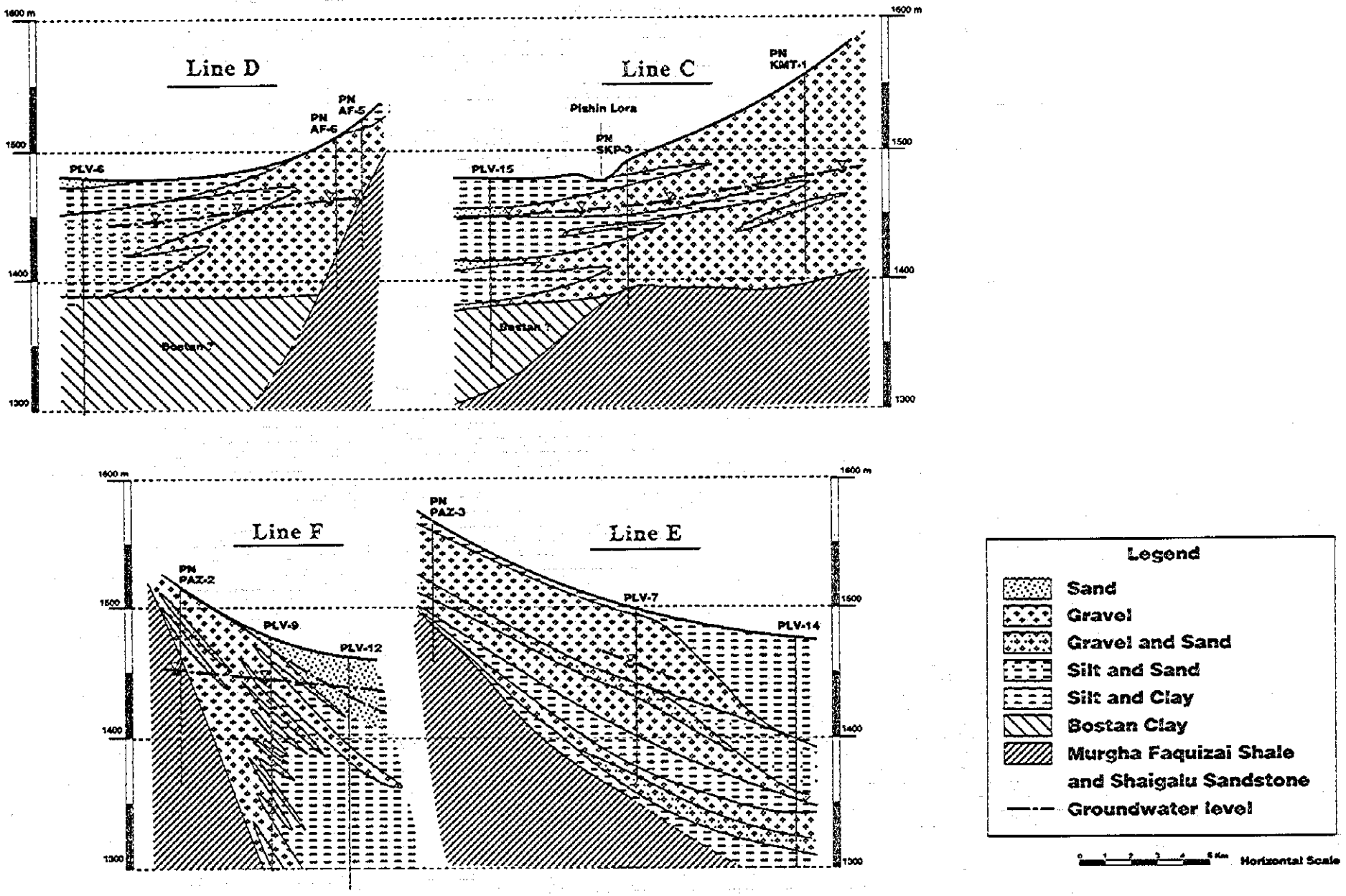

Fig.A.4 Geological Profiles of Pishin Sub-Basin (2)

