10.2.4 Hevale Site

(1) Seismic Refraction Survey

(a) Upper Dam Site

In the upper reservoir area, the seismic compressional wave velocities (Vp) of the successive subsurface zones obtained at the stretch covered by the seismic profiles and the corresponding inferred lithology are as follows:-

350 - 500 m/s	Lateritic soil with pebbles
4,900 - 5,000 m/s	Basalt

The results of the seismic refraction survey, given in the form of seismic sections, reveal the following:

- A layer of lateritic soil mixed with pebbles, etc. covers the stretch between Ch. 470m and Ch. 1,380m, having the average thickness of 8m. A few thin patches of lateritic soil exist in the initial part of the stretch.
- Bedrock (Basalt) is exposed in most part of the stretch between Ch. 0m and Ch. 470m.

The computed seismic compressional wave velocity of the basalt bedrock in this area is 4,900-5,000 m/s testifying its compact and hard nature.

(b) Lower Dam Site

The seismic compressional wave velocities (Vp) of the successive subsurface zones in the lower dam site and the corresponding inferred lithology are as follows:

350 - 500 m/s	Soil with pebbles
1,500 m/s	Riverborne material
4,800 - 5,000 m/s	Bedrock

The results of the seismic refraction survey, given in the form of seismic sections, reveal the following:-

- The overburden, a layer of soil with pebbles, etc., having the average thickness of 15m, covers the left and right banks at the dam axis.
- In the middle part of the axis between Ch. 70m to Ch. 300m, the thin soil/silt cover is underlain by a layer of riverbed material having a maximum thickness of 12m.

- The bedrock lies at RL 240m on the right bank and at RL 241m on the left bank. In the middle part of the axis, it is estimated to lie at RL 136m.

(2) Rotary Cone Drilling

(a) Upper Dam Site

The dam site was explored at 3 boreholes viz. UH1, UH2 and UH3. All the boreholes are vertical. The ground water was not encountered at all boreholes. In addition to drilling, two borrow samples (UPH1 & UPH2) were collected for laboratory tests. The locations of borrow pits are shown in the layout plan (**Fig. 10.1-5**).

(i) UH1 (RL 742.00m at the surface)

Up to RL 727m, there is overburden (laterite). Below this level, the Amygdaloidal Basalt and lies followed by the Volcanic Breccia with the black Tachylytic Basalt (5.5m thick).

The Tachylytic Basalt is susceptible to disintegration on exposure and in such case it has to be excavated to a proper founding layer. A present, the 6m thick Porphyritic Amygdaloidal Basalt layer prevents it from disintegration. Below RL 727m, grouting into the jointed rock has to be carried out to make it impervious.

(ii) UH2 (RL 713.019m at the surface)

Up to RL 682.965m (the bottom of the borehole), there are flows of Compact Porphyritic Basalt. The core recovery varies between 68.57% and 100%. But for the entire length drilled, the rock is heavily jointed. Most of the joints are closely spaced and at various angles. Nearly all joints are stained. Permeability is very low here. RQD is fair i.e. 57.76%.

(iii) UH3 (RL 699.434m at the surface)

In this borehole also, the rocks are in heavily jointed condition. Joints are closely spaced and at various angles. Nearly all the joints are stained. Along some joints weathering of the rock has taken place. The core recovery varies between 37.07% and 100%. RQD also varies between nil and 100%.

(b) Lower Dam Site

(i) LH1 (RL 238.751m at the surface)

Up to RL 228.651m, there is overburden. A large number of closely spaced joints exist between RL 229.021m & RL 226m and between RL 207m & RL 199m. Nearly all joints are stained and RQD is smaller than 65%. Permeability of bedrock is very low.

(ii) LH2 (RL 148.430m at the surface)

Up to RL 136.00m, there is overburden. From RL 136m to RL 125m, the joints are closely spaced. The core recovery was poor i.e. 40%, and RQD is also poor i.e. 32%. Below RL 125m, the number of closely spaced joints is small and the condition of the rock is much improved. The joints are at various angels and majority of the joints are stained. The results of permeability tests for the bedrock indicate very low permeability.

(iii) LH3 (RL 239.071m at the surface)

Up to RL 231.5m, there is overburden. From RL 231.5m to RL 224m, the rock is heavily jointed and the Lugeon value is 12 Lugeons. Between RL 221.23m & RL 217.00m, between RL 207.31m & RL 203.10m and between RL 189.24m & RL 174.00m, there are numerous joints. Nearly all joints are stained and are at various angles. RQD is poor i.e. 47% only. The results of permeability tests generally indicate very low permeability with slightly higher losses as the one noted above.

(3) Geotechnical Appraisal

(a) Geotechnical Appraisal for Upper Dam Site

At the upper dam site, a man-made storage pond is to be created by a 2,310m long (perimeter length) and maximum 27m high rock fill dam with concrete facing. The picturesque area hosts rolling topography abruptly ending at the margin by a deep rocky escarpment. The Deccan Trap basalt prevails in the region and it is largely exposed on surface, or covered with thin reddish brown lateritic soil. Morphologically, two levels

of terraces are noted; the lower rocky one at about RL 700m and another one covered with laterite at about RL 735m. Major part of the storage pond will be in the lower rocky terrace and partially in the upper one. The overburden at the upper dam site comprises of firm to stiff reddish brown sandy silty clay, containing cobbles and boulders. The soil is residual in character, derived from weathering of basalt below.

The overburden of about 15m thickness was observed at UH1. No overburden was encountered at UH2 and UH3. Considering the fact that both UH2 and UH3 are at elevations about 30 to 40m lower than UH1, the overburden seems to have got washed away due to terrain geomorphology and high rainfall in the area.

SPT-value of 6 to 8 was obtained in the upper 5m, indicating firm to stiff consistency. Due to the presence of cobbles and gravels below 10m depth, SPT refusal (N>50) was obtained.

The overburden is classified as Cl (as per IS:1498-1980). The geotechnical properties are as follows:

a)	Gravel	:	5 to 10%
b)	Sand	:	23 to 40%
c)	Silt	:	28 to 35%
d)	Clay	:	27 to 37%
e)	Liquid limit	:	43 to 47%
f)	Plastic limit	:	23 to 26%
g)	Plasticity index	:	20 to 21%
h)	Specific gravity	:	2.65 to 2.72

It is possible to adopt shallow foundations at this site for light structures such as control buildings, pump houses, retaining walls and storage tanks.

The unconfined compression strength ranges from 131 to 1,616 kg/cm^2. Given the maximum height of 27m of Concrete Facing Rock Fill (CFRF) dam here, foundation rock would have adequate strength.

The geological feasibility of this proposal depends on the water tightness of the upper reservoir since the foundation rock has a number of joints.

Equally important is likelihood of escape of water at the escarpment face. It is difficult to prognosticate on this aspect at this stage of investigation, except that:

(i) Borehole UH3 which is at the margin of the proposed pond and close to the escarpment face has intersected 5 closely jointed zones down to the drilling depth of 30m.

(ii) As noted earlier, almost complete water tightness was confirmed by the permeability tests at boreholes.

(iii) Problem of likely leakage from the pond close to the escarpment face should be examined by a detailed investigation at a later stage. This should include scanning of the escarpment by physical and geological reconnaissance.

It is important that the borehole UH1 located in the upper terrace intersected the Volcanic Breccia with black Tachylyte between RL 721m and 716m, i.e. falling within the draw down zone. Incidentally for the upper reservoir, Minimum Draw Down Level (MDDL) is RL 715m and Full Reservoir Level (FRL) is RL 745m. This borehole is far from the reservoir. Nevertheless, in future investigation, possible extension of Tachylyte into the reservoir is to be studied in view of it's potential deterioration of strength due to continuous wetting.

(b) Geotechnical Appraisal for Lower Dam Site

The lower dam site straddles on the riverbed in the wide U-shaped valley underlain by Parametamorphites or Dharmar Group. The lithological assemblage is constituted of mica schist, quartzite, chlorite schist phyllites with gradations to migmatite/granite gneisses.

At the valley bottom, the overburden of sandy silt/silty clay continues down to a maximum depth of 12m. Although permeability has not been measured, it is speculated to be in the range of 10^{-3} to 10^{-4} cm/sec.

The overburden is classified as CI at LH1 and SC or SM at LH2 & LH3.

The Properties are as follows:

<u>At LH1</u>

a)	Gravel	:	Nil to 6%
b)	Sand	:	28 to 39%
c)	Silt	:	27 to 34%
d)	Clay	:	30 to 33%
e)	Liquid limit	:	42 to 45%

f)	Plastic limit	:	25 to 27%
g)	Plasticity index	:	17 to 18%
h)	Specific gravity	:	2.65

At LH2 and LH3

a)	Gravel	:	10%
b)	Sand	:	47 to 57%
c)	Silt	:	19 to 23%
d)	Clay	:	17 to 20%
e)	Liquid limit	:	35 to 37%
f)	Plastic limit	:	20 to 21%
g)	Plasticity index	:	15 to 16%
h)	Specific gravity	:	2.67 to 2.68

It is possible to adopt shallow foundation at this location for all structures except a dam structure, which should be founded on the rock as per the engineering geological report.

The quality of bedrock as foundation for a dam structure is excellent in terms of strength, massiveness and permeability. Furthermore, considering continuous outcrops of quartzite/mica schist at the toe of right bank slope and the deep depth of bedrock as indicated in the seismic survey results of the adjacent areas, designers may consider the following:

(i) If possible, the overflow section may be sited in and close to the right bank where the bedrock exists at a shallow depth.

(ii) A composite dam structure with a rockfill/embankment dam on the left bank is recommendable. For a gravity dam, deep excavation would be required.

(iii) Considering the permeability of bedrock, curtain/consolidation grouting work could be minimized.

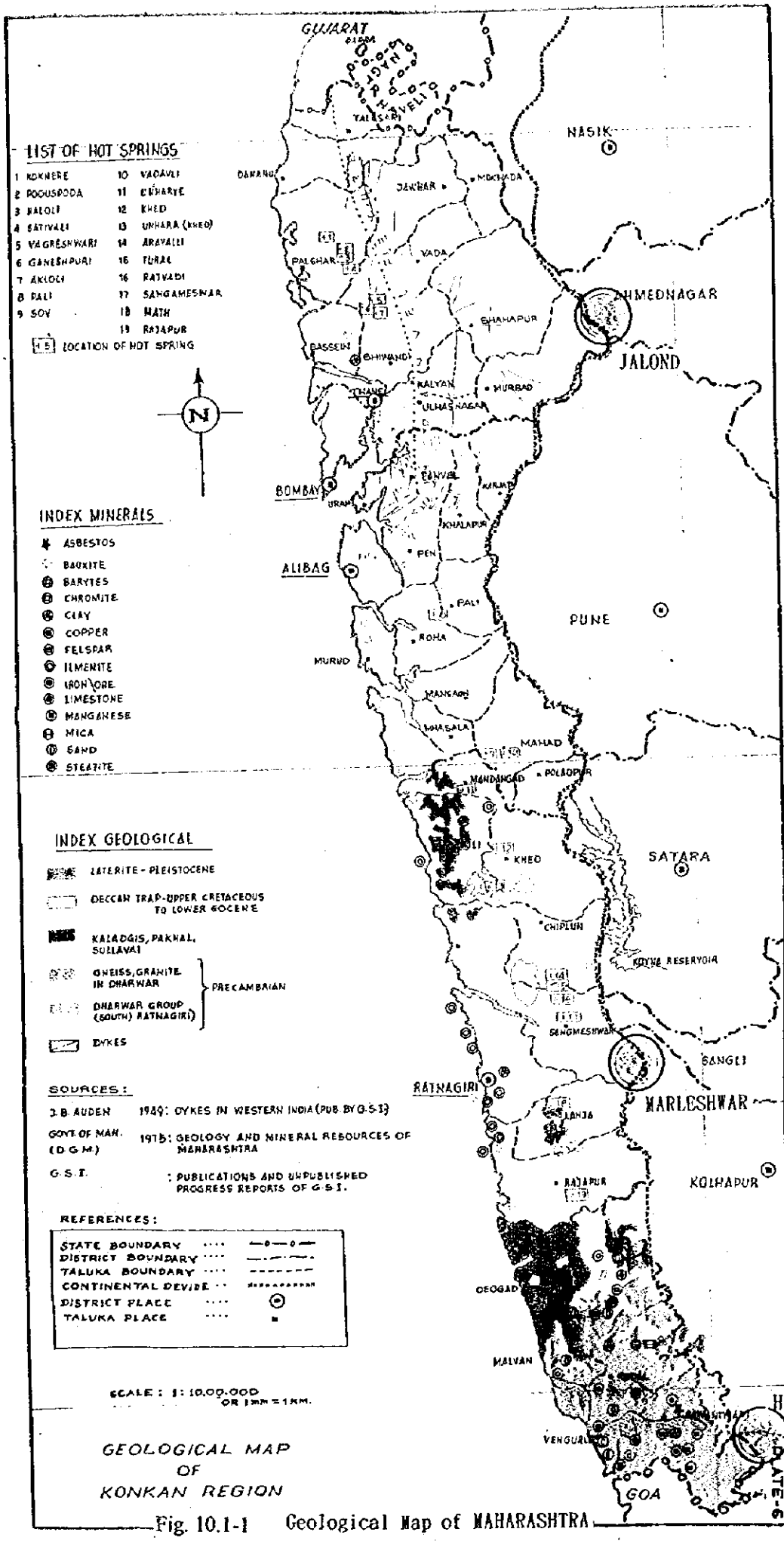


Fig. 10.1-1 Geological Map of MAHARASHTRA

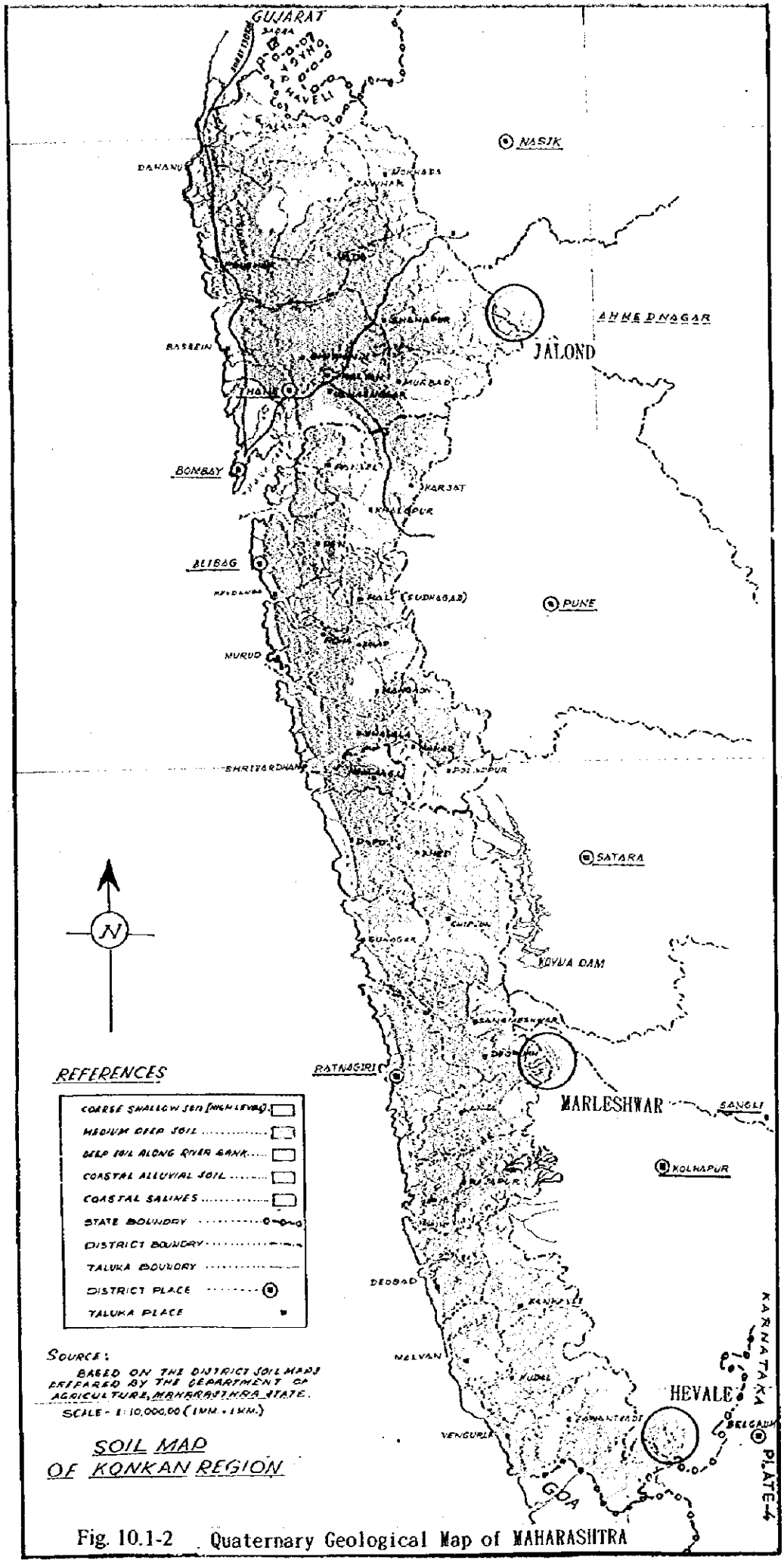
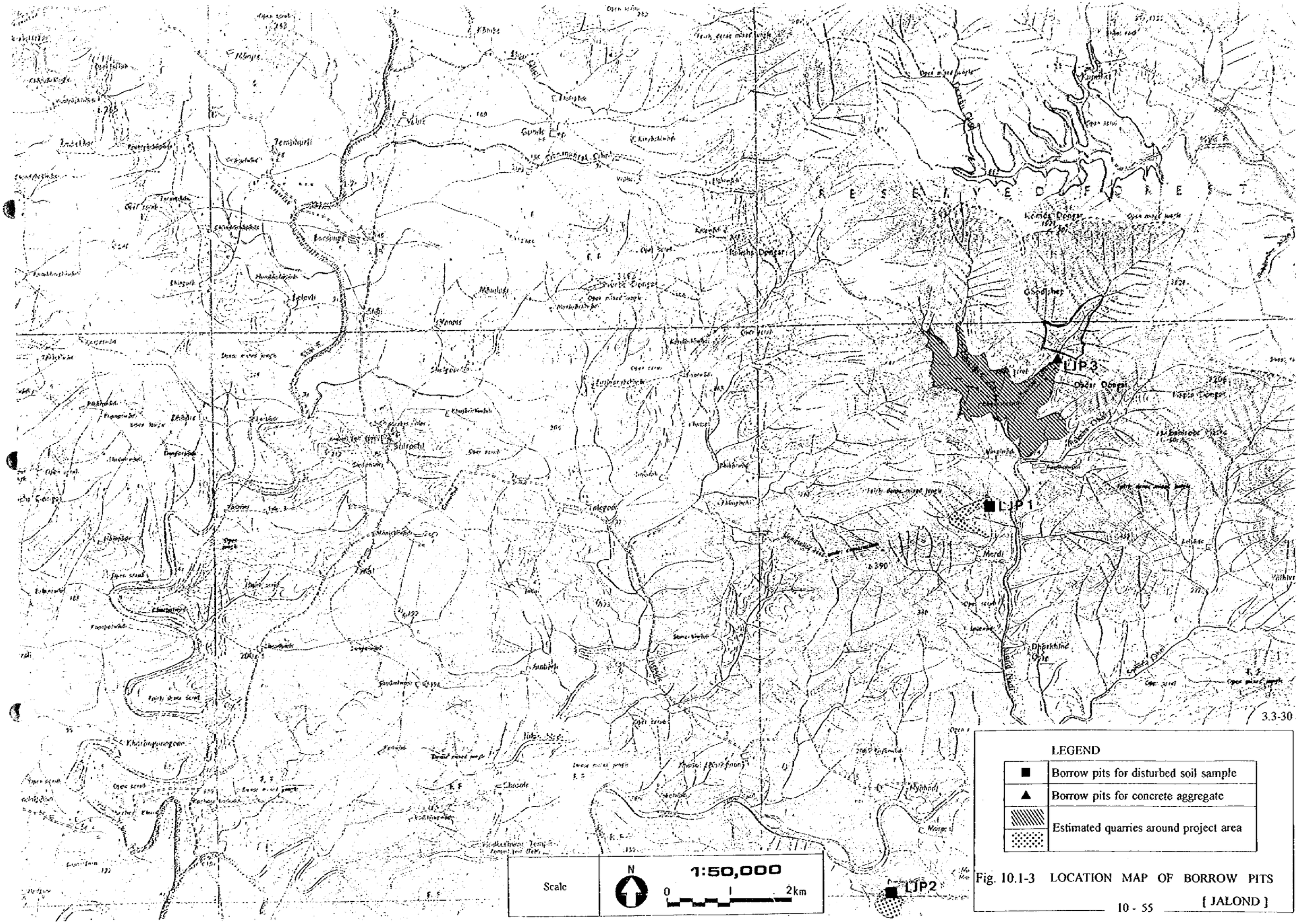


