The Kingdom of Thailand

Electricity Generating Authority of Thailand

UPPER QUAE YAI HYDROELECTRIC DEVELOPMENT PROJECT FEASIBILITY REPORT

Volume 3

(APPENDIX 2 and 3)

June 1980

Japan International Cooperation Agency
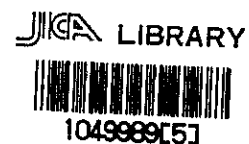
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APPENDIX 2

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CHAPTER 1   GEOLOGY

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RESERVOIR GEOLOGY

1.   Introduction

The Upper Quae Yai project is located at the upstream area of the Quae Yai River and the location of the proposed damsite is about 141 km from Srinagarind dam.

The main figures of the Nam Chon reservoir are as follows:

Height of Dam	185 m
Normal High Water Level	370 m
Catchment Area	4,908 km^2
Reservoir Surface Area at Normal High Water Level	137 km^2
Total Storage Capacity	5,975 x 10^{6}m^3

As various karstic rocks are found in the reservoir area, the geological studies mentioned later have been done to ensure the reservoir watertightness.

The field geological investigation in the reservoir area was carried out by the cooperation team with EGAT geologists and the geologists dispatched by the Japanese Government.

All geologists participated in the investigation would express our thanks to Mr. Srid Aphaiphuminart, Director of Planning Department, EGAT and all other engineers of Planning Department, because people in the Department assisted us very much to execute the work smoothly.

Terms of Field Investigation and participated Geologists are as follows:

* April – July, 1978 and December, 1978 – May, 1979.

* Geologist dispatched by Japanese Government	EGAT Geologist
Yozo Fukutake	Peel Chitakarn
Mamoru Yamada	Panpong Karnchanpan

2. Conclusion

The reservoir watertightness is ensured for the following reasons.

a) The formations comprising the backbones of the eastern and western water-sheds consist of non-calcareous rocks. These rocks can serve as reliable barriers against leakage to other river basins.

b) Formation D which is considered as a risky rock with respect to leakage is widely distributed in the northeast part of the catchment area. However, the width of the distribution gradually dwindles from the left bank (east side) of the damsite, and at a place on the left bank at an elevation of approximately 700 m, the distribution vanishes. Therefore, this Formation D as a whole is enclosed by Formation A, B and C of which the watertightness is ensured.

c) Formation D distributed at other than the above location, especially Formation D distributed at the right bank of the damsite is at an elevation above high water surface level of 370 m. Furthermore, Formation D seen at the right bank approximately 5 km upstream of the damsite continues down below the reservoir water level, but the thickness is small, and the boundary between Formation D and the underlying Formation B is judged to be higher than the high water surface level as a result of geological investigations in the field.

d) Swallets have not been found in strata other than Formation D, while running water is seen throughout the year at main gullies having formations other than Formation D as their basement rocks. This means that formations other than Formation D, even if calcareous, have sufficient resistance against karstic erosion, and that adequate watertightness is possessed as a whole.

e) According to results of chemical analyses of rock samples taken from the various formations, as indicated in Table 1-4, there are fairly large differences in the $CaCO_3$ and $MgCO_3$ contents of samples from Formation D and other formations. These differences in contents indicate that compared

with Formation D, Formation A, B and.C have stronger resistance against karstic erosion.

f) On comparisons of SiO_2 contents of rocks, the samples from Formation D have less than 1%, whereas samples from other formations have more than 5%. Other than SiO_2 content, according to microscopic observation of the rocks, a layer arrangement of SiO_2 mineral of thickness of several milli-meters is seen in the calcareous sandstone of Formation B. And, according to results obtained from drillholes, karstic erosion has not progressed to deeper parts in Formation B at the left bank of the damsite. By this, it can be evaluated that the above-mentioned SiO_2 content and mineral arrange-ment possess strong resistance against karstic erosion.

3. Method and Area Investigated

The reservoir area is very steep topography and covered by jungle. In addition to such hard conditions, poor accessibility and some security problems restricted the field investigations, accordingly photo geological investigation, topographical studies and geotectonic judgments were fully used as listed below. The field survey was carried out at the area where we could go in and for the area where could not go in, the downstream area where the formations at the upstream area of the reservoir are geotectonically continued has been investigated.

List of Method

a) Photo-geological interpretation
   - About 5,000 km^2 - whole catchment area including about 30 km downstream of proposed damsite.
   - Scale of Photo 1 : 50,000, 1 : 15,000 (partially)

b) Summit level analysis
   - Same area as photo interpretation.
   - 1 : 50,000 scale map.

c) Drainage pattern analysis
   - Same area and same scale map as summit level analysis.

d) Field survey

    - From No. 9 site to 30 km downstream of the proposed damsite including from main river to El. about 900 m of both banks.