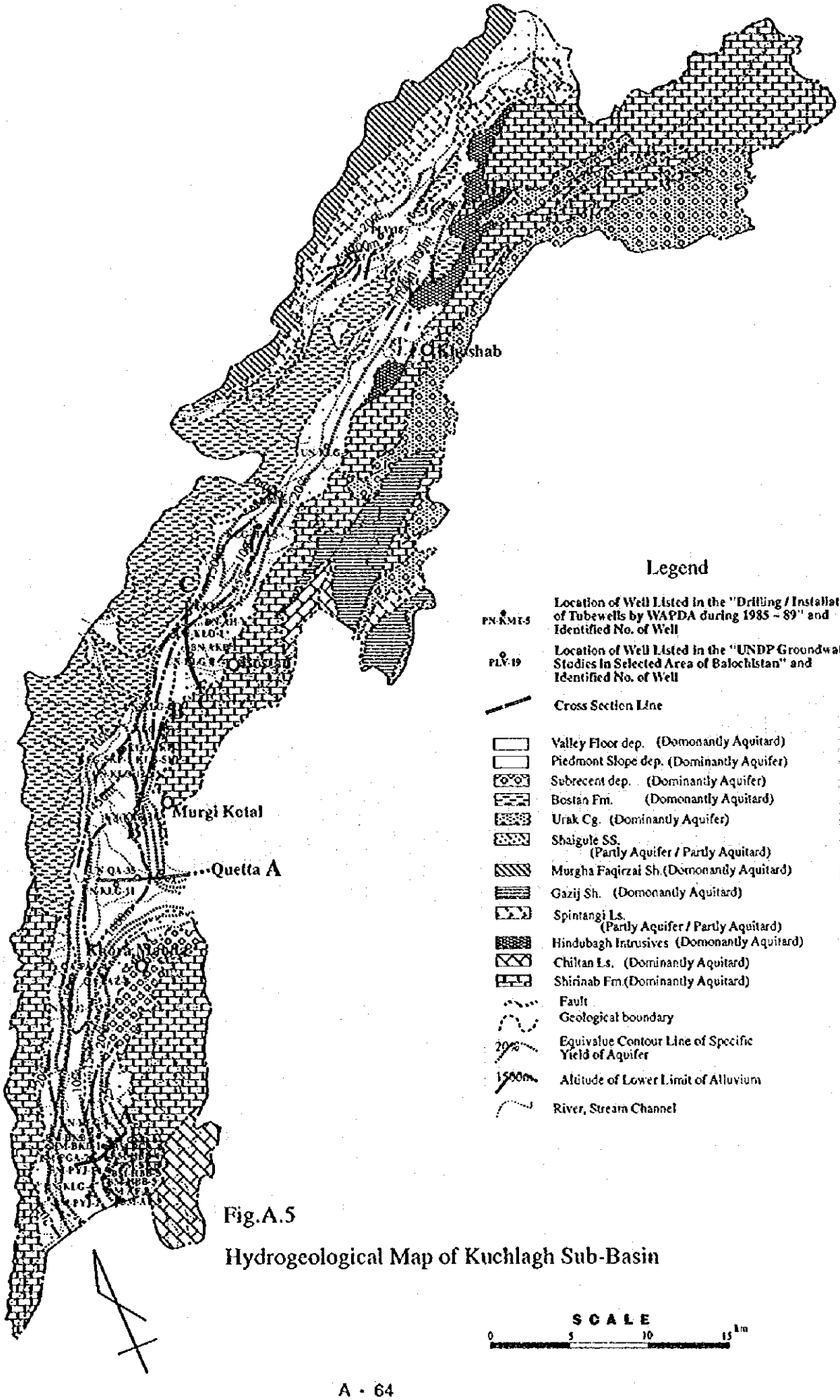

Fig.A.5

Hydrogeological Map of Kuchlagh Sub-Basin

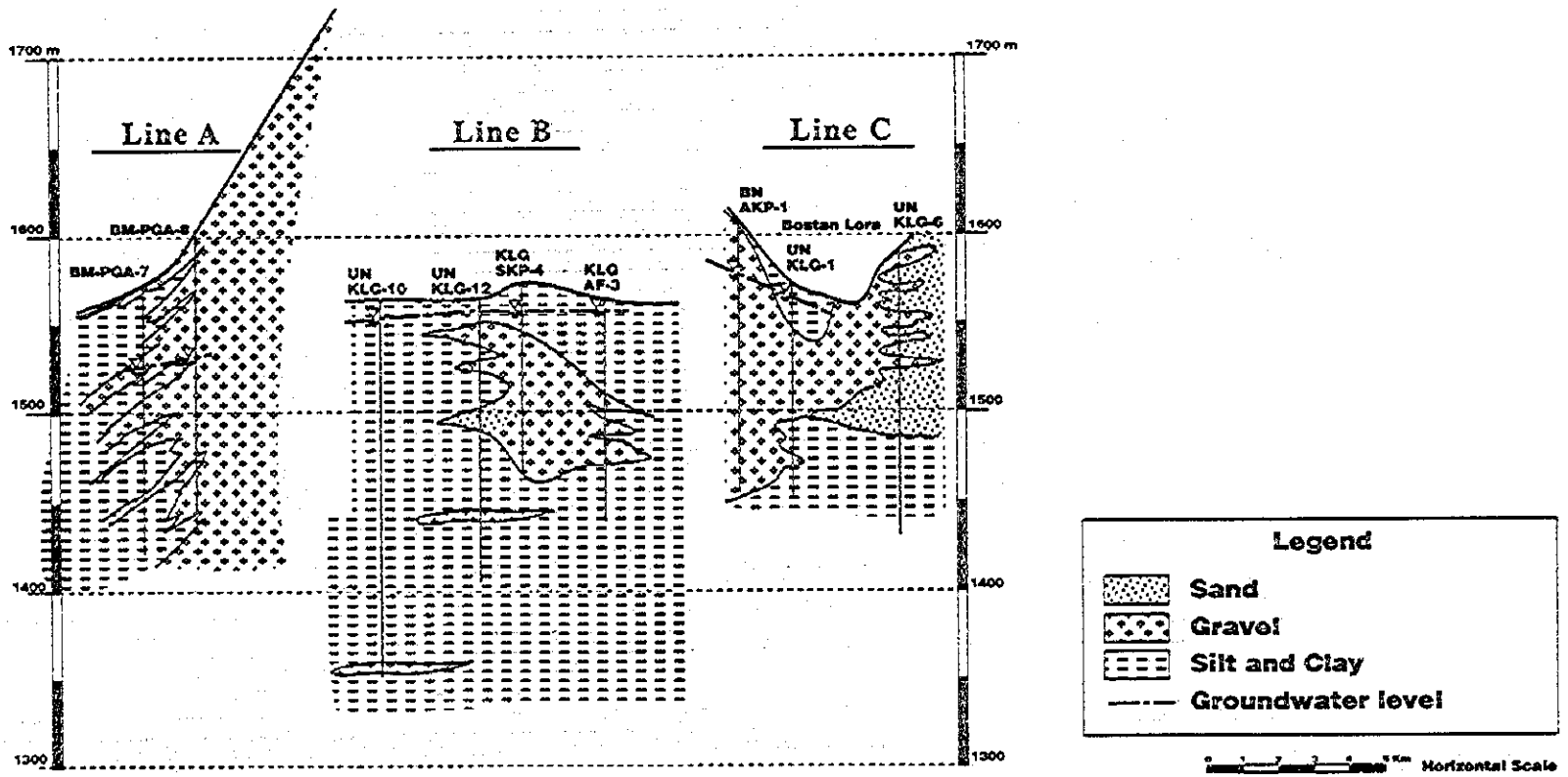

Fig.A.6 Geological Profiles of Kuchlagh Sub-Basin

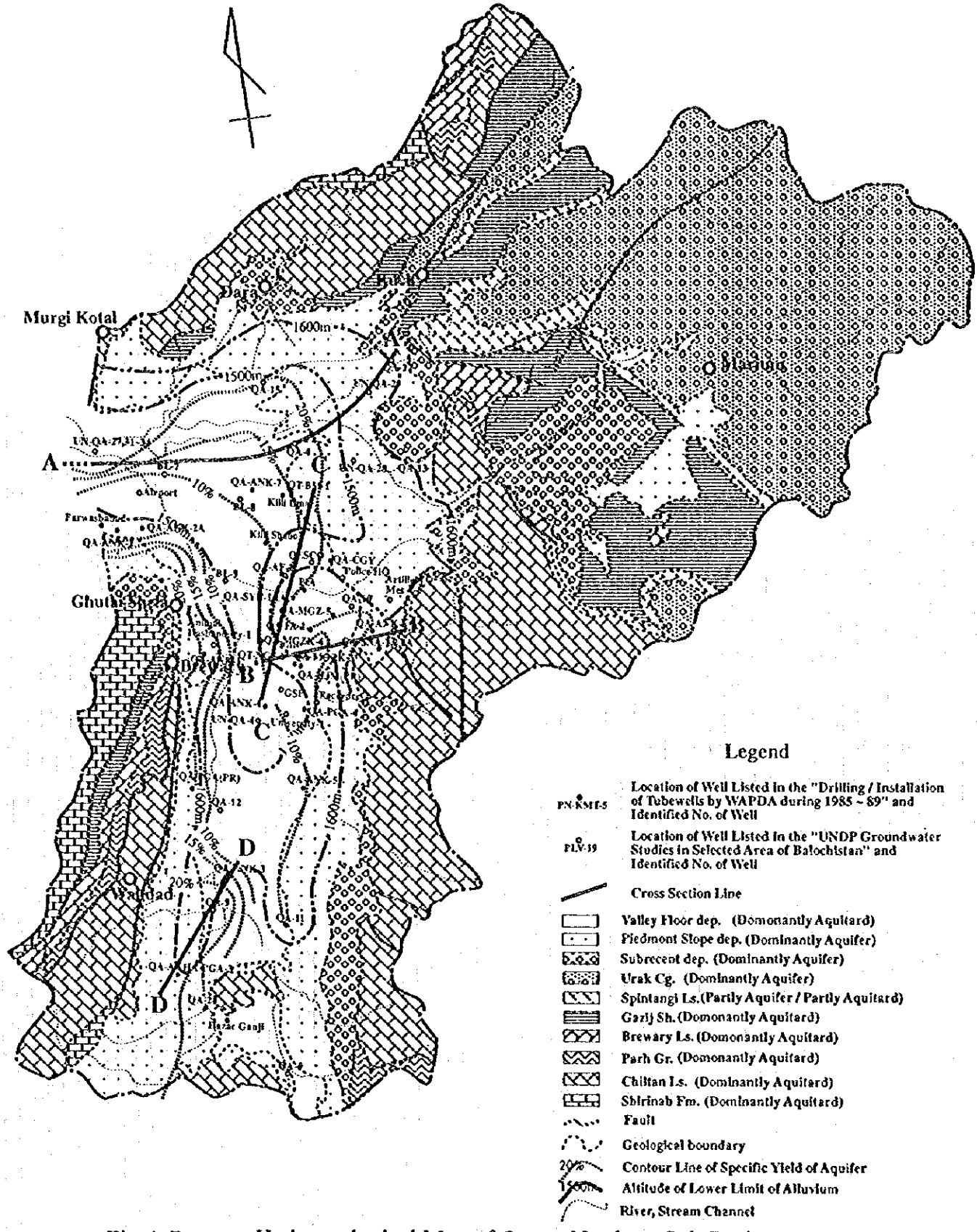

Fig.A.7 Hydrogeological Map of Quetta Northern Sub-Basin

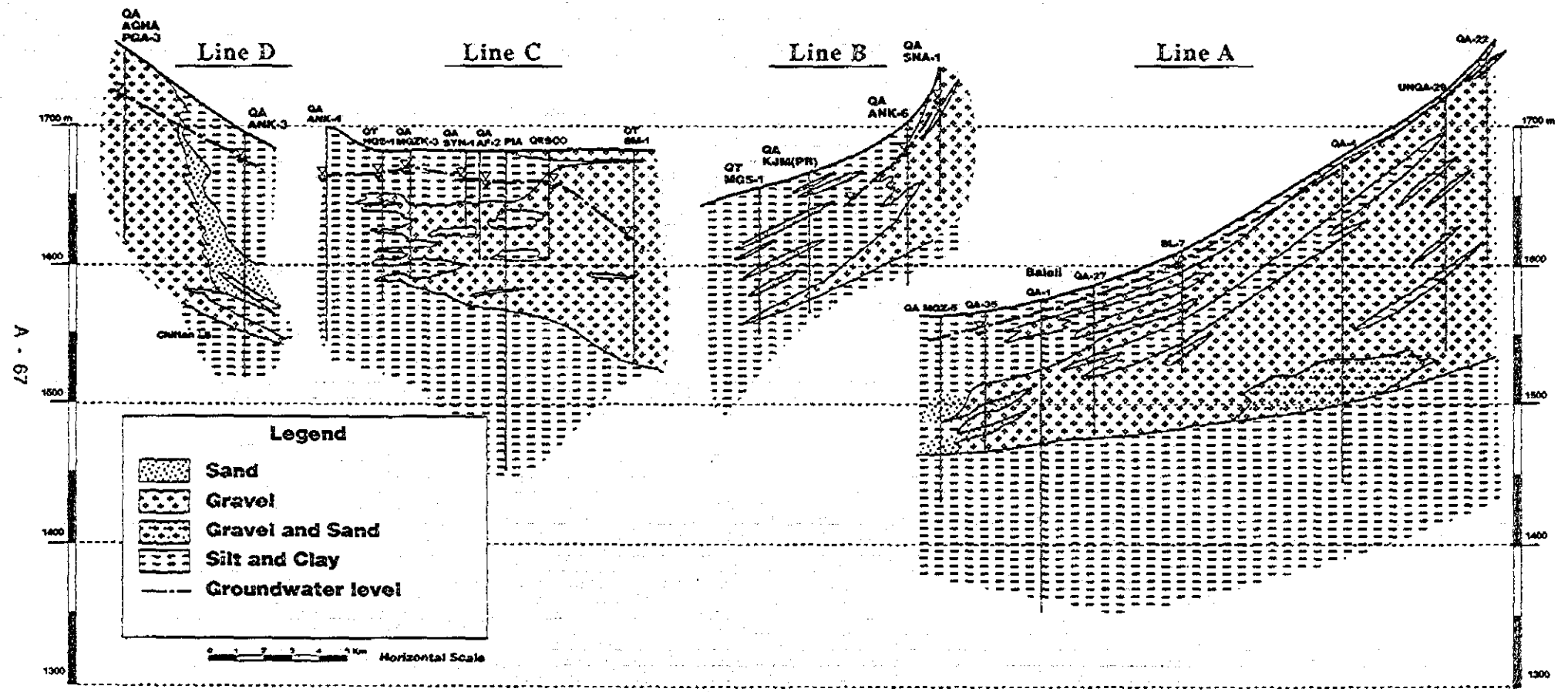

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Fig.A.8 Geological Prifiles of Quetta Sub-Basin

