

THE JAPANESE ECONOMIC COOPERATION AGENCY (JICA)

INTERNATIONAL COOPERATION CENTER
FOR THE ECONOMIC COOPERATION OF JAPAN

MINISTER OF FINANCE
MINISTER OF ECONOMIC AFFAIRS
MINISTER OF INTERNATIONAL TRADE AND MATTER
MINISTER OF AGRICULTURE, FORESTRY AND FISHERIES

MINISTRY OF FINANCE

WORKING UNIT

ANALYSIS OF THE ECONOMIC SITUATION IN THE
ECONOMIC COOPERATION OF JAPAN
AND THE ECONOMIC COOPERATION OF JAPAN

RESEARCH UNIT

RESEARCH UNIT
RESEARCH UNIT

RESEARCH UNIT
RESEARCH UNIT
RESEARCH UNIT

JICA LIBRARY



1112993191

26264

国際協力事業団

26264

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

**MINISTRY OF WATER RESOURCES
HIS MAJESTY'S GOVERNMENT OF NEPAL**

**MASTER PLAN STUDY FOR
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS**

FINAL REPORT

VOLUME VII

**DATA ON GEOLOGICAL INVESTIGATION AND COST
BREAKDOWN OF HYDROPOWER POTENTIAL
SCHEMES**

OCTOBER 1993

**NIPPON KOEI CO., LTD., TOKYO JAPAN
CHUO KAIHATSU CORPORATION, TOKYO JAPAN**

This Report consists of

Volume I	Executive Summary
Volume II	Main Report of Part I (General Study of the Master Plan)
Volume III	Main Report of Part II (Detailed Analysis of Priority Schemes)
Volume IV	Supporting Report
	Appendix I Topography and Geology
	Appendix II Meteorology and Hydrology
	Appendix III Land Use, Environment and Watershed
Volume V	Supporting Report
	Appendix IV Hydroelectric Power Generation
	Appendix V Domestic Water Supply
Volume VI	Supporting Report
	Appendix VI Irrigation
	Appendix VII Flood Mitigation
Volume VII	Data on Geological Investigation and Cost Breakdown of Hydropower Potential Schemes

The cost estimate was based on the March 1993 price level and expressed in US Dollar according to the exchange rate of US\$ 1.00 = Nepal Rupees 46.65 = Japanese Yen 116.30 as of March 31, 1993.

VOLUME VII

DATA ON GEOLOGICAL INVESTIGATION AND COST BREAKDOWN OF HYDROPOWER POTENTIAL SCHEMES

ANNEX I

ANNEX II

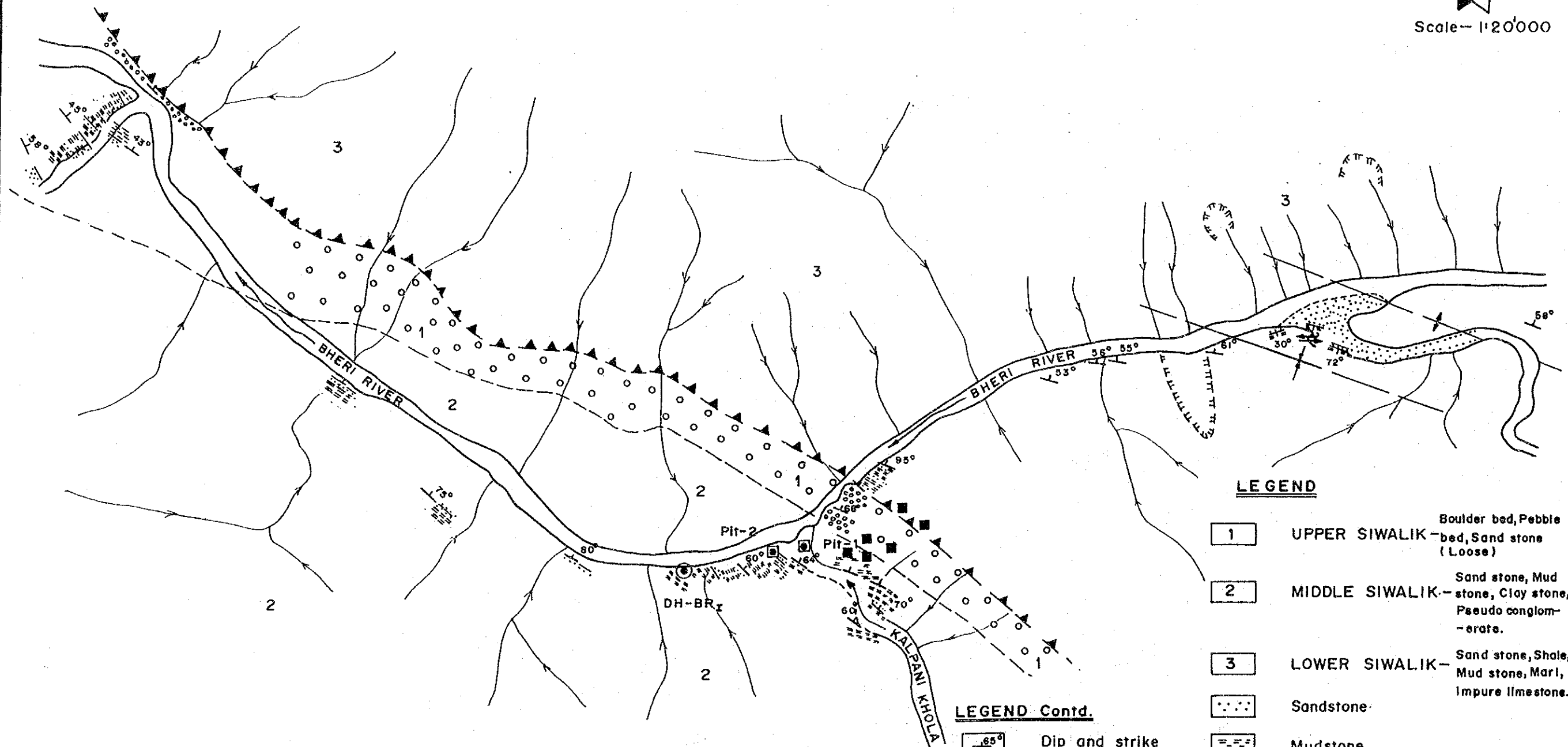
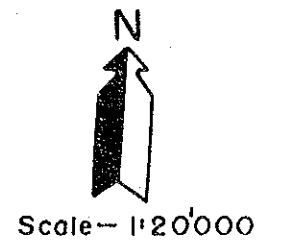
**RESULTS OF GEOLOGICAL INVESTIGATION
DETAILED BREAKDOWN OF CONSTRUCTION COSTS
FOR HYDROPOWER POTENTIAL SCHEMES**

ANNEX 1 RESULTS OF GEOLOGICAL INVESTIGATION

A 1-1	Site Index Maps
A 1-2	Photographs of Drilled Cores
A 1-3	Bore Hole Logs
A 1-4	Lugeon test Results
A 1-5	Sketches of Pits
A 1-6	Laboratory Test Results
A 1-7	Earthquake Data

A 1-1 Site Index Maps

Index Map with Geology (Bheri, BR-I)

