

**THE KINGDOM OF THAILAND  
NATIONAL ENERGY ADMINISTRATION  
MINISTRY OF SCIENCE, TECHNOLOGY AND ENERGY**

**NAM MAE YUAM HYDROELECTRIC  
DEVELOPMENT PROJECT  
FEASIBILITY REPORT**

**VOLUME II**

**(Appendix 1, 2, 3, 4, 5)**

**MARCH, 1984**

**JAPAN INTERNATIONAL COOPERATION AGENCY**



122  
643  
MPN

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**VOLUME II**

(Appendix 1, 2, 3, 4, 5)

MARCH, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

国際協力事業団	
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## A 1 GEOLOGY





Micrograph and Petrographic Description of Rock

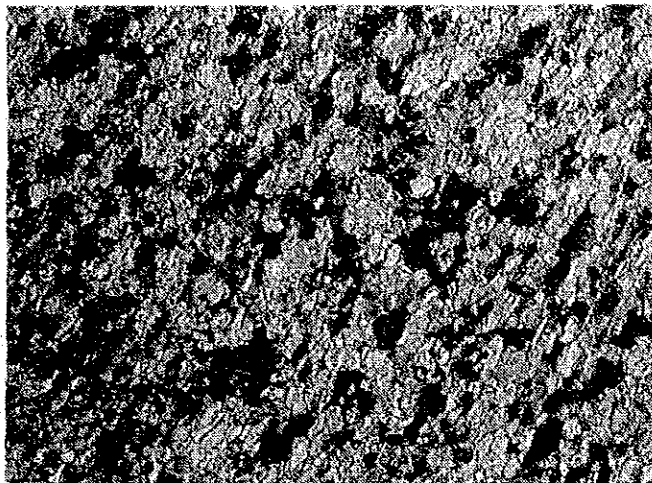
(Plate 1 of 5)

Locality: 5

600 m upstream of A dam axis,  
right bank of Yuam River.

Rock name:

Limestone (massive)



Petrographic description:

0 0.3mm (crossed nicols)

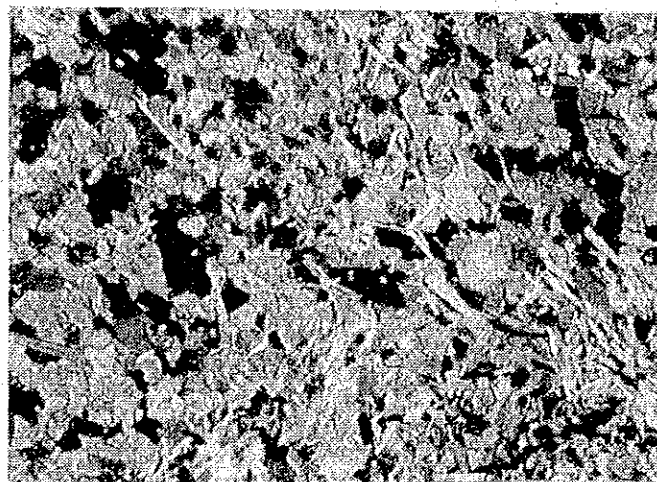
Chief consisting minerals are calcite >> muscovite, quartz and  
chlorite. Dolomite and potassium feldspar are trace in amount.

Locality: 9

200 m upstream of A dam axis,  
right bank of Yuam River.  
(EL. 150 m)

Rock name:

Limestone (laminated)



Petrographic description:

0 0.2mm (crossed nicols)

Chief consisting minerals are calcite > white mica, quartz.  
Banding texture consisting of calcite-rich and mica-rich layers is  
observed.

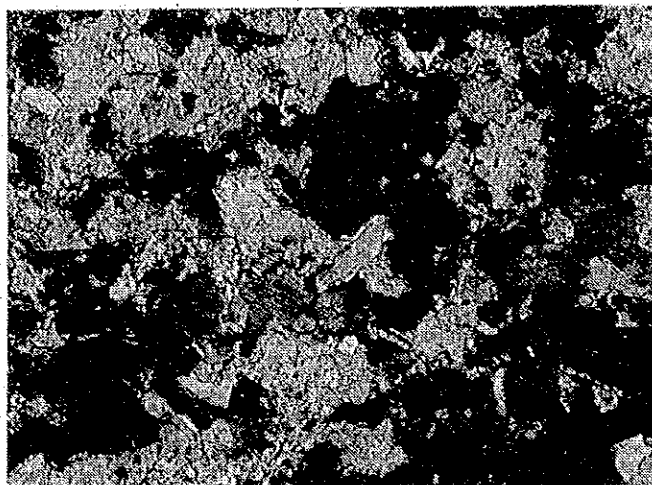
Micrograph and Petrographic Description of Rock  
(Plate 2 of 5)

Locality: 13

1 km downstream of A dam axis,  
left bank of Yuam River.

Rock name:

Sandy limestone



Petrographic description:

0 0.2 mm

(crossed nicols)

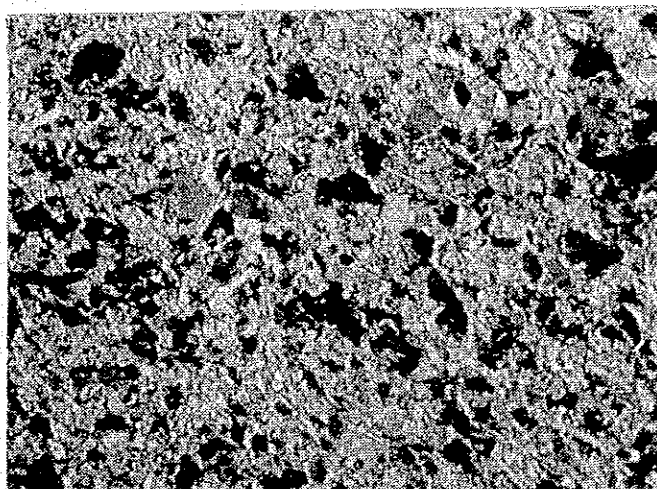
Chief consisting minerals are calcite, dolomite, quartz and  
muscovite.

Locality: 16

Tributary of Huai Uya Kra  
(EL. 460 m)

Rock name:

Siliceous limestone  
(or calcareous sandstone)



Petrographic description:

0 0.3 mm

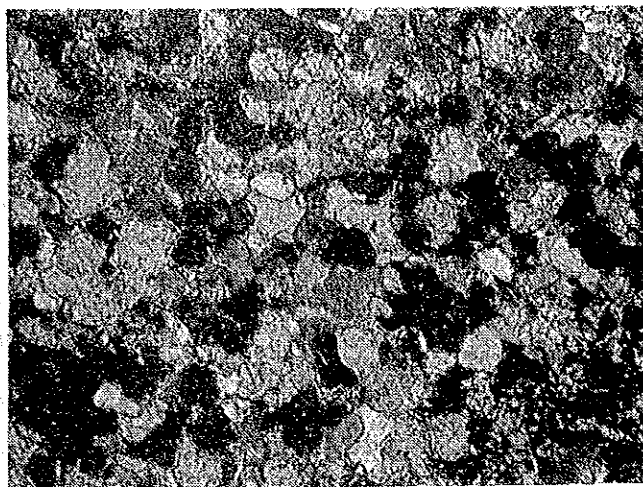
(crossed nicols)

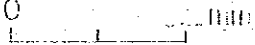
Chief consisting minerals are calcite, quartz and white mica.  
Clay minerals are trace in amount, less than 0.1%.

Micrograph and Petrographic Description of Rock  
(Plate 3 of 5)

Locality: 18  
Huai Uya Kra

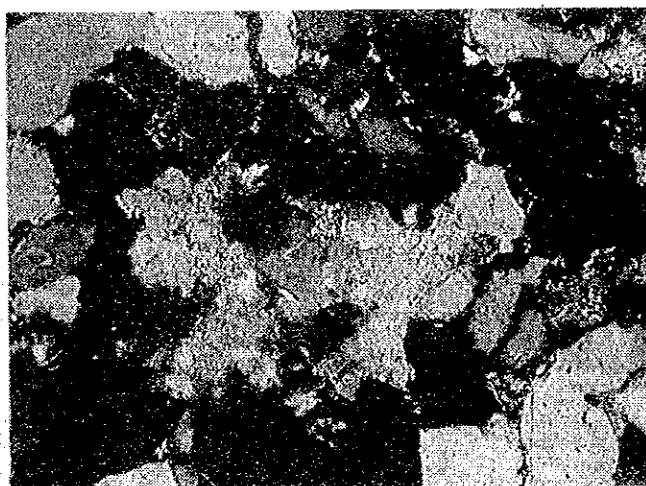
Rock name:  
Calcareous sandstone

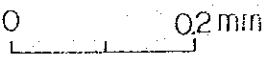


Petrographic description:  0.1 mm (crossed nicols)  
Chief consisting minerals are dolomite, calcite, quartz.  
Accessory minerals are muscovite and pyrite.

Locality: 20  
Huai Mae Lamu

Rock name:  
Sandstone

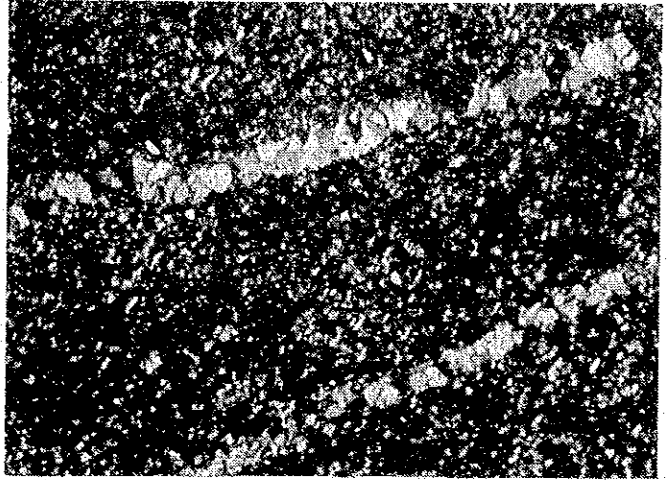



Petrographic description:  0.2 mm (crossed nicols)  
Chief consisting minerals are quartz, dolomite and plagioclase.  
A trace amount of montmorillonite is found.

Micrograph and Petrographic Description of Rock  
(Plate 4 of 5)

Locality: 19  
Right bank of A dam axis

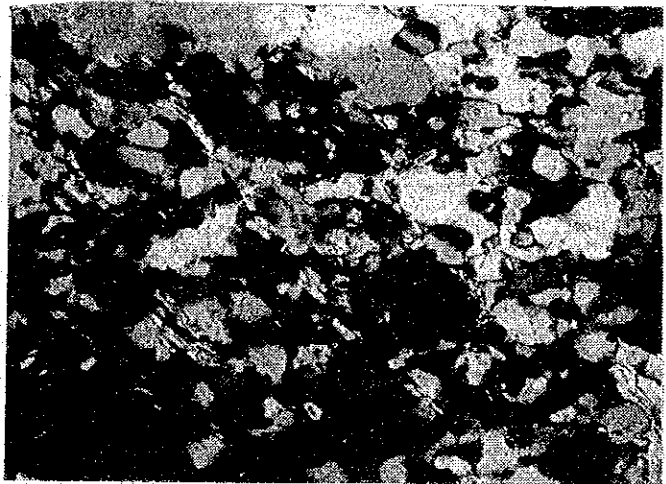
Rock name:  
Shale

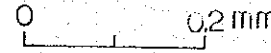


Petrographic description:  0.3mm (crossed nicols)  
Chief consisting minerals are quartz, white mica, graphite and plagioclase. Quartz veins are common.

Locality:  
Huai la cho Kra  
(about 5 km upstream of  
Damsite A)

Rock name:  
Quartzose sandstone



Petrographic description:  0.2mm (crossed nicols)  
Chief consisting minerals are quartz, potassium feldspar and muscovite. A trace amount of tourmaline, zircon and apatite is found.