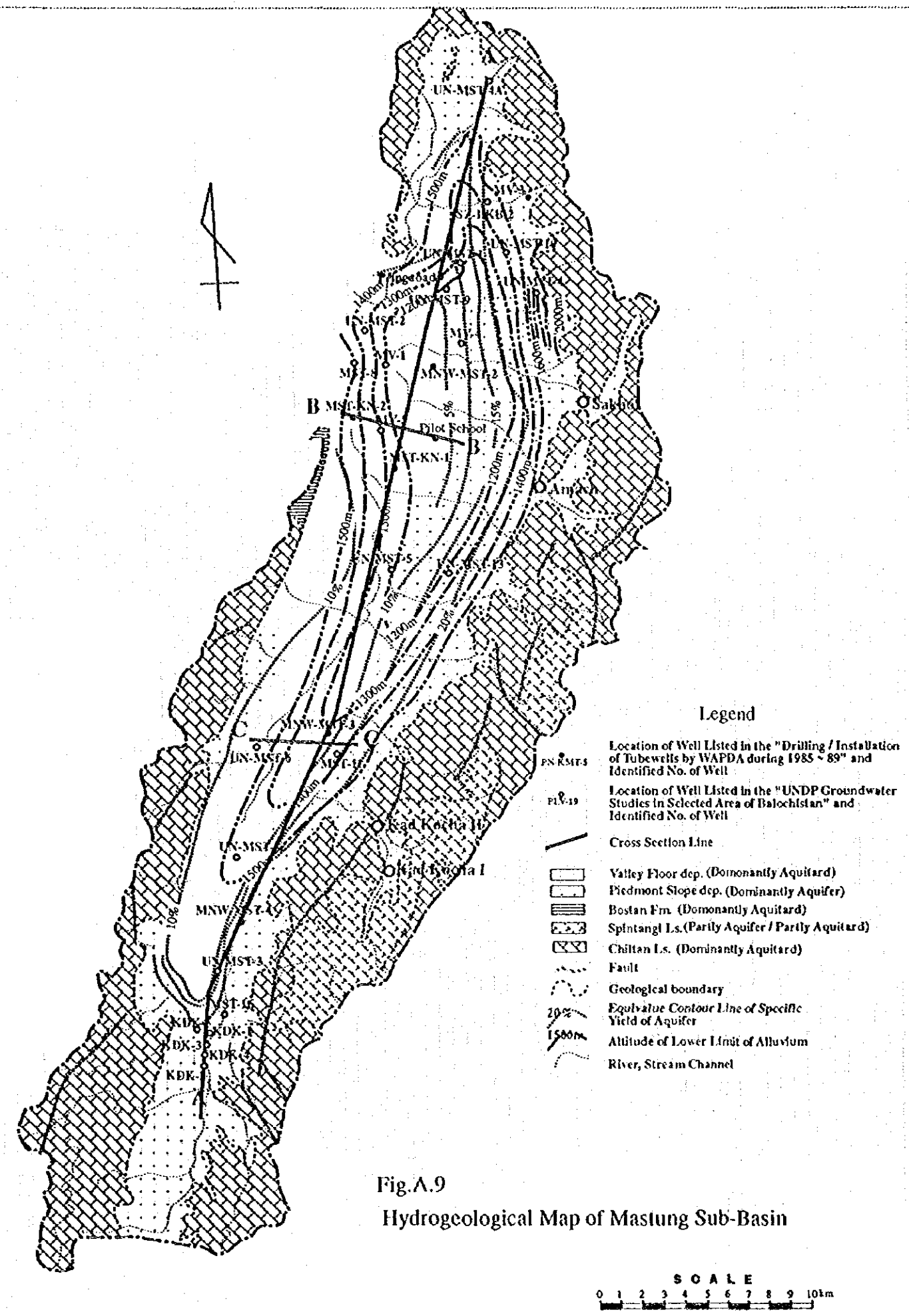

Fig.A.9

Hydrogeological Map of Mastung Sub-Basin

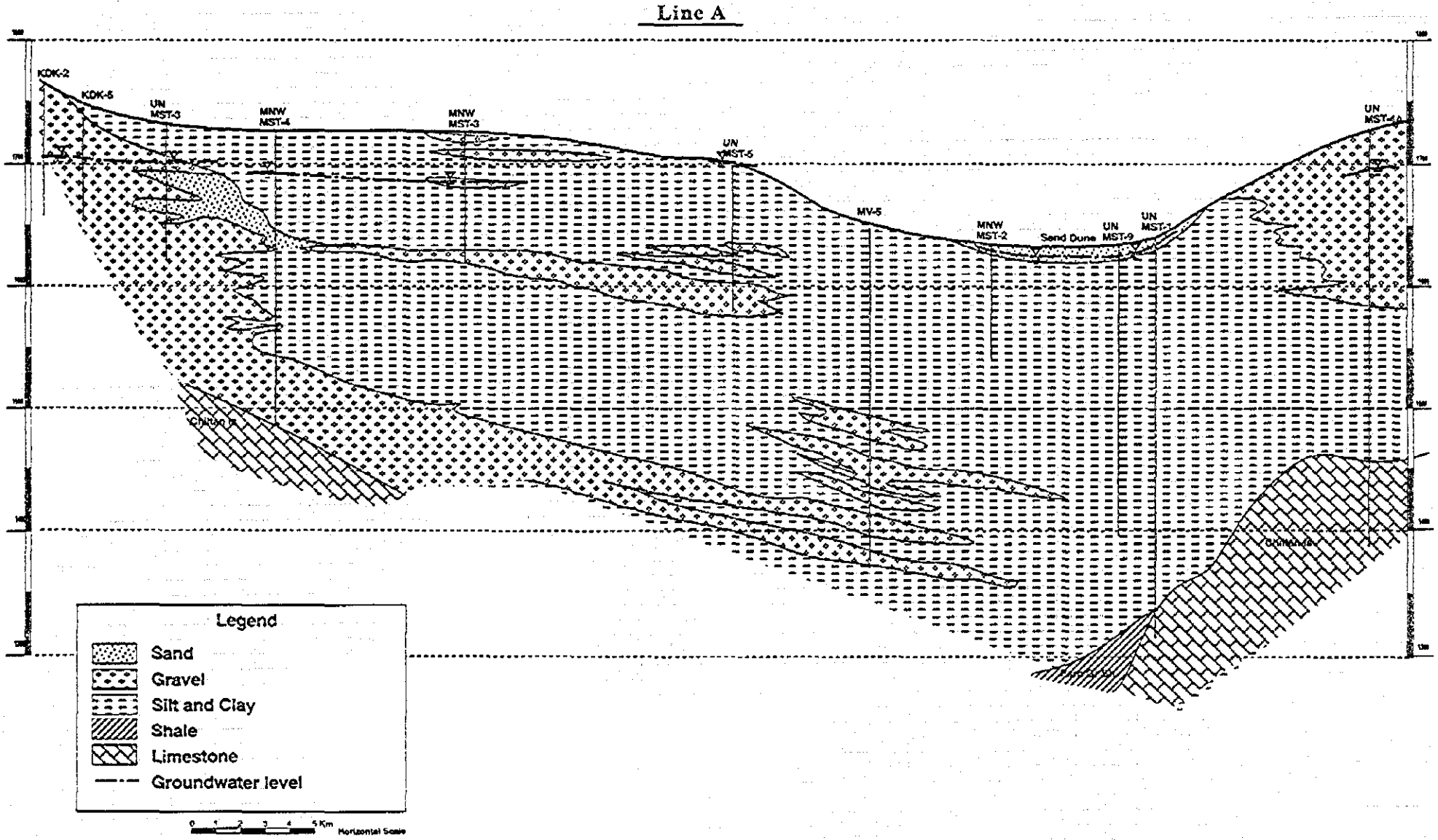

Fig.A.10 Geological Prifiles of Mastung Sub-Basin (1)