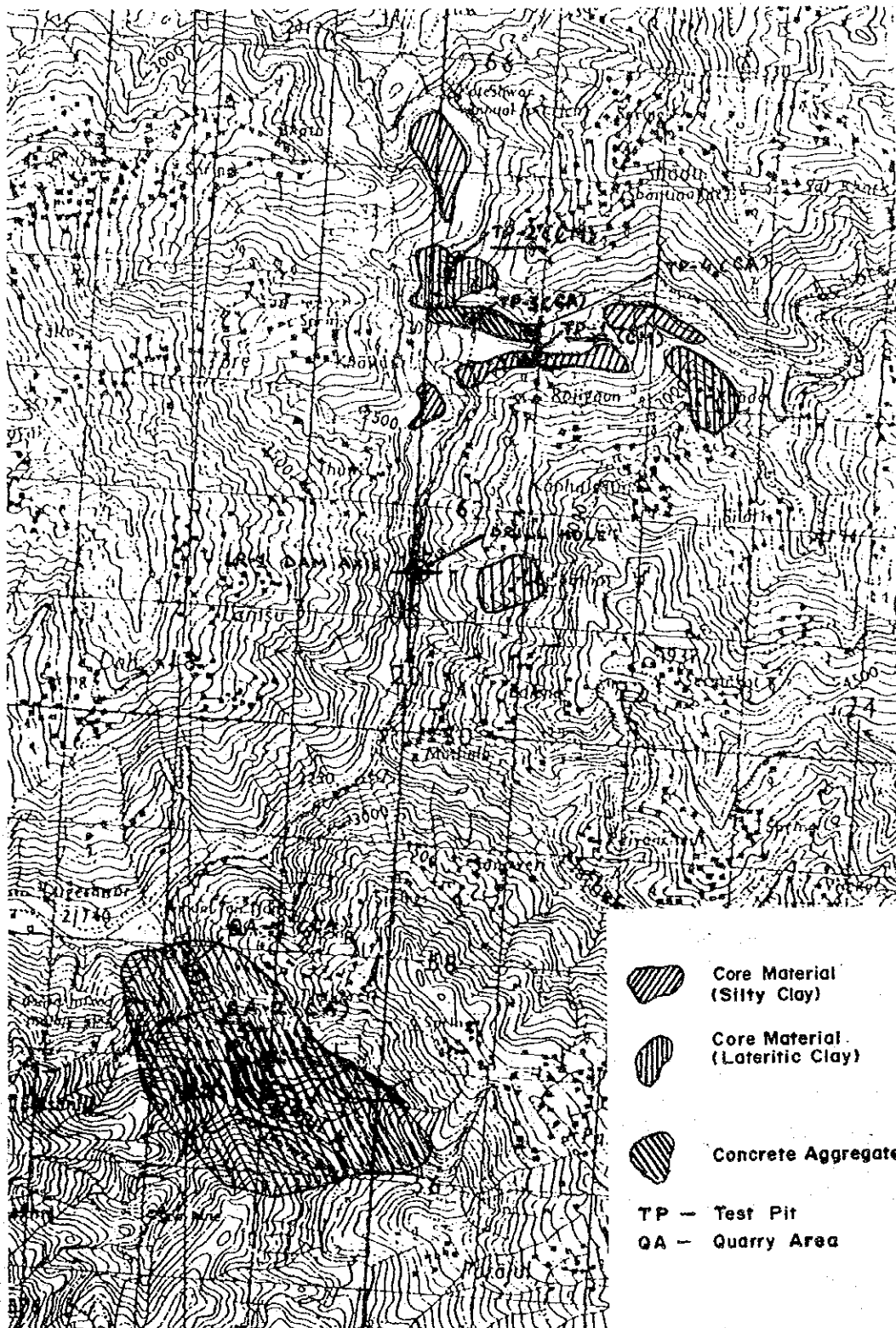


LEGEND

- | | | |
|---|----------------|---|
| 1 | UPPER SIWALIK | Boulder bed, Pebble bed, Sand stone (Loose) |
| 2 | MIDDLE SIWALIK | Sand stone, Mud stone, Clay stone, Pseudo conglomerate. |
| 3 | LOWER SIWALIK | Sand stone, Shale, Mud stone, Marl, Impure limestone. |

LEGEND Contd.

- | | | | |
|--|------------------|--|-----------------------|
| | Dip and strike | | Sandstone |
| | Anticline | | Mudstone |
| | Syncline | | Conglomerate/Boulders |
| | Landslide | | Pebble bed |
| | House/Settlement | | Siltstone |
| | Thrust Fault | | |



Scale : 1:50'000

INDEX MAP (LOHORE KHOLE)

Location map showing damsite, borrow area for core material and quarry area for concrete aggregates.