Micrograph and Petrographic Description of Rock  
(Plate 5 of 5)

Locality:

Damsite C (about 12 km upstream  
of Damsite A)



Rock name:

Granite

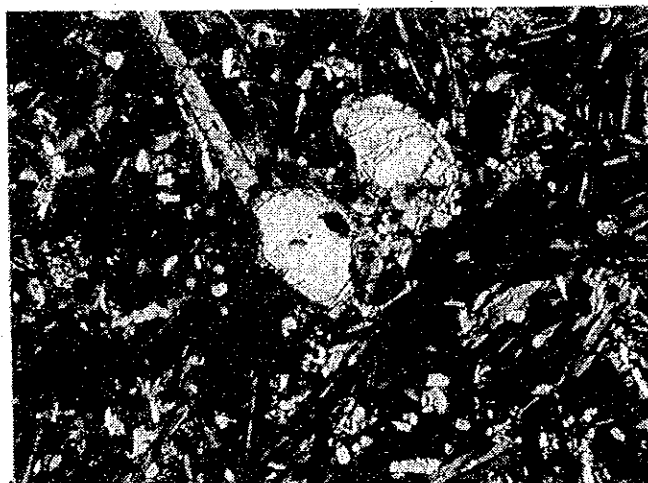
Petrographic description:

0 0.5 mm (crossed nicols)

Chief consisting minerals are quartz, potassium feldspar,  
plagioclase, biotite and muscovite. Mica is partly replaced by  
chlorite and montmorillonite.

Locality:

Ngao river (about 3 km  
upstream of junction of Yuan  
river and Ngao river)



Rock name:

Basalt

Petrographic description:

0 0.5 mm (crossed nicols)

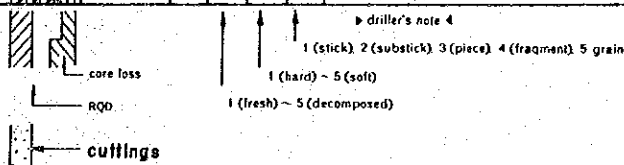
Phenocrysts are of olivine, plagioclase and clinopyroxene.  
Microphenocrysts are of plagioclase, clinopyroxene and magnetite.

# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL - 1 (SHEET 1 OF 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Apr. 13 - 1983  
 ELEVATION 186.6 m DEPTH OF OVERBURDEN 10.0 m COMPLETED Apr. 21 - 1983  
 COORDINATE 1966 286.9N 375 168.2E LENGTH OF ROCK DRILLING 70.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 19.34 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE --- CORE RECOVERY 27.6 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BYE CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE		DEPTH	ELEVATION	
					COLOR	WEATHER- ING	HARD- NESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
0m			0 → 100%								20%	100%	0m	186.6
1		△							Reddish brown, silt ~ clay.				1	
2		△							2.0 Yellowish brown, silt ~ clay.				2	
3		△							3.0 Light brownish yellow, very fine grained sand ~ silt.				3	
4		△							Light brownish yellow, very fine grained sand ~ silt.				4	
5		△											5	
6		△							6.0 Yellowish brown ~ brown, fine grained sand ~ silt.				6	
7		△											7	
8		△											8	
9		△							9.0 Dark brown, medium grained sand				9	
10									10.0 Black ~ dark brownish black, sandy cuttings.(?)				10	
1	Weathered Black shale (?)												1	
2													2	
3													3	
4									13.5 Non-calcareous black shale. Weathered along cracks.				4	
5													5	
6									Generally hard shale, weathered along cracks in part.				6	
7													7	
8									Slightly cracky broken along bedding planes.				8	
9													9	
20													20	166.6



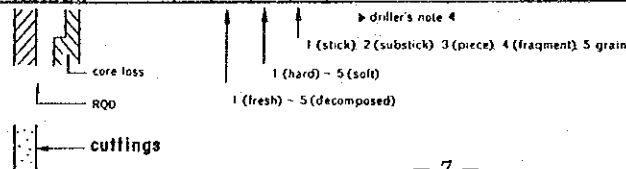
# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT

HOLE No. DL-1 (SHEET 2 OF 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Apr. - 13 - 1983  
 ELEVATION 186.6 m DEPTH OF OVERBURDEN 10.0 m COMPLETED Apr. - 21 - 1983  
 COORDINATE 1966 2869N 375 168.2E LENGTH OF ROCK DRILLING 70.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 19.34 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE --- CORE RECOVERY 27.6 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN		
20m			0 - 100 %									20m	166.6	
1	Black shale	60°			Black	2	2	2	Partially opened along calcite veins due to solution.				1	
2						3	2	3					2	
3						3	3	3-4	22.1				3	
4	Shale	60°			Dark grey	2	3	3-4	Generally weathered color (dark brown ~ reddish brown) along cracks and some of bedding planes.				4	
5						3	3	3					5	
6						3	3	3	Partially gravelly cores. Small solution cavities along calcite veins.				6	
7						3	3	4					7	
8						2	3	3					8	
9		55°				3	3	4	28.0				9	
30	(Black shale)				(Black)	2	2	3	29.15 - 70.0m				30	
1									Obtained only cuttings. All cuttings are black and non-calcareous.				1	
2													2	
3													3	
4													4	
5													5	
6													6	
7													7	
8													8	
9													9	
40												40	146.6	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-1 (SHEET- 3 of 4 )  
 LOCATION Dam left bank DEPTH OF HOLE 800 m COMMENCED Apr - 13 - 1983  
 ELEVATION 186.6 m DEPTH OF OVERBURDEN 10.0 m COMPLETED Apr - 21 - 1983  
 COORDINATE 1966 286.9N 375 168.2E LENGTH OF ROCK DRILLING 70.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 19.34 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE --- CORE RECOVERY 27.6 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION					
40m			0 → 100 %											146.6 m
1									29.15m - 70.0m					
2									Obtained only cuttings.					
3									All cuttings are black					
4									and non-calcareous.					
5														
6														
7														
8														
9														
50														
1	(Black shale)													
2														
3														
4														
5														
6														
7														
8														
9														
60														126.6

(Black shale)

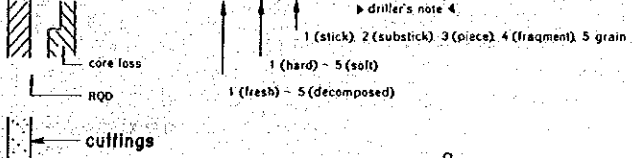
(Black)

$K = 1.10 \times 10^{-4}$

$K = 1.72 \times 10^{-4}$

$K = 1.98 \times 10^{-4}$

$K = 7.23 \times 10^{-4}$



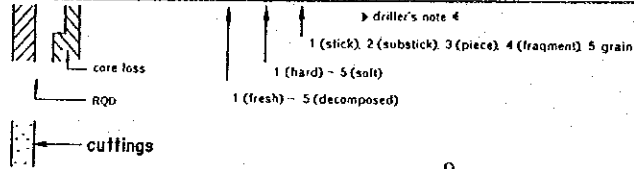


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-1 (SHEET 4 of 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Apr. 13 - 1983  
 ELEVATION 186.6 m DEPTH OF OVERBURDEN 10.0 m COMPLETED Apr. 21 - 1983  
 COORDINATE 1966 286.9N 375 168.2E LENGTH OF ROCK DRILLING 70.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 19.34 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE — CORE RECOVERY 27.6 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
60m			0 → 100%											126.6
1	Black shale (Black shale)				(Black)				29.15 - 70.0 m	K = 7.55 x 10 <sup>-4</sup>				
2									Obtained only cuttings. All cuttings are black and non-calcareous.					
3														
4														
5														
6														
7														
8	Black shale				(Black)				70.0	K = 7.46 x 10 <sup>-4</sup>				
9									Black shale, partially gravelly cores.					
10									71.0					
1	Black shale				(Black)				71.0 - 76.15 m	K = 6.43 x 10 <sup>-4</sup>				
2									Obtained only cuttings. All cuttings are black and non-calcareous.					
3														
4														
5														
6														
7	Black shale				(Black)				77.0 - 79.0 m	Lu = 1.3				
8									Partially gravelly cores generally cores are broken into pices (less than 10 <sup>cm</sup> ). Reconsolidated sheared zone at 78.7 - 79.0 m					
9														
10														

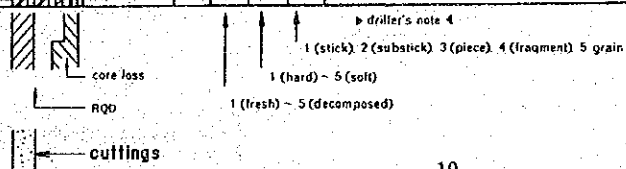


## GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-2 (SHEET 1 OF 3)

LOCATION Dam left bank DEPTH OF HOLE 60.0 m COMMENCED May - 1 - 1983  
 ELEVATION 151.1 m DEPTH OF OVERBURDEN 3.2 m COMPLETED May - 14 - 1983  
 COORDINATE 1966 350.7N 375 194.1E LENGTH OF ROCK DRILLING 56.8 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 53.8 m LOGGED BY M. Shlbata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 94.7 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
0m			0 → 100%							20%	0m	151.1 m
0 - 3.2	Overburden	△							Topsoil and talus deposits. (Some gravel and soil)			
3.2 - 5.8					Brown	4	3	4	Weathered black shale, mostly flaky and brittle cores.			
5.8 - 12.7					Brownish grey	3	3	3	Weathered along cracks and some of bedding planes, but most of cores are 15~20 <sup>cm</sup> long.			
12.7 - 13.0						3	3	3	Clay seam at 12.7 m Cracky and weathered at 12.3 m - 13.0 m			
13.0 - 13.5						3	3	3	13.5			
13.5 - 15.0					Black, partially pale grey thin bands.	2	2	2	Generally fresh, partially weathered along cracks.			
15.0 - 17.0						2	2	2	Some small solution cavities along bedding planes (calcite veins along bedding planes)			
17.0 - 20.0						(3)	(3)	(3)				



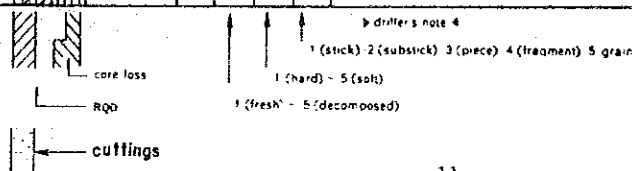
# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT

HOLE No. DL-2 (SHEET 2 of 3)

LOCATION Dam left bank DEPTH OF HOLE 60.0 m COMMENCED May - 1 - 1983  
 ELEVATION 151.1 m DEPTH OF OVERBURDEN 3.2 m COMPLETED May - 14 - 1983  
 COORDINATE 966 360.7N 375 194.1E LENGTH OF ROCK DRILLING 56.8 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 53.8 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 94.7%

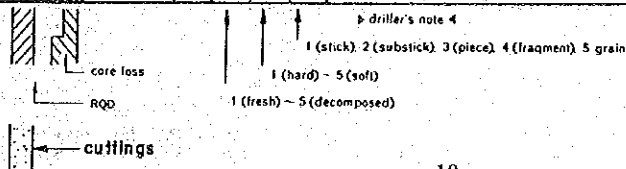
DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING						
20m			0 - 100%										20m	131.1 m
1		35°					3		Generally cracky and somewhat brittle.				1	
2		20°			3	3	(4)		Partially black shale changes into pale gray due to weathering.			2		
3													3	
4		0°			(4)	(4)	4						4	
5		30°						25.2					5	
6					3	3	3		Partially pale gray stripes in black shale.			6		
7		35°			(2)	(2)	2	27.7					7	
8					3	3	3		Some longitudinal cracks sustained by oxidation and solution. (with small cavities)			8		
9					3	3	3						9	
30							(4)	31.0					30	
1		35°			3	2			Generally somewhat cracky. All planes of cracks are sustained by oxidation.			1		
2													2	
3					2	3						3		
4		15°			3	4			Partially weathered (reddish brown) cracks.			4		
5					3	3							5	
6		65°			3	1			Black clayey material at 36.1m (dip=65°)			6		
7		35°			2	2							7	
8					3				Partially small solution cavities along calcite veins.			8		
9		35°			(2)								9	
40												40	111.1	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuan PROJECT HOLE No. DL-2 (SHEET 3 of 3 )  
 LOCATION Dam left bank DEPTH OF HOLE 60.0 m COMMENCED May - 1 - 1983  
 ELEVATION 151.1 m DEPTH OF OVERBURDEN 3.2 m COMPLETED May - 14 - 1983  
 COORDINATE 1966 3507N 375 194.1E LENGTH OF ROCK DRILLING 56.8 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 53.8 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 94.7 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING					
40m			0 → 100%										151.1
1		35°			3	3	3		Less weathering along cracks or bedding planes below 40.7 m			1	
2					3	3	3					2	
3					2	(2)	(2)		Partially cross joints with calcite veins.			3	
4					2							4	
5		30°			3	3-4	3-4		Slightly sheared			5	
6					3	3	3		Partially gravelly cores, but less weathering.			6	
7					2	(2)	(2)					7	
8		35°			(3)	3	4					8	
9					3	3	3		Quartz veins at 48.5m, 48.8m. Slightly disturbed around quartz veins.			9	
50					2	(2)	(2)					50	
1	Black shale	10°										1	
2						3	3		Partially gravelly cores, but less weathering. (Rocks may be not loosened)			2	
3					3	3	3					3	
4						4	4					4	
5		35°			3	2	2		Rather clear pale grey thin bands at 55.0m, 56.0m			5	
6					3	2	3					6	
7		35°			3	3	3					7	
8					3	3	4					8	
9	(Black shale?)				(Black)				Cuttings. Black shale (?) Non calcareous.			9	
60												60	91.1