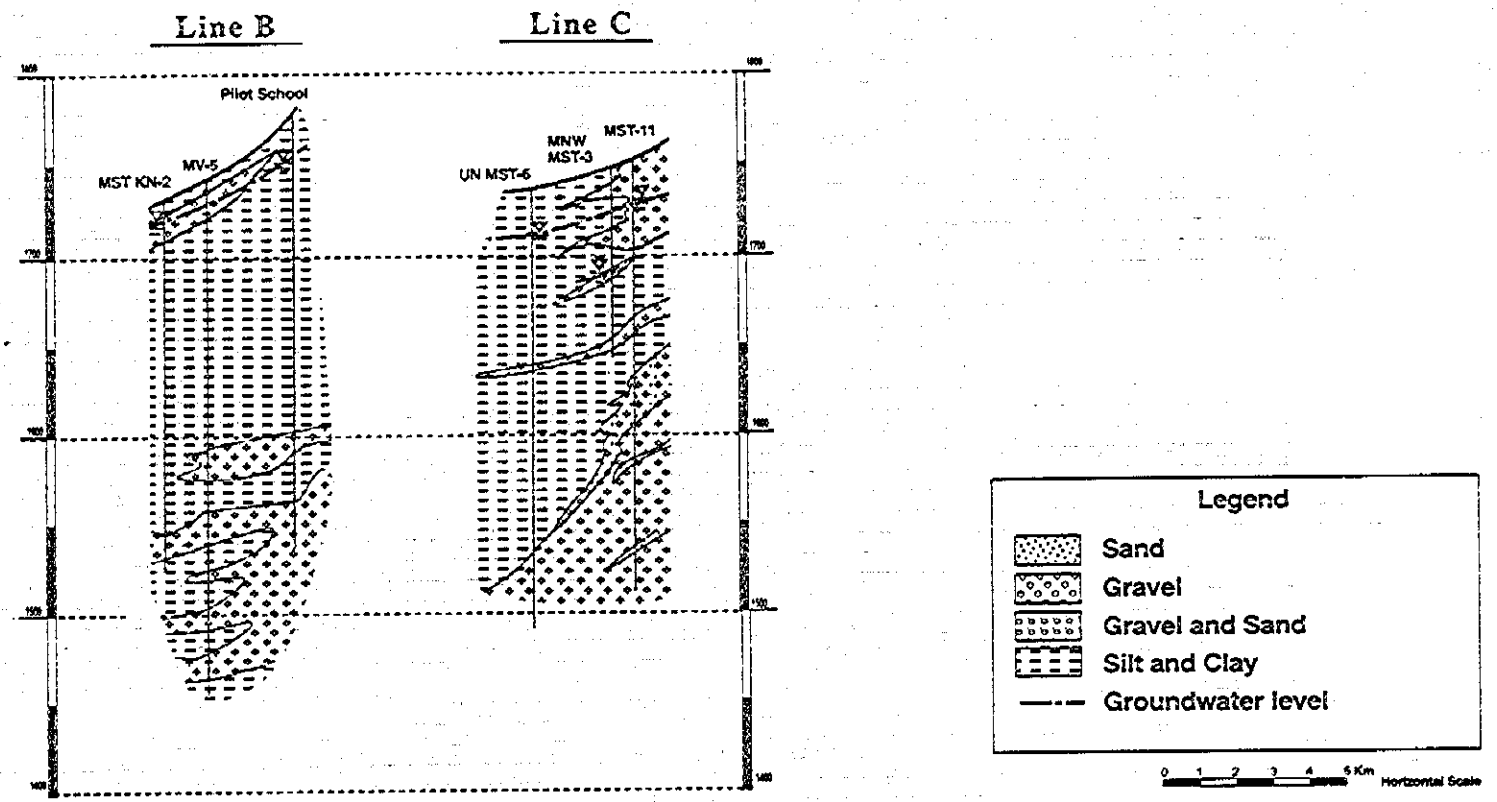

Fig.A.11 Geological Profiles of Mastung Sub-Basin (2)