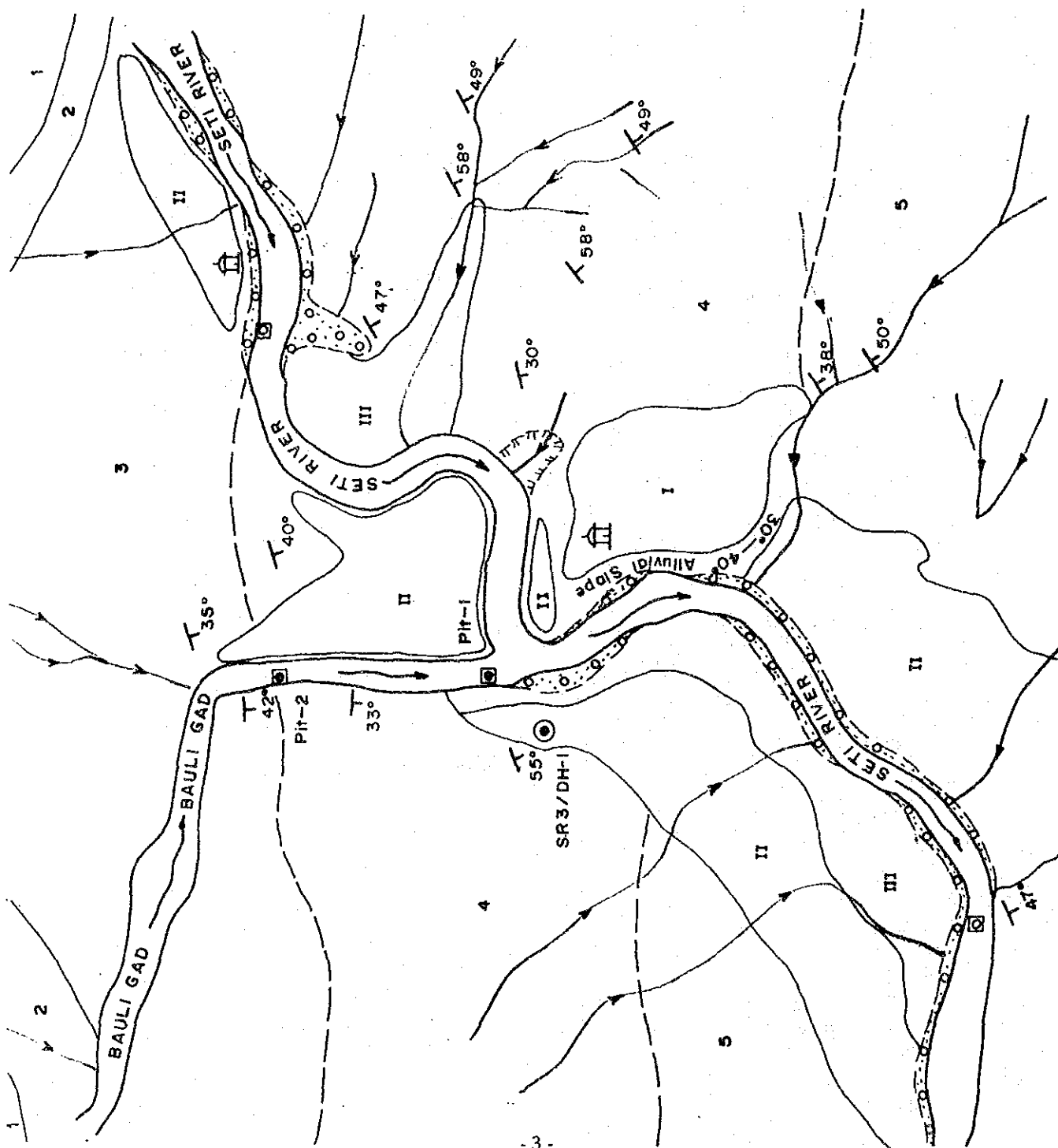


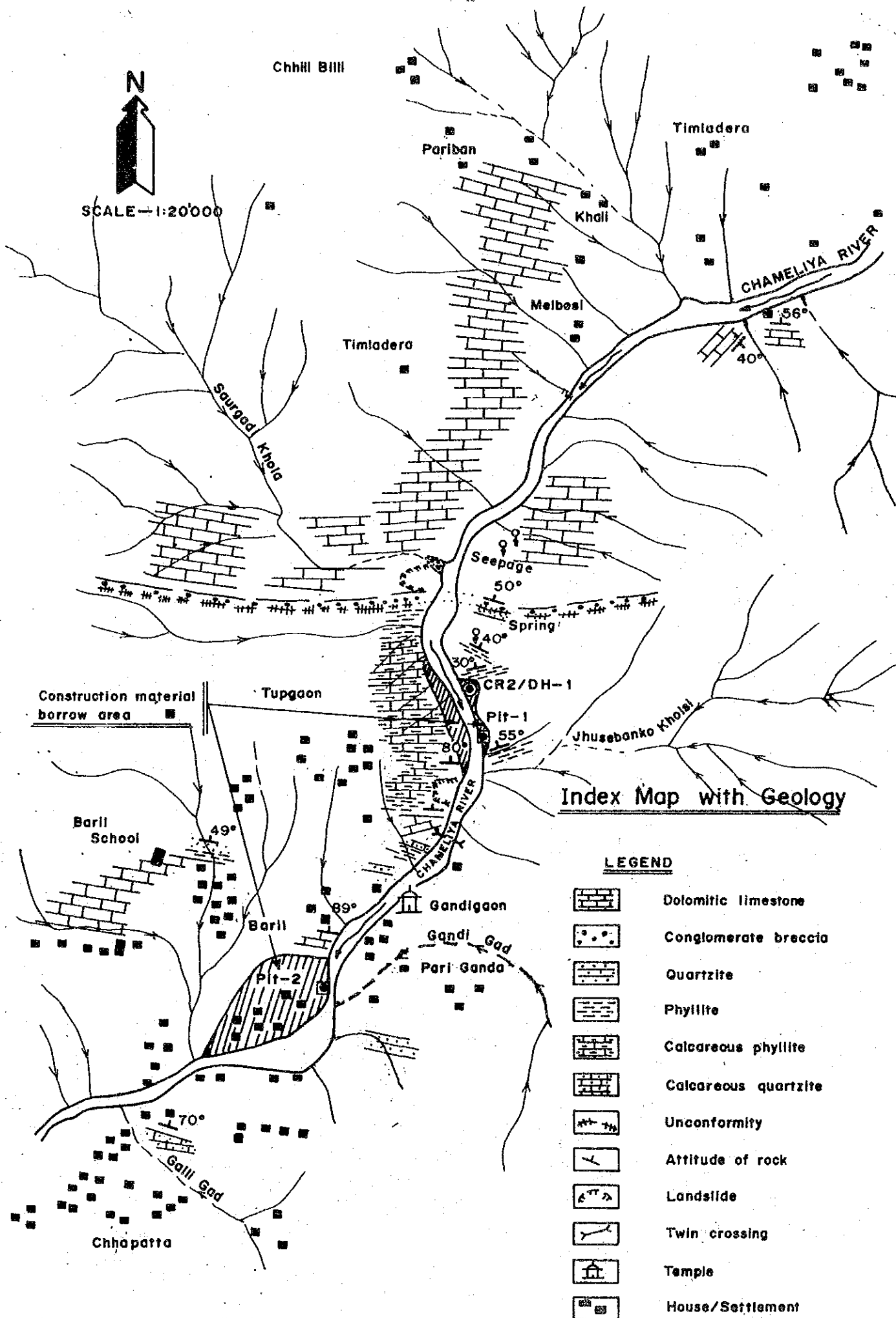
SCALE - 1:20000

Index Map with Geology

LEGEND

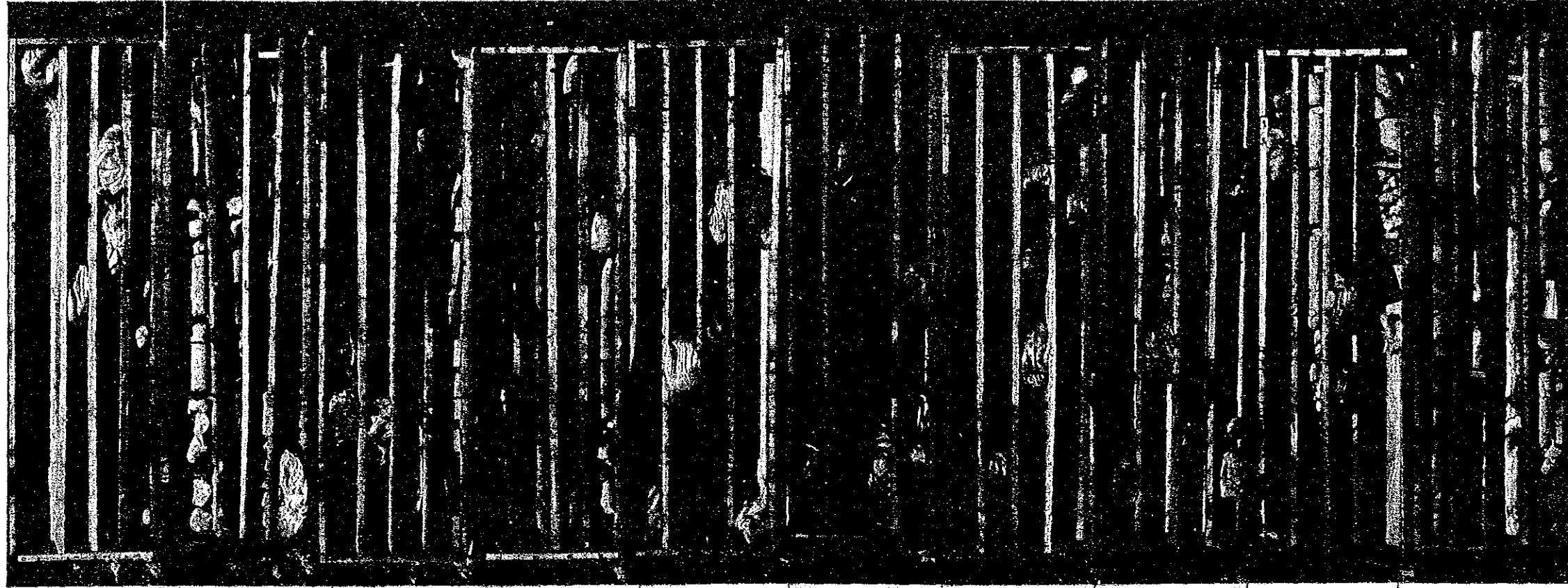
5	Phyllite
4	Griffy Phyllite
3	Slate
2	Quartzite
1	Calcareous Quartzite
III	Third Stage Terrace
II	Second Stage Terrace
I	First Stage Terrace
60°	Landslide
56°	Attitude of Rock
⌈	Temple
⊞	Pit Location
⊙	Drill Hole
⊞	Alternative Borrow Area