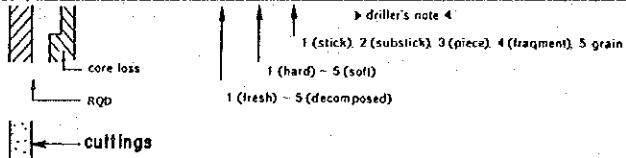


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 1 OF 6)

LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May-18-1983  
 ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun-24-1983  
 COORDINATE 1966 430.9N 375 2293E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 49.2 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH		
0m			0 → 100 %						0.35 Topsoil, dark brown	DRILL WATER RETURN			0m	90.7
1					Brownish grey ~ black	3	3	3	Weathered black shale. Cracky and weathered along cracks.				1	
2								Cuttings				2		
3								Partially solution cavities along calcite veins.				3		
4								4.6				4		
5								Bedding planes not so obvious. Sound shale but weathered along cracks.				5		
6												6		
7												7		
8					Black	3	3	3	Sheared and black soft materials at 8.3 - 8.5m				8	
9												9		
10									Sheared and black soft materials at 10.85 - 10.95m				10	
11												11		
12									11.0 - 20.0m				12	
13									Cuttings				13	
14									Cutting materials are mostly medium or coarse grained rock fragments of black shale.				14	
15									(No reaction with acid)				15	
16					(Black)							16		
17												17		
18												18		
19												19		
20												20	70.7	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 2 OF 6)

LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May - 18 - 1983

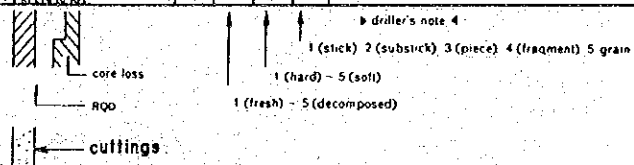
ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun - 24 - 1983

COORDINATE 1966 430.9N 375 229.3E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 49.2%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN		
20m			0 → 100%									20m	70.7	
1					(Black)				20.0 - 22.35m			1		
2									Cuttings			2		
3		10°			Black	2 3	2 3	3 4	22.35			3		
4									Weathered cracks. Somewhat brittle, bedding planes are not so clear.			4		
5		20°			Black	2 3	3	4 3	23.7			5		
6									Cuttings			6		
7					(Black)				Black gravelish cores slightly weathered along cracks.			7		
8									Black cuttings.			8		
9		20°(?)			(Black)	2-3	3	4	Small gravelly cores some cores with weathered colour.			9		
30					(Black)							30		
1	Black shale				Blk.	2 3	3	4 3	With some quartz veins			1		
2									gravelly cores			2		
3					Blk.	2 3	3	4 3	Cuttings of black shale.			3		
4									Minor foldings observable.			4		
5					(Black)				33.7 - 40.0 m			5		
6									Black shale cuttings.			6		
7												7		
8												8		
9												9		
40												40	50.7	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 3 OF 6)

LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May-18-1983

ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun-24-1983

COORDINATE 1966 430.9N 375 229.3E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM

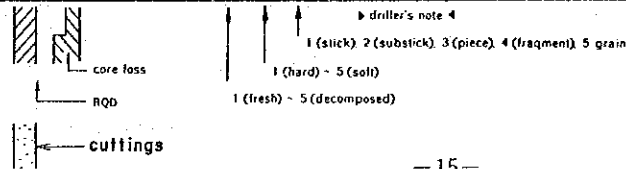
ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 49.2 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE		DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
40m			0 ~ 100 %									40m	50.7	
1												1		
2												2		
3					Black	2	3	4	42.7	Minor folding with thin quartz veins.			3	
4						3	2	3		Partially weathered planes at cracks			4	
5												5		
6										Black shale cuttings from 43.4 to 60.0m			6	
7												7		
8										Cuttings are mostly medium or coarse			8	
9										Grained black-shale particles.			9	
50												50		
1										Very slightly including of whitish quartz grains.			1	
2												2		
3												3		
4												4		
5												5		
6												6		
7												7		
8												8		
9												9		
60												60	30.7	

Black shale

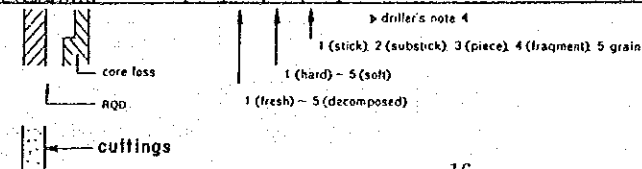
56.9 - 57.0 m  
Several gravelly cores of quartz veins.



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 4 OF 6 )  
 LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May-18-1983  
 ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun-24-1983  
 COORDINATE 1966 4309N 375 229.3E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M.Shibata  
 BEARING OF ANGLE HOLE CORE RECOVERY 49.2 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					DESCRIPTION	WATER TABLE			DEPTH	ELEVATION		
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	WATER PRESSURE TEST		LEAKAGE OF DRILLING WATER	DRILL WATER RETURN					
60m			0 → 100										20%	50%	100%	60m	30.7 m
1					Black (Black)					Cuttings						1	
2					Black (Black)	1	3	4		Black shale, slightly weathered along cracks. Only gravelly cores.						2	
3		Quartz vein			Black (Black)					Cuttings						3	
4					Black and white	2	1	3		Very hard quartz veins and gravelly black shale.						4	
5					Black and white	3	3	4		Cuttings						5	
6					(Black)					Cuttings						6	
7					(Black)					67.5						7	
8						2	3	4		Generally gravelly cores. Minor folding with thin quartz veins.						8	
9						3		3		Cuttings						9	
70						2	3	4		Partially weathered along cracks.						70	
1						3		3		Cuttings						1	
2						2	3	4		Cuttings						2	
3					Black and white	2	3	4		72.8						3	
4						3	2	3		Somewhat long cores are recovered.						4	
5						3	3	4		Cuttings						5	
6						3	1	3		Cuttings Mostly gravelly cores.						6	
7					Whity greenish grey	3	3	3		Calc shale, bedding planes are not so clear. Partially flaky.						7	
8						2	4	4		Sheared at 77.95 ~ 78.3 m						8	
9						2	3	2		Somewhat whitish (whitish means rather calcareous)						9	
80						3	2	3								80	10.7



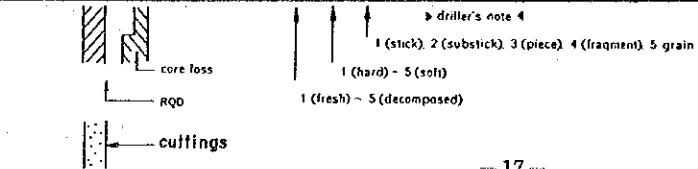


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 5 OF 6)

LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May - 18 - 1983  
 ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun - 24 - 1983  
 COORDINATE 9664309N 375 229.3E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 49.2%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE			DESCRIPTION	WATER TABLE		DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS		CORE CUTTING	WATER PRESSURE TEST			LEAKAGE OF DRILLING WATER
80m			0 → 100%								80m	10.7	
1					Whity greenish grey	2	3	2	Partially slightly sheared and slightly flaky.			1	
2							5	5				2	
3							2	(3)				3	
4												4	
5							3	2	Rock color gradually change rather pale greenish.			5	
6							5	5	The more greenish the less calcareous.			6	
7							2	(3)				7	
8												8	
9							3	3	Generally sheared partially clayey.			9	
90							(4)	(4)				90	
1							4	4	Sheared part			1	
2							(4)	3				2	
3							4	4	Sheared part			3	
4							(4)	(3)	Most of cores are broken into small pieces.			4	
5							3	2				5	
6							3	4	Sheared at 94.5m			6	
7							(4)	(3)	Pale greenish clay at 95.6m			7	
8							3	3				8	
9							3	2				9	
100							4	3	Somewhat sheared at 96.9 - 97.4m			100	-10.7

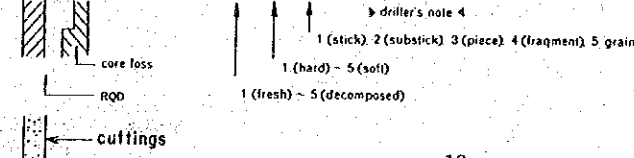


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-3 (SHEET 6 OF 6)

LOCATION Dam left bank DEPTH OF HOLE 120.0 m COMMENCED May-18-1983  
 ELEVATION 90.7 m DEPTH OF OVERBURDEN 0.35 m COMPLETED Jun-24-1983  
 COORDINATE 1966430.9N 375229.3E LENGTH OF ROCK DRILLING 119.65 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 58.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 49.2 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE			DESCRIPTION	WATER TABLE			DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS		WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
100m			0 → 100%											
1	Calcareous shale				Greyish pale - green	2	3	3	Sheared at 101.2 ~ 101.4 m	DRILL WATER RETURN 20% 50 100% 100m Lu = 1.5  Lu = 2.2  Lu = 0.4  Lu = 0.8				
2							3	3						
3							2	2						
4							4-5	4-5						
5							4-3	4	Core loss at 104.3-104.7m					
6							3	3	Generally somewhat flaky.					
7							4	3	Reconsolidated sheared zone					
8							3	4	Flaky cores.					
9							4	3						
10							2	2	Somewhat whitish and slightly massive clay seam at 111.4 m					
11	Calcareous shale				Whity greenish grey	2	3	3	Clay seam at 111.7m and 111.9m					
2							2	3	Generally fresh slightly exfoliative along bedding planes.					
3							3	2						
4							3	2						
5							2	2	Clay seam at 114.7m					
6							3	3	Somewhat clayey at 116.0m					
7							3	(3)						
8							3-2	3						
9							2	2						
10							3	3						
120														-30.7

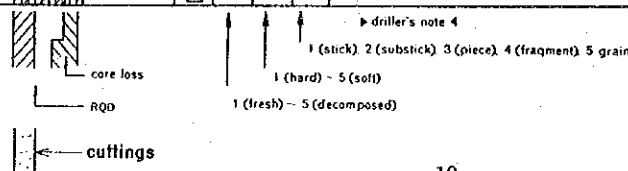


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-4 (SHEET 1 OF 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Jul. 23-1983  
 ELEVATION 191.4 m DEPTH OF OVERBURDEN 1.5 m COMPLETED Aug. 22-1983  
 COORDINATE 1965 774.5N 375 425.7E LENGTH OF ROCK DRILLING 78.5 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 77.0 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE CORE RECOVERY 98.1%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION						
0m			0 - 100%									20%	100%	0m	191.4 m
0-1.5	Overburden	△			(Reddish brown)				Lateritic soil.						
1.5-2.0								3	Dark grey, slightly impure Ls. Massive no bedding plane.						
2.0-3.0								2	All cracks sustained by oxidation (reddish brown). No solution cavities or fissures.						
3.0-4.0								3							
4.0-5.0								2	Partilly core loss.						
5.0-6.0								2							
6.0-7.0								3							
7.0-8.0								3							
8.0-9.0	Limestone							2							
9.0-10.0								2	Longitudinal crack with rough planes (reddish brown) at 10.4m - 10.8m						
10.0-11.0								2	Thin solution fissure at 11.2m-11.3m, 11.3m-11.4m and 11.8m-12.0m						
11.0-12.0								3	All cracks sustained by oxidation.						
12.0-13.0								3							
13.0-14.0								3							
14.0-15.0								3							
15.0-16.0								3	Solution fissur at 16.8m-17.0m						
16.0-17.0								3							
17.0-18.0								3	Cracky at 18.5m - 18.6m						
18.0-19.0								3	Reddish clay at 19.3m						
19.0-20.0	Sandy limestone							3							



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-4 (SHEET 2 OF 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Jul. -23-1983