Fig. 10.1-2 Quaternary Geological Map of MAHARASHTRA



3.3-30

LEGEND

■	Borrow pits for disturbed soil sample
▲	Borrow pits for concrete aggregate
▨	Estimated quarries around project area

Fig. 10.1-3 LOCATION MAP OF BORROW PITS

RESERVED FOREST

RESERVED FOREST

RESERVED FOREST

UMP3

UMP4

UMP1

LMP2

LMP3

LMP1

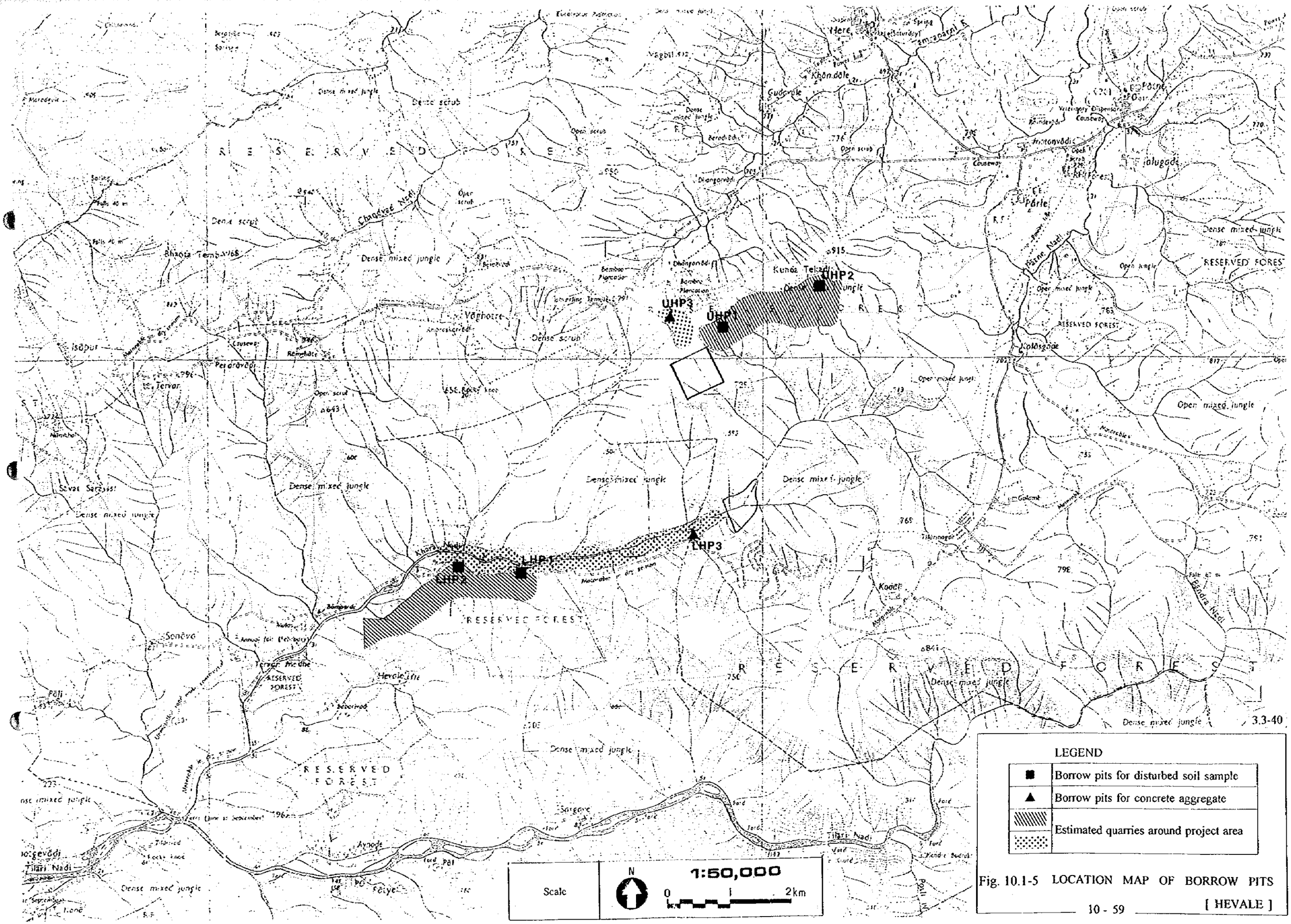
RESERVED FOREST 3.3-36

Scale	N	1:50,000 0 1 2km

LEGEND

■	Borrow pits for disturbed soil sample
▲	Borrow pits for concrete aggregate
▨	Estimated quarries around project area
⁘	