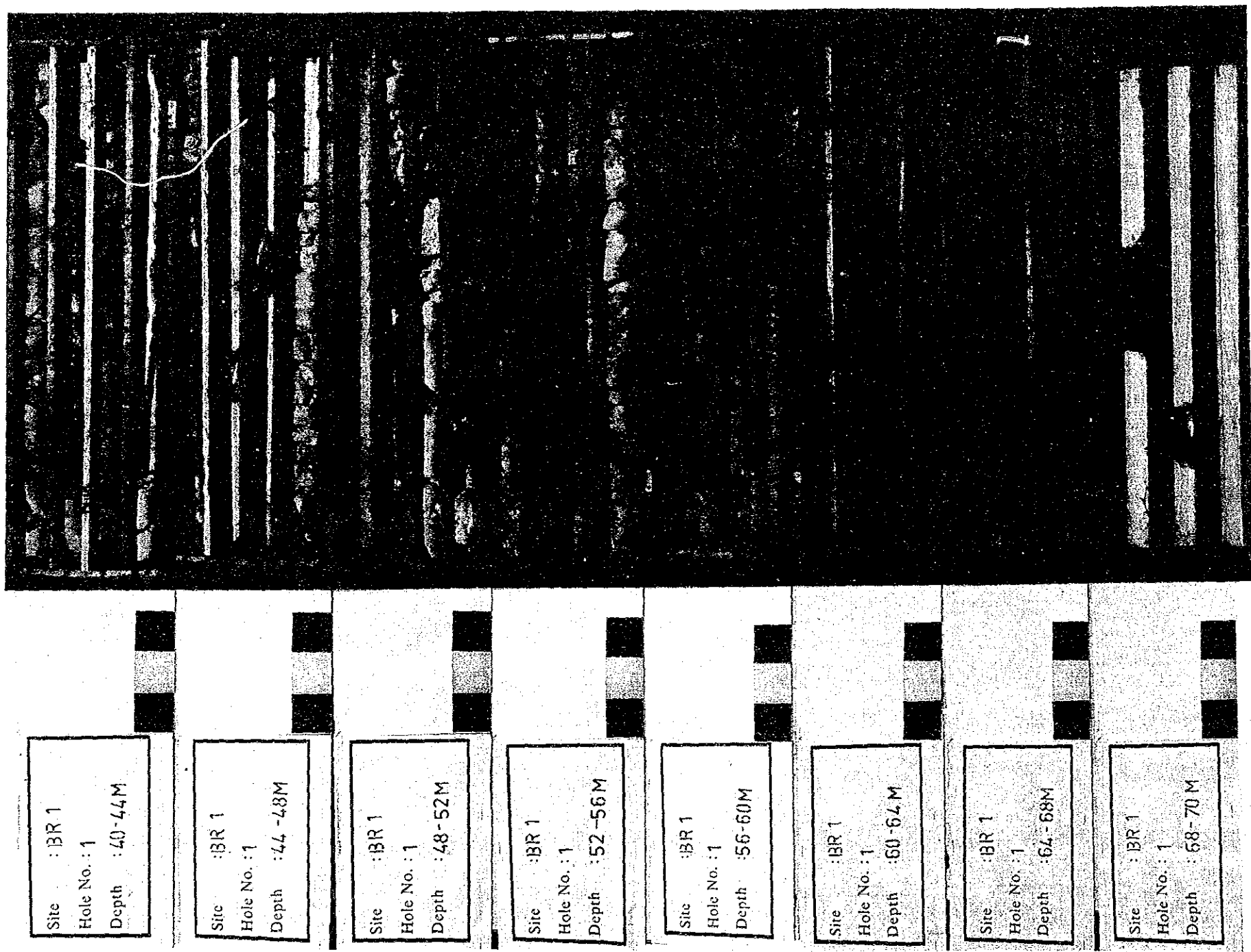


A 1-2 Photographs of Drilled Cores

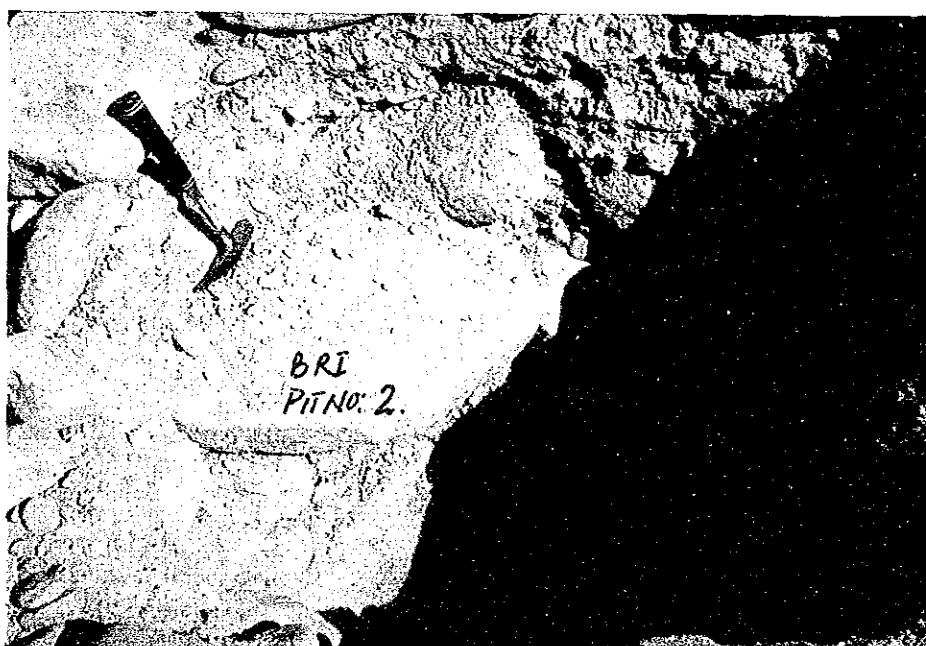
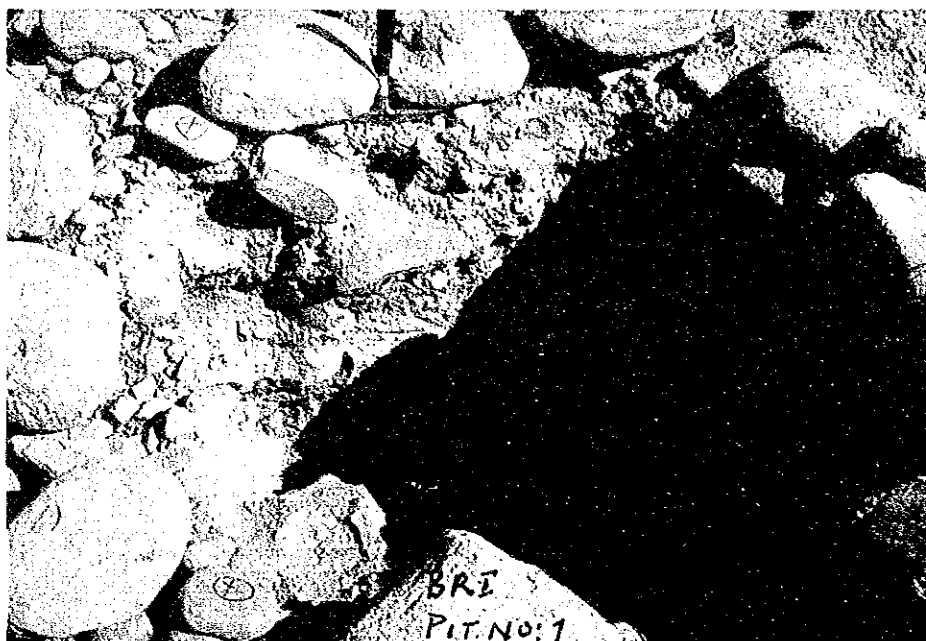
Site : BR 1 Hole No. : 1 Depth : 0 - 4 M	
Site : BR 1 Hole No. : 1 Depth : 4 - 8 M	
Site : BR 1 Hole No. : 1 Depth : 8 - 12 M	
Site : BR 1 Hole No. : 1 Depth : 12 - 16 M	
Site : BR 1 Hole No. : 1 Depth : 16 - 20 M	
Site : BR 1 Hole No. : 1 Depth : 20 - 24 M	
Site : BR 1 Hole No. : 1 Depth : 24 - 28 M	
Site : BR 1 Hole No. : 1 Depth : 28 - 32 M	
Site : BR 1 Hole No. : 1 Depth : 32 - 36 M	
Site : BR 1 Hole No. : 1 Depth : 36 - 40 M	



Photographs of Drilled Cores at BR-1 (1/2)



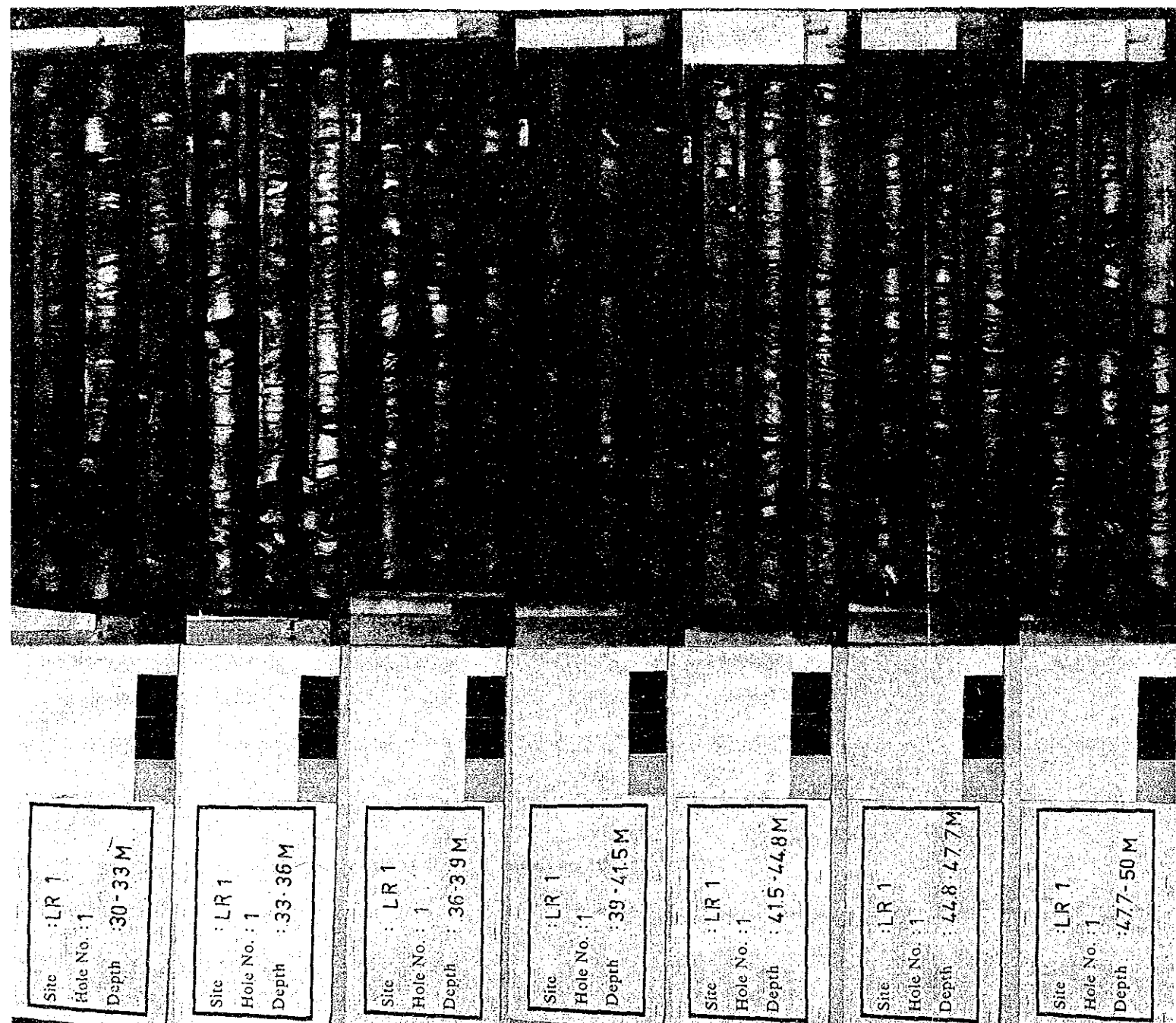
Photographs of Drilled Cores at BR-1 (2/2)



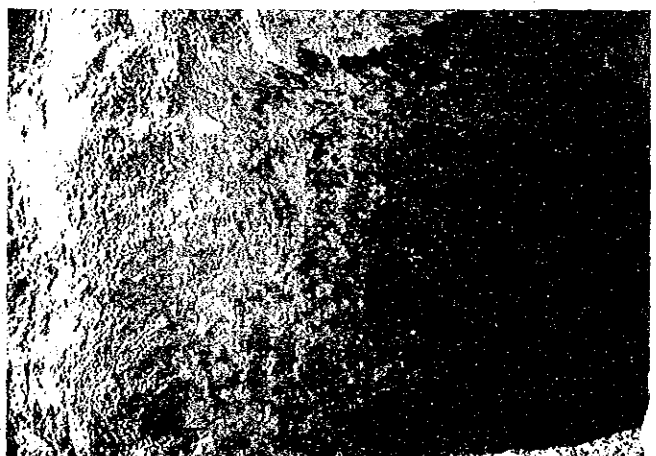
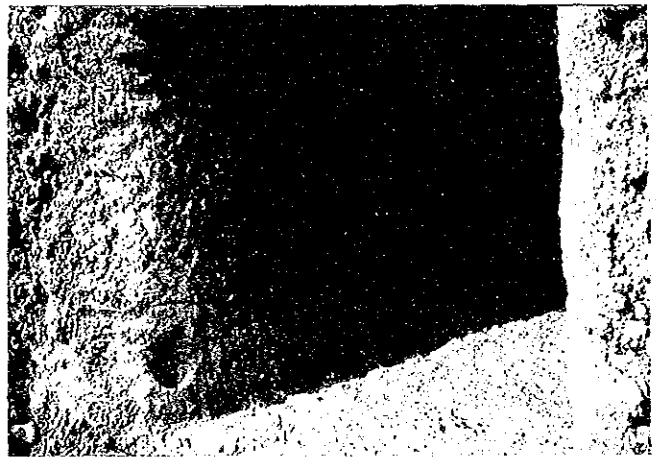
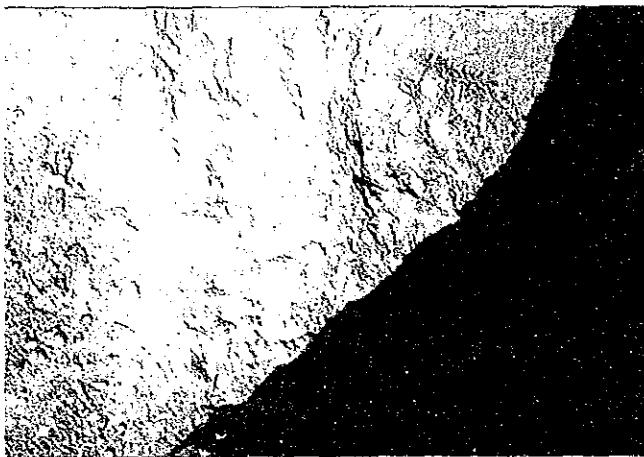
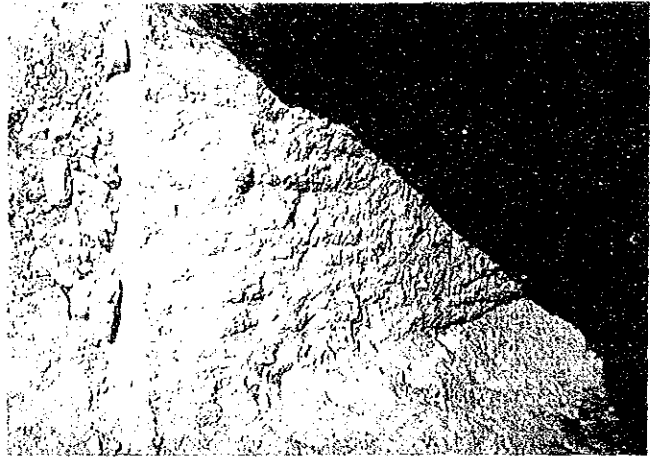
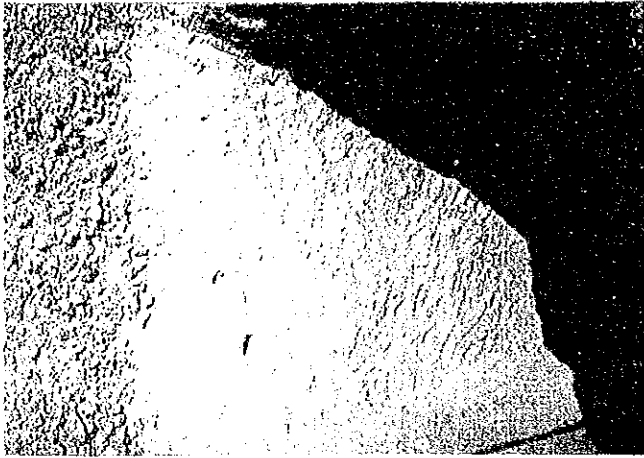
Photographs of Pits Dug at BR-1