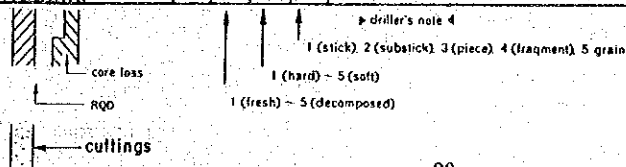
ELEVATION 191.4 m DEPTH OF OVERBURDEN 1.5 m COMPLETED Aug -22-1983

COORDINATE 1965 774.5N 375 425.7E LENGTH OF ROCK DRILLING 78.5 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 77.0 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 98.1 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN		
20m			0 → 100%									20m	171.4 m	
1	Sandy limestone				Dark grey partially reddish brown	3	2	2	Slightly soluble along most of cracks.				1	
2						3	3	3	Slightly disturbed and brittle at 21.5 m				2	
3	Limestone				Light brown	3	3	3	23.0				3	
4						3	3	3	Slightly brecciated and reconsolidated limestone, partially cracky and brittle.				4	
5						3	3	(4)	25.1				5	
6	Calcareous breccia				Light brownish	3	3	3	Somewhat weathered breccia (inclusions of sandy and shaly breccias). Partly small solution cavities. Slightly brittle as a whole.				6	
7						3	3	3	28.1				7	
8						(4)	(4)	(4)					8	
9								2	Calcareous shale with sandy part.				9	
30								3	Somewhat calcareous as a whole.				30	
1	Calcareous shale with sandy part				Light yellowish ~ greenish grey	3	3	3	Partially small solution cavities along bedding planes.				1	
2						3	3	(2)					2	
3						3	3	3	Sheared and brownish clay at 32.5 m				3	
4						3	3	(3)	Partially flaky (at shaly part)				4	
5						3	3	(2)					5	
6						3	3	4	Cracky and weathered along cracks.				6	
7	Calcareous sandstone				Grey ~ dark grey	2	2	2	Very slightly calcareous medium grained sandstone partially shaly in bands.				7	
8						3	3	3	Partially cracky.				8	
9						3	3	3					9	
40												40	151.4	

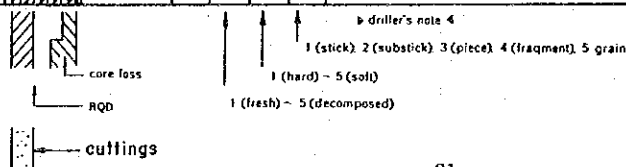


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-4 (SHEET 3 OF 4)

LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Jul. - 23 - 1983  
 ELEVATION 191.4 m DEPTH OF OVERBURDEN 1.5 m COMPLETED Aug. - 22 - 1983  
 COORDINATE 965 774.5N 375 425.7E LENGTH OF ROCK DRILLING 78.5 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 77.0 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 98.1%

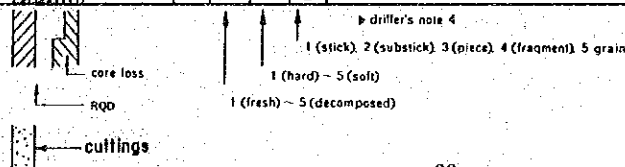
DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION				
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				DESCRIPTION			
40m			0-100%							40m	151.4 m				
1	Shaly Limestone				Whity grey with pale greenish thin band	2	1	Gradually changes. Limestone banded with a few greenish shale.	20%	50	100%	40m	151.4 m		
2														3	Partially rather massive. Slightly weathered along cracks.
3															
4	Calcareous sandstone				Light grey	3	2	Small solution cavities at 46.9m, 47.8m	Lu = 0.3	50	100%	40m	151.4 m		
5														3	49.5m
6															
7	Limestone (Slightly shaly)				Grey	3	2	Gradually changes Limestone banded with calcareous shale. Most of cores broken along their bands.	Lu = 0.5	50	100%	40m	151.4 m		
8														3	52.5
9															
10															



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DL-4 (SHEET 4 OF 4 )  
 LOCATION Dam left bank DEPTH OF HOLE 80.0 m COMMENCED Jul. - 23 - 1983  
 ELEVATION 191.4 m DEPTH OF OVERBURDEN 1.5 m COMPLETED Aug. - 22 - 1983  
 COORDINATE 1965 774.5N 375 425.7E LENGTH OF ROCK DRILLING 78.5 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 77.0 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 98.1%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION									
					COLOR	WEATHER- ING	HARD- NESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN											
60m			0 → 100%							20%	50%	100%	60m	131.4 m									
1	Limestone (Slightly shaly)				Grey, partially yellowish brown at cracks	2	2	2	Hard banded or shaly limestone with some weathered planes of cracks.	Lu=2.2													
2															A few solution small cavities in part.								
3																							
4																							
5																							
6																							
7																							
8																							
9																3	3	3	Some small solution cavities at 68.5m - 69.5m	Lu=1.7			
70																2	2	3	Banded limestone hard but partially weathered along cracks	Lu=2.0			
1	(3)	1	2	72.2																			
2	3	3	3	Fault	Lu=2.5																		
3	4-5	4-5	4-5	Somewhat cracky due to faulting.																			
4	3	2	3	75.0																			
5	2	3	3	75.5 Fault.																			
6	3	4-5	4-5	Small fault at 76.2m (dip 50°)																			
7	2	3	3	Weathered crack at 77.3m																			
8	(3)	2	2																				
9		(3)	(3)																				
80														111.4									



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. S-1 (SHEET 1 OF 3 )

LOCATION Spillway DEPTH OF HOLE 43.5 m COMMENCED Mar. 24 - 1983

ELEVATION 126.2 m DEPTH OF OVERBURDEN 1.0 m COMPLETED Apr. 2 - 1983

COORDINATE 966 353N 375 0142E LENGTH OF ROCK DRILLING 42.5 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 6.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE CORE RECOVERY 19.2 %

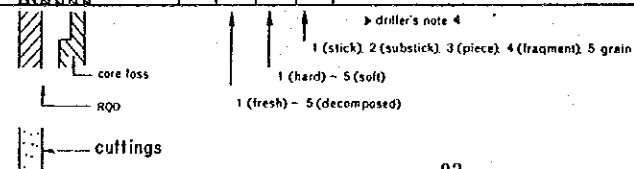
DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION					
0m			0 → 100 %										0m	126.2
1	TOP SOIL	△			(Light brn.)				Brown silt~clay (Maybe overburden)				1	
2									Cuttings(?)				2	
3									Materials are mixture of grey and yellowish brown particles.				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	106.2

Soft materials (Strongly weathered rocks?)

(Yellowish brown and grey)

(Brownish yellow)

K=348 x 10<sup>-3</sup>  
K=9.83 x 10<sup>-3</sup>  
K=6.24 x 10<sup>-3</sup>  
K=5.35 x 10<sup>-3</sup>  
K=4.04 x 10<sup>-3</sup>  
K=1.26 x 10<sup>-3</sup>

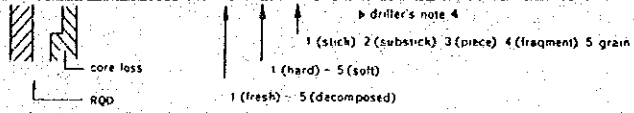


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. S-1 (SHEET 2 of 3)

LOCATION Spillway DEPTH OF HOLE 43.5 m COMMENCED Mar. 24 - 1983  
 ELEVATION 126.2 m DEPTH OF OVERBURDEN 1.0 m COMPLETED Apr. 2 - 1983  
 COORDINATE 1966 395.3N 375 04.2E LENGTH OF ROCK DRILLING 42.5 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 6.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE CORE RECOVERY 19.2%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
20m			0 → 100%							DRILL WATER RETURN			20m	106.2
1	Soft materials				(Brownish yellow)				22.0				1	
2									Black cuttings, non-calcareous				2	
3									Carbonized(?)				3	
4									Probably soft or brittle part of black shale rocks.				4	
5													5	
6													6	
7													7	
8													8	
9									Bedding planes are not so clear. Black shale, graphite rich. Some rock fragments and cuttings.				9	
30													30	
1									31.0				1	
2									Many thin calcite veins. Brittle in general.				2	
3									32.0				3	
4									Sheared and clayey at 32.7 ~ 33.5m				4	
5									Mostly gravelish cores.				5	
6									35.5				6	
7									Black cuttings.				7	
8													8	
9									39.2				9	
40									Sheared black clayey materials of 39.3 ~ 39.4m				40	86.2



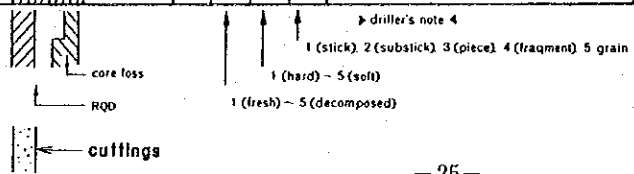


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. S-1 (SHEET 3 OF 3 )

LOCATION Spillway DEPTH OF HOLE 43.5 m COMMENCED Mar. 24 - 1983  
 ELEVATION 126.2 m DEPTH OF OVERBURDEN 1.0 m COMPLETED Apr. 2 - 1983  
 COORDINATE 066 305.3N 375 014.2E LENGTH OF ROCK DRILLING 42.5 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 6.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE — CORE RECOVERY 19.2 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION					
40m			0 ~ 100%									20% 50 100%	40m	86.2 m
1	Black shale				Black	2	3	4 5 (3)	Generally brittle. Partially calcite veins.				1	82.7
2							4 5 6	Sheared black clayey materials at 41.3 - 41.4 m	2					
3							3 3 (3)	Black clayey materials at bottom of hole. Bottom of hole at 43.5 m	3					
4													4	
5													5	
6													6	
7													7	
8													8	
9													9	
0													0	
1													1	
2													2	
3													3	
4													4	
5													5	
6													6	
7													7	
8													8	
9													9	
0													0	

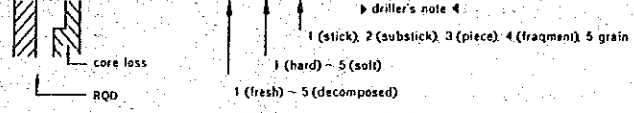


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. I - 1 (SHEET 1 OF 2)

LOCATION Intake DEPTH OF HOLE 40.0 m COMMENCED May-18-1983  
 ELEVATION 143.6 m DEPTH OF OVERBURDEN 4.0 m COMPLETED Jul-27-1983  
 COORDINATE 966516.2N 375483.6E LENGTH OF ROCK DRILLING 36.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 13.4 m LOGGED BY M. Shibato  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 31.5 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
0m			0 → 100 %									0m	143.6 m	
1	Overburden	△				(Brown)			Overburden from 0 to 4.0m					
2									Brown lateritic soil.					
3														
4									4.0					
5	Black shale (Weathered black shale?)	△				(Grey ~ brownish grey)			Brownish grey Cuttings (Non-calcareous)					
6														
7	Black shale (Weathered black shale?)	△				(Light grey ~ black)	3	3	8.0					
8									Weathered black shale					
9	Black shale (Weathered black shale?)	△				(Light grey ~ black)	3	3	Fault breccia at 8.3m - 8.5m Dip of fault = 60° (Thickness 5 ~ 6 cm) Generally cracky					
10									Core loss					
11	Black shale (Weathered black shale?)	△				(Brownish grey)			10.0					
12									Brownish grey Cuttings (as same as at 4.0m - 8.0m) (Non-calcareous)					
13	Black shale (Weathered black shale?)	△				(Light grey ~ black)	3	3	15.0					
14									Gravelly cores					
15	Weathered Black shale?	△				(Brownish grey)			16.0					
16									Brownish grey cuttings (Non-calcareous)					
17	Weathered Black shale?	△				(Brownish grey)			19.65					
18									Gravelly cores					
19														
20												20	123.6	

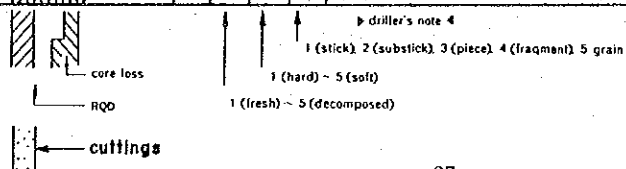


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. I-1 (SHEET 2 OF 2)