Fig. 10.1-4 LOCATION MAP OF BORROW PITS



3.3-40

Fig. 10.1-5 LOCATION MAP OF BORROW PITS

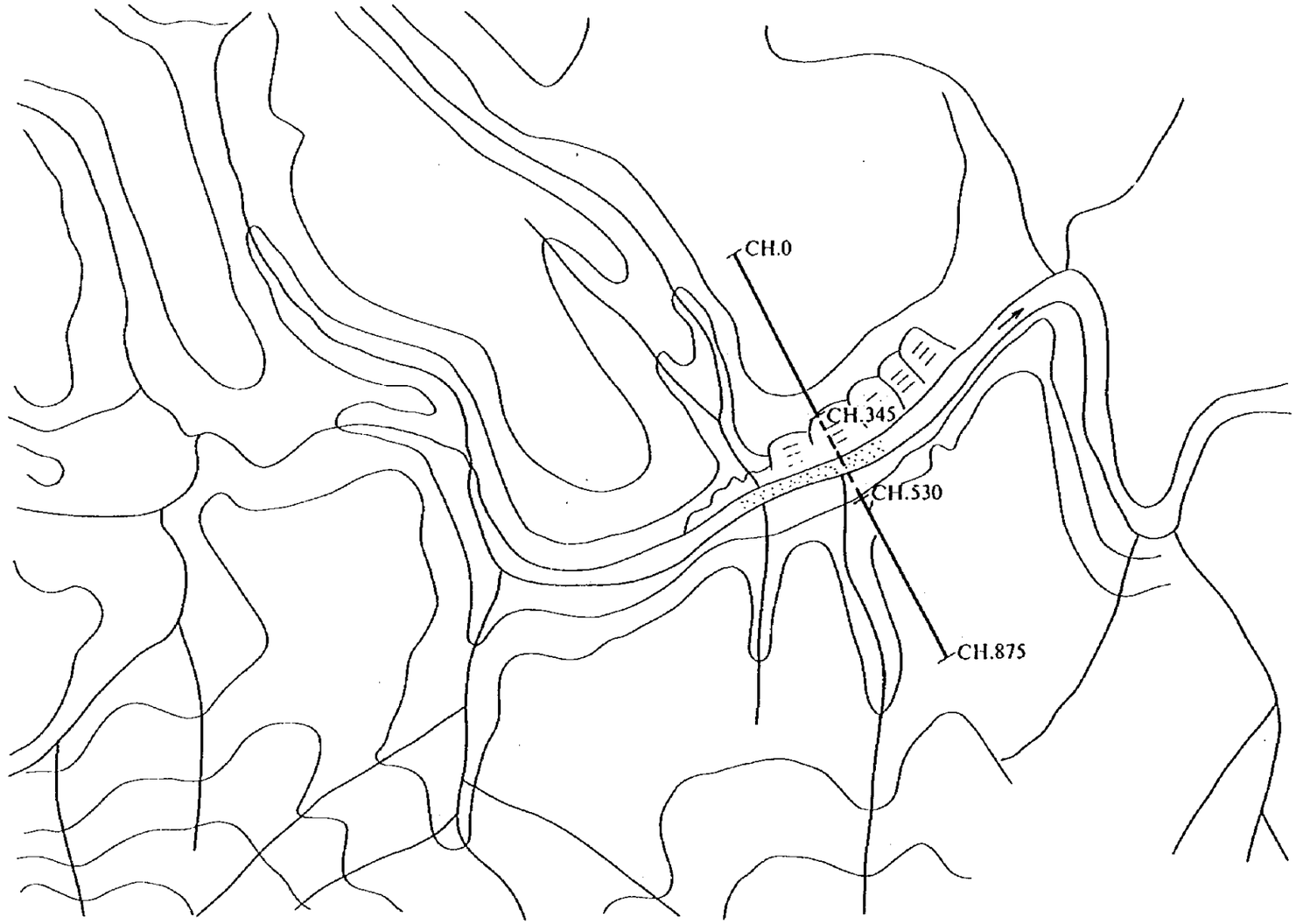


Fig. 10.1-6 Layout of Investigation at Upper Jalond Site

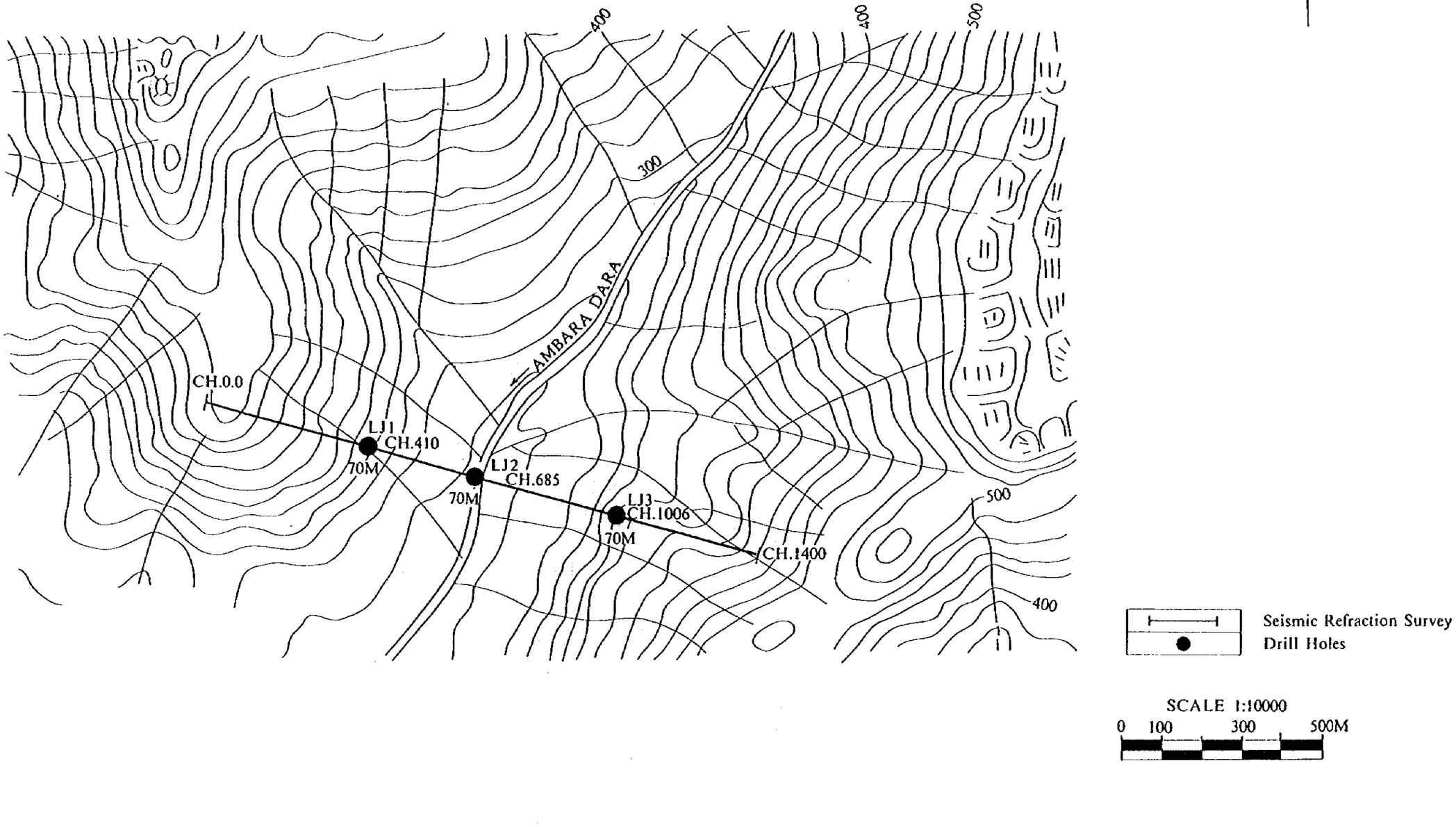


Fig. 10.1-7 Layout of Investigation at Lower Jalond Site

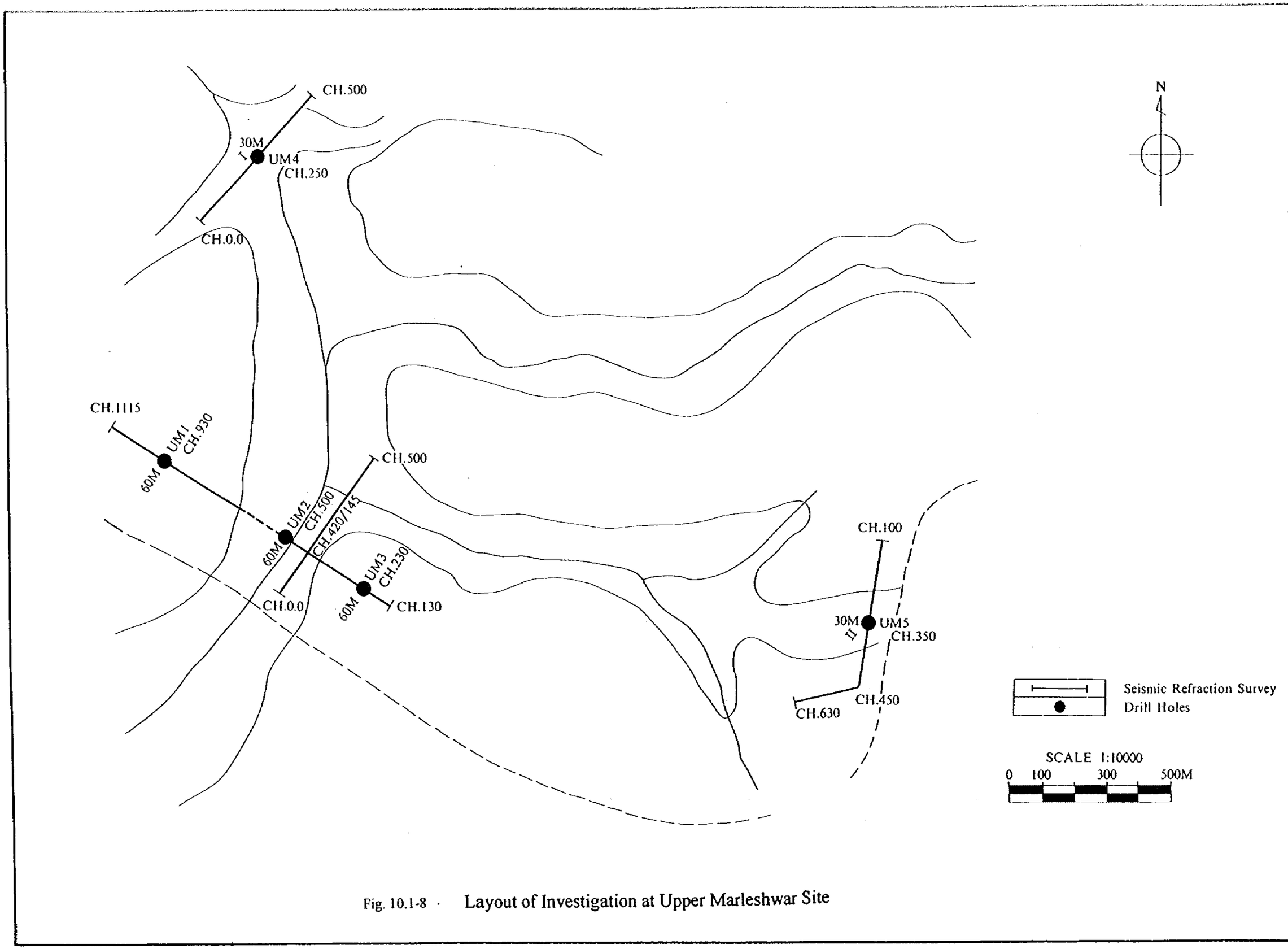


Fig. 10.1-8 · Layout of Investigation at Upper Marleshwar Site

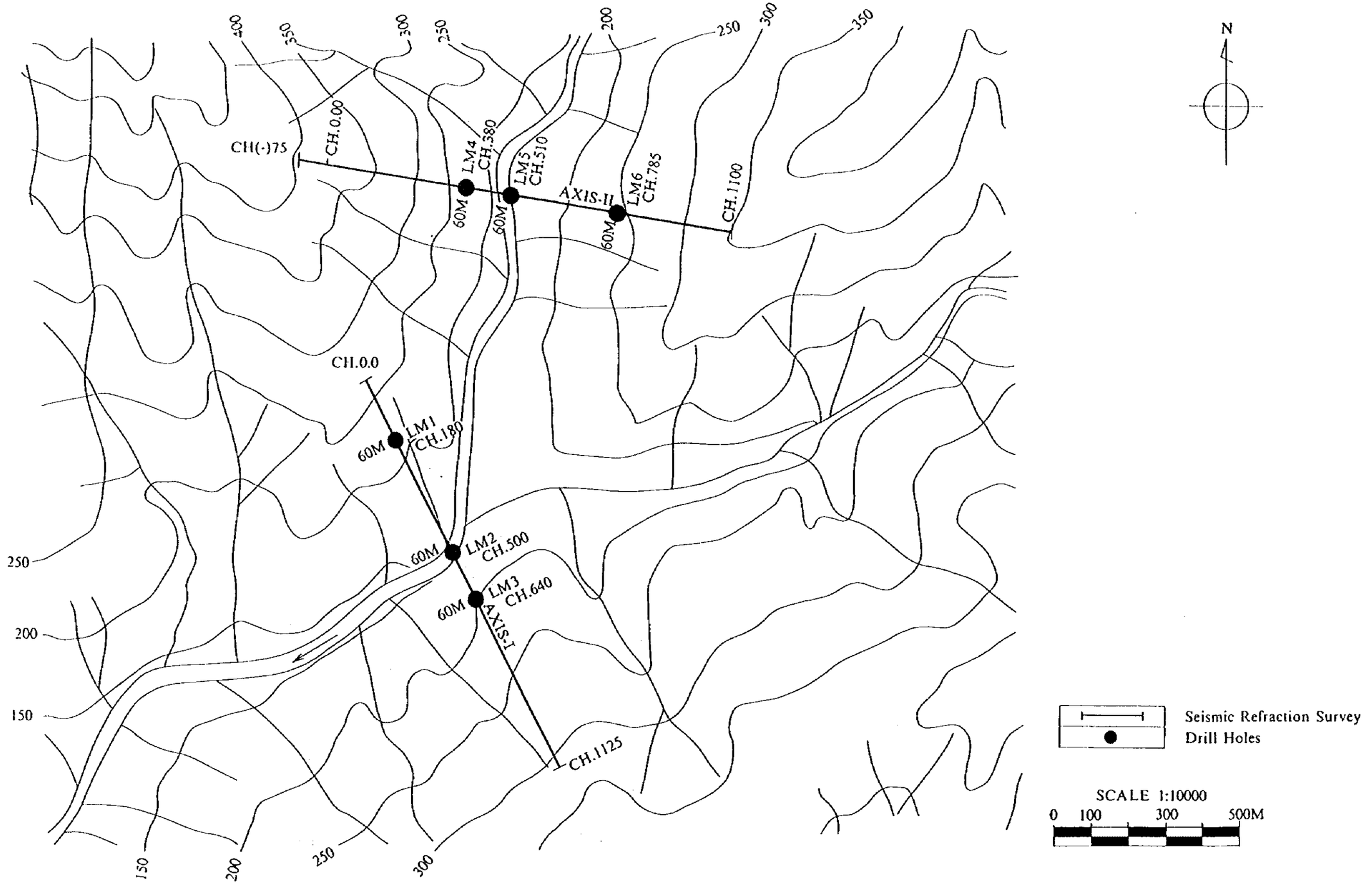


Fig. 10.1-9 Layout of Investigation at Lower Marleshwar Site

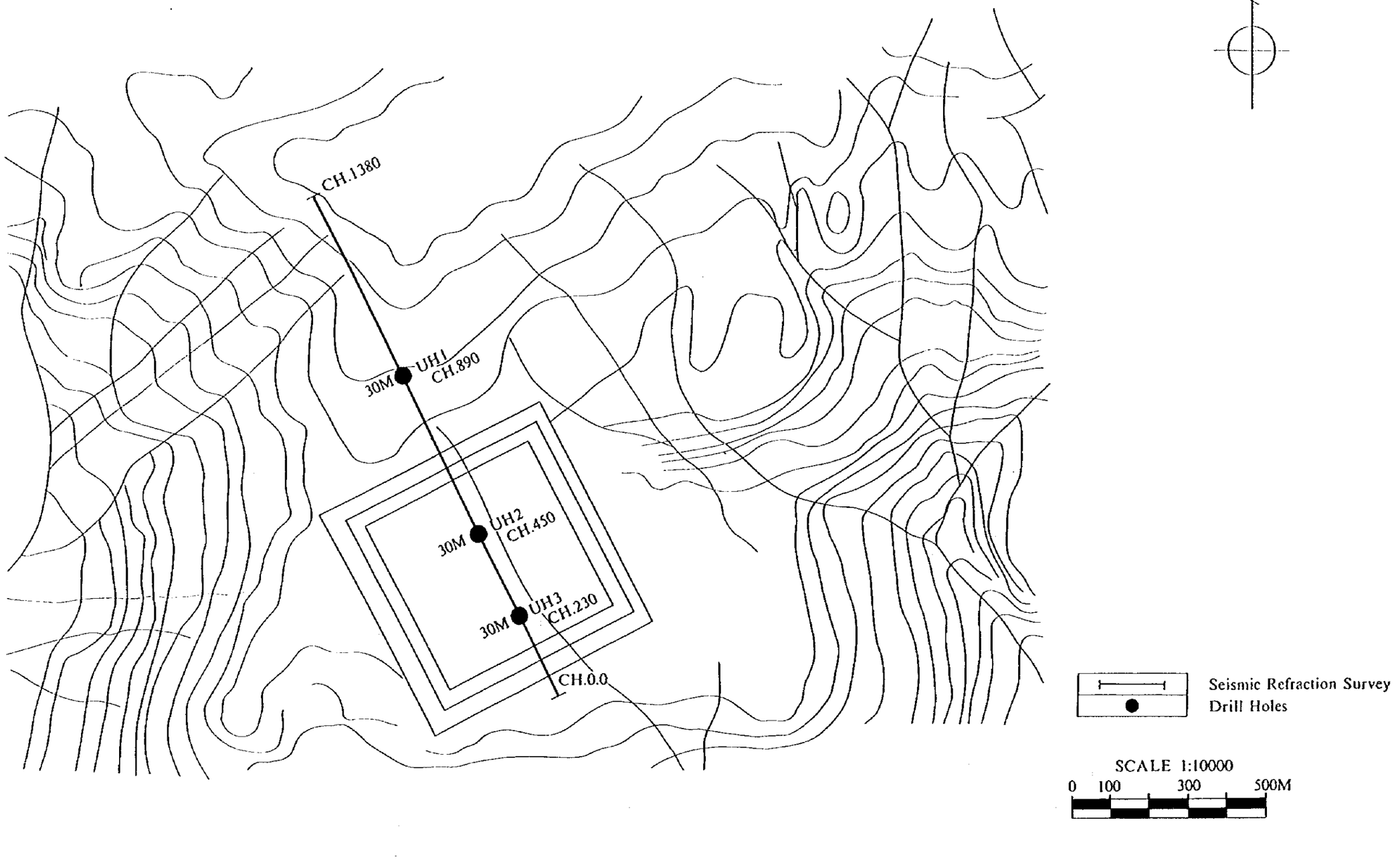


Fig. 10.1-10 Layout of Investigation at Upper Hevale Site

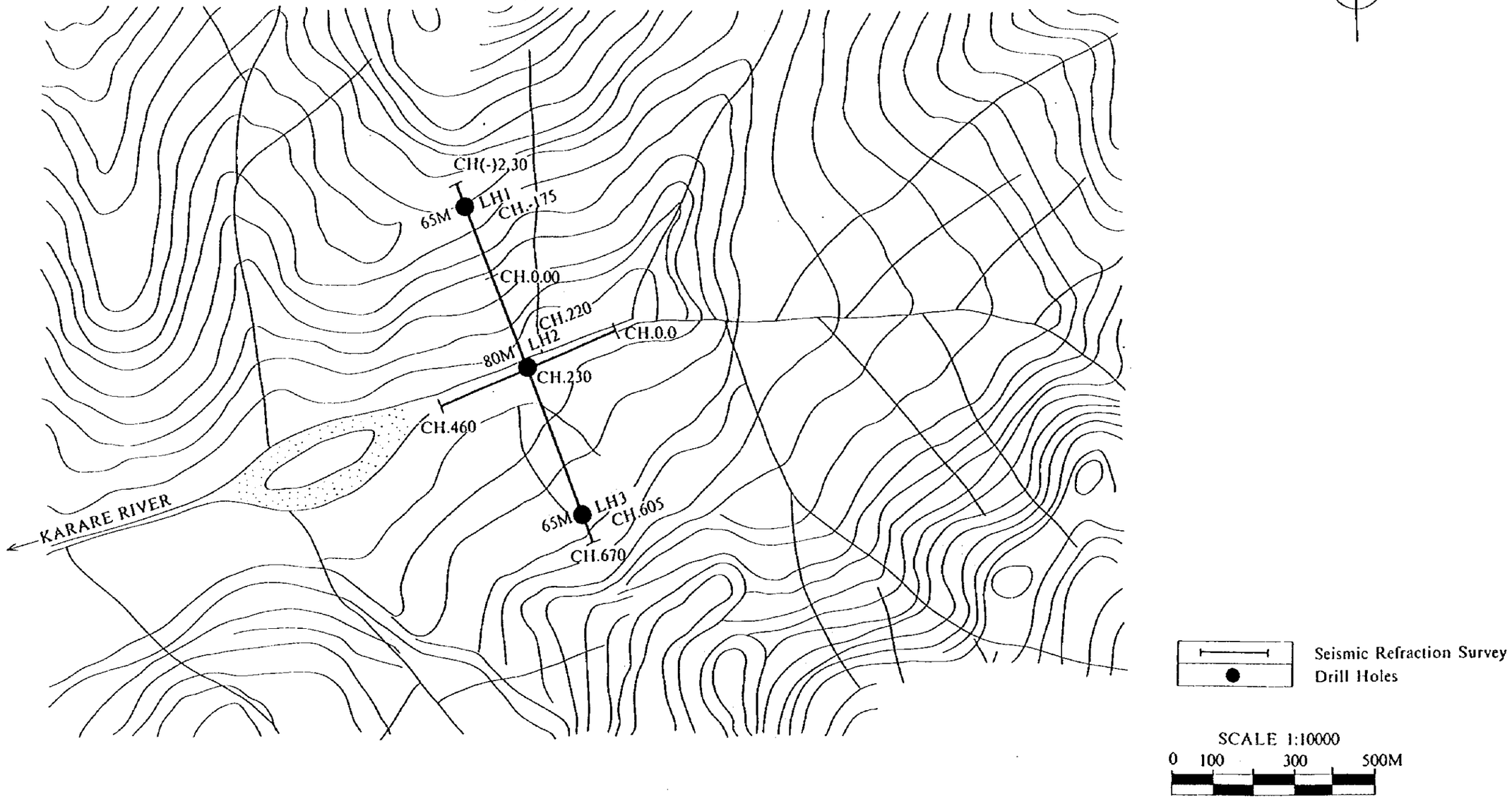


Fig. 10.1-11 Layout of Investigation at Lower Hevale Site