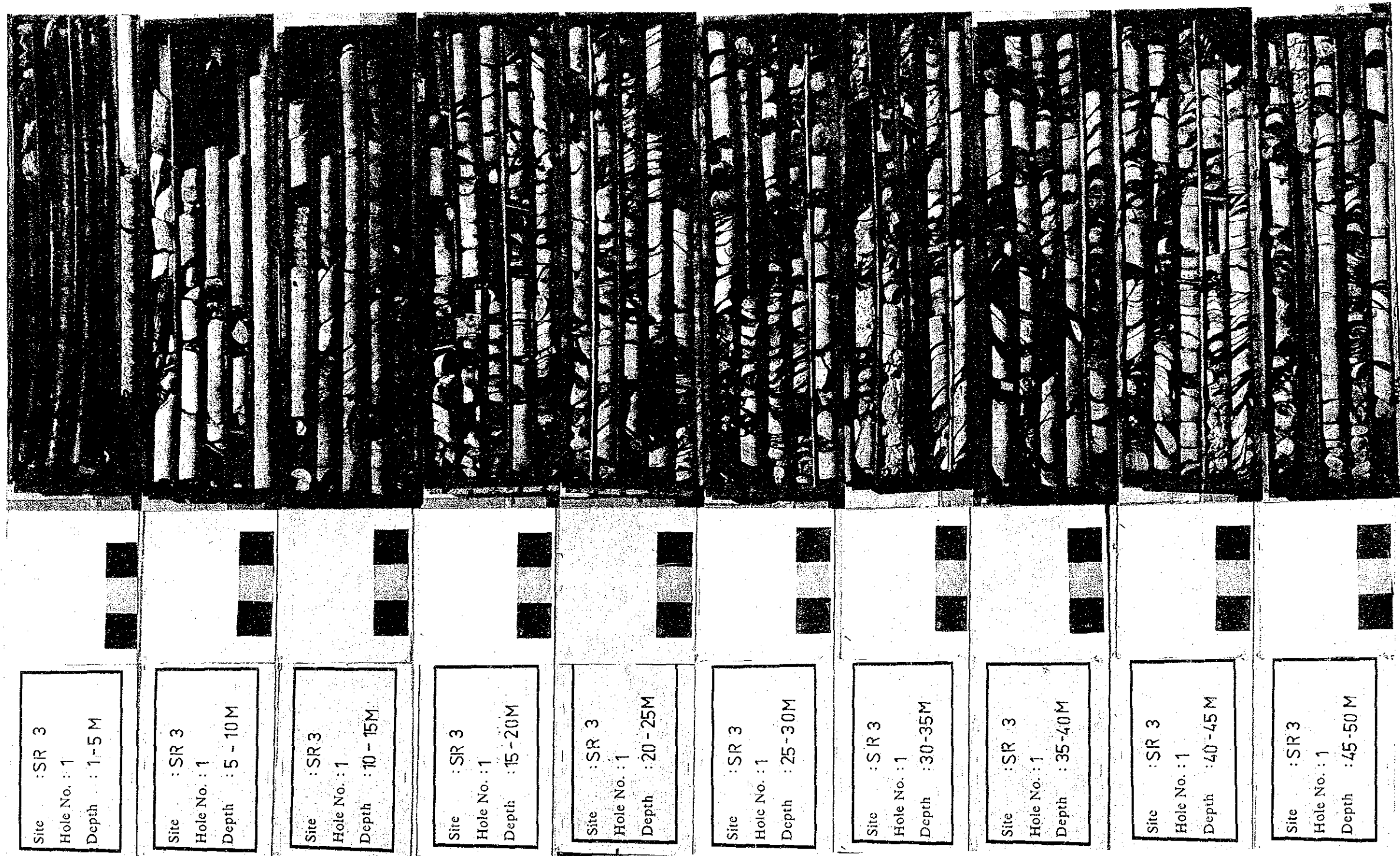
Photographs of Drilled Cores at LR-1 (1/2)



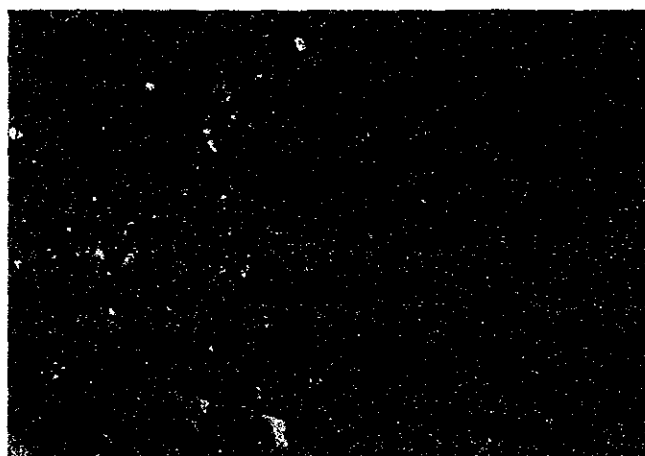
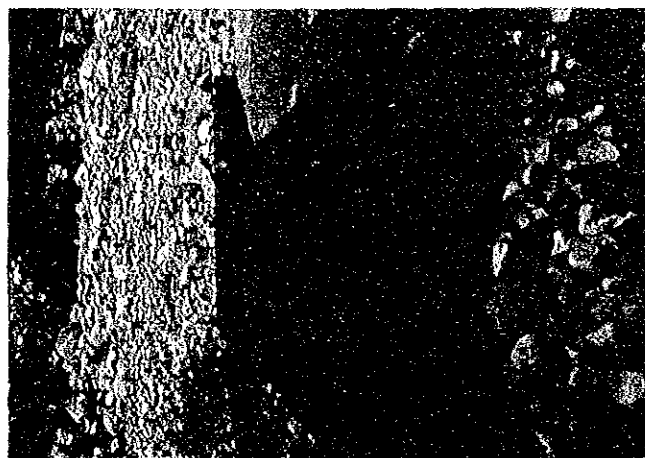
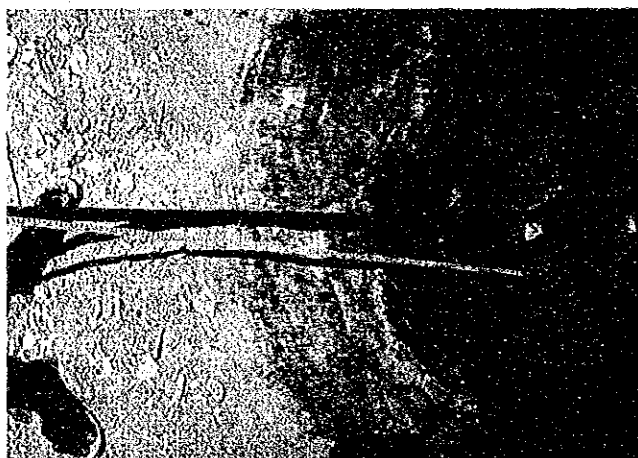
Photographs of Drilled Cores at LR-1 (2/2)