LOCATION Intake DEPTH OF HOLE 40.0 m COMMENCED May-18-1983  
 ELEVATION 143.6 m DEPTH OF OVERBURDEN 4.0 m COMPLETED Jul-27-1983  
 COORDINATE 1966562N 375483.6E LENGTH OF ROCK DRILLING 36.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 13.4 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE CORE RECOVERY 31.5%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN		
20.0	(Black shale?)		0 = 100%		(Grey)				20.0				20.0	123.6
1	(Black shale?)				Light grey	3	3	4	21.15				1	
2	(Black shale?)				(Black)			3	22.0				2	
3	(Black shale?)				(Black)				24.0				3	
4	(Black shale?)				(Black)				27.4				4	
5	(Black shale?)				Brownish grey ~ black	3	3	3	27.4				5	
6	(Black shale?)				(Black)			(4)	27.4				6	
7	(Black shale?)				(Black)				27.4				7	
8	(Black shale?)				(Black)				27.4				8	
9	(Black shale?)				(Black)			3	27.4				9	
30	(Black shale?)				(Black)			(4)	27.4				30	
1	(Black shale?)				Grey ~ black, Partially brown (along cracks)			3	27.4				1	
2	(Black shale?)				Grey ~ black, Partially brown (along cracks)			4	27.4				2	
3	(Black shale?)				Grey ~ black, Partially brown (along cracks)			3	27.4				3	
4	(Black shale?)				Grey ~ black, Partially brown (along cracks)			(3)	27.4				4	
5	(Black shale?)				Grey ~ black, Partially brown (along cracks)			(4)	27.4				5	
6	(Black shale?)				Grey ~ black, Partially brown (along cracks)				27.4				6	
7	(Black shale?)				Grey ~ black, Partially brown (along cracks)			3	27.4				7	
8	(Black shale?)				Grey ~ black, Partially brown (along cracks)			(4)	27.4				8	
9	(Black shale?)				Grey ~ black, Partially brown (along cracks)			3	27.4				9	
40	(Black shale?)				Grey ~ black, Partially brown (along cracks)			3	27.4				40	103.6

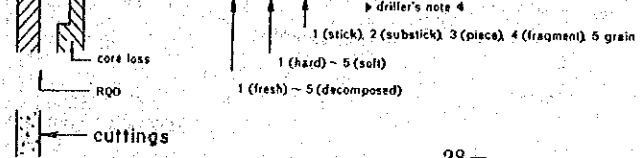


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-1 (SHEET 1 OF 3)

LOCATION Dam right bank DEPTH OF HOLE 60.0 m COMMENCED Aug. 18 - 1983  
 ELEVATION 142.2 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Sep. 1 - 1983  
 COORDINATE 1966 551.8N 375 447.3E LENGTH OF ROCK DRILLING 54.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 34.8 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 64.4 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN			
0m			0 → 100									20%	100%	0m	142.2
0-6.0	Overburden	△							Reddish brown laterite soil 1.0 Yellowish brown soil.						
6.0-10.0	Weathered shale	35° 35°			Brownish grey	3 3 4	3 3 4	3 3 4	Black shale? Rock color is changed to brownish grey due to weathering. Generally gravelly cores.						
10.0-16.5	Black shale	15° 15° 15°			Black, partially brown	3 3 3-4 2	3 3 3 (4)	3 3 3 3	Somewhat weathered as a whole. Generally cores broken along bedding planes.						
16.5-20.5	Black shale	10°			Black, partially brown	3 2 3	3 3 3	3 3 3	Partially weathered along bedding planes. Most of cores are less than 10cm long. Longitudinal crack with red plane at 19.5-20.5m						
20.5-20.0														20m	122.2

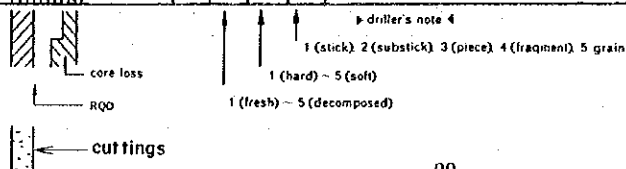


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-1 (SHEET 2 of 3)

LOCATION Dam right bank DEPTH OF HOLE 60.0 m COMMENCED Aug-18-1983  
 ELEVATION 142.2 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Sep-1-1983  
 COORDINATE 1966 551.8 N 375 447.3 E LENGTH OF ROCK DRILLING 54.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 34.8 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 64.4 %

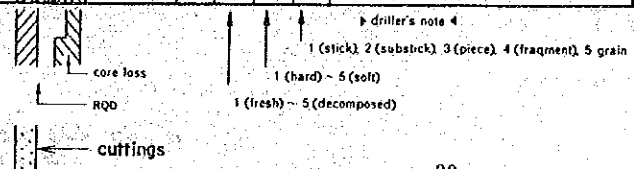
DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DRILL WATER RETURN		
20m			0 = 100%		Black	2-3	2-3	3	Sheared at 20.6 - 20.8m				20m	122.2
1				(Dark grey)	Black	3	3	3	Cuttings	Somewhat weathered, generally cracky.				
2				(Dark grey)	Black	3	2-3	3	Cuttings					
3				(Dark grey)	Black	3	2-3	3	Cuttings					
4				(Dark grey)	Black	3	3	3	24.8					
5				(Dark grey)	Black	2	2	3	Slightly weathered along bedding planes.					
6				(Dark grey)	Black	3	3	(2)	Partially flaky.					
7				(Dark grey)	Black	3	3	3						
8				(Dark grey)	Black	3	3	4	28.9					
9				(Dark grey)	Black	3	3	4	Cuttings	Generally brittle.				
30				(Dark grey)	Black	3	3	4	Cuttings					
1				(Dark grey)	Black	3	3	4	31.0					
2				(Dark grey)	Black	3	3	3	Some cracks reddish at its planes.					
3				(Dark grey)	Black	3	3	3	Graphite rich at 32.5m-32.7m					
4				(Dark grey)	Black	3	3	3	Cores generally broken into small pices.					
5				(Dark grey)	Black	2	2	(4)	35.2					
6				(Dark grey)	Black	3	3	3	35.8 Cuttings					
7				(Dark grey)	Black	3	3	3	Slightly weathered along some cracks.					
8				(Dark grey)	Black	3	3	3	Generally brittle					
9				(Dark grey)	Black	2	2	(4)	Minorfolding at part, B.P not clear.					
40				(Dark grey)	Black								40	102.2



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-1 (SHEET 3 OF 3 )  
 LOCATION Dam right bank DEPTH OF HOLE 60.0 m COMMENCED Aug-18-1983  
 ELEVATION 142.2 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Sep-1-1983  
 COORDINATE 966 551.8N 375 447.3E LENGTH OF ROCK DRILLING 54.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 34.8 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 64.4 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTINGS	DESCRIPTION			
40m			0 → 100							20% 50% 100%	40m	102.2
1	Black shale				3	4	4	Most of cores are gravelly. B.P not clear.	GL 45.3	LU = 1.3	1	
2					3	3	3				2	
3					2	3					3	
4							44.0				4	
5							Cuttings				5	
6							45.6				6	
7							Minorfolding at 46.5m cores generally broken into small pices.				7	
8							Cuttings				8	
9							Cuttings				9	
50							Cuttings				60	
1	Shaly limestone				3	3	4	Black shaly part with calciteveins.	LU = 0.4	LU = 0.6	1	
2					3	3	4				2	
3							54.9				3	
4							Somewhat shaly limestone, rather massive.				4	
5							58.3				5	
6							Black shaly part at 58.3 - 58.5m				6	
7							(Very slightly sheared)				7	
8											8	
9											9	
60											60	82.2



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-2 (SHEET 1 OF 4.)

LOCATION Dam right bank DEPTH OF HOLE 80.0 m COMMENCED Sep-10-1983

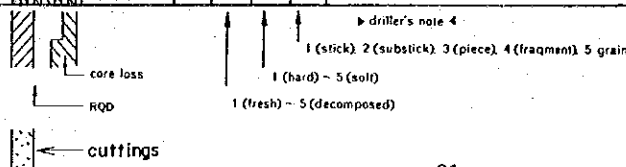
ELEVATION 103.9 m DEPTH OF OVERBURDEN 2.0 m COMPLETED Oct-14-1983

COORDINATE 1966 502.2N 375 412.9E LENGTH OF ROCK DRILLING 78.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 52.95 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 67.9 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BITTING CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING						
0m			0 → 100 %									0m	103.9	
0-1.0	Overburden	△			Yell. brn.				Silt, sand, small gravels and rock fragments			1		
1.0-2.0		△			Yell. brn.				Silt, sand, small rock fragments			2		
2.0-3.0					Dark grey				Dark grey cuttings (non-calcareous)			3		
3.0-4.0					Dark grey				Dark grey cuttings (non-calcareous)			4		
4.0-6.4	Black shale				Dark grey ~ black	3	3	4	Black shale, weathered along cracks and some bedding planes generally cracks			5		
6.4-7.9					Black	3	2	3	Hard shale, some cracks are sustained by oxidation in reddish colour.			6		
7.9-21.90								(4)	Obtained only cuttings. Black cuttings at 7.9m-20.0m			7		
21.90-20.0												8		
20.0-10.0												9		
10.0-0												10		
0-20												20	83.9	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-2 (SHEET 2 of 4)

LOCATION Dam right bank DEPTH OF HOLE 80.0 m COMMENCED Sep-10-1983

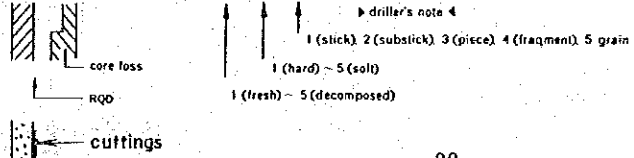
ELEVATION 103.9 m DEPTH OF OVERBURDEN 2.0 m COMPLETED Oct-14-1983

COORDINATE 1966 502.2N 375412.9E LENGTH OF ROCK DRILLING 78.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 52.95 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 67.9 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION			
20m			0 + 100									83.9
1	Calcareous (Calc. shale)				Whitish greenish (Pale green)				Pale green cuttings, (no reaction with acid)			
2									21.9			
3	Calcareous shale				Whitish greenish	2	2	2	Weakly schistose, bedding not so clear.			
4									24.0-24.5 m Core loss.			
5									Upper part is somewhat whitish.			
6					Whitish greenish grey			2	Whitish part is rather calcareous than greenish part.			
7												
8												
9					Whitish greenish grey			3~4	Slightly sheared around 28.5m somewhat brittle in part.			
30												
1									Rather greenish shale.			
2	Calcareous shale								Somewhat flaky due to shearing at 31.7m-32.4m			
3									Generally slightly schistose			
4									Little weathered cracks or bedding planes.			
5					Pale greenish grey							
6												
7									Weathered crack at 37.2m			
8									38.2			
9	Calcareous (Calc. shale)				(Greenish grey)				Cuttings at 38.2m-41.0m			



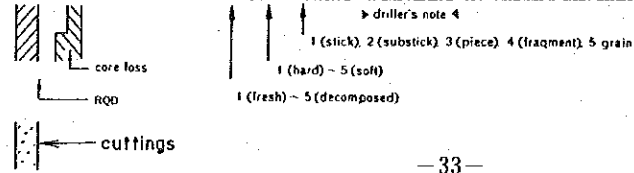


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-2 (SHEET 3 of 4)