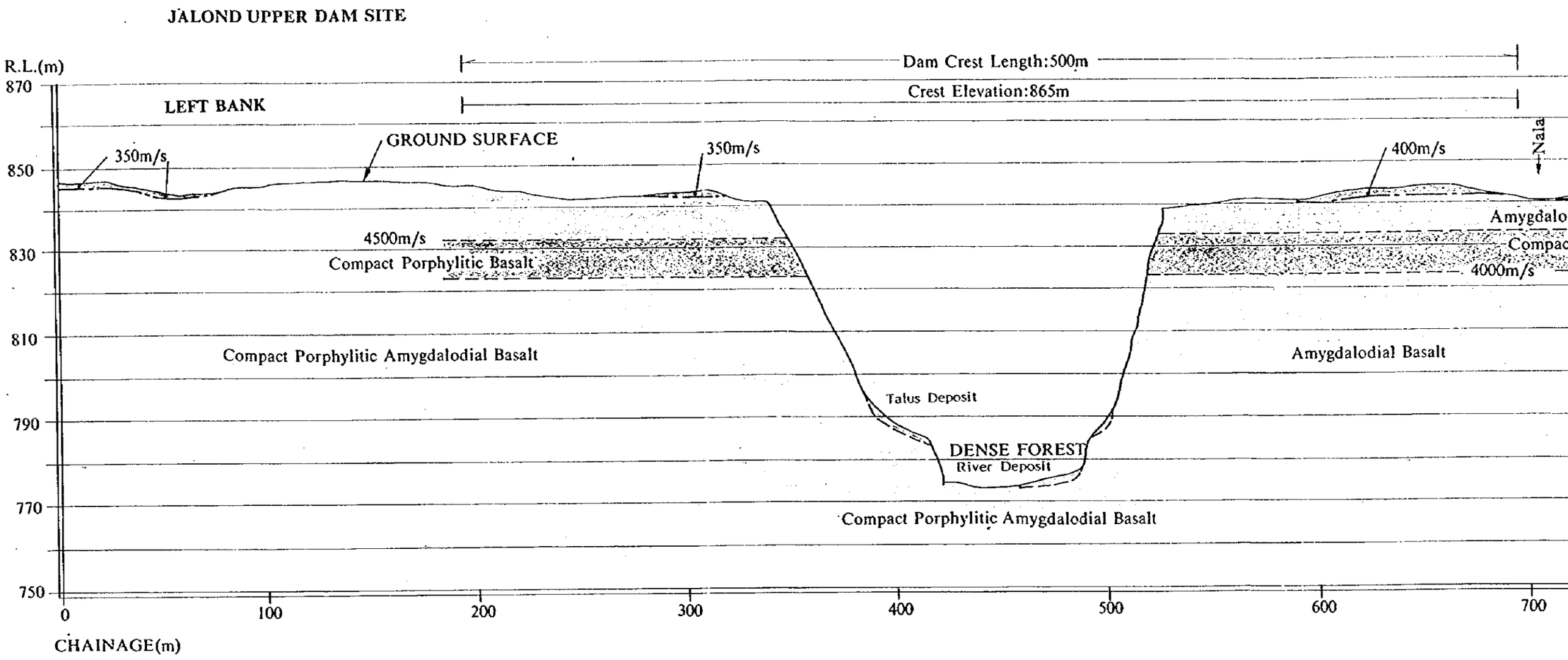
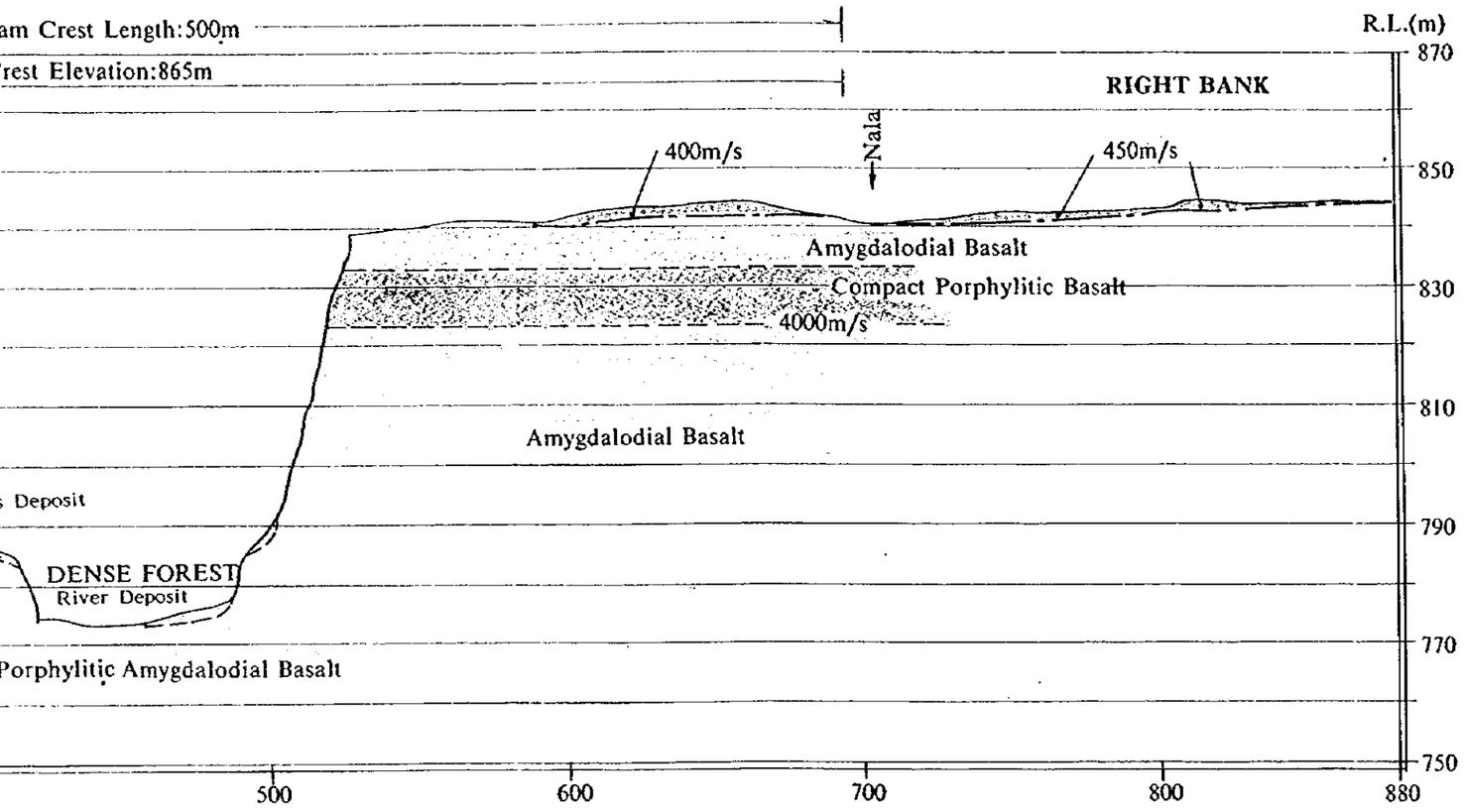


Fig. 10.1-12 Geological Cross Section of Jalond Upper Reservoir

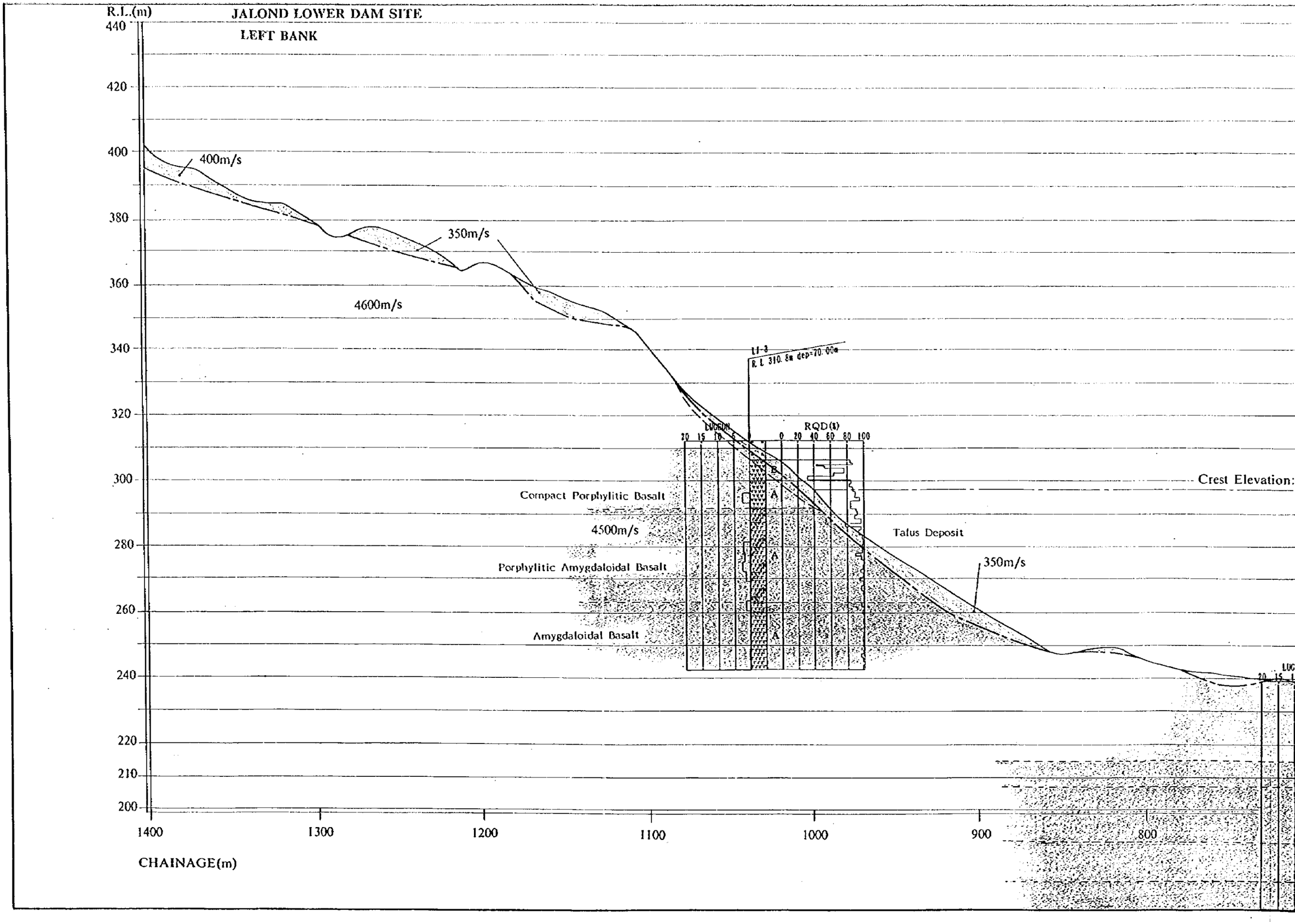


350-450m/s	SOIL
4000-4500m/s	BASALT

Legend

	River Deposit
	Talus Deposit
	Compact Porphylitic Amygdalodial Basalt
	Compact Porphylitic Basalt
	Amygdalodial Basalt

ological Cross Section of Jalond Upper Reservoir


JALOND LOWER DAM SITE
LEFT BANK
R.L.(m)
440
420
400
380
360
340
320
300
280
260
240
220
210
200
400m/s
350m/s
4600m/s
4500m/s
Compact Porphylitic Basalt
Porphylitic Amygdaloidal Basalt
Amygdaloidal Basalt
Talus Deposit
350m/s
Crest Elevation
LI-3
R.L 310.8m dep=70.00m
LUGEON
RQD(%)
1400
1300
1200
1100
1000
900
800
CHAINAGE(m)