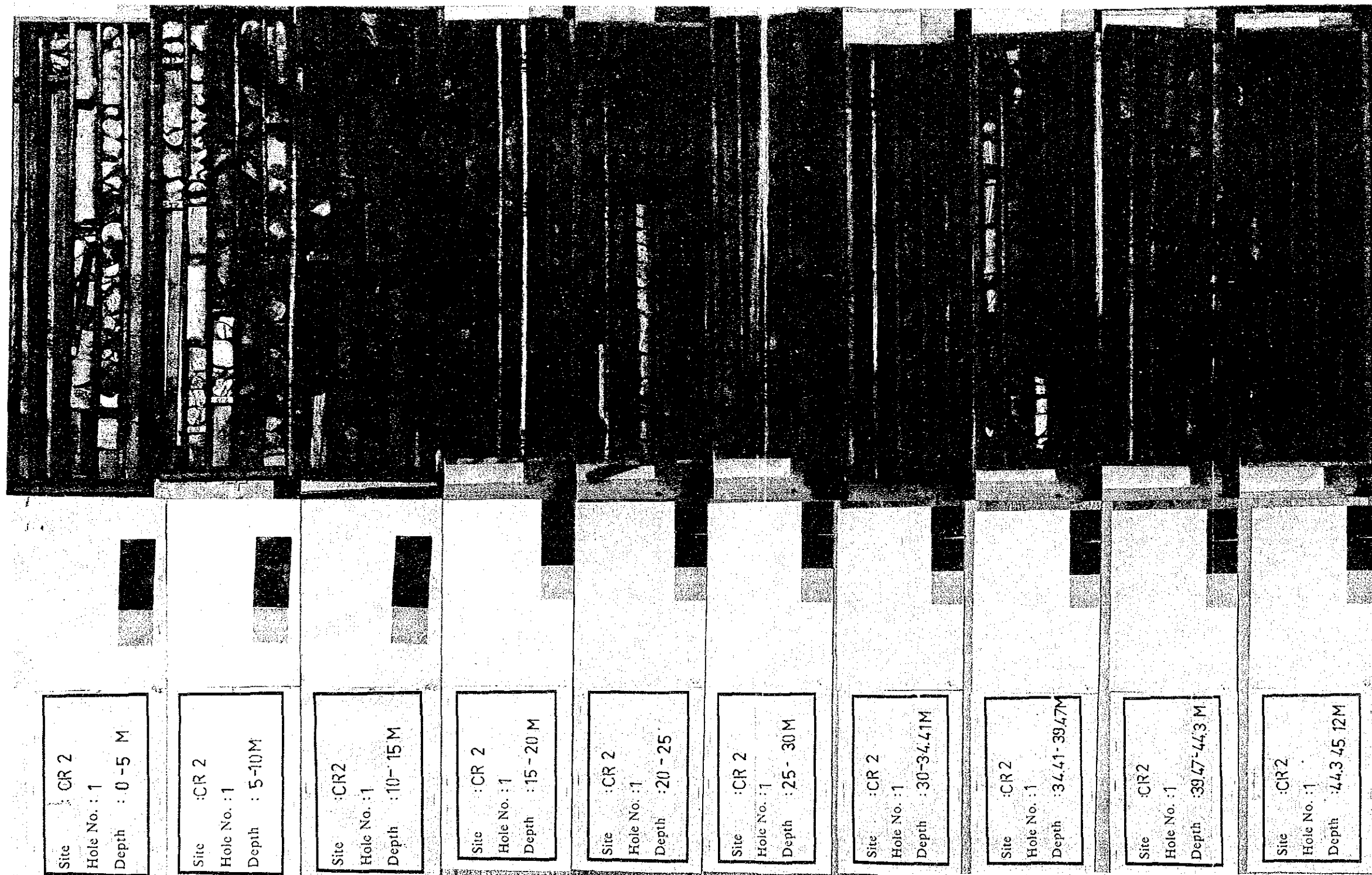
Photographs of Pits Dug at LR-1



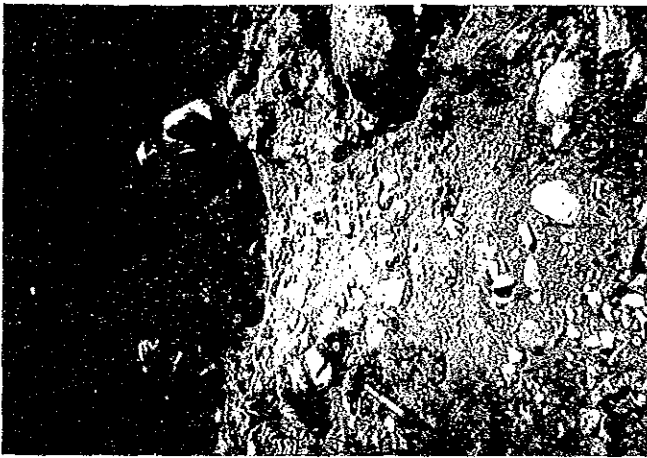
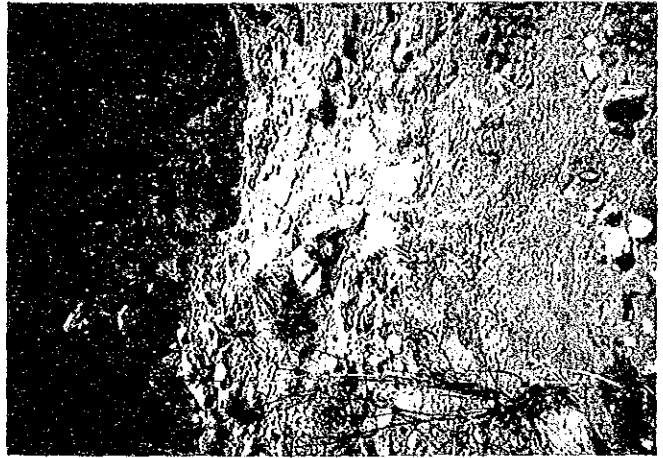
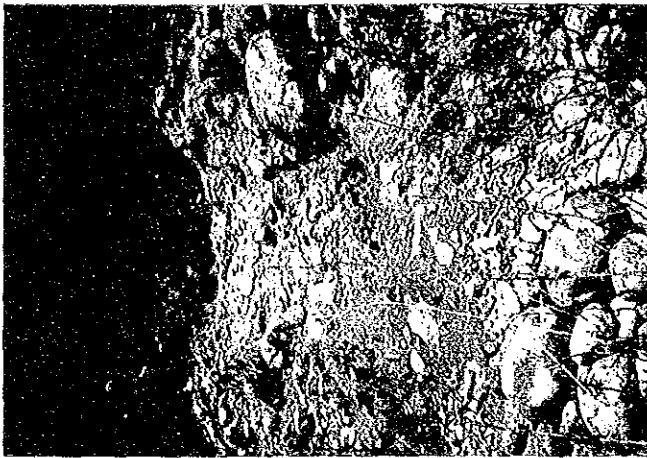
Photographs of Drilled Cores at SR-3



Photographs of Pits Dug at SR-3



Photographs of Drilled Cores at CR-2



Photographs of Pits Dug at CR-2

A 1-3 Bore Hole Logs

DRILLING CORE LOG

Name of Project KARNALI BASIN MASTER PLAN PROJECT No. of Hole 1

Location BRI (BHERI) Depth of Bedrock 0 m Bore Hole Dia. 76 mm Depth of Hole 70 m

Elevation 1500 m Core Recovery 50.81 % Type of ACER'S Bushmaster Operator BISHNU K.C.

Direction VERTICAL Underground Water Table 0.98 m Capacity of Pump 1/min Supervisor N.D. MASKE

Depth (m)	Geological Symbol	Geology	Rock Quality Classifications	Core Characteristics			Permeability Test		Drilling Status		Date Drilled
				Color	Weathering	Hardness	Rock Quality Designation	p - q curve P (kg/cm ²) q (1/m min)	Lugeon Value	Infiltrate Water Vol. (l/min) Loss Water Vol. (l/min) Bit Type	
1											22/1/93
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											

Remarks

YELLOWISH BROWN FEO STAINED MEDIUM TO COARSE SALT & PEPPER GREY SANDSTONE (SLUDGE). 5-4% BIOTITE DO - DO - FINE TO MEDIUM GRAINED. (SLUDGE) POORLY CONSOLIDATED FINE TO MEDIUM SANDSTONE.

DARK GREY CLAYEY SILTSTONE GREY FINE GRAINED SANDSTONE FINE TO MEDIUM SILTSTONE AND SANDSTONE.

LIGHT GREY, FEO STAINED MEDIUM SAND SLUDGE (SANDSTONE)

GREY MEDIUM GRAINED SAND WITH FEO STAIN YELLOWISH BROWN SPOTS SLUDGE. (SANDSTONE)

GREY FINE GRAINED SAND SLUDGE (SANDSTONE). 5% BIOTITE

GREY FINE TO MEDIUM GRAINED SAND SLUDGE (SANDSTONE)

GREY MEDIUM SANDSTONE - FEO STAINED DARK GREY SANDSTONE / MUDSTONE SLUDGE

LIGHT GREY MEDIUM GRAINED SAND SLUDGE. (SANDSTONE) MED SANDSTONE WITH PEBBLES

GREY TO DARK GREY FINE GRAINED SAND WITH CLAY SLUDGE



DRILLING CORE LOG

Name of Project KARNALI BASIN MASTER PLAN PROJECT No. of Hole 1

Location BRI BHARI Depth of Bedrock 0 m Bore Hole Dia. 76 mm Depth of Hole 70 m

Elevation ~ m Core Recovery 50.8 % Drill Machine Acker's Bushmaster Operator BISHNU K.C.