LOCATION Dam right bank DEPTH OF HOLE 80 m COMMENCED Sep-10-1983  
 ELEVATION 103.9 m DEPTH OF OVERBURDEN 2.0 m COMPLETED Oct-14-1983  
 COORDINATE 19665022N 375 412.9E LENGTH OF ROCK DRILLING 78.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 52.95 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 67.9 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING				
40m			0-100%								40m	63.9
1	Calc. shale				Pale greenish grey	2	3	3	Cuttings.			
2	Calc. shale				Pale greenish grey	2	3	3	Slightly flaky due to steep foliation.			
3					Pale greenish grey	2	3	(4)	42.7			
4	Calc. shale				Pale greenish grey	2	3	3	Cuttings (Reaction with acid)			
5	Calc. shale				Pale greenish grey	2	3	4	44.0			
6					Greenish grey	2	3	4	Somewhat brittle due to shearing.			
7					Greenish grey	2	3	4	45.0			
8	Calcareous shale				Pale greenish grey	2	3	3	Cuttings. (Reaction with acid)			
9	Calcareous shale				Pale greenish grey	2	3	3	46.0			
10					Pale greenish grey	2	3	3	Somewhat sheared as a whole.			
11					Pale greenish grey	2	3	3	47.0			
12					Pale greenish grey	2	3	3	Clayed at 49.4m			
13					Pale greenish grey	2	3	3	Clay seam along bedding plane at 50.5m			
14					Pale greenish grey	2	3	3	51.0			
15					Pale greenish grey	2	3	3	Somewhat more calcareous (whitish)			
16					Pale greenish grey	2	3	3	52.1			
17					Pale greenish grey	2	3	3	Cuttings (Reaction with acid)			
18					Pale greenish grey	2	3	3	53.0			
19					Pale greenish grey	2	3	3	Longitudinal crack with rough plane at 54.5m			
20					Pale greenish grey	2	3	3	54.5			
21					Pale greenish grey	2	3	3	Colcite veins are perpendicular to bedding planes.			
22					Pale greenish grey	2	3	3	55.0			
23					Pale greenish grey	2	3	3	55.5			
24					Pale greenish grey	2	3	3	56.0			
25					Pale greenish grey	2	3	3	56.5			
26					Pale greenish grey	2	3	3	57.0			
27					Pale greenish grey	2	3	3	57.5			
28					Pale greenish grey	2	3	3	58.0			
29					Pale greenish grey	2	3	3	58.5			
30					Pale greenish grey	2	3	3	59.0			
31					Pale greenish grey	2	3	3	59.4			
32					Pale greenish grey	2	3	3	59.8			
33					Pale greenish grey	2	3	3	60.0			
34					Pale greenish grey	2	3	3	60.2			
35					Pale greenish grey	2	3	3	60.4			
36					Pale greenish grey	2	3	3	60.6			
37					Pale greenish grey	2	3	3	60.8			
38					Pale greenish grey	2	3	3	61.0			
39					Pale greenish grey	2	3	3	61.2			
40					Pale greenish grey	2	3	3	61.4			
41					Pale greenish grey	2	3	3	61.6			
42					Pale greenish grey	2	3	3	61.8			
43					Pale greenish grey	2	3	3	62.0			
44					Pale greenish grey	2	3	3	62.2			
45					Pale greenish grey	2	3	3	62.4			
46					Pale greenish grey	2	3	3	62.6			
47					Pale greenish grey	2	3	3	62.8			
48					Pale greenish grey	2	3	3	63.0			
49					Pale greenish grey	2	3	3	63.2			
50					Pale greenish grey	2	3	3	63.4			
51					Pale greenish grey	2	3	3	63.6			
52					Pale greenish grey	2	3	3	63.8			
53					Pale greenish grey	2	3	3	64.0			
54					Pale greenish grey	2	3	3	64.2			
55					Pale greenish grey	2	3	3	64.4			
56					Pale greenish grey	2	3	3	64.6			
57					Pale greenish grey	2	3	3	64.8			
58					Pale greenish grey	2	3	3	65.0			
59					Pale greenish grey	2	3	3	65.2			
60					Pale greenish grey	2	3	3	65.4			
61					Pale greenish grey	2	3	3	65.6			
62					Pale greenish grey	2	3	3	65.8			
63					Pale greenish grey	2	3	3	66.0			
64					Pale greenish grey	2	3	3	66.2			
65					Pale greenish grey	2	3	3	66.4			
66					Pale greenish grey	2	3	3	66.6			
67					Pale greenish grey	2	3	3	66.8			
68					Pale greenish grey	2	3	3	67.0			
69					Pale greenish grey	2	3	3	67.2			
70					Pale greenish grey	2	3	3	67.4			
71					Pale greenish grey	2	3	3	67.6			
72					Pale greenish grey	2	3	3	67.8			
73					Pale greenish grey	2	3	3	68.0			
74					Pale greenish grey	2	3	3	68.2			
75					Pale greenish grey	2	3	3	68.4			
76					Pale greenish grey	2	3	3	68.6			
77					Pale greenish grey	2	3	3	68.8			
78					Pale greenish grey	2	3	3	69.0			
79					Pale greenish grey	2	3	3	69.2			
80					Pale greenish grey	2	3	3	69.4			
81					Pale greenish grey	2	3	3	69.6			
82					Pale greenish grey	2	3	3	69.8			
83					Pale greenish grey	2	3	3	70.0			
84					Pale greenish grey	2	3	3	70.2			
85					Pale greenish grey	2	3	3	70.4			
86					Pale greenish grey	2	3	3	70.6			
87					Pale greenish grey	2	3	3	70.8			
88					Pale greenish grey	2	3	3	71.0			
89					Pale greenish grey	2	3	3	71.2			
90					Pale greenish grey	2	3	3	71.4			
91					Pale greenish grey	2	3	3	71.6			
92					Pale greenish grey	2	3	3	71.8			
93					Pale greenish grey	2	3	3	72.0			
94					Pale greenish grey	2	3	3	72.2			
95					Pale greenish grey	2	3	3	72.4			
96					Pale greenish grey	2	3	3	72.6			
97					Pale greenish grey	2	3	3	72.8			
98					Pale greenish grey	2	3	3	73.0			
99					Pale greenish grey	2	3	3	73.2			
100					Pale greenish grey	2	3	3	73.4			



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DR-2 (SHEET 4 of 4 )

LOCATION Dam right bank DEPTH OF HOLE 80.0 m COMMENCED Sep-10-1983

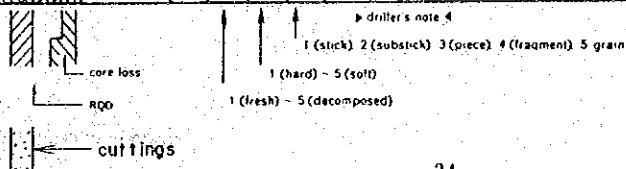
ELEVATION 103.9 m DEPTH OF OVERBURDEN 2.0 m COMPLETED Oct-14-1983

COORDINATE 1966 5022N 375 412.9E LENGTH OF ROCK DRILLING 78.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 52.95 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 67.9 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION				
60m			0-100									43.9	
1	Shaly limestone				Pale greenish grey	1	2	1	Partially sheared and slightly brittle.	Lu=0.9			
2					Pale greenish grey	2	3	2					62.3
3					Pale grey	1	3	2					Shaly limestone somewhat brittle due to shearing
4		2	4	3	63.4								
5	Calcareous shale				Pale greenish grey	3	3	Sheared and reconsolidated at 65.4 ~ 65.6 m	Lu=0.4				
6						4	2						
7						3	3					67.6	
8	Calcareous shale				Whity greenish grey	1	1	Somewhat whitish more calcareous shale. B.P is not so clear. Clay seam at 69.0m	Lu=0.7				
9						2	1					Core recovery is good in general.	
10						2	1						
11					Whity greenish grey	2	2	Weathering is very few.	Lu=1.0				
12						2	2						
13						2	2					Clay seam at 76.4m	



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-1 (SHEET 1 of 2)

LOCATION Dam upstream DEPTH OF HOLE 22.0 m COMMENCED - -

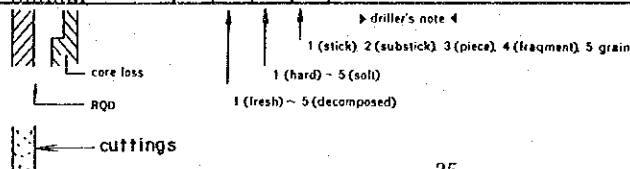
ELEVATION 74.5 m DEPTH OF OVERBURDEN 9.8 m COMPLETED - -

COORDINATE 1966 424.9N 375 397.6E LENGTH OF ROCK DRILLING 12.2 m DRILLED BY

ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 10.6 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE S59°W CORE RECOVERY 86.9%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF LITHO CASING	OBSERVATION OF CORE					WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION			
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION								
0m			0 → 100%									20%	30%	100%	0m	74.5	
0-1.5m	Sand and gravel (Riverbed Deposits)	[Diagram]	[Diagram]						0-1.5m								
1.5									Sand and gravels Sand: Medium grained Gravels: L=10~15cm sandstone								
4.7									Gravels; hard L=3~10cm								
5.5									Medium grained sand								
8.8	Calcareous shale	[Diagram]	[Diagram]						8.8								
9.8									Gravelly								
10.65									Calcareous shale.								
10.65									Partially recovered only cuttings. Slightly sheared in general, all cores are flaky.								
14.2									Partially flaky, exfoliative along bedding plane. Somewhat schistose.								
14.2									Only cutting is recovered								
14.2									Partially flaky								
14.2																	
14.2																	
14.2																	
20																20	57.2



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-1 (SHEET 2 of 2 )

LOCATION Dam upstream DEPTH OF HOLE 22.0 m COMMENCED - -

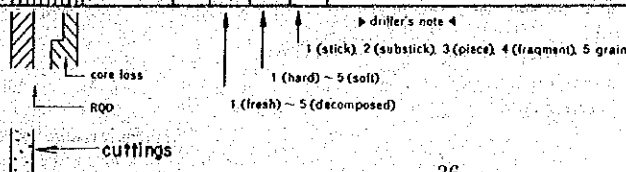
ELEVATION 74.5 m DEPTH OF OVERBURDEN 9.8 m COMPLETED - -

COORDINATE \_\_\_\_\_ LENGTH OF ROCK DRILLING 12.2 m DRILLED BY \_\_\_\_\_

ANGLE FROM HORIZONTAL 60 ° TOTAL LENGTH OF CORE 10.6 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE S59°W CORE RECOVERY 86.9 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	WATER PRESSURE TEST		LEAKAGE OF DRILLING WATER	DRILL WATER RETURN			
20m			0-100%												57.2
1	Calcareous shale				Pale greenish grey	2	3	3		Partially minorfolding with calcite veins					
2							(4)	4		End of hole at 22m					55.5
3															
4															
5															
6															
7															
8															
9															
0															



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 1 OF 6)

LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep - 3 - 1983

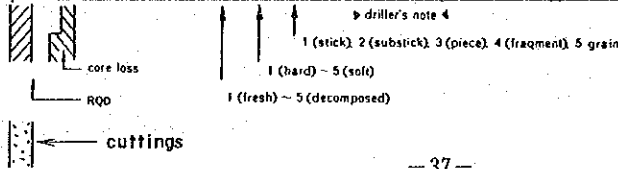
ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct. - 21 - 1983

COORDINATE 1966 333.3N 375 398.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE N31°E CORE RECOVERY 70.1 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE			DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS	CORE CUTTING		WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER			
0m			0 → 100 %							DRILL WATER RETURN	20%	60%	100%	0m	91.3
0-6	Overburden	△						Materials obtained from the hole are in plastic sacks.	Brown or yellowish brown silt ~ fine grained sand.						
6.0								Core loss							
6.0-9.0	Weathered shale							(Brownish grey) ~ black	Cuttings Some of cuttings are of overburden and some cuttings are black.						
9.0-11.4	Black shale							Whity grey ~ black	Back shale with thin quartz veins. Partially minorfolding somewhat brittle.						
11.4-17.2	Black shale							Black, partially pale grey bands	Rather clear bedding at 15.5m - 17.2m Somewhat exfoliative in general.						
17.2-18.0									Core loss from 18.0m to 31.5m (Casing drilling)						
18.0-20.0															74.0



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 2 OF 6)

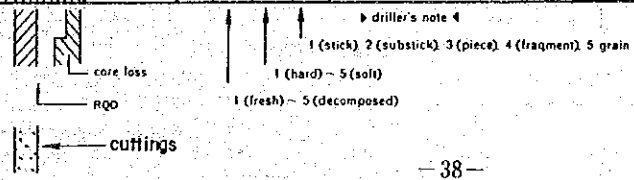
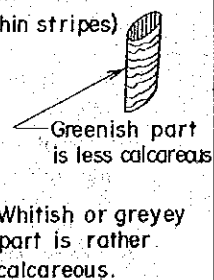
LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep - 3 - 1983  
 ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct. - 21 - 1983  
 COORDINATE 066 333.3N 375 308.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE N 31° E CORE RECOVERY 70.1 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE					DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	WATER TABLE		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH		
20m			0-100%										20m	74.0	
1										Casing drilling from 18.0m - 31.5m core loss			1		
2													2		
3										Lithologic boundary of black shale and calcareous shale exists between 18.0m and 31.5m			3		
4													4		
5													5		
6													6		
7													7		
8													8		
9													9		
30													30		
1										31.5m			1		
2										Weathered calcareous shale. Mostly gravelly cores.			2		
3													3		
4										Very slightly schistose shale, somewhat exfoliative. (Very thin stripes)			4		
5													5		
6													6		
7													7		
8													8		
9													9		
40													40	56.7	