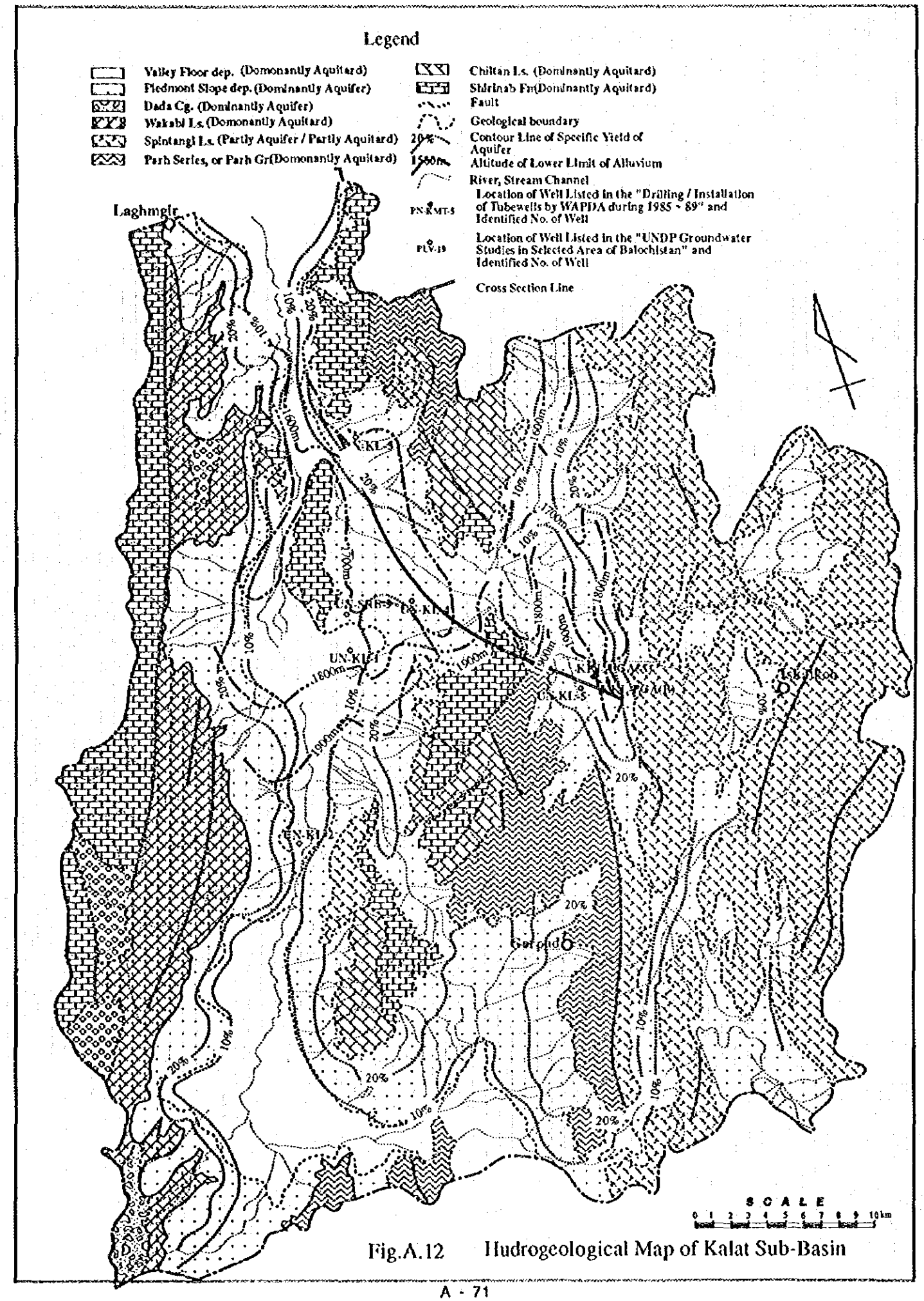

Fig.A.12 Hudrogeological Map of Kalat Sub-Basin

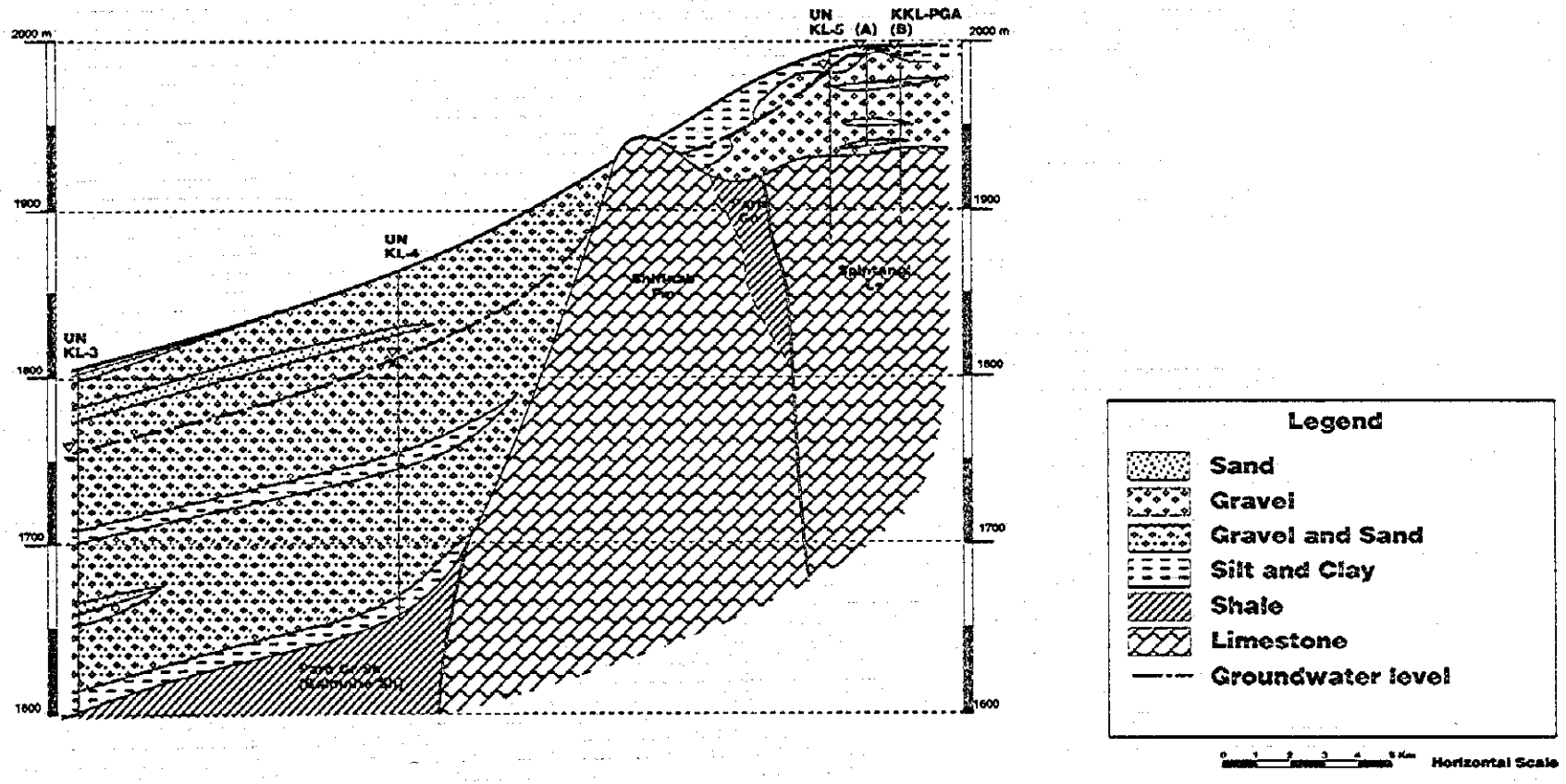

Fig.A.13 Geological Profiles of Kalat Sub-Basin

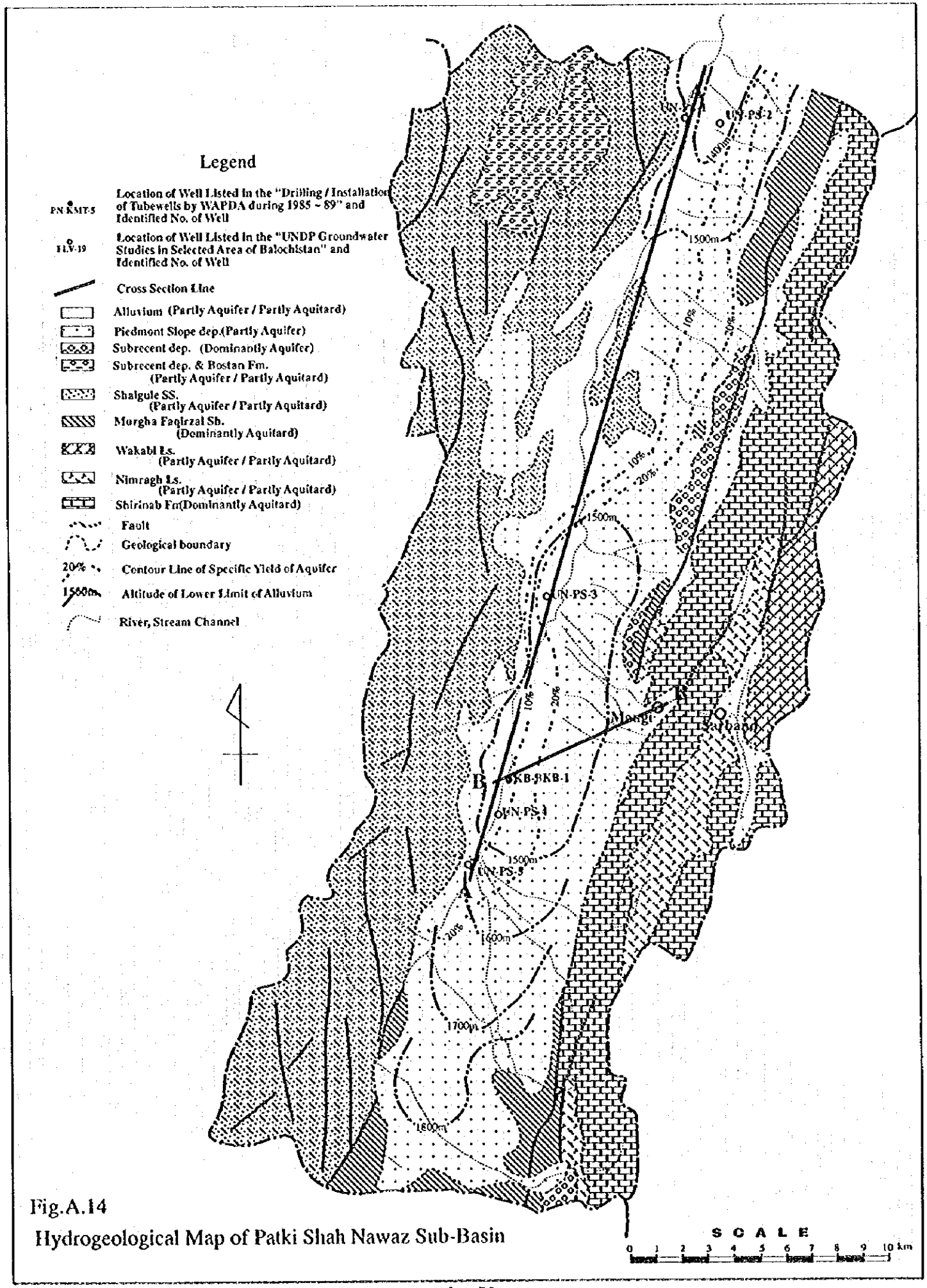

Fig.A.14

Hydrogeological Map of Patki Shah Nawaz Sub-Basin