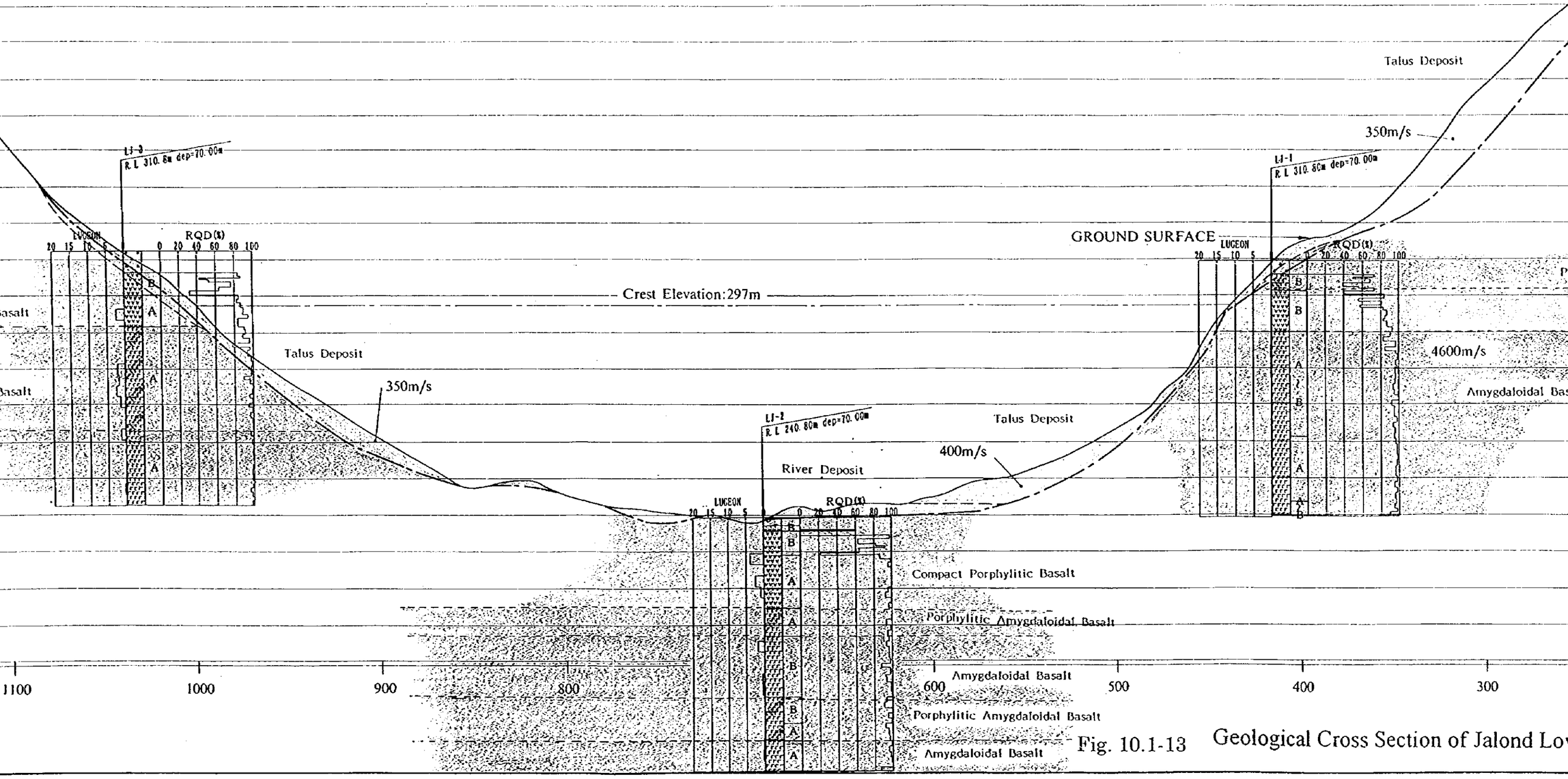


Fig. 10.1-13 Geological Cross Section of Jalond Lo

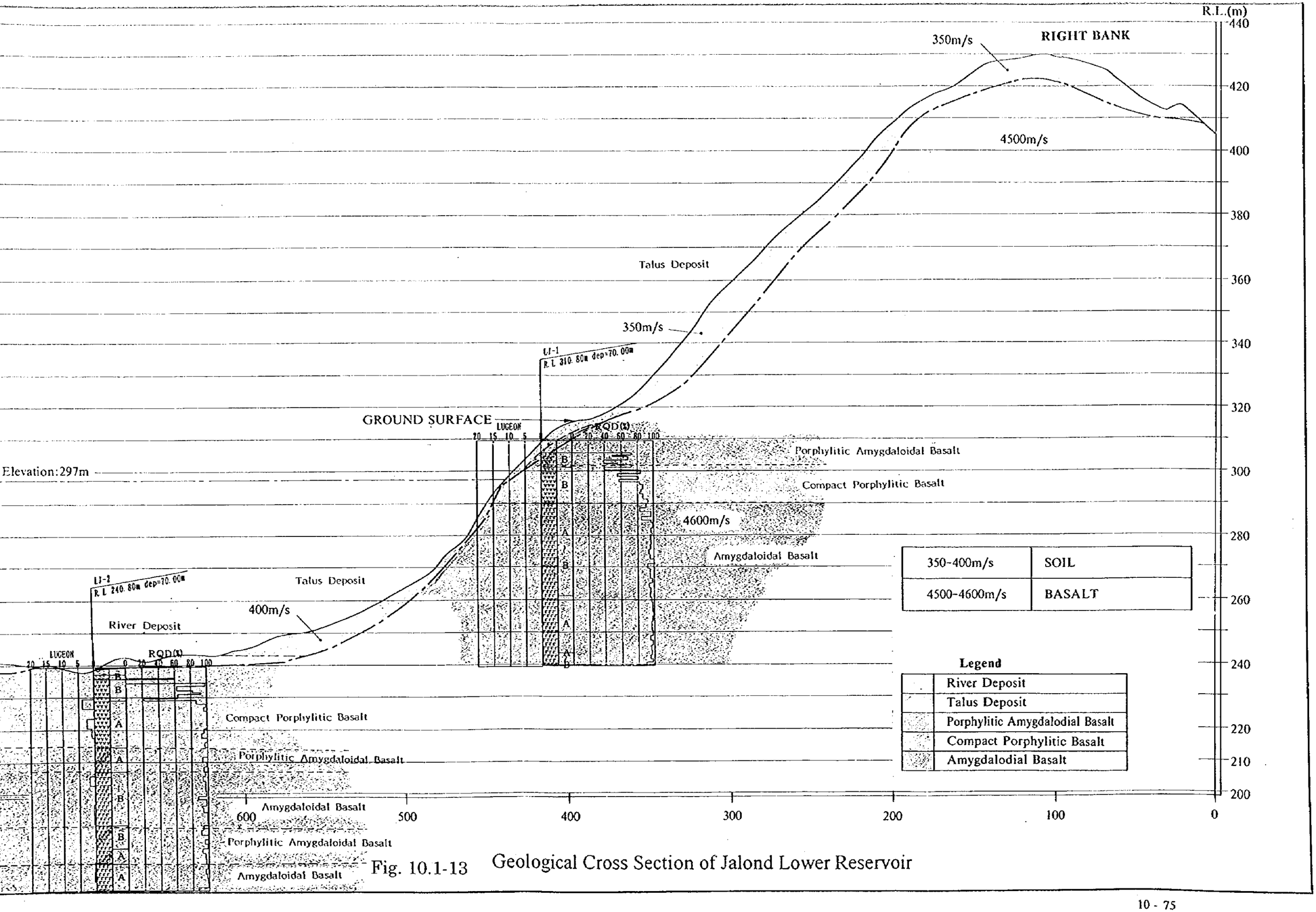


Fig. 10.1-13 Geological Cross Section of Jalond Lower Reservoir

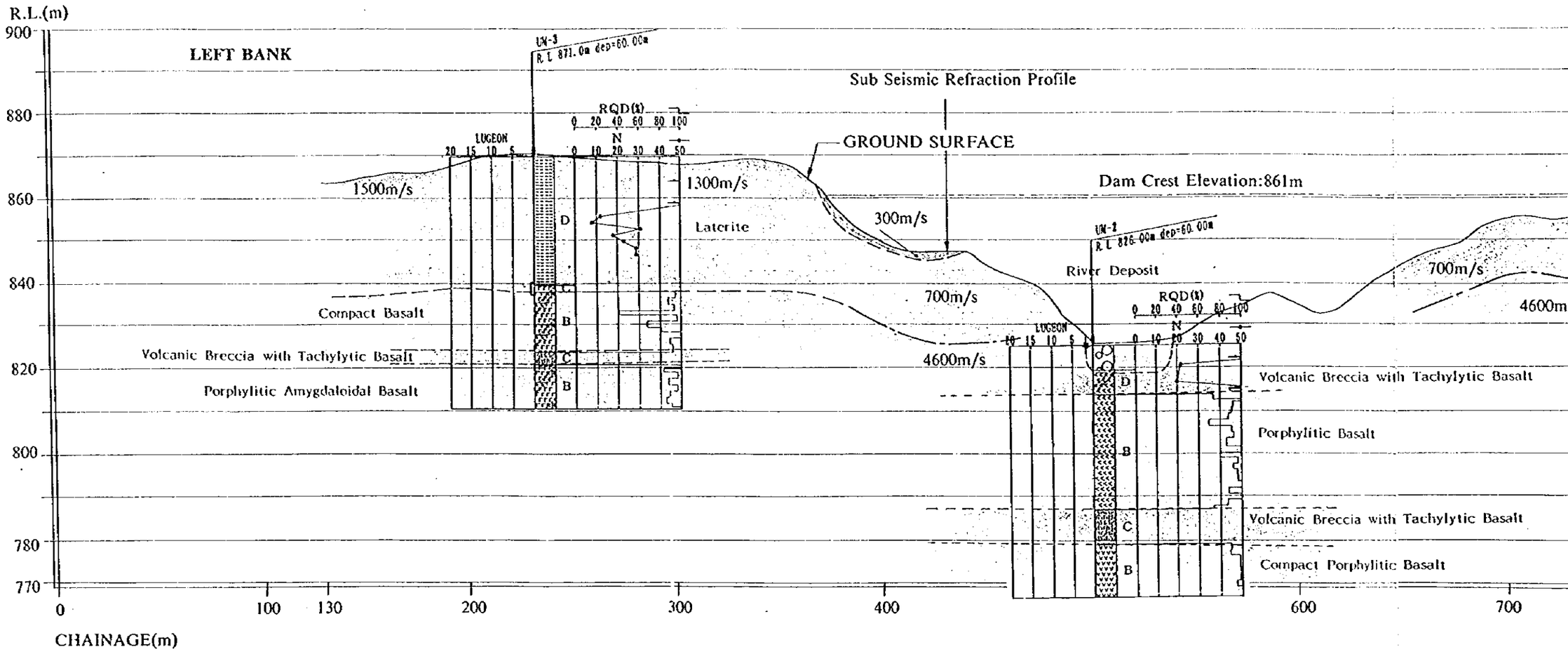


Fig. 10.1-14 Geological Cross Section of Marleshwar Upper Reservoir

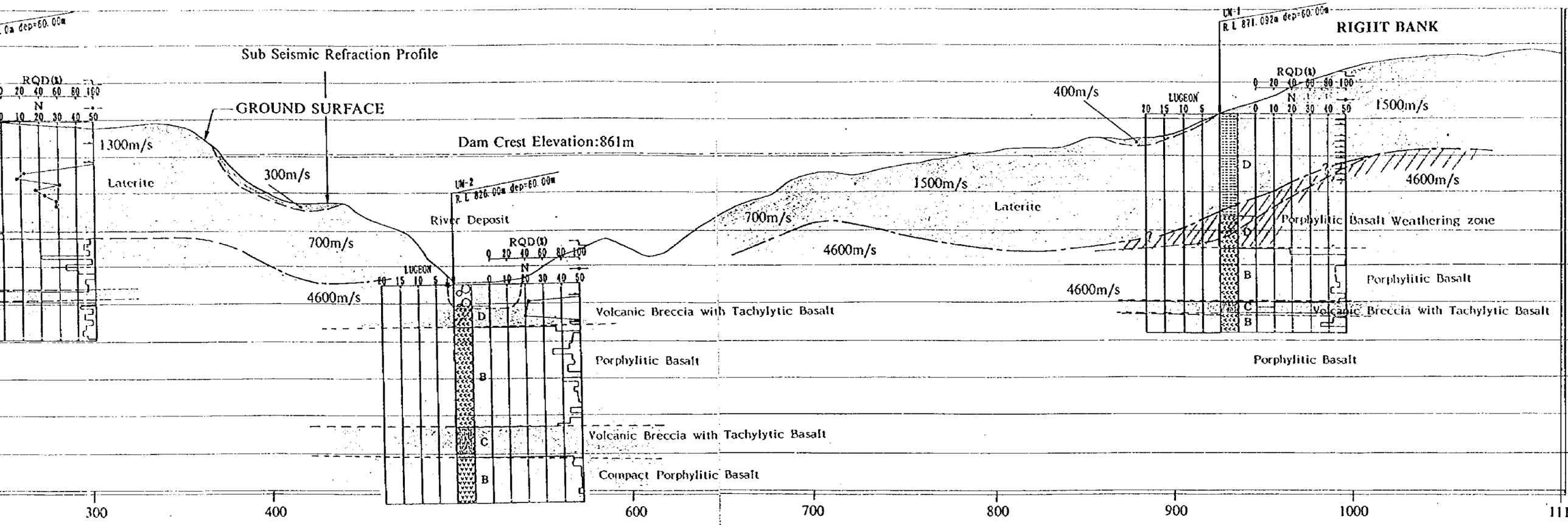
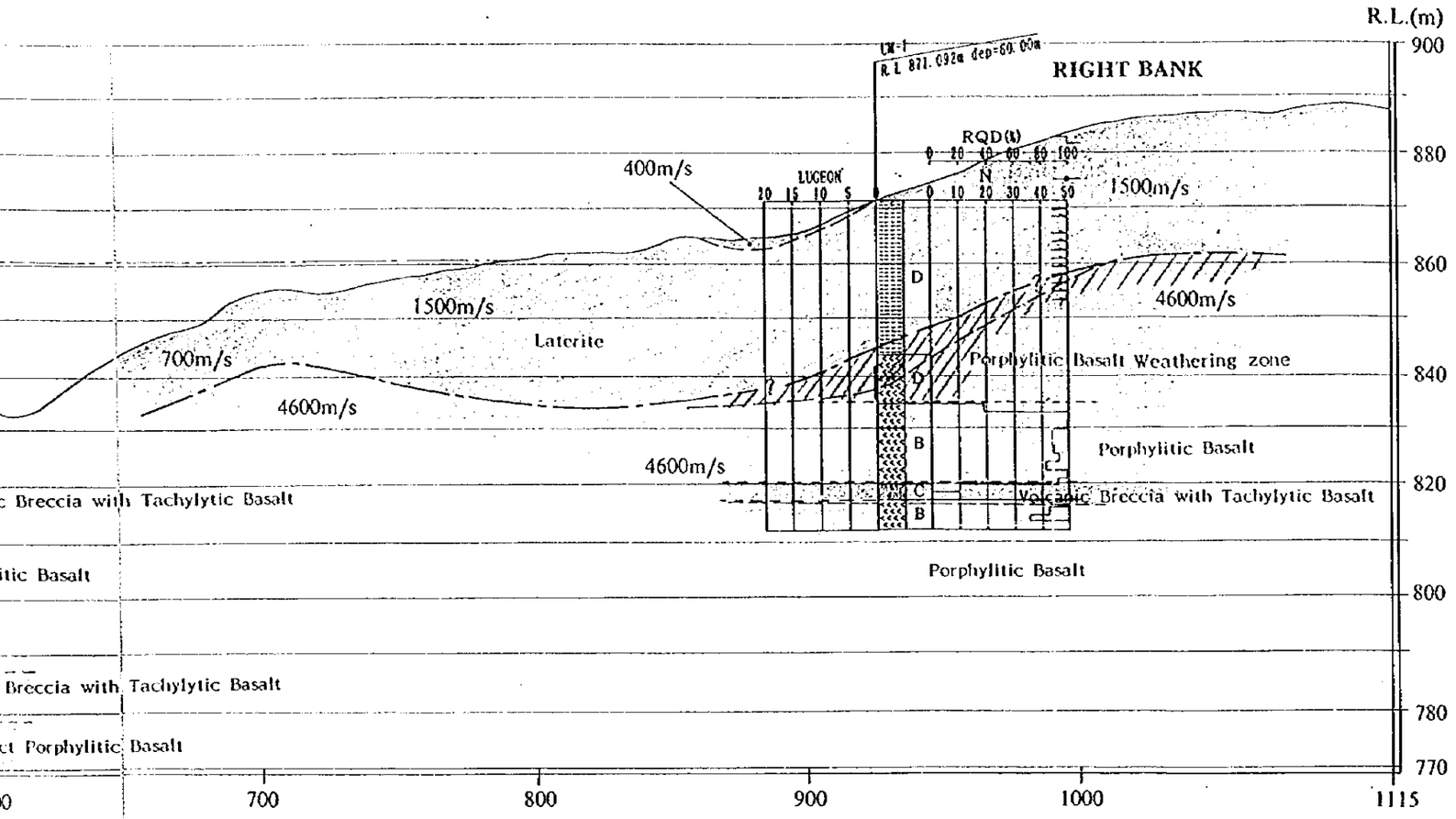


Fig. 10.1-14 Geological Cross Section of Marleshwar Upper Reservoir



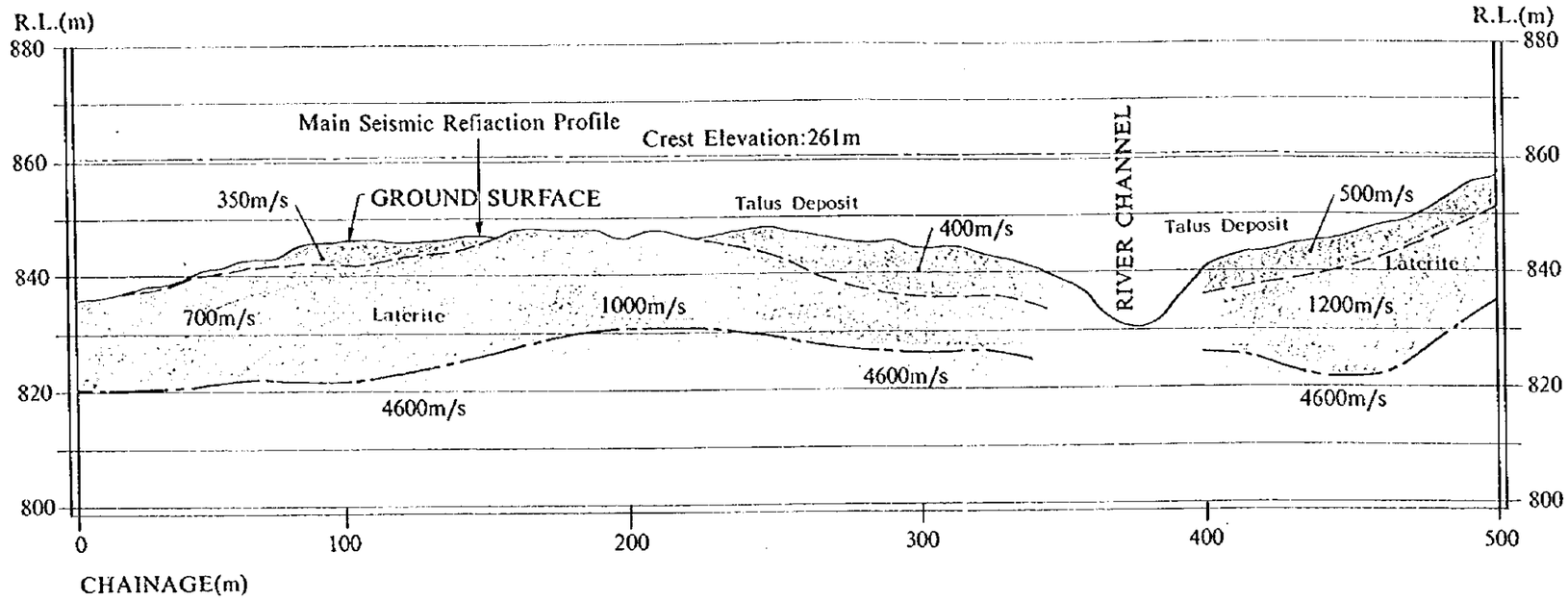
300-400m/s	SOIL
700-1500m/s	LATERITE
4500m/s	BASALT.

Legend

	River Deposit
	Talus Deposit
	Laterite
	Compact Basalt, Compact Porphylitic Basalt
	Volcanic Breccia & Tachylytic Basalt
	Porphylitic Amygdalodial Basalt
	Porphylitic Basalt

hwar Upper Reservoir

MARLESHWAR UPPER SITE MAIN DAM (CROSS PROFILE)

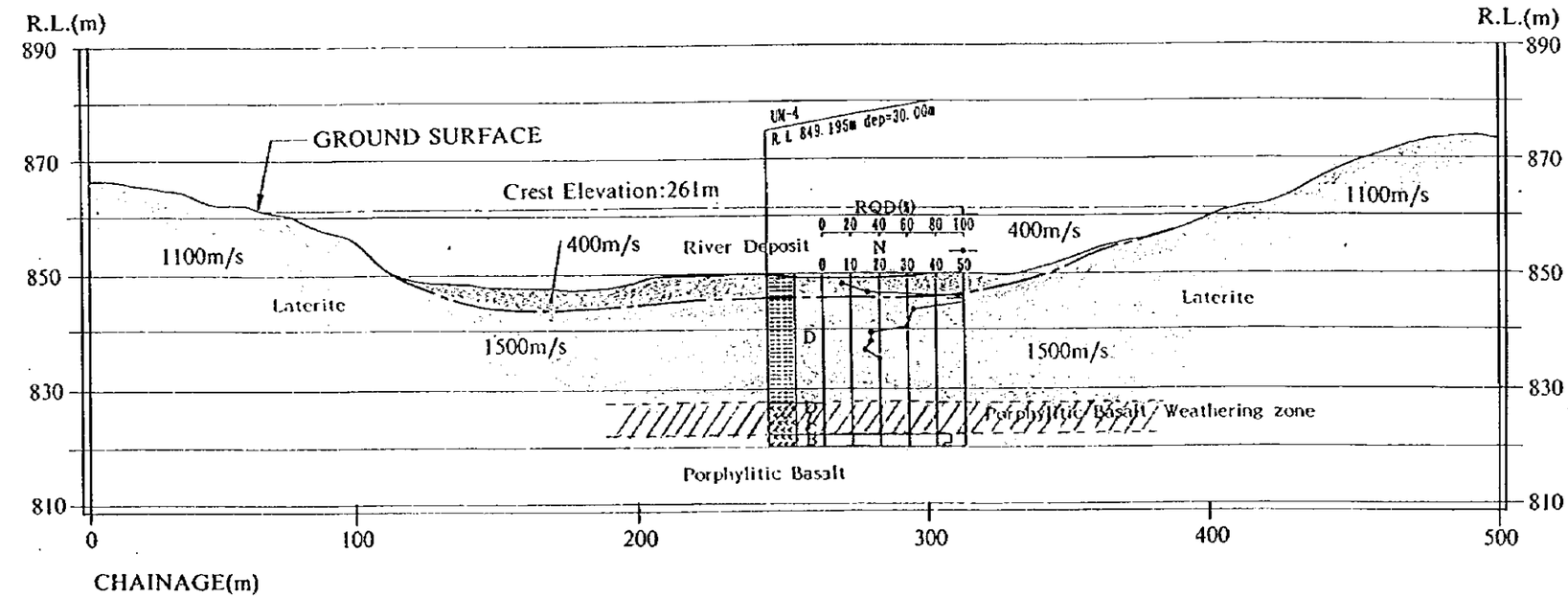


Legend

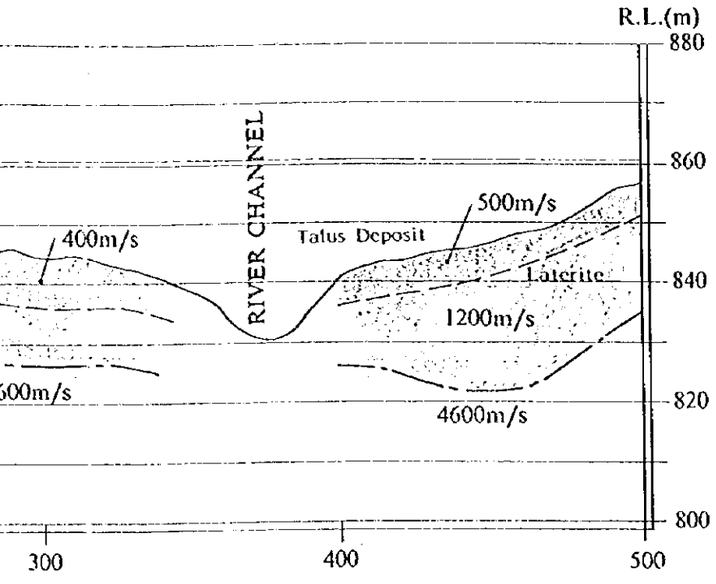
	Talus Deposit or Surface Soil
	Laterite
	Porphylitic Basalt (weathering zone)