Calcareous shale

Pale yellowish grey

Pale greenish grey



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 3 of 6)

LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep. 3 - 1983

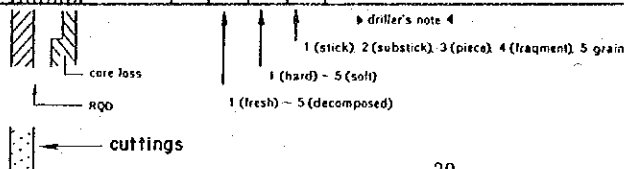
ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct. 21 - 1983

COORDINATE 1966333.3N 375 398.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE N31E CORE RECOVERY 70.1%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	OBSERVATION OF CORE					DESCRIPTION	WATER TABLE			DEPTH	ELEVATION
				CEMENTATION KIND OF BIT CASING	COLOR	WEATHER- ING	HARD- NESS	CORE CUTTING		WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH		
40m			0 → 100							20%	30%	100%	40m	39.4
1		30°		Greenish grey	2	3	3	3	Flaky at 41.0 <sup>m</sup> - 41.5 <sup>m</sup>				1	
2									Greenish grey cuttings				2	
3				Pale greenish grey	2	3	3	3	Partially quartz veins slightly exfoliate as a whole				3	
4		20°											4	
5		35°											5	
6									45.8 <sup>m</sup> - 46.2 <sup>m</sup> Cuttings				6	
7				Pale greenish grey	2	3	3	3					7	
8		30°											8	
9				Pale greenish grey	2	3	3	3	Sheared clay at 49.5~49.7 <sup>m</sup>				9	
50									49.7 Core loss } Brittle partially quartz veins				50	
1									50.2 Core loss				1	
2									51.05 Core loss				2	
3		30°		Pale greenish grey	2	3	3	3	Partially weathered cracks or bedding planes				3	
4													4	
5				Pale greenish grey	2	3	3	3	Very hard quartz vein at 55.2 <sup>m</sup> - 55.3 <sup>m</sup>				5	
6													6	
7									From 56 <sup>m</sup> to 60 <sup>m</sup> , core box is lost.				7	
8									Driller reports during transportation, the core box was fallen into river.				8	
9													9	
60													60	22.1

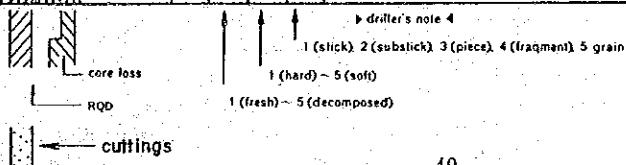


# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 4 of 6)

LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep. 3 - 1983  
 ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct. 21 - 1983  
 COORDINATE 1966 333.3N 375 398.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE N31E CORE RECOVERY 70.1 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE			DESCRIPTION	WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION	
					COLOR	WEATHERING	HARDNESS					
6.0m			0 → 100 %								22.1	
1	Calcareous shale				Pall greenish grey		3 3	Quartz veins at 60.6 <sup>m</sup> - 60.7 <sup>m</sup> and 61.55 - 61.65 <sup>m</sup>	↑ Lu = 1.2			1
2						2	Somewhat brecciated in part and brittle.	2				
3					(4)	(4)		3				
4						64.6m	4					
5	Fault zone				Pale greenish grey	3	4 3	Fault zone with clay and breccia and sheared rocks.	↑ Lu = 0.6			5
6						3 3	Generally brittle.	6				
7					2	3 3	(Sheared at shaly part)	7				
8					4	3 4	Not sheared at limestone	8				
9	Shaly limestone				Grey with thin grey, partially light yellowish grey	2	2 2	Very slightly weathered as a whole.	↑ Lu = 0.7			9
70							3 3	Most of cracks somewhat weathered.				70
1							1 3	Slightly banded and shaly.				1
2							2 3	Sheared and brecciated at 73.4 - 73.5 m (reconsolidated)				2
3		3 (4)	Weathered along cracks.	3								
4		2 3	Slightly banded (with greyish stripes) limestone.	4								
5		2 3	Partially slightly weathered along cracks or cross joints.	5								
6		2 3		6								
7		2 3		7								
8		2 3		8								
9		2 3		9								
80											4.8	





# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 5 OF 6)

LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep. 3 - 1983

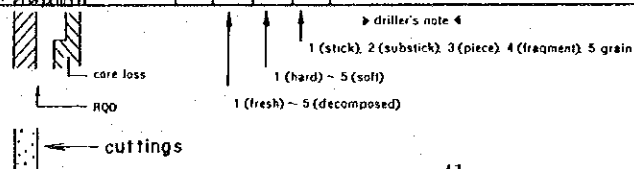
ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct. 21 - 1983

COORDINATE 1966 333.3N 375.398.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE N31E CORE RECOVERY 70.1%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				DESCRIPTION	WATER TABLE	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	HARDNESS	CORE CUTTING						
80m			0 → 100%										4.8 m	
1	Shaly limestone	15°	I	I	Pale grey partially slightly yellowish	2	2	2	Generally cracky and weathered color along planes of cracks. (No solution phenomena) (Bedding planes not clear) Clay seam at 84.1m	Lu = 1.8				
2						1	1	(3)						
3						3	3	4						
4						2	2	3						
5	limestone		I	I	Grey	2	2	2	Fresh slightly shaly limestone. Partially slightly flaky along bands (One kind of sheared planes?) Generally massive. (Calcareous contents are rather high)	Lu = 2.3				
6						1	1	1						
7						1	1	3						
8	Shaly limestone	20°	I	I	Yellowish grey	3	2	3	Weathered part somewhat shaly	Lu = 1.0				
9						3	3	3						
10	limestone	30°	I	I	Dark grey	1	2	2	94.0 Shaly limestone; (Difinition) Rather exfoliative along bedding planes, and rocks color is rather dark grey than the rocks called slightly shaly limestone. Partically somewhat exfoliative. (Calc. contents are rather high)	Lu = 0.6				
1						1	1	1						
2						1	1	1						
3						2	(3)	(3)						

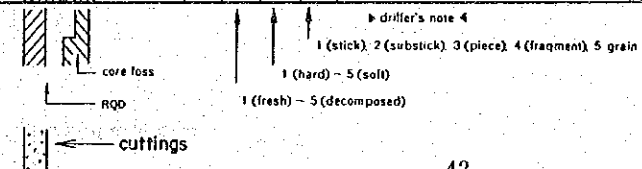


## GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. DU-2 (SHEET 6 OF 6)

LOCATION Dam upstream DEPTH OF HOLE 120.0 m COMMENCED Sep - 3 - 1983  
 ELEVATION 91.3 m DEPTH OF OVERBURDEN 6.0 m COMPLETED Oct - 21 - 1983  
 COORDINATE 1966.333.3N 375.398.2E LENGTH OF ROCK DRILLING 114.0 m DRILLED BY ROEM  
 ANGLE FROM HORIZONTAL 60° TOTAL LENGTH OF CORE 79.9 m LOGGED BY M. Shibata  
 BEARING OF ANGLE HOLE N31E CORE RECOVERY 70.1%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTA-TION KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE			DEPTH	ELEVATION													
					COLOR	WEATHER-ING	HARD-NESS	CORE CUTTING	DESCRIPTION	WATER PRESSURE TEST	LEAKAGE OF DRILLING WATER																
100m			0 → 100																								
1	limestone	Shaly limestone	100%		Dark grey	1	2	2	102.5m	Exfoliated along bedding planes (sliced cores) Somewhat weathered at 104.0m ~ 105.0m Small solution cavities at 104.6m	Lu = 1.2																
2						2	(3)	(3)																			
3						3	3	4																			
4						Yellowish grey	3	3																			
5							(2)	3																			
6						Dark grey	Shaly limestone	100%									Dark grey	3	4	3	Lu = 0.5						
7																		2	3								
8						Shaly limestone	Shaly limestone	100%									Grey	100%	1	2	2	Lu = 0.8					
9																			2	2							
10																			3	(3)							
1	3	(3)																									
2	3	(3)																									
3	(2)	1																									
4	2	2																									
5	3	(3)																									
6	2	3																									
7	3	(3)																									
8	2	3																									
9	3	(3)																									
120																120	- 29.8										



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuum PROJECT HOLE No. P-1 (SHEET 1 OF 2)

LOCATION Power house DEPTH OF HOLE 40.0 m COMMENCED Oct.-19-1983

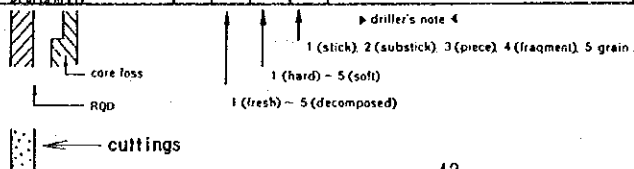
ELEVATION 90.8 m DEPTH OF OVERBURDEN 7.4 m COMPLETED Oct.-23-1983

COORDINATE 1966 669.5N 375 088.3E LENGTH OF ROCK DRILLING 32.6 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90° TOTAL LENGTH OF CORE 31.5 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE CORE RECOVERY 96.6%

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE				WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
					COLOR	WEATHERING	FRACTURE	CORE CUTTING			
0.0			0 → 100%							0m	90.8
0 ~ 3.0	Overburden	△									
3.0	River bed deposits	△			Materials obtained from the hole are in plastic sacks.						
6.0	Fine grained sandstone	○			Dark grey (Crack plane: Yellowish brown)	2 3	3				
7.4	Black shale	○			Black brownish grey	3 3	3				
13.4					Black	2 3	3				
14.3											
18.7											
20.0											70.8



# GEOLOGIC LOG OF DRILL HOLE

Nam Yuam PROJECT HOLE No. P-1 (SHEET 2 of 2)

LOCATION Power house DEPTH OF HOLE 40.0 m COMMENCED Oct - 19 - 1983

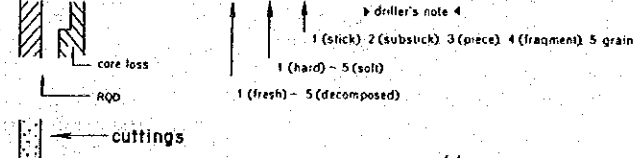
ELEVATION 90.8 m DEPTH OF OVERBURDEN 7.4 m COMPLETED Oct - 23 - 1983

COORDINATE 966 669 5N 375 088.3E LENGTH OF ROCK DRILLING 32.6 m DRILLED BY ROEM

ANGLE FROM HORIZONTAL 90 ° TOTAL LENGTH OF CORE 31.5 m LOGGED BY M. Shibata

BEARING OF ANGLE HOLE \_\_\_\_\_ CORE RECOVERY 96.6 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION FOR KIND OF BIT CASING	OBSERVATION OF CORE					WATER TABLE WATER PRESSURE TEST LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION		
					COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION					
20m			0 → 100							20%	20m	70.8		
1	Black shale	35°			Black	2	2	2	2	Small solution cavities along 20.7 calcite veins at 20.7m	LU = 1.3			
2						2	2	2	Very slightly weathered along bedding planes or joints.					
3						2	2	2	Partially exfoliative along bedding planes.					
4						3	3	3	Some planes of cross joints are smooth. (with dark greenish mineral - chlorite ?)					
5						2	2	2						
6						1	(3)	2	2	29.0				LU = 4.2
7						(3)	3	3						
8								(4)	3					LU = 2.5
9									2	Generally few cracks, partially cross joints with calcite veins.				
30						Black with white bands	30°			Black with white bands				1
1	1	2	2	Cores separated along cross joints in parts.										
2	2	2	2											
3	1	2	2	Many calcite veins and somewhat folding. Partially small solution cavities along calcites veins. Slightly brittle in general.										
4	3	3	3											
5	(3)	3	(4)											
6				3										
7				3										
8				3										
9				3										
40										40	50.8			



## A 2 HYDROLOGY



1. Catchment Area of the Damsites

In this study, two damsites, i.e. site A and B were proposed for investigation. Catchment areas of both sites were measured with the available topographical maps (scale: 1/250,000, "Chiangwat Chiang Mai" and "Amphoe Li") published by U.S. Army Map Service, Far East.

Catchment area of Ban Tha Rua G.S. was also measured with the said map.

The catchment areas employed in the study were as follows.

Damsite A	:	5,920 km <sup>2</sup>
Damsite B	:	5,810 km <sup>2</sup>
Ban Tha Rua G.S.:		5,770 km <sup>2</sup>

## 2. Evapotranspiration

Evapotranspiration was calculated by the following two methods.