    - 1 : 5,000 scale maps enlarged from 1 : 50,000 maps.

e) Chemical analysis of rock and water sample.

4.   Data and Previous Investigation

a)   Geological Map of Thailand   1 : 1,000,000

        1969, by Department of Mineral Resources

b)   Geological Map of Kanchanaburi Province.   1 : 250,000

        1971, by German Mission

c)   Quae Yai No. 1 Project, Geological Investigation of Reservoir Area.

        1972, by EPDC for EGAT

d)   Geological Map, Sheet No. ND 47-7 and ND 47-3

        (East side of the project area)   1 : 250,000

        1976, by Department of Mineral Resources

e)   Photo-Geological Interpretation for Upper Quae Yai Project   1 : 50,000

        1978, by UNEX for EGAT

f)   Restudy of photo-geological interpretation for the whole catchment area and some field investigation surround No. 5 and Nam Chon damsite were carried out on April - August, 1978 by Expert dispatched from Japanese Government and EGAT's geologists - See Preliminary Report Upper Quae Yai Project Report No. 846-2112, August 1978 and Geology of Damsite Area Upper Quae Yai Project Report No. 842-2116 December 1978.

g)   Site inspection by IBC (International Board of Consultant) was carried out on January and on November 1979. The reports were submitted.

5. Topography

The catchment area of the Upper Quae Yai project is 4,980 km² and it is defined by N.L. 16°30' at the upstream end and by N.L. 15°10' at the downstream end approximately. The East Longitude 98°55' is nearly the center line of the catchment area and its widest width is about 60 km.

Whole reservoir area is covered by the dense jungle and shows the steep topography, especially along the main river. The Quae Yai river in the reservoir area, though meandering partially, flows straightly from NNW to SSE direction in accordance with the prominent direction of the mountainous structures.

The mountain range of the eastern divide is generally higher than the western divide which borders to the Quae Yai river and the elevations of this mountains at the eastern and at the western divide are from about 1,200 m to about 2,000 m and from 1,000 m to about 1,800 m respectively. Besides, the average elevation of the mountainous area between both of the divides and the main river is about 700 - 1,000 m.

The remarkable karstic phenomena are seen at the eastern half of the catchment area.

The topography of the reservoir area is divided into two areas as follows:

a) The area along main river

The topography along the main river excepting the area around the junction between the main river and the Mae Chan river is quite steep and the slope angle at both banks is generally 45° to 60° or steeper. Many rapids and many cliffs are formed in this area, accordingly, basing on the topographic map of 1 : 5,000 scale enlarged from 1 : 50,000, the width of the reservoir water surface at El. 370 m is more or less 420 m in average.

b) The area along Mae Chan River

The river banks along the Mae Chan river including the main river of some certain km downstream from the junction with the main river become wide suddenly. The widest width of the reservoir surface is about 7 km basing on the same map of 1 : 5,000 scale. The topography in this area is hilly plain with gentle unduration and the river terrace topography is wall formed.

6.   Morphological Analysis based on Summit Level Map

A summit level map is a topographic map which reproduces the topography of a certain age - old topography - by subdividing a certain region into portions of equal area and connecting the points of highest elevation in the subdivisions. The aim is to make comparison studies of this old topography and the present topography to obtain information concerning resistance to erosion, geologic structure, upheaval, etc. of bedrock.

The summit level map having every 100 m contour lines made for the Upper Quae Yai Project area was obtained by subdividing into grids of 1 km^2 on a 1/50,000 topographic map.

(1)   Topographic Classification by Summit Level Map

The heights of elevations, the densities of contour lines spacings (degree of slope) and the directions of contour lines on the summit level map were considered and the project area was grouped into the following three topographic division (see Fig. 1-2).

        Group I Area   - Mountain body having watershed
        Group II Area   - Mainstream and major tributaries
        Group III Area - Area between Group I and II

(2)   Characteristics of Areas

        Group I Area   - Elevations from 900 to 1,800 m, contour line spacings not
                          more than 1 cm, with NNW-SSE predominant direction.

        Group II Area   - Elevations from 300 to 800 m, contour line spacings generally
                          not more than 1 cm, but 2 - 7 cm at parts. Contour lines
                          predominant in NNW-SSE direction.

        Group III Area - Elevations from 700 to 1,000 m, contour line spacings mostly
                          around 2 cm and 3 to 7 cm. Areas of this claccification are
                          so-called peneplain areas, and the greatest number of dolines
                          in the Upper Quae Yai Project area is distributed in these
                          areas. The distribution frequency is higher than 75% as
                          indicated in Fig. 1-5.