350-500m/s	SOIL
700-1200m/s	LATERITE
4600m/s	BASALT

MARLESHWAR UPPER SITE SADDLE DAM-I

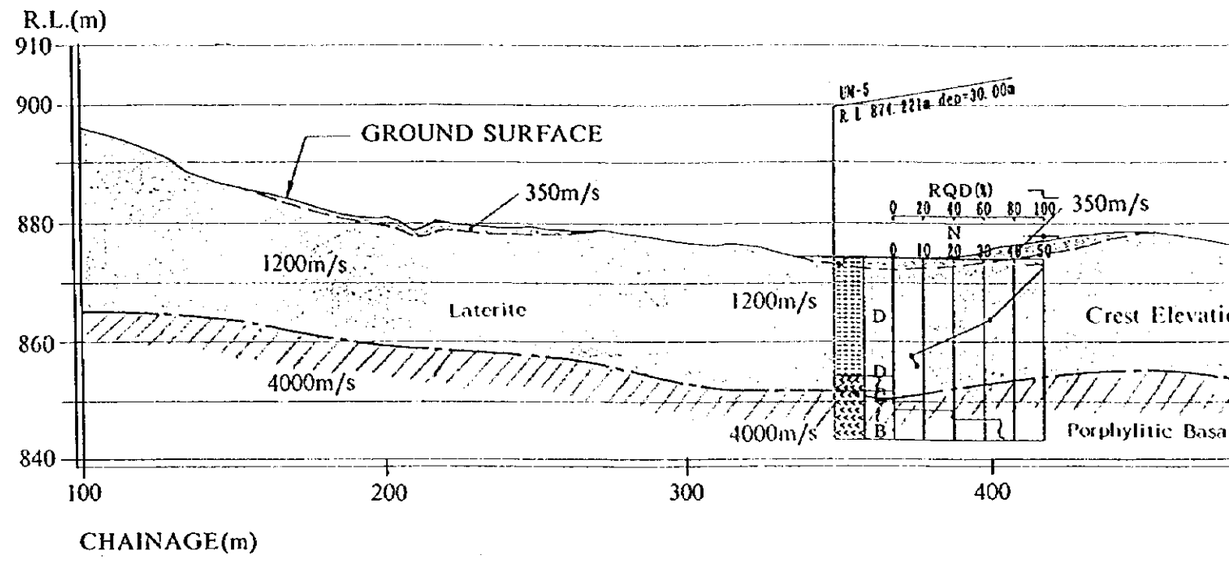


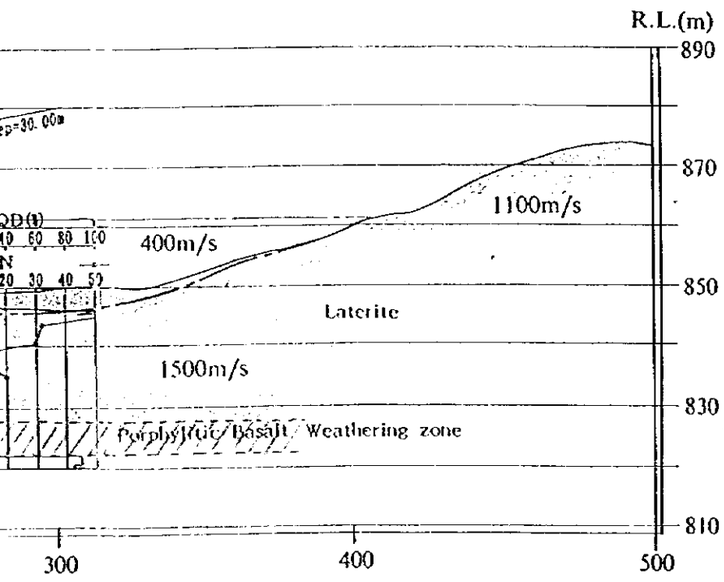
400m/s	SOIL
1100-1500m/s	LATERITE



Legend	
	Talus Deposit or Surface Soil
	Laterite
	Porphylitic Basalt (weathering zone)

350-500m/s	SOIL
700-1200m/s	LATERITE
4600m/s	BASALT

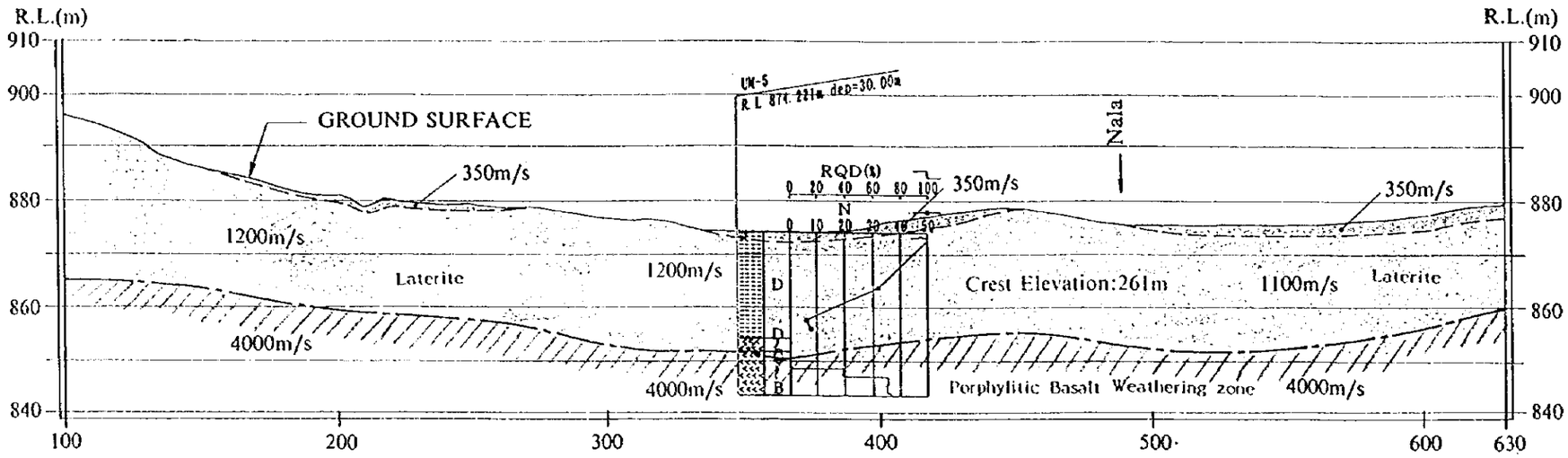




400m/s	SOIL
1100-1500m/s	LATERITE

Fig. 10.1-15 Geological Cross Section of Marleshwar Saddle Dam

MARLESHWAR UPPER SITE SADDLE DAM-II



350m/s	SOIL
1100~1200m/s	LATERITE
4000m/s	BASALT

Fig. 10.1-15 Geological Cross Section of Marleshwar Saddle Dam

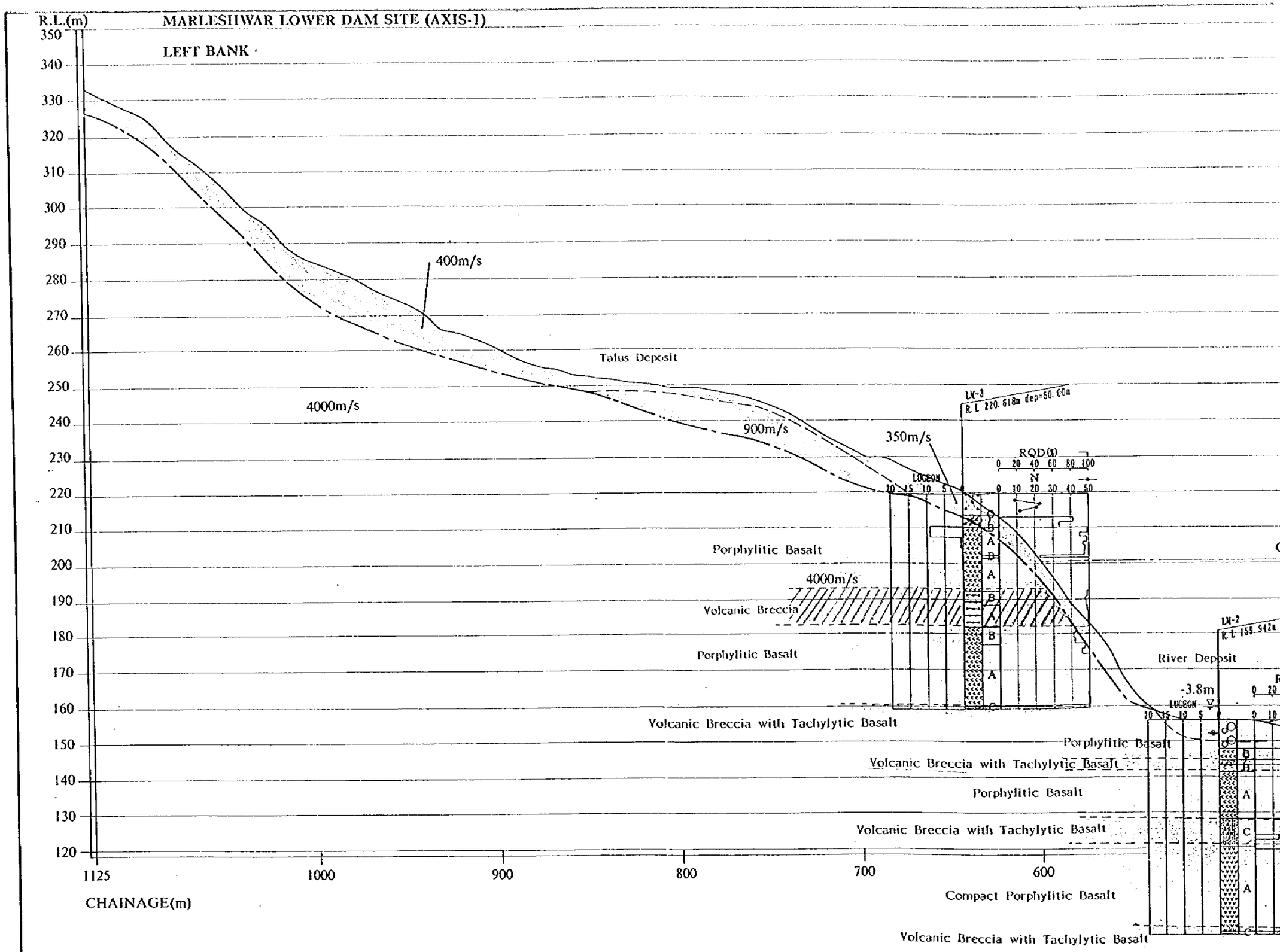


Fig. 10.1-16 Geological Cross Section

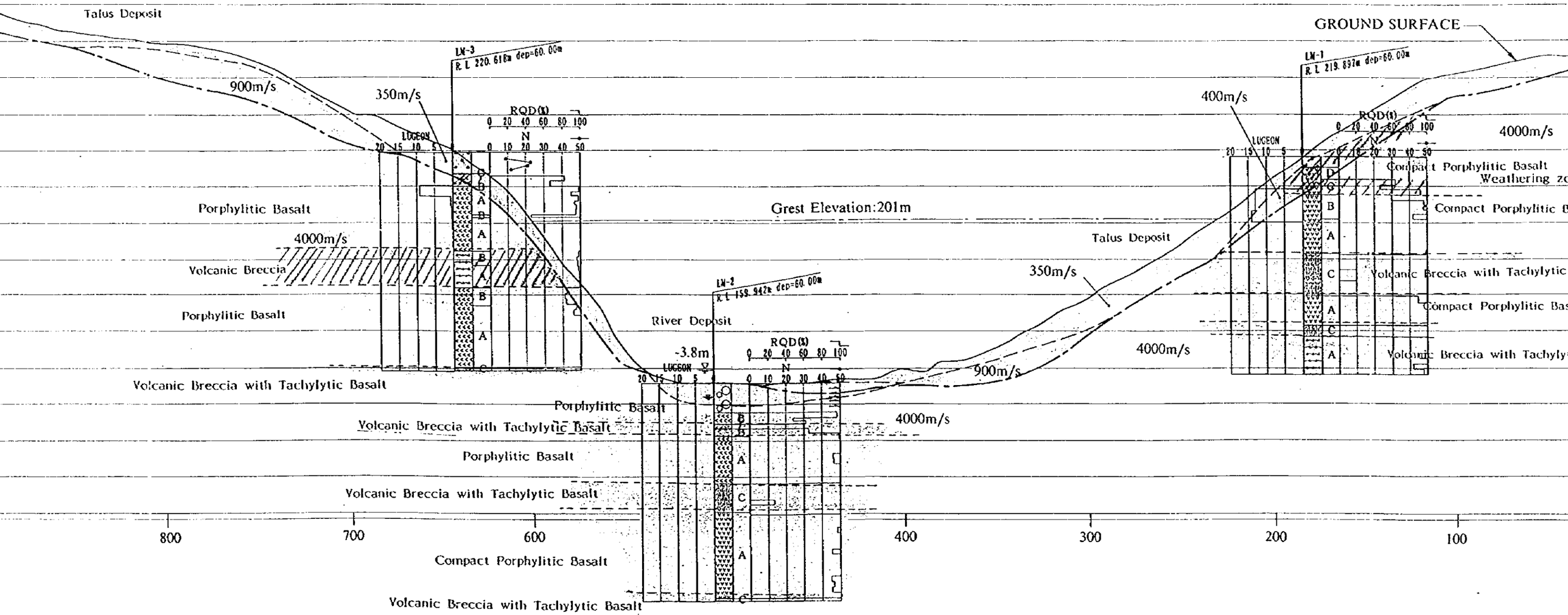
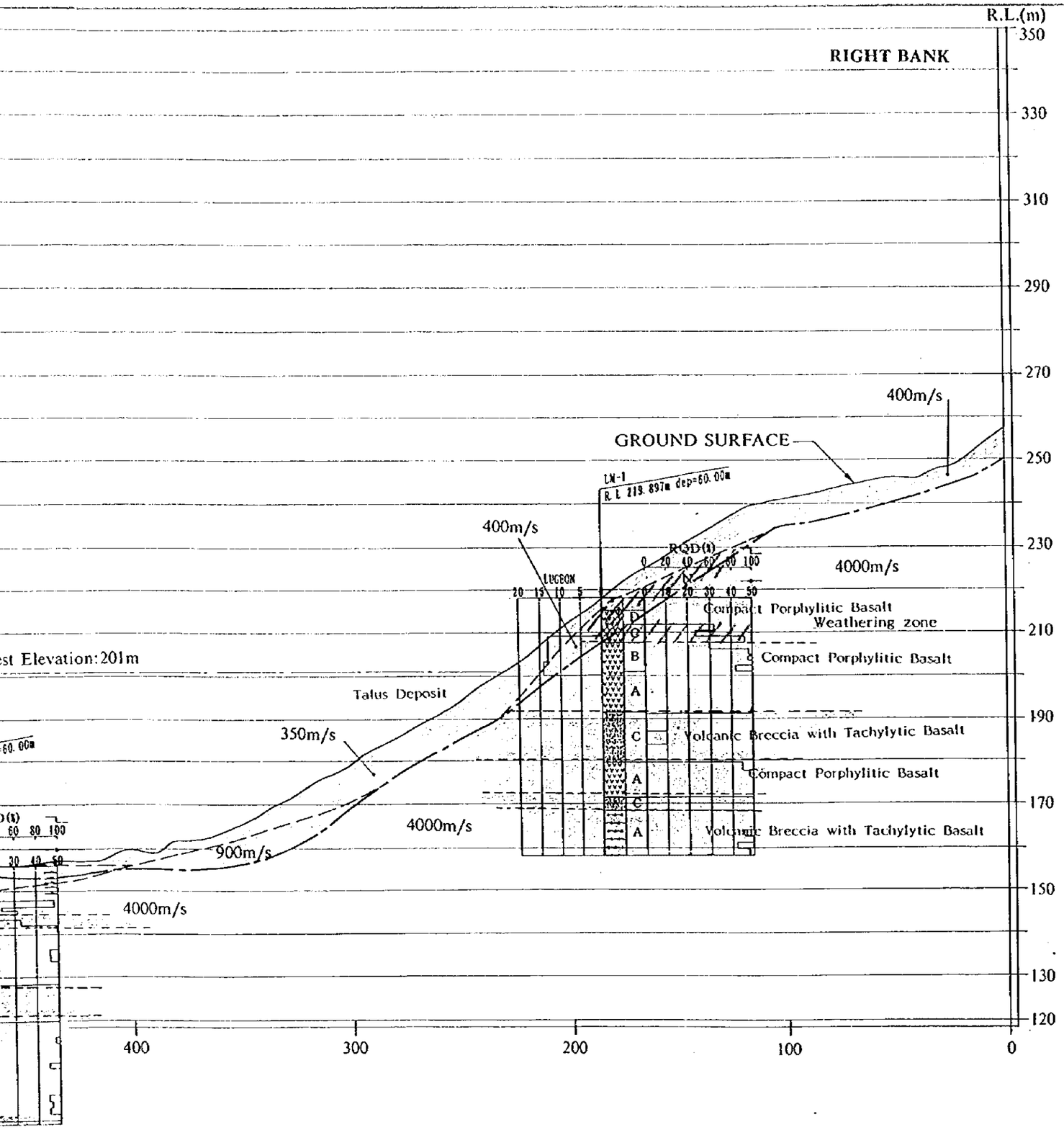


Fig. 10.1-16 Geological Cross Section of Marleshwar Lower Reservoir (Axis.-I)



Legend

	River Deposit
	Talus Deposit
	Porphylitic Basalt
	Compact Porphylitic Basalt
	Volcanic Breccia with Tachylytic Basalt
	Volcanic Breccia

350-400m/s	SOIL
900m/s	PEBBLES & BOULDERS/ WEATHERED ROCK
4000m/s	BASALT

f Marleshwar Lower Reservoir (Axis.-I)