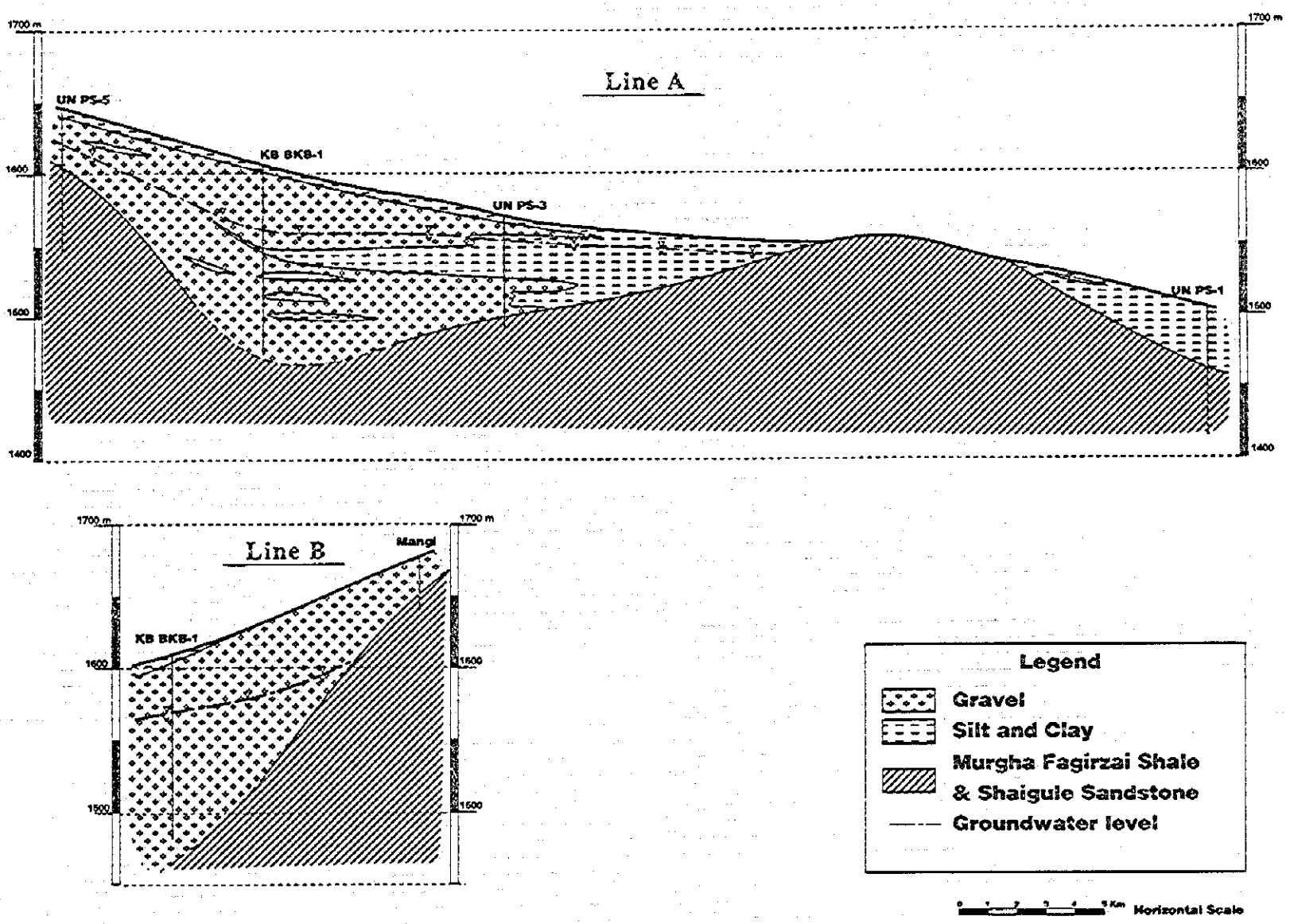

Fig.A.15 Geological Profiles of Patki Shah Nawaz Sub-Basin

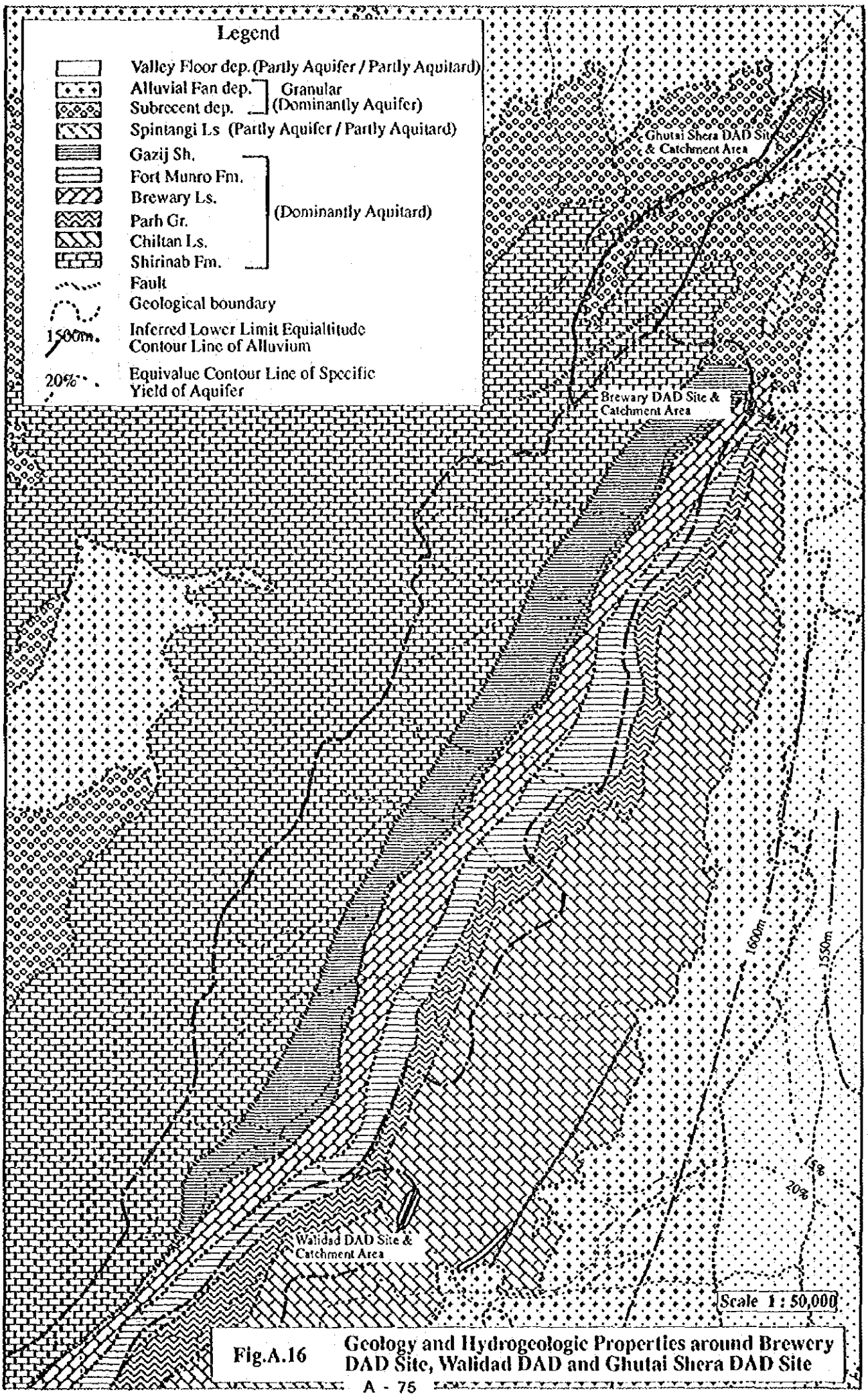

Fig.A.16 Geology and Hydrogeologic Properties around Brewery DAD Site, Walidad DAD and Ghutai Shera DAD Site