(3)   Considerations

a)   The foundation rocks which are widely distributed in Group III areas and
      underlain Formation D are severely folded, but this is not prominently
      shown in the summit level map. From this, it can be surmised that folding
      ended prior to the peneplanation of Group III areas.

b)   At the vicinity of the confluence of the Quae Yai and Mae Chan river where
      the width of the reservoir is greatest and along the Mae Chan river (Area
      F, see Fig. 1-2), it is estimated there is distribution of a Tertiary formation
      consisting of sand, gravel and silt. This formation is not seen in peneplain
      of Group III areas. This type of formation has been confirmed to be distri-
      buted inside the Srinagarind Reservoir area.

c)   The river topography along the mainstream from approximately 20 km
      upstream of the Nam Chon damsite to approximately 10 km downstream
      shows a gorge. In this area the difference in elevation between the present
      topography and the old topography is approximately 800 m. This indicates
      that this area in a certain geological was heaved up and then (until the
      present) subjected to severe down-cutting erosion.

d)   From the geologic conditions of b) and c), it is judged that as a whole the
      Mae Chan river basin is subsiding and the Nam Chon damsite surroundings
      are heaving up, and it is considered there is a strong connection between
      the previously-mentioned Tertiary deposit and this subsidence of the
      basement.

7.   Geology

(1)   General Geologic Structure

The geologic structure in the catchment area of this Project is roughly divided
into two tectonic provinces which is formed by the tectonic line consisted of the
several faults group locating along the mountain range of the eastern divide and
having the direction of NNE-SSW. The direction of folding and faults at both areas
divided by this tectonic line is changed as follows:

* Their directions at the eastern side (along Huai Kha Khaeng) of this tectonic line show N-S or NNE-SSW.

* However, the directions at the western side (whole catchment area) of this tectonic line are changed to NW-SE.

(2)   General Geology

The outline of the reservoir geology based on the general geologic sequence (Table 1-1) is explained hereinafter, however, as the river deposit, the talus deposit and the land slide in this area are not remarkable due to the steep topography, the expalnations for them are eliminated on this report.

(a)   Metamorphic Rock

This rock distributes mainly at the mountain ranges of both divides and another distribution of this rock (semi schist) is found about 20 km downstream of the proposed damsite, in addition to them, some part of alternation of calcareous sandstone and shale belonging to Formation B, for instance, about 3 km upstream of the proposed damsite, is metamorphosed to schist.

Most of the metamorphic rocks confirmed at the field is estimated to be clastic sediment origin. They are mainly schist or phyllite, however, the grade of the metamorphism is variable in places. The metamorphism in this area is estimated so as to have close relation to intrusion of Granite taking its distribution into consideration and the origin rock of the schist is assumed to be mainly Formation A.

Judging from engineering geological point of view, this schist is quite available as a barrier to prevent the leakage water from the reservoir to another catchment area.

(b)   Formation A

Formation A is estimated to be the oldest rocks in the Project area and its distribution is remarkably found along the east foot of the eastern divide, that is, along the major tectonic line mentioned in (1). Furthermore, this formation is continued from the eastern divide of Srinagarind reservoir which is located at the

downstream of this Project and is impounding now.

Formation A consists of mainly quartzite, locally sandstone, slate and schist. They are quite hard and have well watertightness as a foundation rock of a big reservoir as we have experienced at Srinagarind reservoir.

(c)   Formation B

Formation B is covering Formation A in conformity and main distribution of this rock is found around the proposed damsite, at the west side mountainous area, along the main river near the junction with the Mae Chan river and along the eastern divide contacted with Formation A.

Formation B is mainly consists of calcareous sandstone and alternation of calcareous sandstone and shale. The remarkable character of this rock around the proposed damsite is as follows:

Lower part :   Fine alternation of calcareous sandstone and shale, locally like schist

Middle part :   Massive calcareous sandstone, but shows remarkable banded structure

Upper part :   Massive calcareous sandstone and less banded structure than middle part

The chemical component of this rock collected at the damsite is as follows:

$CaCO_3$, $MgCO_3$ 74%, SiO_2 20%, Others

And, according to the microscopic observation, alternated pattern of $CaCO_3$ and SiO_2 is clearly seen with the thickness less than several mm.

As regarding the engineering geological judgement of this formation, the watertightness of this formation is ensured by the following data:

* According to the photo-geological interpretation, few dolines of small scale are formed in this formation, at the eastern area of the proposed damsite, but their elevation is higher than 1,000 m. Excepting this area, no any doline is formed at this formation of the catchment area.