Inclination VERTICAL Water Table 0.98 m Capacity of Pump 1 l/min Supervisor N.D. MAKHE

Depth (m)	Elevation (m)	Geological Symbol	Geology	Rock Quality Classifications	Color	Weathering	Core Characteristics		Permeability Test		Drilling Status		Core Recovery (%)	Remarks	Date Drilled
							Hardness	Rock Quality Designation	P (kg/cm ²)	p - q curve	Infiltrate Water Vol.	Loss Water Vol. (l/min)			
51	56.75		SANDSTONE	POOR ROCK	Light Grey	SLIGHTLY WEATHERED	20	20					31%	GREY MEDIUM GRAINED SANDSTONE	5/2/83
52	56.10		SANDSTONE	POOR ROCK	Grey	SLIGHTLY WEATHERED II	40	40					0%	DARK GREY MEDIUM GRAINED SANDSTONE (SLUDGE)	
53	55.65		PEBBLE BEARING CLAYEY SANDSTONE	POOR ROCK	DARK GREY	SLIGHTLY WEATHERED II	60	60					35%	DARK GREY COARSE PEBBLY SANDSTONE	
54	55.60		SANDSTONE	POOR ROCK	Grey	SLIGHTLY WEATHERED II	80	80					100%	BLACK CLAYEY MUDSTONE	
55			CLAYEY MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II								BLACK CLAYEY MUDSTONE, V. SOFT.	
56	56.15		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							75%	BLACK SILTY MUDSTONE, MODERATELY HARD.	6/2/83
57	55.9		SILTY MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	BLACK CLAYEY SILTY MUDSTONE (SOFT)	
58	57.2		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	BLACK MUDSTONE	7/2/83
59	57.6		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	BLACK SILTY MUDSTONE, MODERATELY HARD.	8/2/83
60	58.10		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	BLACK CLAYEY MUDSTONE - LOOSE (SOFT)	
61	60.25		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	LIGHT YELLOWISH BROWN SILTSTONE	
62	60.76		MUDSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	GREY MEDIUM TO COARSE SAND	
63	61.90		SILTSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	LIGHT YELLOWISH BROWN SILTSTONE	9/2/83
64	63.45		SILTSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	BLACK CLAYEY MUDSTONE	
65	64.00		SILTSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	LIGHT YELLOWISH BROWN SILTSTONE	
66	66.00		SILTSTONE	POOR ROCK		SLIGHTLY WEATHERED II							100%	DARK GREY SILTY MUDSTONE	
67	68.00		SILTSTONE	POOR ROCK		SLIGHTLY WEATHERED II							53%		
68	68.00		SANDSTONE (SLUDGE)	POOR ROCK		SLIGHTLY WEATHERED II							0%	GREY SANDSTONE (SLUDGE)	
69	70.00		SANDSTONE	POOR ROCK		SLIGHTLY WEATHERED II								FEW FRAGMENTS OF SANDSTONE CHIPS.	
70															
71															
72															
73															
74															
75															
76															
77															
78															

DRILLING CORE LOG

Name of Project KARNALI BASIN MASTER PLAN PROJECT

No. of Hole LR-1

Location Lokore khola

Depth of Bedrock 14.58 m

Bore Hole Dia. 75 mm

Depth of Hole 50.0 m

Elevation m

Core Recovery 89.81 %

Type of Drill Machine

Operator UDAYA CHETRI / NAR BHADUR

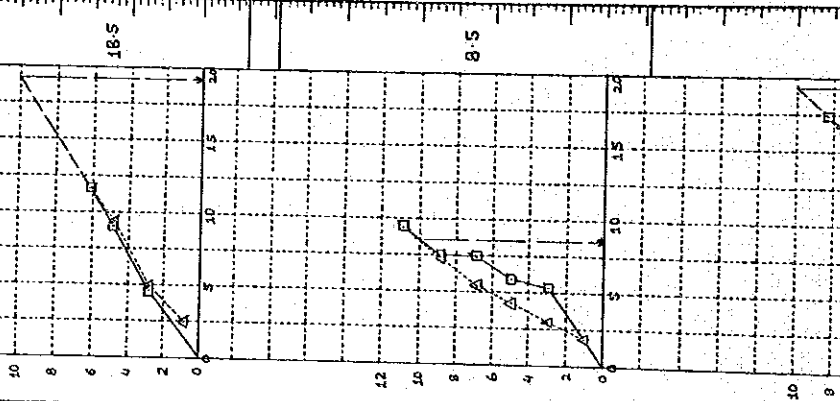
Inclination Vertical

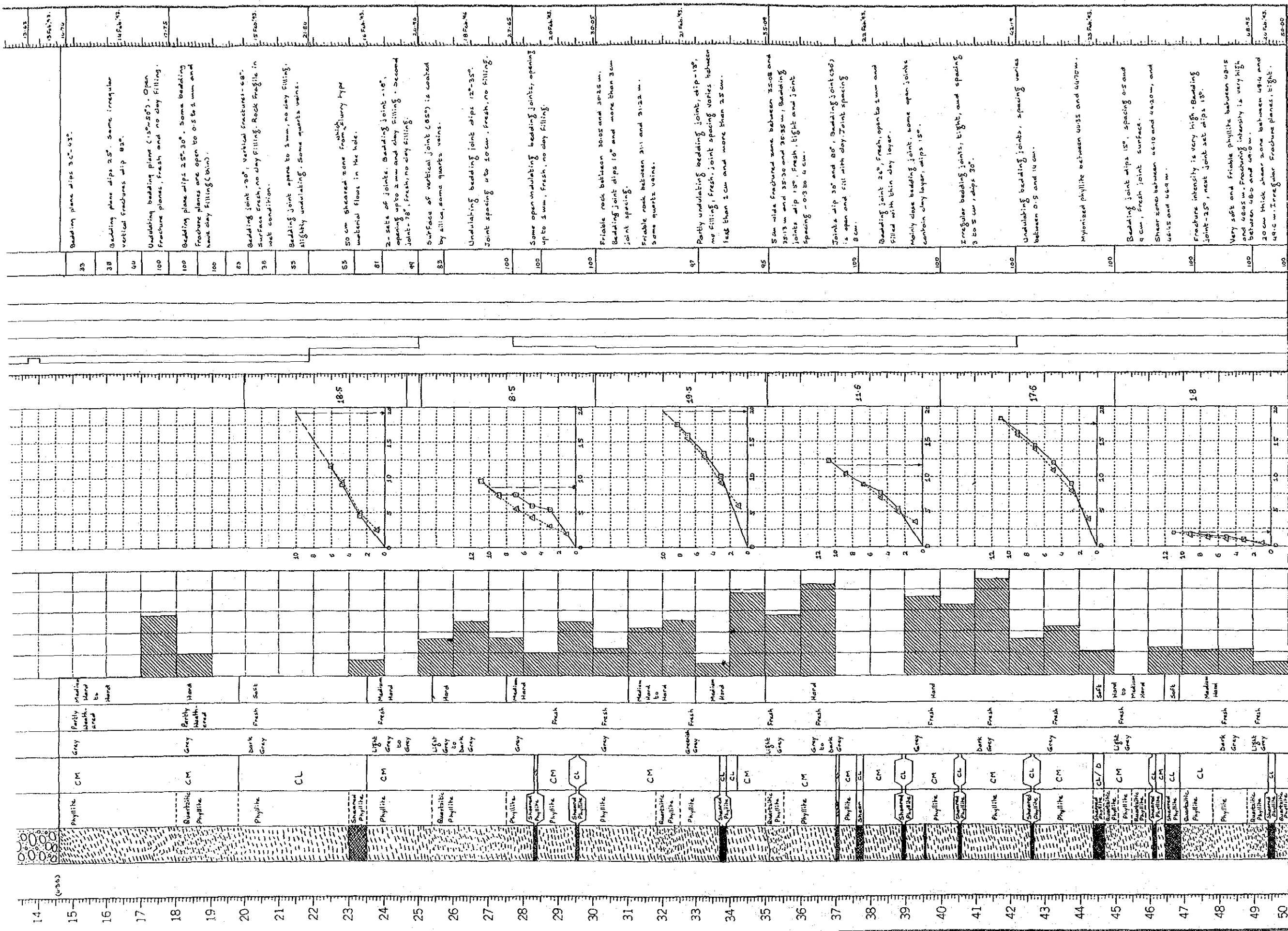
Water Table 6.05 m

Capacity of Pump 50-300 l/min

Supervisor PRAKASH SHRESTHA/WATANABE

Depth (m)	(Thickness) Geological Symbol	Geology	Rock Quality Classifications	Core Characteristics			Permeability Test		Drilling Status		Core Recovery(%)	Remarks	Date Drilled
				Color	Weathering	Hardness	Rock Quality Designation	p - q curve P (kg/cm ²) q (1/m.min)	Infiltrate Water Vol. Loss Water Vol. (l/min)	Bit Type			
1		Colluvium					20 40 60 80%					Excavation to 2.6 m depth for drilling platform.	
2												NW impregnated casing bit.	
3		Colluvium (Angular boulders of gneiss, quartzite, gneiss, phyllite in sandy silty clay)										NW impregnated drilling bit.	8 Feb 1995
4												Max. diameter of boulders - 15 cm.	3 Feb
5												Max. diameter of boulder - 10 cm.	9 Feb 93
6													6 Feb
7													10 Feb 93
8												Max. diameter of phyllite boulder - 65 cm.	9 Feb
9													9 Feb 93
10													10 Feb 93
11		Alluvium (Boulders of gneiss, quartzite, quartz in sandy silty clay)										Some of the rounded quartzite boulders are around 25 cm in diameter.	12 Feb 93
12													13 Feb
13													15 Feb 93
14													16 Feb
15		Phyllite	CM	Gray	Partly weathered to Hard	Medium Hard to Hard						Bedding plane dips 30°-45°.	17 Feb 93
16													18 Feb 93
17												Bedding plane dips 25°. Some irregular vertical fractures dip 82°.	19 Feb 93
18		Quartzitic Phyllite	CM	Gray	Partly weathered	Hard						Undulating bedding plane (15°-50°). Open fracture planes, fresh and no clay filling.	20 Feb 93
19												Bedding plane dips 25°-30°. Some bedding fracture planes are open to 0.5 to 1 mm and have clay filling (thin).	21 Feb 93
20		Phyllite	CL	Dark Gray	Fresh	Soft						Bedding joint - 70°. Vertical fractures - 60°. Surface crack, no clay filling. Rock fragile in wet condition.	22 Feb 93
21												Bedding joint opens to 1 mm, no clay filling. Slightly undulating. Some quartz veins.	23 Feb 93
22													24 Feb 93
23		Shale										50 cm sheared zone from slurry type material flows in the hole.	25 Feb 93
24		Phyllite	CM	Light Gray to Gray	Fresh	Medium Hard						2- sets of joints. Bedding joint - 10° opening up to 2 mm and clay filling. Second joint - 70°, fresh, no clay filling.	26 Feb 93
25		Quartzitic Phyllite		Light Gray to Dark Gray	Hard	Hard						Surface of vertical joint (65°) is coated by silica, some quartz veins.	27 Feb 93
26												Undulating bedding joint dips 12°-35°. Joint spacing 4 to 10 cm. Fresh, no filling.	28 Feb 93
27		Phyllite	CM	Gray	Fresh	Medium Hard						Some open undulating bedding joints, opening up to 1 mm, fresh, no clay filling.	29 Feb 93
28		Shale											30 Feb 93
29		Phyllite	CL	Gray	Fresh	Hard to Hard						Fracture rock between 30.05 and 30.25 m. Bedding joint dips 16° and more than 30 cm joint spacing.	31 Feb 93
30												Fracture rock between 31 and 31.22 m. Some quartz veins.	32 Feb 93