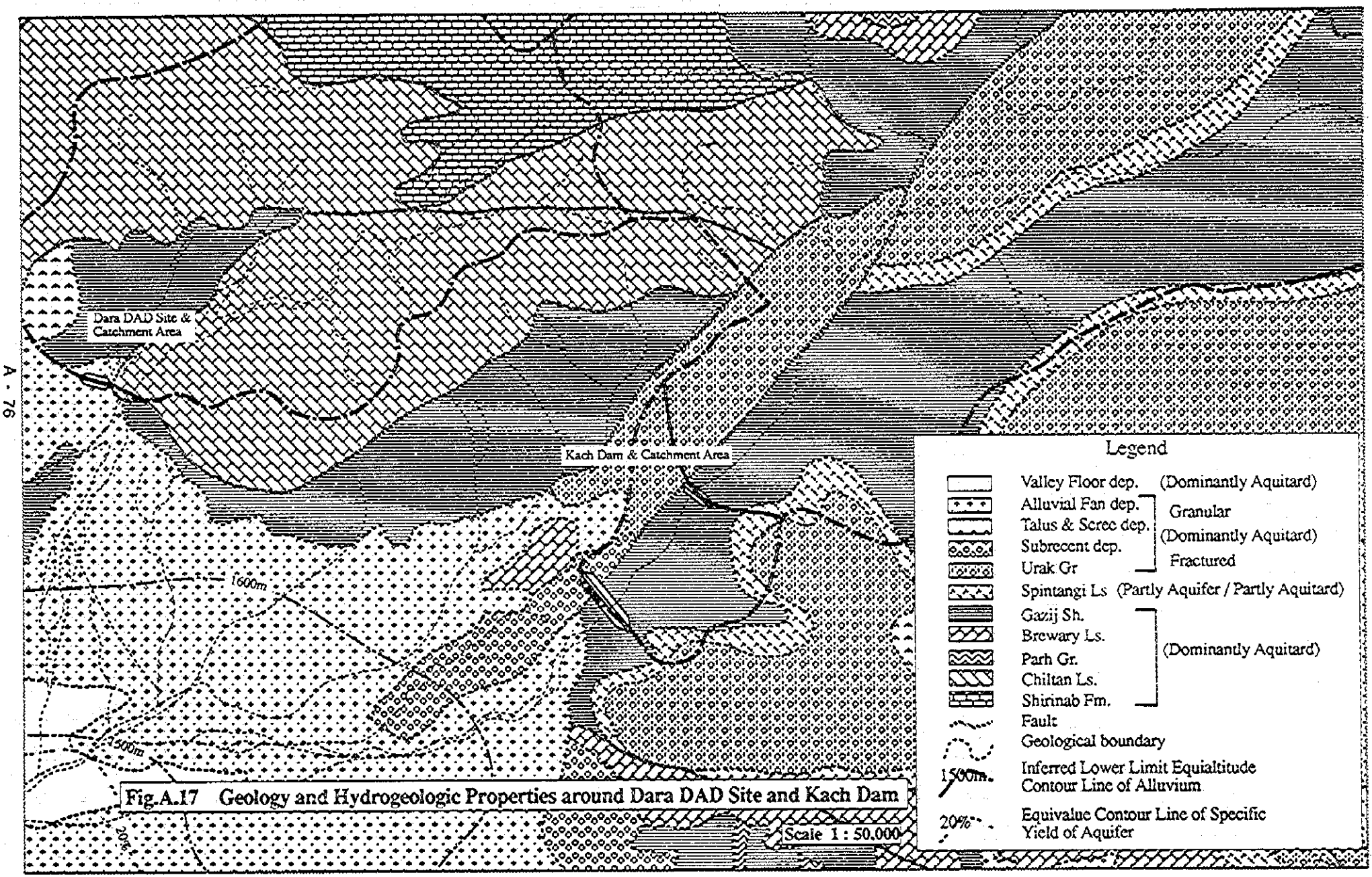

Fig.A.17 Geology and Hydrogeologic Properties around Dara DAD Site and Kach Dam

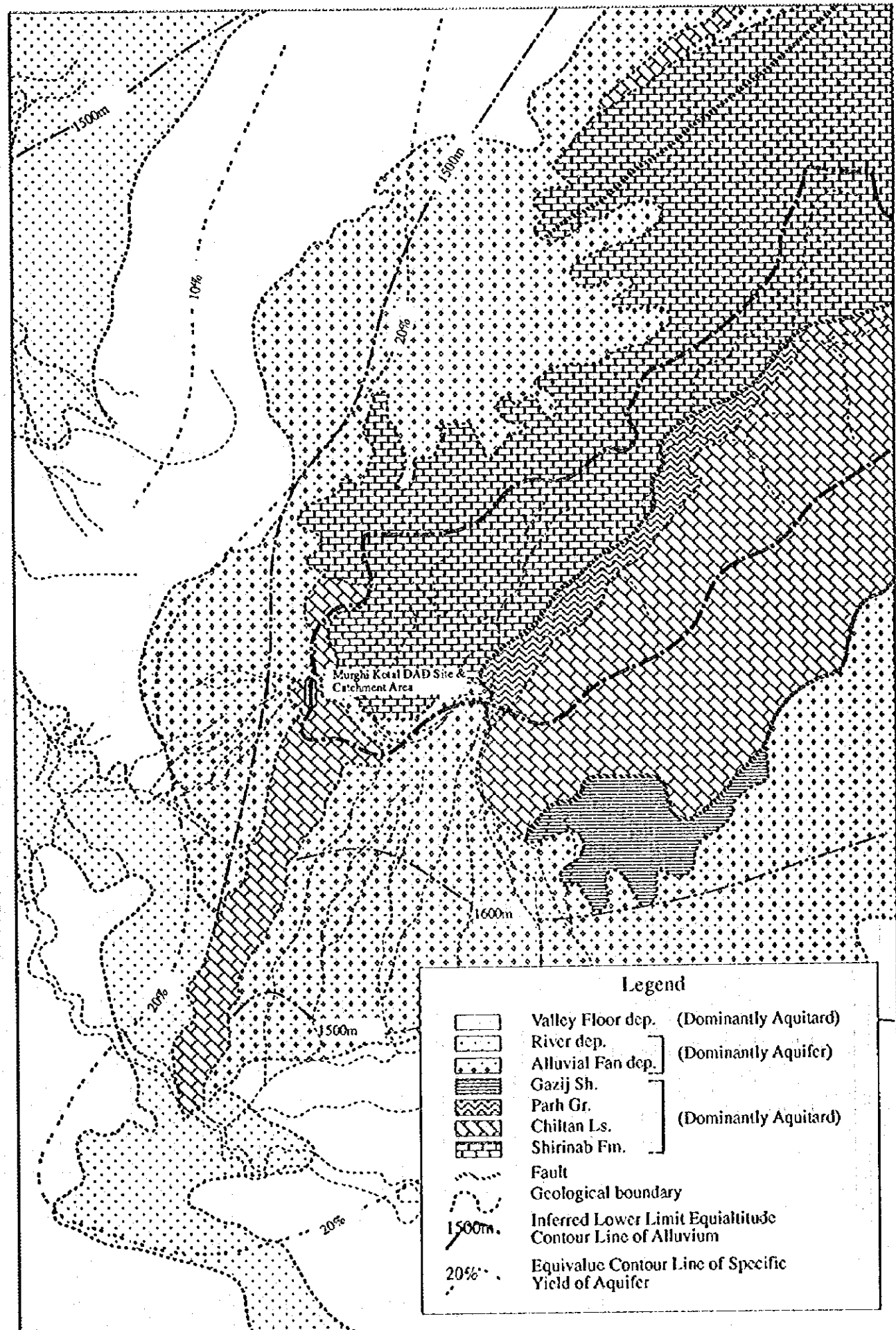

Fig.A.18 Geology and Hydrogeologic Properties around Murghi Kotal DAD Site

Scale 1 : 50,000

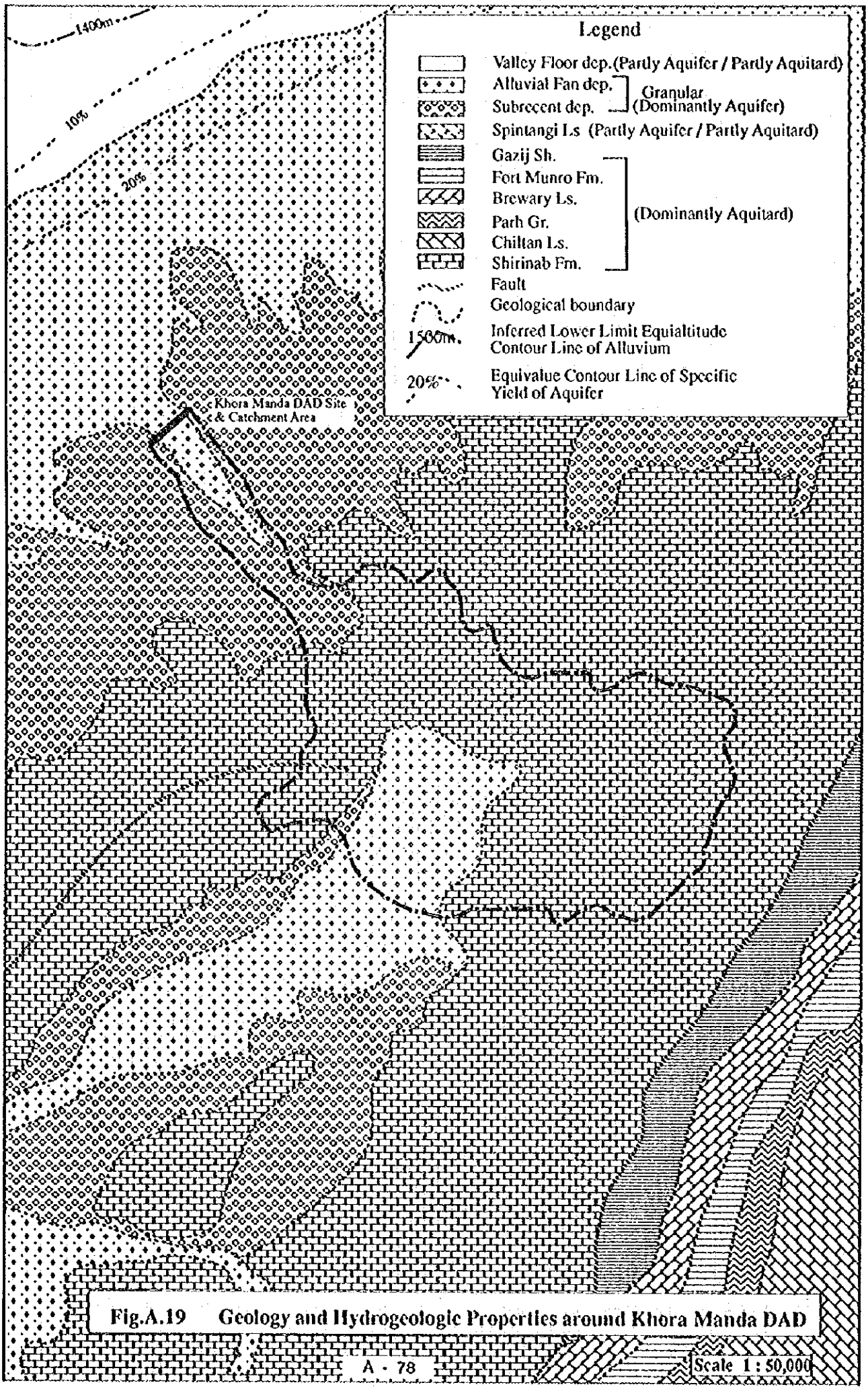

Fig.A.19 Geology and Hydrogeologic Properties around Khora Manda DAD

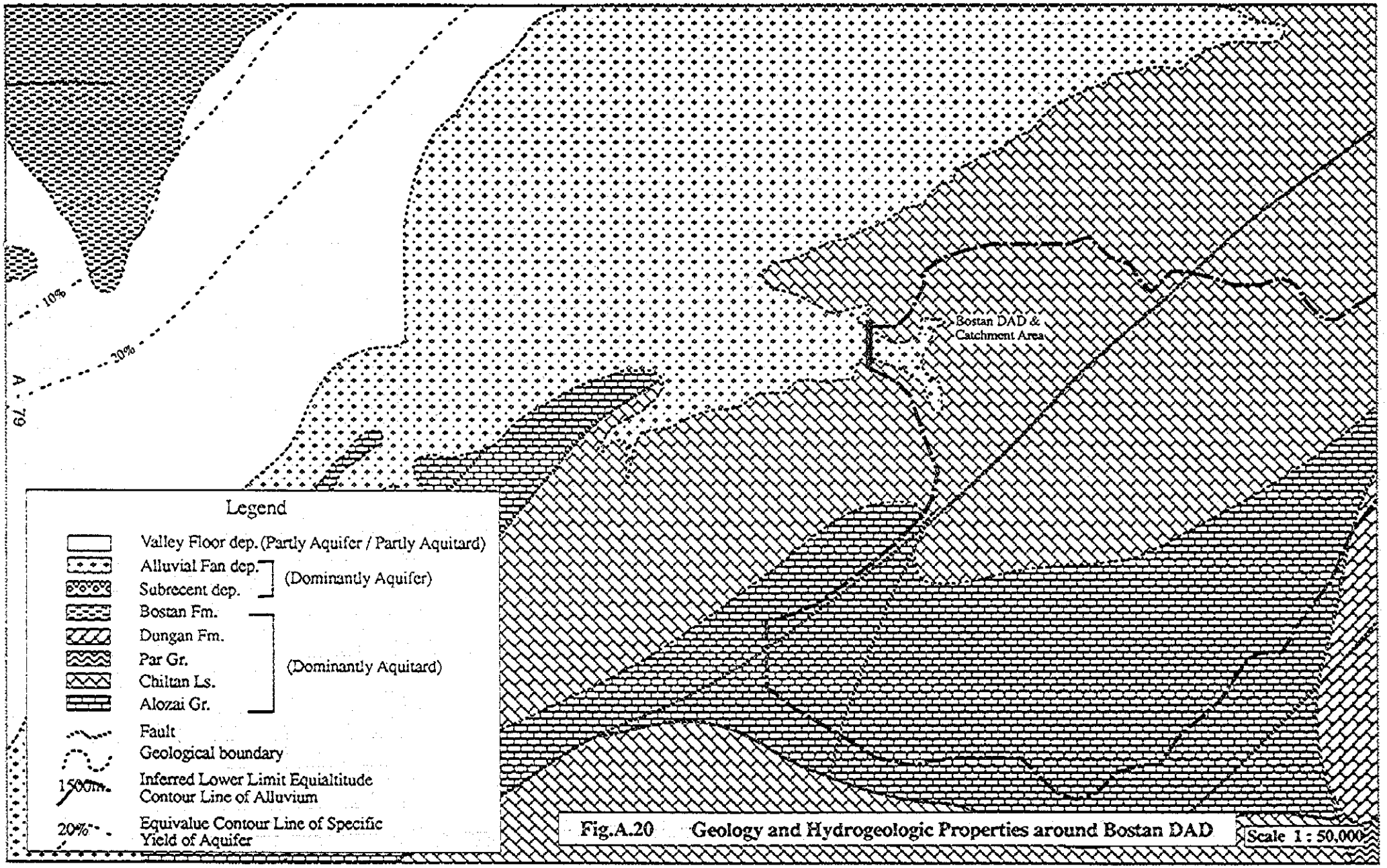

Fig.A.20 Geology and Hydrogeologic Properties around Bostan DAD

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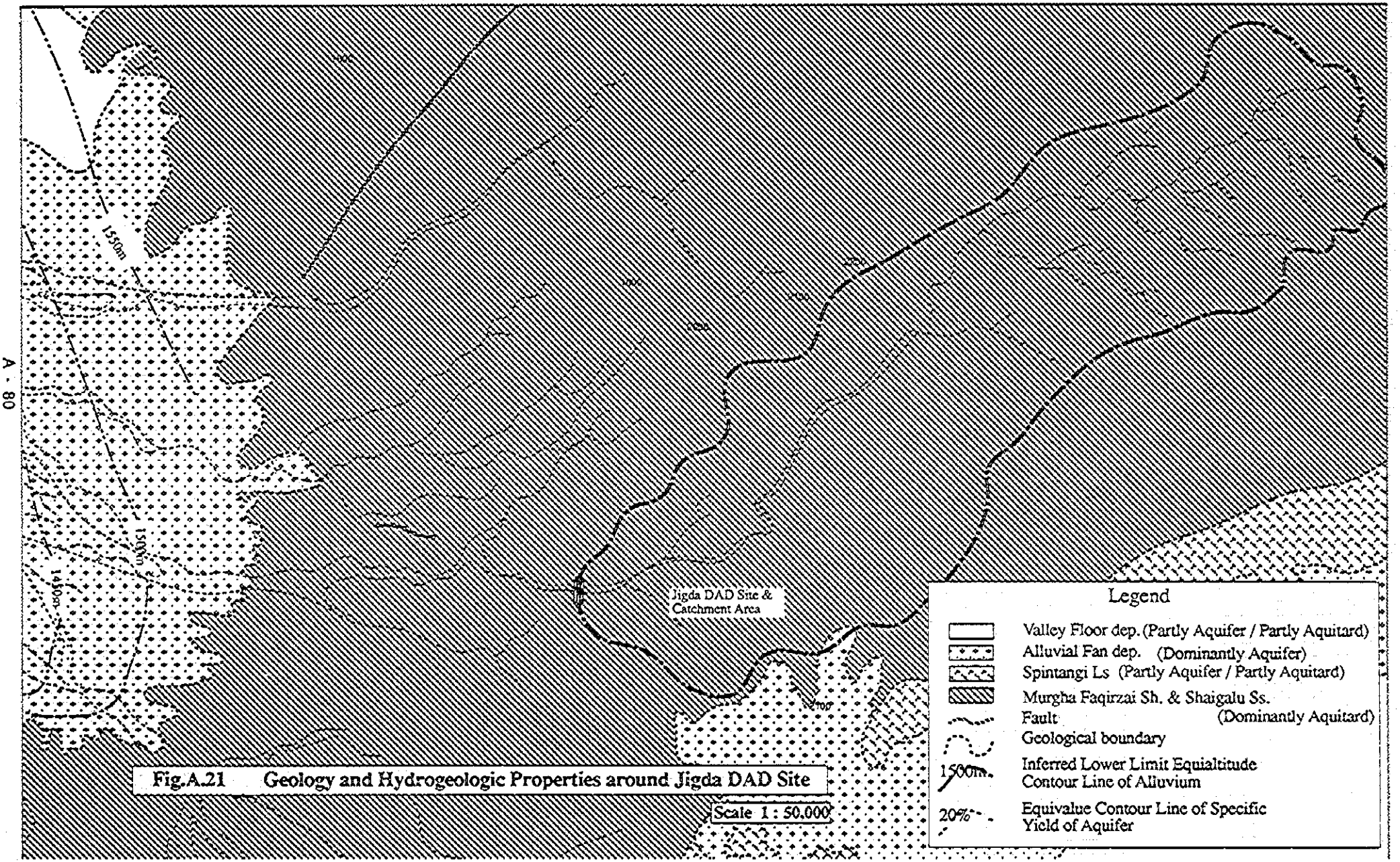