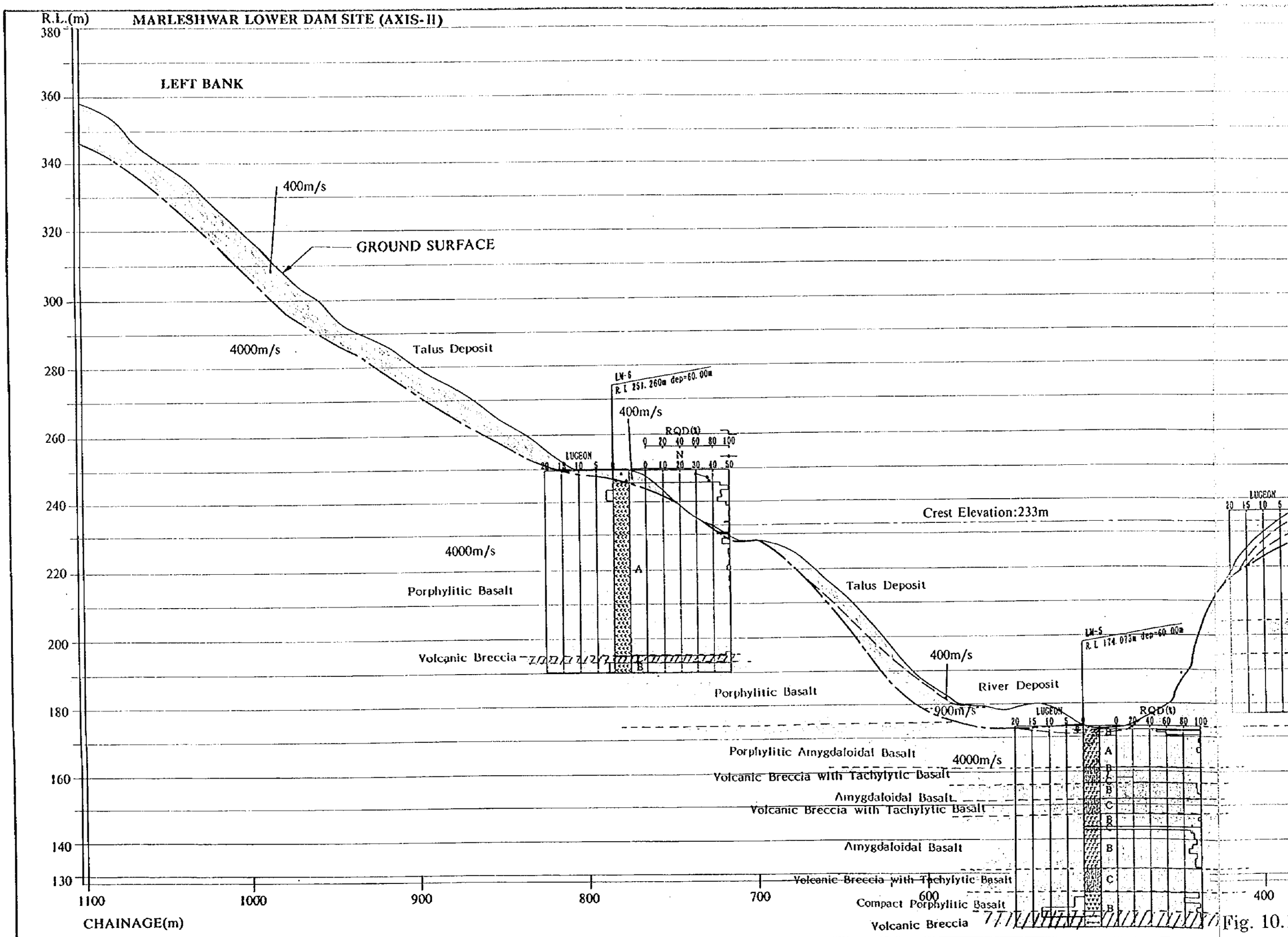

MARLESHWAR LOWER DAM SITE (AXIS-II)
R.L.(m)
380
360
340
320
300
280
260
240
220
200
180
160
140
130
LEFT BANK
400m/s
GROUND SURFACE
4000m/s
Talus Deposit
LM-6
R.L 251.260m dep=60.00m
400m/s
RQD(%)
0 20 40 60 80 100
LUGEON
N
20 15 10 5
0 10 20 30 40 50
Crest Elevation:233m
4000m/s
Porphylitic Basalt
Volcanic Breccia
A
B
Talus Deposit
LM-5
R.L 174.075m dep=60.00m
400m/s
River Deposit
Porphylitic Basalt
900m/s
Porphylitic Amygdaloidal Basalt
4000m/s
Volcanic Breccia with Tachylytic Basalt
Amygdaloidal Basalt
Volcanic Breccia with Tachylytic Basalt
Amygdaloidal Basalt
Volcanic Breccia with Tachylytic Basalt
Compact Porphylitic Basalt
Volcanic Breccia
1100
1000
900
800
700
600
400
CHAINAGE(m)

Fig. 10.

RIGHT BANK

CE

osit

m/s

Basalt

Breccia

LN-6
R.L 251.260m dep=60.00m
400m/s
RQD(%)
0 20 40 60 80 100
N
0 10 20 30 40 50
LUGEON
20 15 10 5 0
A
B

Talus Deposit

Crest Elevation:233m

Porphylitic Basalt

LN-5
R.L 174.073m dep=60.00m
400m/s
River Deposit
900m/s
LUGEON
RQD(%)
20 15 10 5 0
0 20 40 60 80 100
B
A
C
B
C
B
C
B

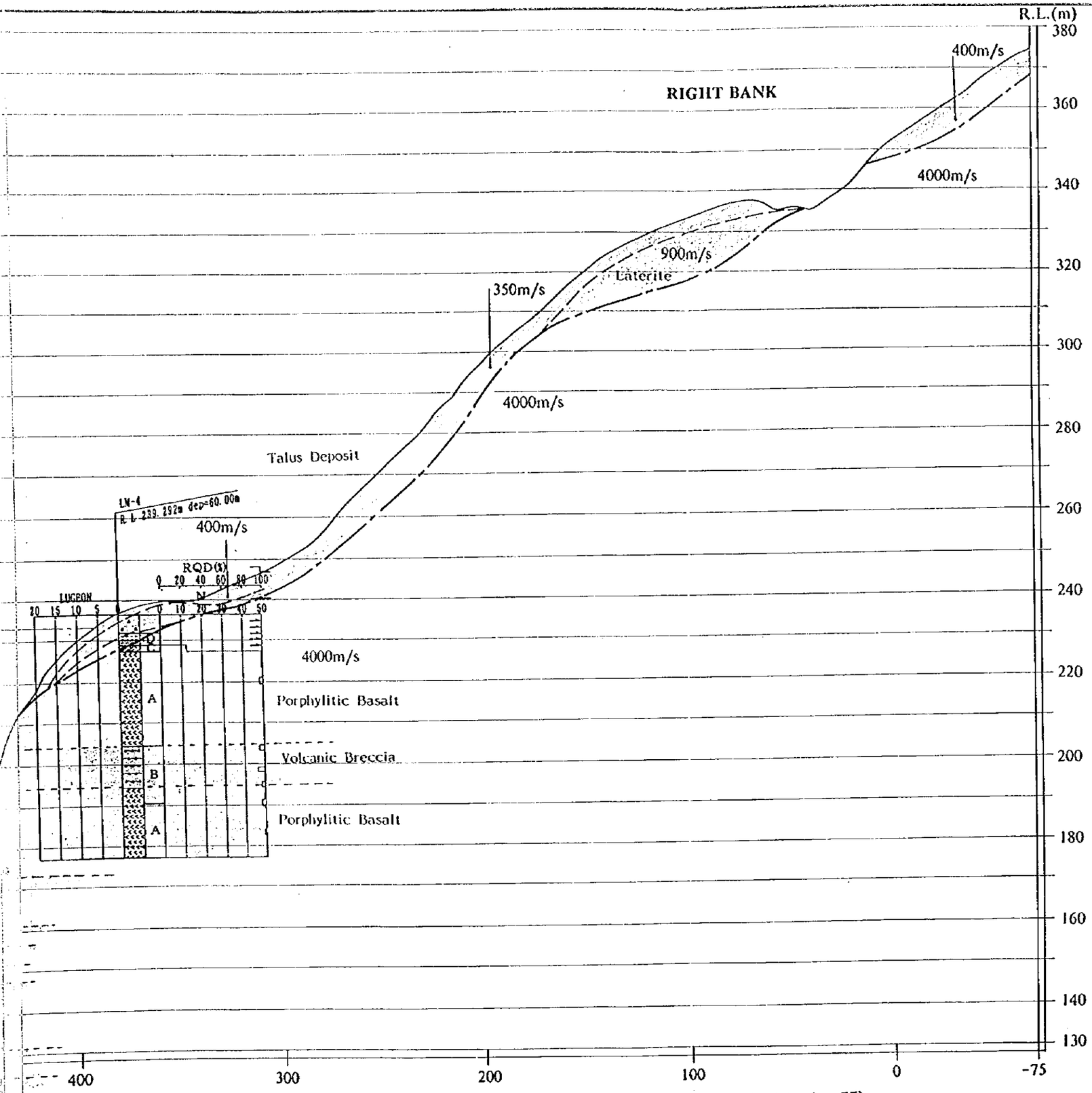
Porphylitic Amygdaloidal Basalt
4000m/s
Volcanic Breccia with Tachylytic Basalt
Amygdaloidal Basalt
Volcanic Breccia with Tachylytic Basalt
Amygdaloidal Basalt
Volcanic Breccia with Tachylytic Basalt
Compact Porphylitic Basalt
Volcanic Breccia

LN-4
R.L 239.292m dep=60.00m
400m/s
RQD(%)
0 20 40 60 80 100
N
0 10 20 30 40 50
LUGEON
20 15 10 5 0
D
A
B
A

Talus Deposit
900m/s
Laterite
350m/s
4000m/s
4000m/s
Porphylitic Basalt
Volcanic Breccia
Porphylitic Basalt

800 700 600 400 300 200 100

Fig. 10.1-17 Geological Cross Section of Marleshwar Lower Reservoir (Axis.-II)



Legend

	River Deposit
	Talus Deposit
	Laterite
	Porphylitic Basalt
	Volcanic Breccia
	Volcanic Breccia with Tachylytic Basalt
	Porphylitic Amygdalodial Basalt
	Amygdalodial Basalt
	Compact Porphylitic Basalt

350-400m/s	SOIL
900m/s	PEBBLES & BOULDERS/ WEATHERED ROCK
4000m/s	BASALT

Fig. 10.1-17 Geological Cross Section of Marleshwar Lower Reservoir (Axis.-II)

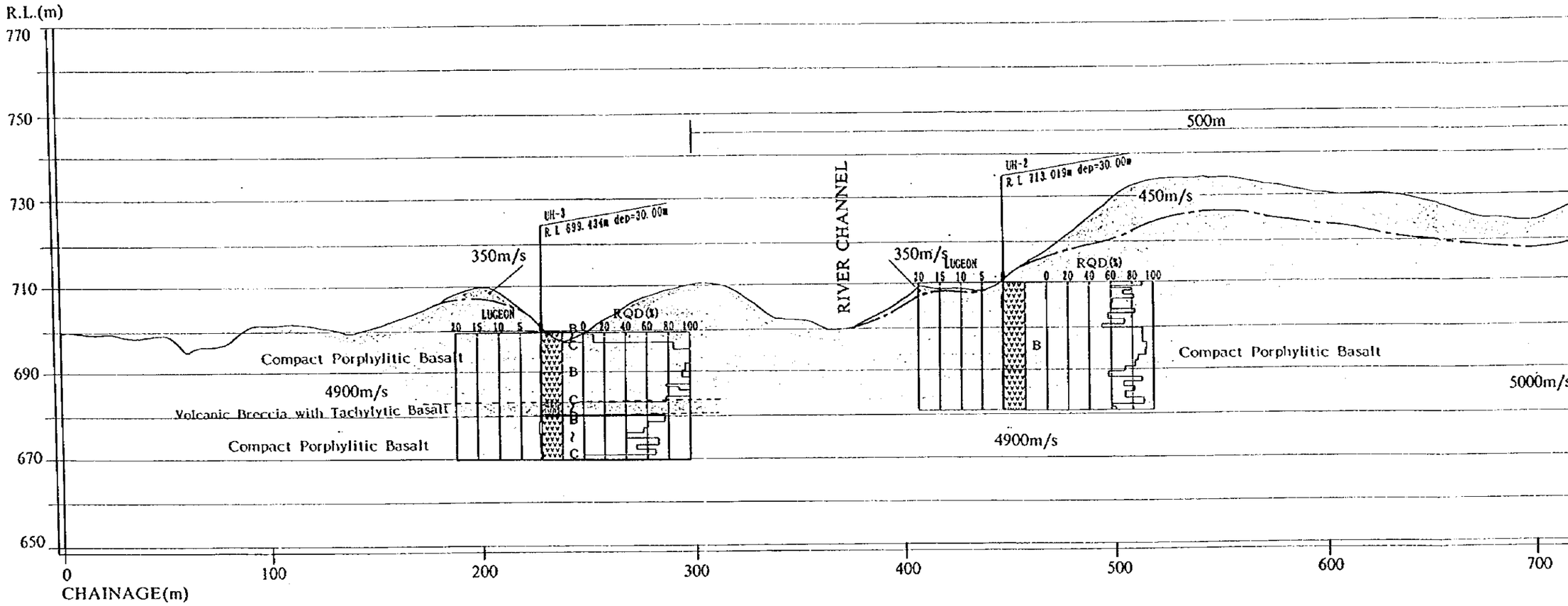
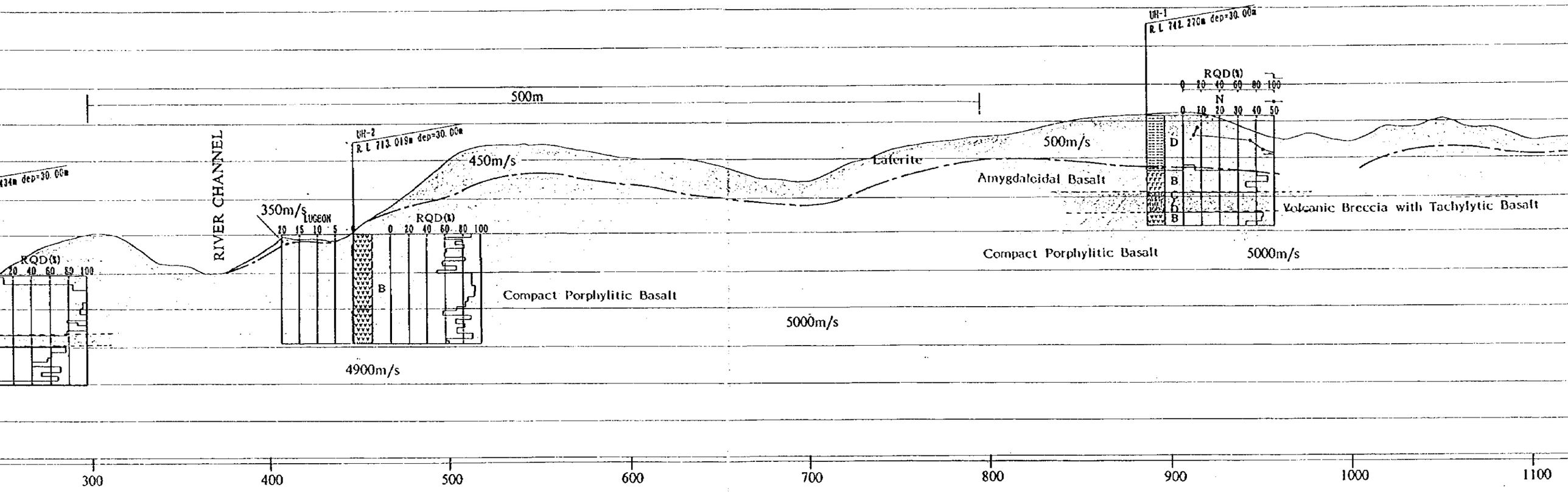
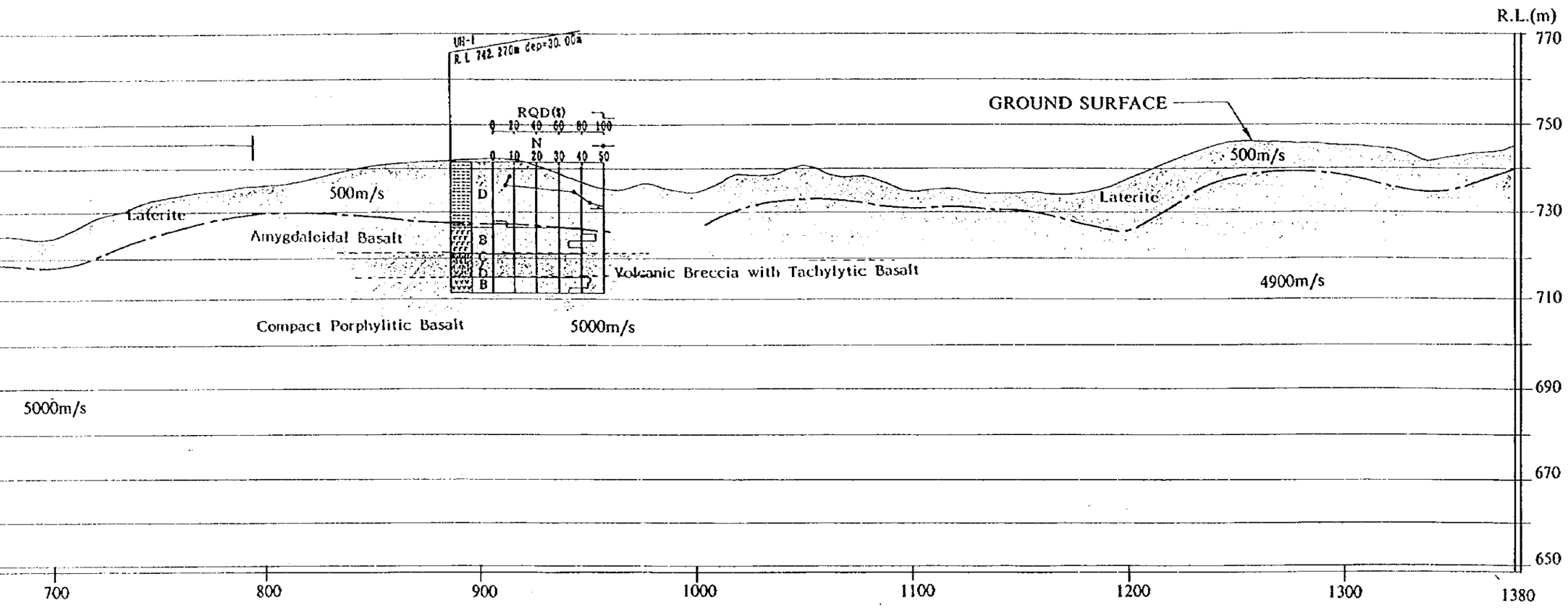


Fig. 10.1-18 Geological Cross Section of Hevale Upper Rese



350-500m/s	LATERITIC SOIL WITH PEBI
4900-5000m/s	BASALT.