### (1) Thornthwaite Method

$$E_{pT} = 0.533 D_o \left( \frac{10t_j}{J} \right)^a$$

where  $a = 6.75 \times 10^{-7} J^3 - 7.71 \times 10^{-5} J^2 + 1.79 \times 10^{-2} J + 0.49$

$$J = \sum_{j=1}^{12} \left( \frac{t_j}{5} \right)^{1.514}$$

$E_{pT}$  = Monthly average of daily evapotranspiration  
[mm/day]

$D_o$  = Daytime ratio i.e.  
daily daytime/12 hrs

$t$  = Monthly average temperature [ $^{\circ}C$ ]

$j$  = Month (1 - 12)

$J$  = Indicator of Month

### (2) Blaney and Criddle Method

$$E_{pT} = K C t$$

where  $E_{pT}$  = Monthly average evaporation  
[inch/month]

$C$  = Ratio of monthly daytime to annual daytime

$t$  = Monthly average temperature [ $^{\circ}F$ ]

$K$  = Coefficient corresponding to kind of flora

When units are converted to metric system, the equation becomes:

$$E_{pT} = K \cdot C \cdot (45.72^t + 812.8)$$

In these equations, daytime ratios  $D_o$  and  $C$  were obtained by the following way.

$D_o$ ; based on the table below, the value at latitude  $18^{\circ}$  North was interperated.



C; given by the following figure.

Coefficient for flora (K) is 0.7 corresponding to deciduous forest in semi-dry region<sup>(1)</sup>.

References

- (1) Hideaki Nakano, "Forestry Hydrology" p.p.95 - 120, 1980.  
3rd ed. Kyo-ritsu Press.

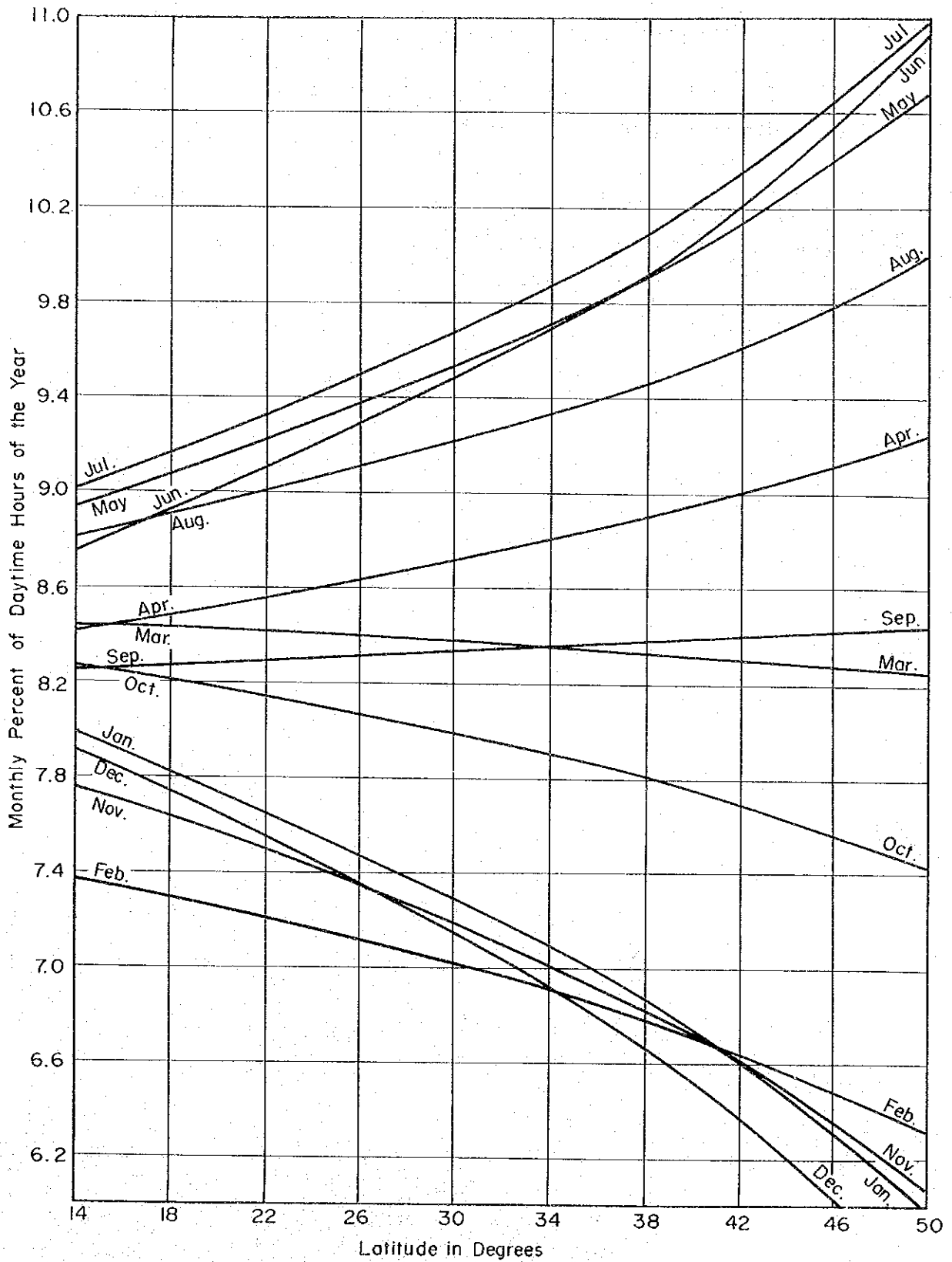


Fig. 2.1 Percent of Annual Sunshine Hours Occurring During the Indicated Month

Table 2.1 Daytime Ratio, ref. (1)

(Unit: 12 hr/day)

Lat. N.	10	18*	20	24	26	28	30	32	34	36	38	40	42	44	46
Mon.															
JAN	0.965	0.929	0.920	0.899	0.889	0.878	0.867	0.855	0.843	0.830	0.817	0.802	0.787	0.770	0.752
FEB (28)	0.982	0.961	0.956	0.941	0.935	0.929	0.922	0.915	0.908	0.900	0.893	0.884	0.875	0.865	0.855
FEB (29)	0.982	0.961	0.956	0.942	0.936	0.930	0.923	0.916	0.909	0.902	0.894	0.885	0.877	0.867	0.857
MAR	1.003	1.001	1.000	0.997	0.996	0.996	0.995	0.994	0.993	0.992	0.991	0.990	0.989	0.988	0.986
APR	1.026	1.044	1.048	1.055	1.060	1.065	1.070	1.076	1.081	1.087	1.093	1.100	1.107	1.115	1.123
MAY	1.045	1.079	1.087	1.104	1.114	1.123	1.134	1.144	1.156	1.167	1.180	1.193	1.208	1.223	1.240
JUN	1.055	1.096	1.106	1.129	1.141	1.153	1.166	1.180	1.194	1.209	1.225	1.242	1.261	1.280	1.302
JUL	1.051	1.088	1.097	1.118	1.129	1.140	1.152	1.164	1.177	1.191	1.206	1.221	1.237	1.255	1.274
AUG	1.034	1.057	1.063	1.077	1.084	1.091	1.098	1.106	1.114	1.123	1.132	1.141	1.151	1.162	1.174
SEP	1.012	1.017	1.018	1.022	1.024	1.025	1.027	1.029	1.031	1.033	1.035	1.037	1.039	1.041	1.045
OCT	0.990	0.975	0.971	0.964	0.960	0.956	0.952	0.947	0.942	0.938	0.932	0.927	0.921	0.915	0.909
NOV	0.970	0.937	0.929	0.913	0.904	0.895	0.885	0.875	0.865	0.854	0.842	0.830	0.817	0.803	0.787
DEC	0.960	0.919	0.909	0.887	0.875	0.863	0.850	0.838	0.824	0.809	0.794	0.778	0.760	0.742	0.721

Note: \*; Lat. 18°N. was interperated

### 3. Sedimentation

#### 3.1 Geology in the project area

The project area stretches from North to South with distance of 160 km while from West to East with 30 to 50 km width, covering catchment of 6,000 km<sup>2</sup>. In the area, rugged topography in youthfulness is widely seen.

The area is mainly composed of sedimentary rock of Paleozoic and Mesozoic age, and granite of Mesozoic age. The ground is covered in most area by laterite which is generally formed by weathering in humid and high temperature region.

#### 3.2 Sediment

Due to the laterite covering the ground, eroded and flowing material in the river is very fine. In other words, the river flow contains suspended load. On the other hand, since the river gradient is rather mild and river flow is relatively slow, bed material would not be very involved in the flow. Measurement of suspended load has been conducted at three gaging stations along the river. But one gaging station was omitted because it measures on a tributary. Instead, a measurement on the Moei river was taken into account.

##### (1) Density of sediment deposit

The following equation gives an average density of sediment deposit after t years.

$$W_{av.} = W_1 + 0.434 K \left[ \frac{t}{t-1} (\ln t - 1) \right] \quad \text{ref. (1)}$$

where  $W_{av.}$  = Average density of sediment deposit after t years.

$W_1$  = Initial density of sediment deposit shown in the table below.

K = Coefficient

t = Years

Table 3.1 Initial Density and Coefficient

(Unit: lb/ft<sup>3</sup>)

Reservoir Operation	Sand (>0.05 mm)		Silt (0.005 to 0.05 mm)		Clay (0.005 mm)	
	W <sub>1</sub>	K	W <sub>1</sub>	K	W <sub>1</sub>	K
Sediment always submerged or nearly submerged	93	0	65	5.7	30	16.0
Normally a moderate reservoir drawdown	93	0	74	2.7	46	10.7
Normally a considerable reservoir drawdown	93	0	79	1.0	60	6.0
Reservoir normally empty	93	0	82	0.0	78	0.0

For a hundred year sedimentation, the following densities were derived

Table 3.2 Average Density after 100 years

(Unit: gr/cm<sup>3</sup>)

Reservoir Operation	Sand	Silt	Clay
	W <sub>100</sub>	W <sub>100</sub>	W <sub>100</sub>
Sediment always submerged or nearly submerged	1.490	1.185	0.886
Normally a moderate reservoir drawdown	1.490	1.254	1.008
Normally a considerable reservoir drawdown	1.490	1.291	1.113
Reservoir normally empty	1.490	1.313	1.249

In this study stage, no information is available for composition of sediment deposit in Nam Yuam reservoir. Therefore, an average figure of the said densities could be employed, i.e. 1.30 gr/cm<sup>3</sup>.

(2) Estimation of sediment

Using the average density derived above, the suspended load measured in weight at gaging stations was converted to load in volume. At the same time the amount of load was expressed by form of specific discharge.

In addition, bed load was considered, referring other report. The report of Lower Quae Yai Environmental and Ecological Investigation mentions 10% of bed load against suspended load in terms of volume, while the Feasibility Study Report of Upper Quae Yai mentions 20% thereof. In this report, thus, it is decided to consider 20% of bed load against suspended load in terms of volume.

Consequently, following sediments are estimated at each gaging stations.

Sop Han	(C.A. = 2,496 km <sup>2</sup> )	136.2 m <sup>3</sup> /km <sup>2</sup> /yr
Ban Tha Rua	(C.A. = 5,770 km <sup>2</sup> )	109.6 m <sup>3</sup> /km <sup>2</sup> /yr
Tha Song Yang	(C.A. = 8,360 km <sup>2</sup> )	196.9 m <sup>3</sup> /km <sup>2</sup> /yr

Finally the specific sediment discharge of 140 m<sup>3</sup>/km<sup>2</sup>/yr which is conservatively obtained by enlarging the figure at Sop Han has been adopted in this study.

Therefore, the total amount of sediment deposit is estimated to be  $82.9 \times 10^6$  m<sup>3</sup>

$$140 \times 5,920 \times 100 = 82.9 \times 10^6$$

This sediment occupies only 18.6% of total storage volume of the reservoir. Assuming horizontal surface of deposit, sediment level becomes EL.129.0 m.

References

- (1) Davis, Sorensen "Handbook of Applied Hydraulics" McGraw-Hill, 1969
- (2) SETEC, "Environmental and Ecological Investigation of L.Q.Y. Project" Vol.II : Main Report, 1978. Aug.

- (3) JICA, "Feasibility Study Report of U.Q.Y. Project" Vol.I :  
Main Report, 1980 Jun.