Fig.A.21 Geology and Hydrogeologic Properties around Jigda DAD Site

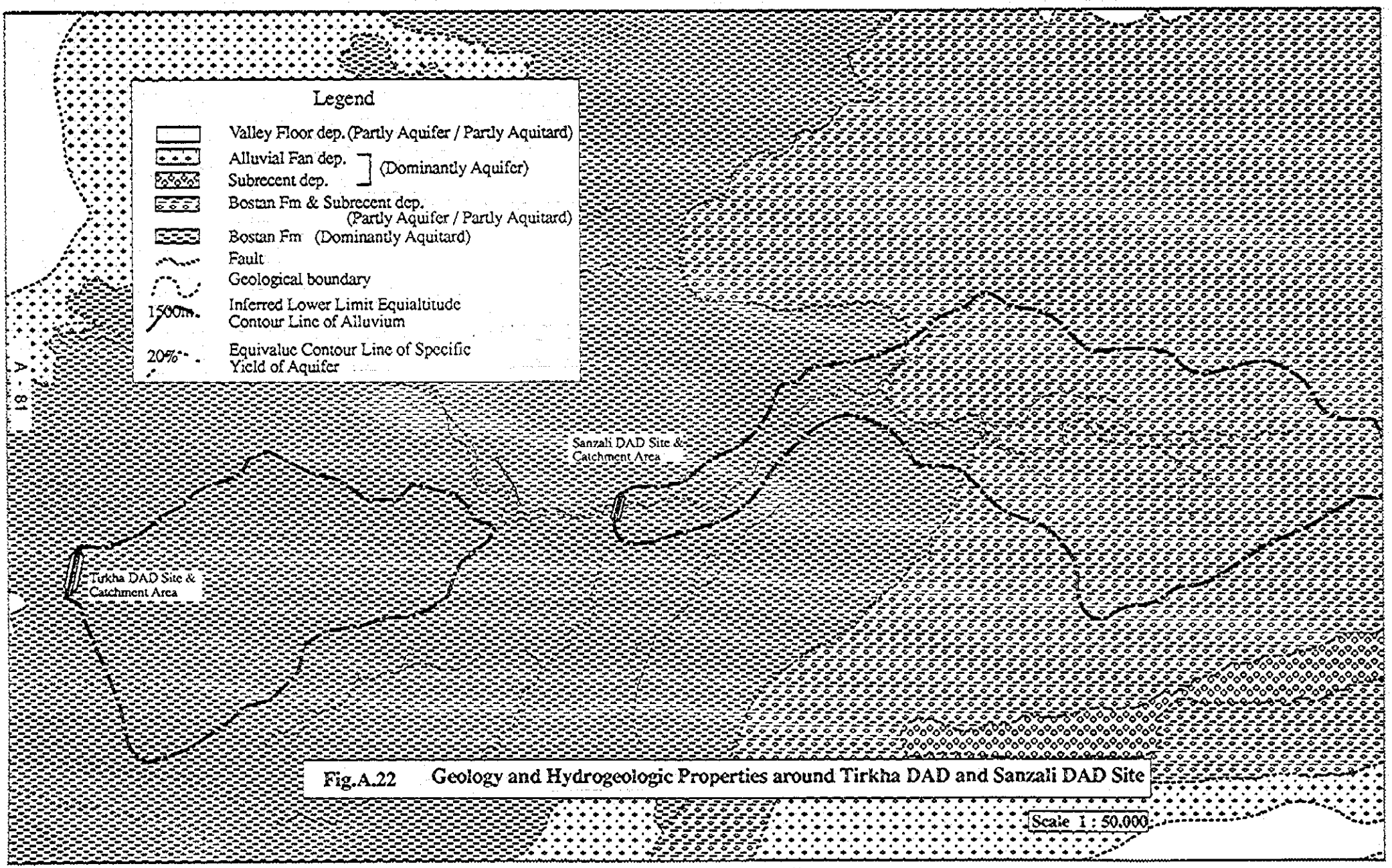

Fig.A.22 Geology and Hydrogeologic Properties around Tirkha DAD and Sanzali DAD Site

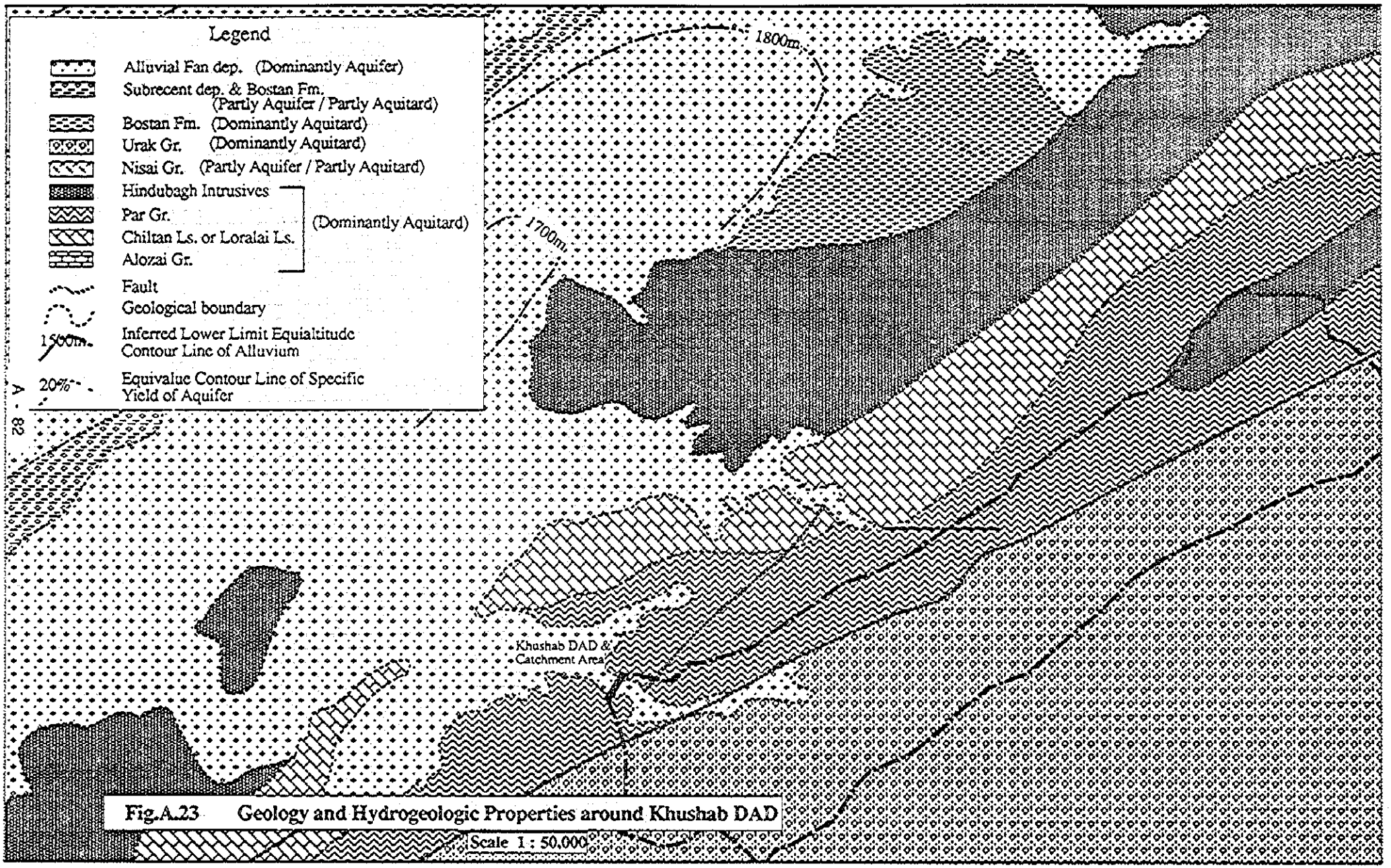

Fig.A.23 Geology and Hydrogeologic Properties around Khushab DAD

Scale 1 : 50,000