END OF RUN

CORE
SCALE 1:100

583

SR3/HI

Chambre (Bojanz)

11.55 m

iii

50.05 m

1250 C Abb 1 Pm

Core Recovery

14%

Drill Machine ACKER BUSHMASTER

Operator Ram Hari K.C.

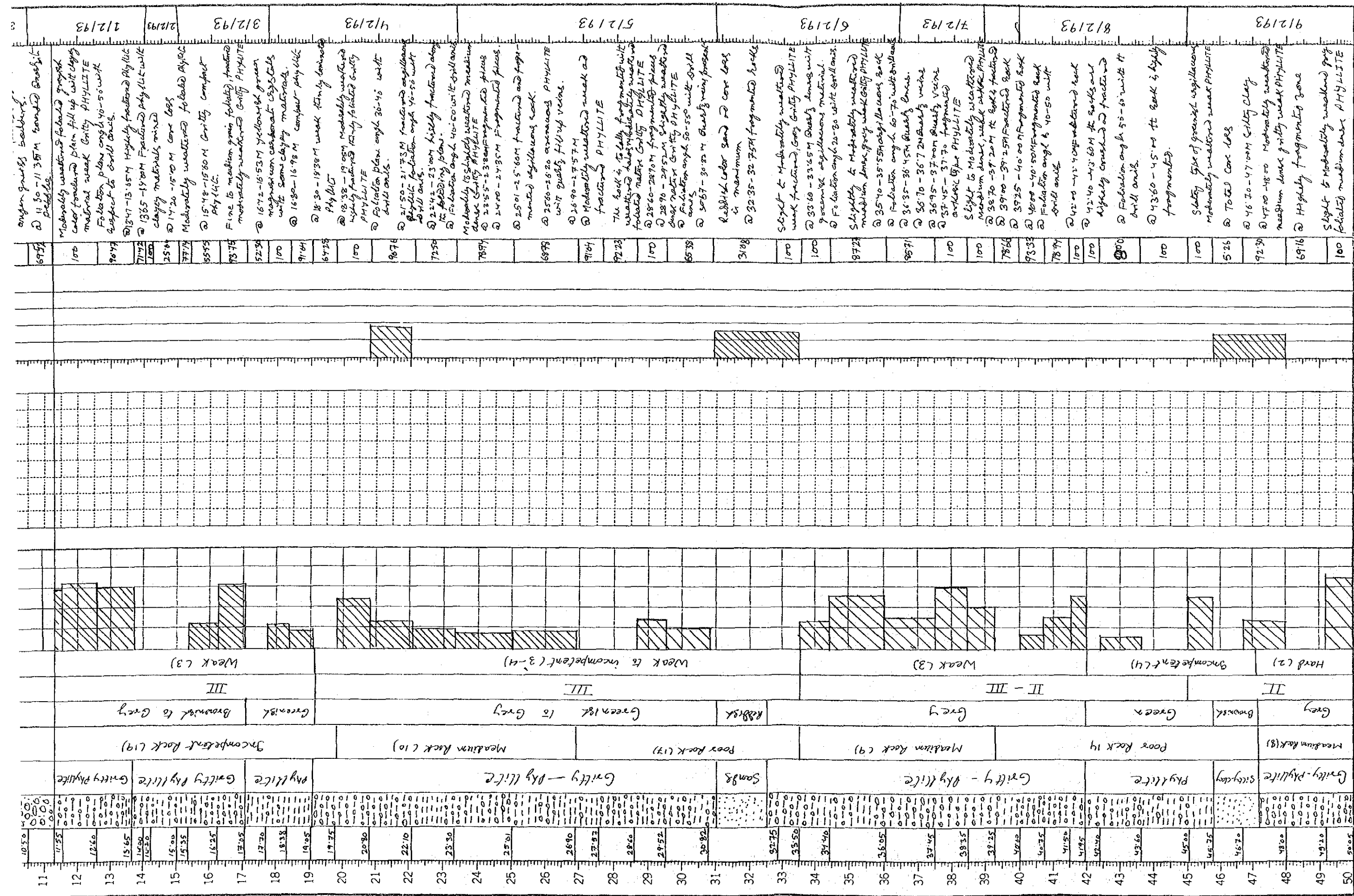
Vertical

Water Table

Capacity of Pump	1/min
100	100
200	200
300	300
400	400
500	500
600	600
700	700
800	800
900	900
1000	1000

Supervisor K. R. Pondyal

[illegible]



DRILLING CORE LOG

Name of Project

No. of Hole	CR2/DH1
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56
57	57
58	58
59	59
60	60
61	61
62	62
63	63
64	64
65	65
66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

Location Chameliya River CR2

Depth of Bedrock	7.35 m
1	1.00
2	1.00
3	1.00
4	1.00
5	1.00
6	1.00
7	1.00
8	1.00
9	1.00
10	1.00
11	1.00
12	1.00
13	1.00
14	1.00
15	1.00
16	1.00
17	1.00
18	1.00
19	1.00
20	1.00
21	1.00
22	1.00
23	1.00
24	1.00
25	1.00
26	1.00
27	1.00
28	1.00
29	1.00
30	1.00
31	1.00
32	1.00
33	1.00
34	1.00
35	1.00
36	1.00
37	1.00
38	1.00
39	1.00
40	1.00
41	1.00
42	1.00
43	1.00
44	1.00
45	1.00
46	1.00
47	1.00
48	1.00
49	1.00
50	1.00
51	1.00
52	1.00
53	1.00
54	1.00
55	1.00
56	1.00
57	1.00
58	1.00
59	1.00
60	1.00
61	1.00
62	1.00
63	1.00
64	1.00
65	1.00
66	1.00
67	1.00
68	1.00
69	1.00
70	1.00
71	1.00
72	1.00
73	1.00
74	1.00
75	1.00
76	1.00
77	1.00
78	1.00
79	1.00
80	1.00
81	1.00
82	1.00
83	1.00
84	1.00
85	1.00
86	1.00
87	1.00
88	1.00
89	1.00
90	1.00
91	1.00
92	1.00
93	1.00
94	1.00
95	1.00
96	1.00
97	1.00
98	1.00
99	1.00
100	1.00

Bore Hole Dia.	76	mm
1	10	mm
2	10	mm
3	10	mm
4	10	mm
5	10	mm
6	10	mm
7	10	mm
8	10	mm
9	10	mm
10	10	mm
11	10	mm
12	10	mm
13	10	mm
14	10	mm
15	10	mm
16	10	mm
17	10	mm
18	10	mm
19	10	mm
20	10	mm
21	10	mm
22	10	mm
23	10	mm
24	10	mm
25	10	mm
26	10	mm
27	10	mm
28	10	mm
29	10	mm
30	10	mm
31	10	mm
32	10	mm
33	10	mm
34	10	mm
35	10	mm
36	10	mm
37	10	mm
38	10	mm
39	10	mm
40	10	mm
41	10	mm
42	10	mm
43	10	mm
44	10	mm
45	10	mm
46	10	mm
47	10	mm
48	10	mm
49	10	mm
50	10	mm
51	10	mm
52	10	mm
53	10	mm
54	10	mm
55	10	mm
56	10	mm
57	10	mm
58	10	mm
59	10	mm
60	10	mm
61	10	mm
62	10	mm
63	10	mm
64	10	mm
65	10	mm
66	10	mm
67	10	mm
68	10	mm
69	10	mm
70	10	mm
71	10	mm
72	10	mm
73	10	mm
74	10	mm
75	10	mm
76	10	mm
77	10	mm
78	10	mm
79	10	mm
80	10	mm
81	10	mm
82	10	mm
83	10	mm
84	10	mm
85	10	mm
86	10	mm
87	10	mm
88	10	mm
89	10	mm
90	10	mm
91	10	mm
92	10	mm
93	10	mm
94	10	mm
95	10	mm
96	10	mm
97	10	mm
98	10	mm
99	10	mm
100	10	mm

Depth of Hole 45.12 m

Elevation m

Core Recovery	62 %
100	100
90	90
80	80
70	70
60	60
50	50
40	40
30	30
20	20
10	10
0	0

Drill Machine Acee Bush Master

Operator S.B. Thapa

Direction	Inclination	Vertical
-----------	-------------	----------

Underground	
Water Table	1.95 m

Capacity of Pump 50-100 1/min

Supervisor T.B. Chhetri

[illegible]