Fig. 10.1-18 Geological Cross Section of Hevale Upper Reservoir



350-500m/s	LATERITIC SOIL WITH PEBBLES.
4900-5000m/s	BASALT.

Legend

	Talus Deposit
	Laterite
	Amygdaloidal Basalt
	Volcanic Breccia with Tachylytic Basalt
	Compact Porphylitic Basalt

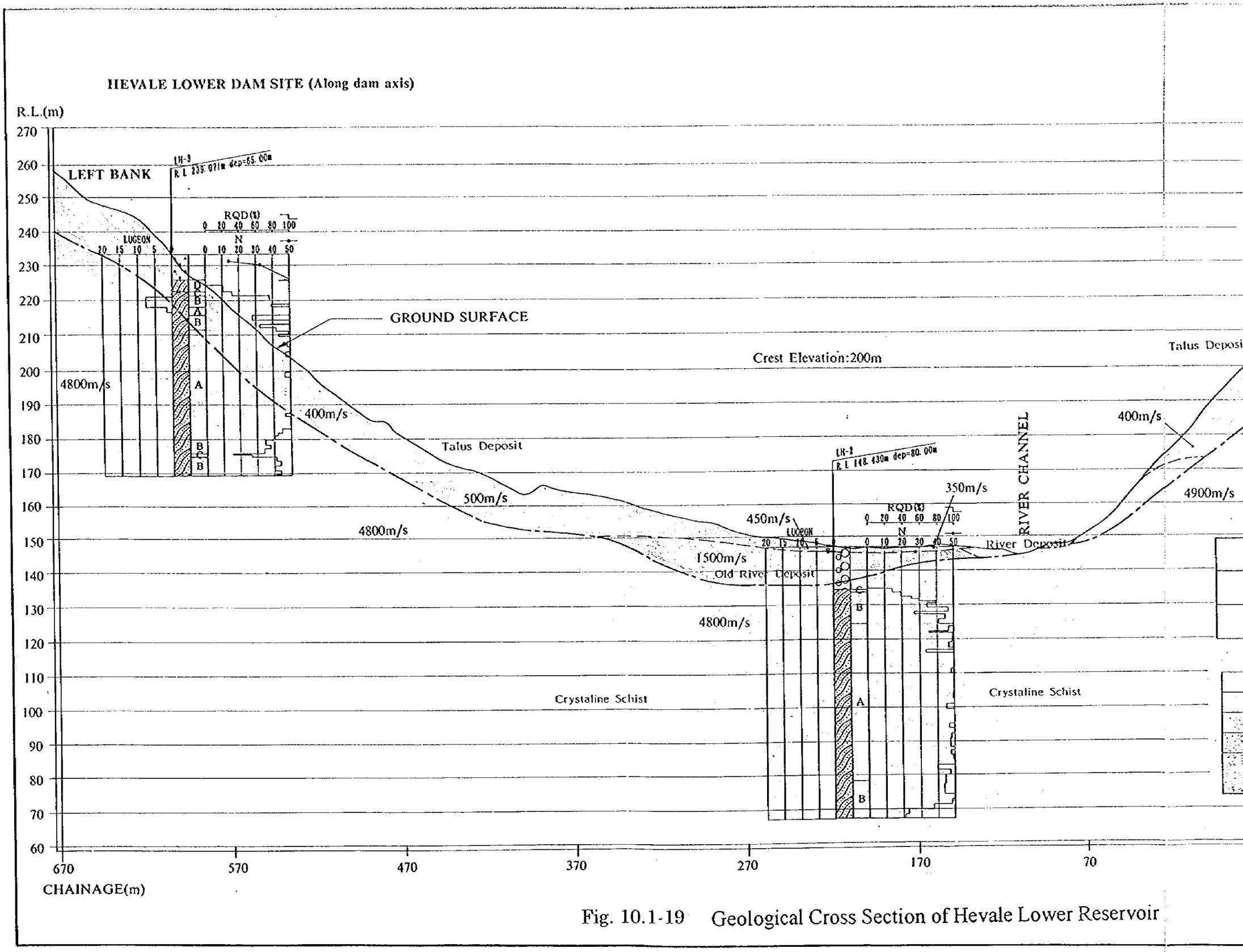
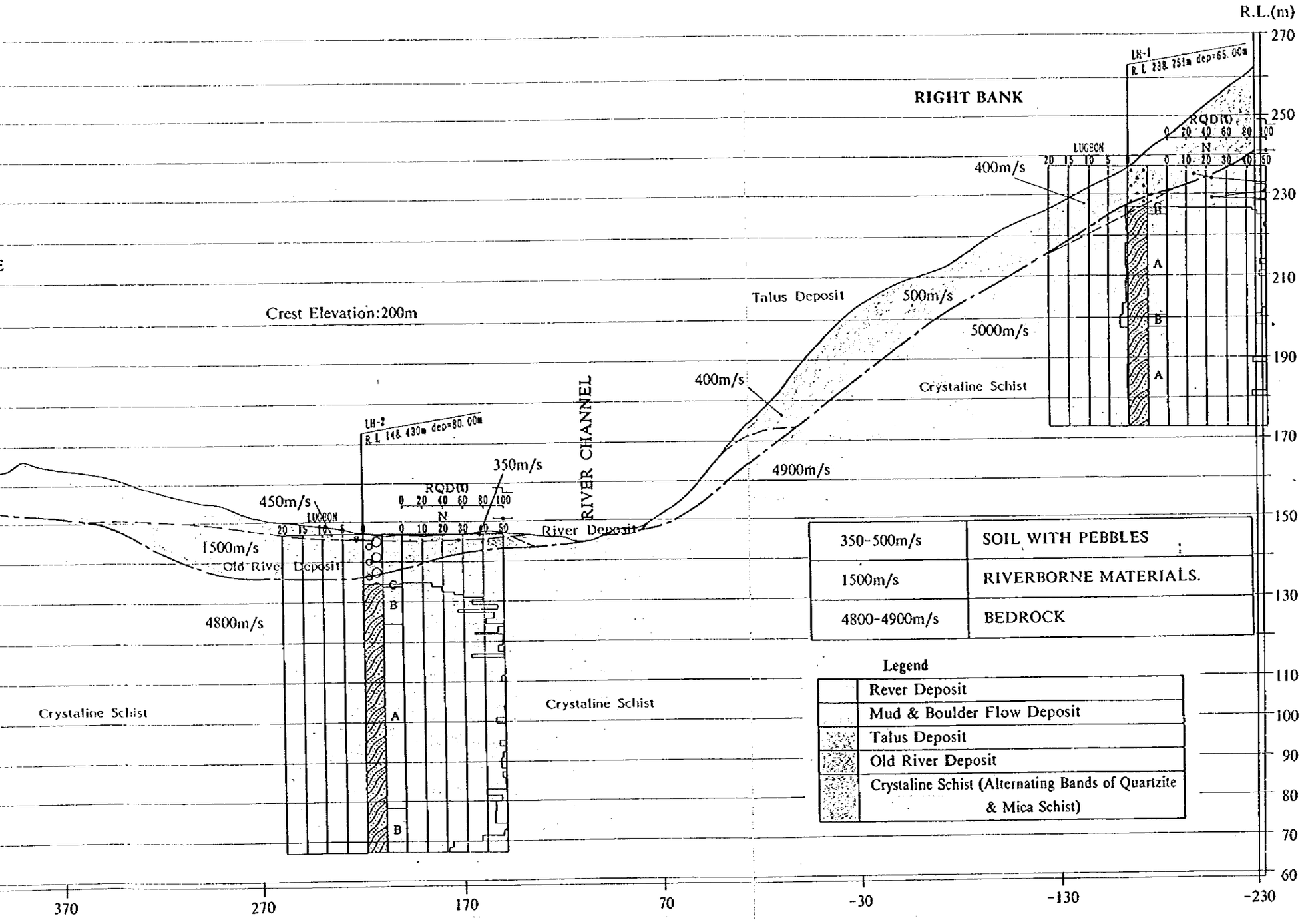


Fig. 10.1-19 Geological Cross Section of Hevale Lower Reservoir



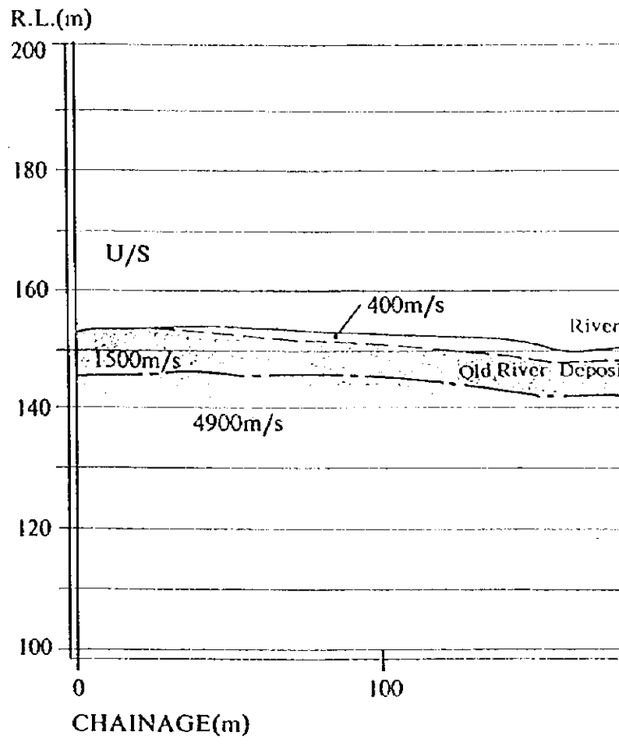
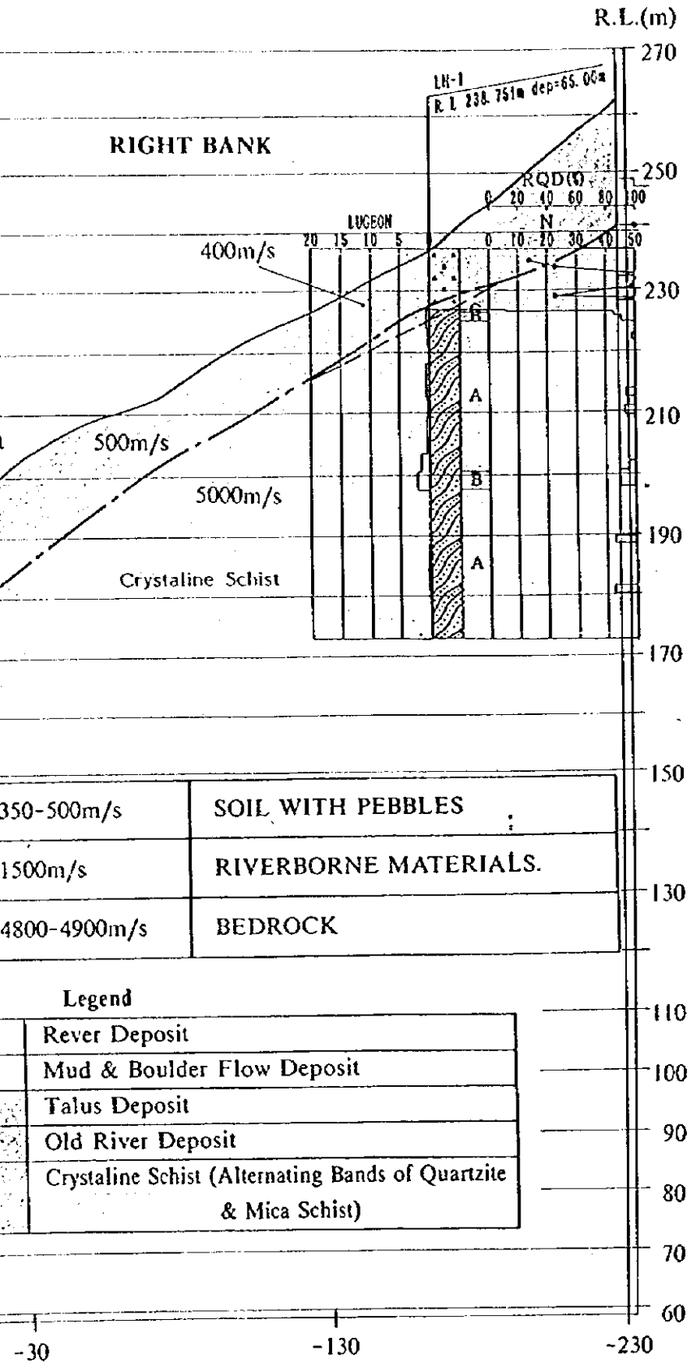


Fig. 10.1-19 Geological Cross Section of Hevale Lower Reservoir

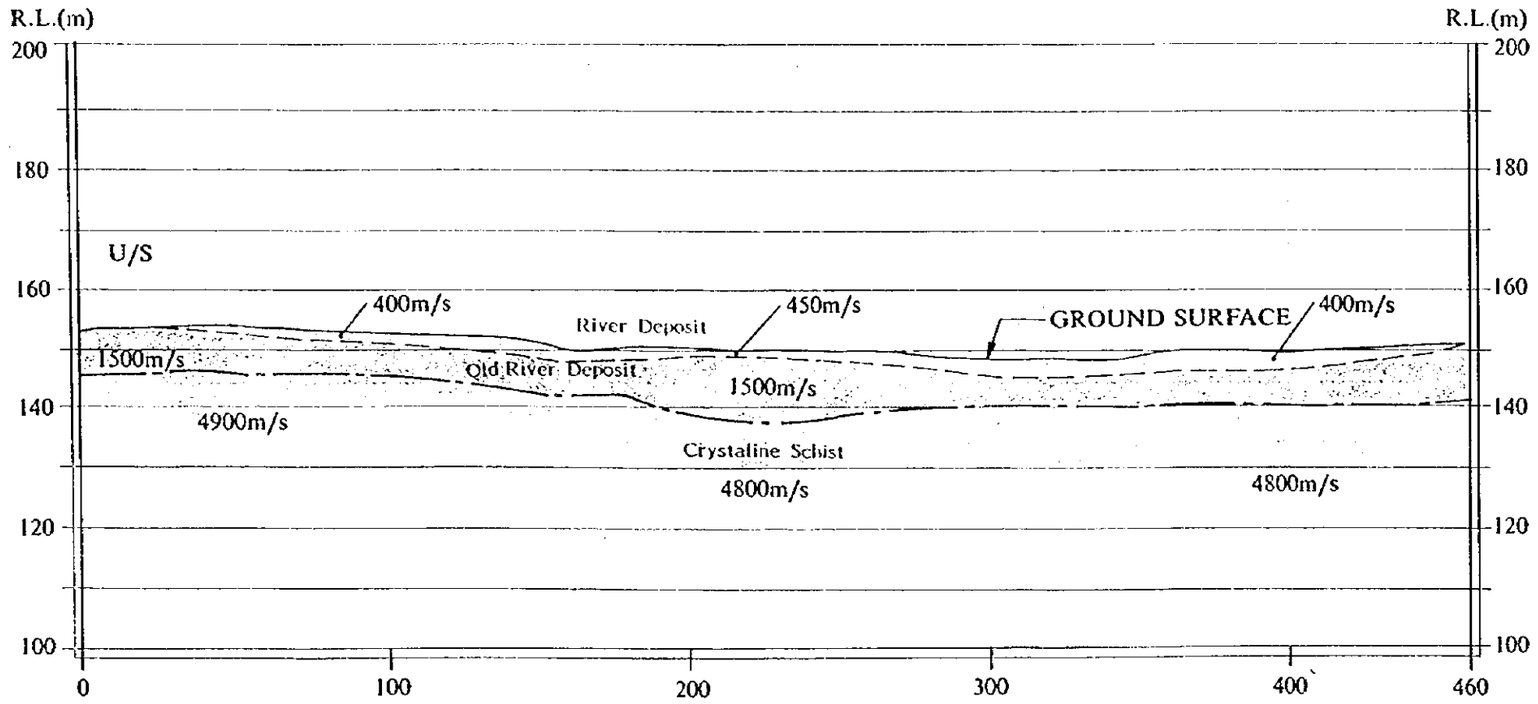


350-500m/s	SOIL WITH PEBBLES
1500m/s	RIVERBORNE MATERIALS.
4800-4900m/s	BEDROCK

Legend

	Rever Deposit
	Mud & Boulder Flow Deposit
	Talus Deposit
	Old River Deposit
	Crystaline Schist (Alternating Bands of Quartzite & Mica Schist)

HEVALE LOWER DAM SITE (Across dam axis)



350-500m/s	SOIL WITH PEBBLES
1500m/s	RIVERBORNE MATERIALS.
4800-4900m/s	BEDROCK