* Two rock massess of this formation which will be submerged in the reservoir water have not any doline and even some small cavities are found on the outcrop at the proposed damsite, the cavities are only limited within several meters from the ground and no any karstic erosions are found in the deeper part basing on the results of the drill holes at the damsite.

(d)   Formation C

Formation C is covering Formation B in conformity. The distribution of this rock is found at almost whole project area excepting the area of metamorphic rock and Formation A at both divides.

Formation C consists of sandstone, calcareous sandstone, shale, conglomerate, impure limestone, etc. The conglomerate of this formation is different from the conglomerate in Formation D mentioned later, because the gravels of this conglomerate (Formation C) consist of pebbles of quartzite, sandstone and slate.

Formation C is the basement rock of Formation D which is pure karstic limestone or dolomite estimated to be high permeable, accordingly this formation will be able to be used as a good barrier to prevent the leakage water through Formation D.

(e)   Formation D

Basing on the previous investigation data, this limestone has been classified as Rat Buri limestone belongs to upper carboniferous-permian of paleozoic era, however, during our field investigation, we could not find the key fossile to clarify the geologic age of this limestone and furthermore, according to the latest information for this limestone, this limestone may not belong to the geologic age said before.

Therefore, the geologic age of this formation is not mentioned in this report and we use the name of Formation D for this rock temporarily in this report.

Formation D is covering Formation C and other older formations with

angular unconformity, this formation distributes widely in the whole project area and will be submerged under the reservoir water at some places of the reservoir area such the place along the main river from about 5 km upstream of the junction with the Mae Chan river to the reservoir end.

Formation D mainly consists of pure limestone, cataclastic dolomite and dolomitic limestone, but reddish brown conglomerate and dark gray hard limestone contained shell fossiles are also found at many places in the project area.

Formation D is characterized as karstic limestone and many doline are formed in this rock area, therefore if this limestone distributes continuously from the reservoir area to the downstream area or to the outside of the catchment area, there are possibilities to leak the reservoir water through the doline or other karstic topographies. However, this formation in the reservoir area is enclosed by the other watertight formations as mentioned in 2 (Conclusion of Reservoir Watertightness).

(f)   Tertiary System

The distribution of tertiary deposit is observed at the place from 6 km downstream of the junction between the Quae Yai and the Mae Chan river to about 11 km upstream along the Mae Chan river with about 5 km width. This formation is not confirmed in the firld, but the same drainage pattern and the same topographical conditions are confirmed on the tertiary deposit area in the Srinagarind Reservoir by the photo geological interpretation.

The deposit is estimated consists of semi-consolidated silt, sand and gravels having horizontal bedding plane.

(g)   Granite

Basing on the existing data, the time of the intrusion of the granite in this area is estimated to be middle to late mesozoic. The biggest granite mass is found on the western foot of the west divide about 15 km west from the proposed damiste. And other small granite masses are found along the eastern divide.

As previously stated, the intrusion of granite has close relation to metamorphic rock and both of them are at the suitable locations to present the leakage

water to another basins.

8.   Running Water

Running water investigations were made during the dry season for the major
tributaries in the stretch from approximately 12 km upstream of Nam Chon Dam past
the damsite at approximately 25 km downstream.

The locations of running water, spring water and under flow streams are
indicated in Table 1-2 and Fig. 1-3. In the investigation area, springing and under
flow are seen at Huai Tong Thai located immediately downstream of the right bank
of the damsite and at tributaries located downstream of Huai Tong Thai, while such
phenomena are not seen at tributaries further upstream.

The characteristic phenomena in the present investigation are that the section
of approximately 7 km between the sinking point at El. 425 m at Huai Tong Thai and
the springing point at El. 100 m is an underflow section, that the water quantity at the
springing site seems to be larger than the disappearing quantity, and that the spring
points of the water sinking at Huai Du Hgae and Huai Pa Chi downstream of the above-
mentioned tributary have not been discovered, and when these phenomena are
considered, as described in the Clause of Damsite Selection, No. 5 damsite is un-
suitable because of the many unconfirmed factors from a geological standpoint.

For the area investigated, the states of running water at tributaries in the
vicinity of Nam Chon Dam are as indicated below.

	Name or Location of Stream	Running Water	Geology
1)	Huai Phra (9 km upstream) (Left Bank of Reservoir)	Yes	Formation C
2)	Huai Yai (7 km upstream) (Right Bank)	Yes	Formation B & C
3)	Stream; 4 km upstream (Left Bank)	No in the dry season	Formation B

Name of Location of Stream	Running Water	Geology
4) Stream; 5 km downstream (Left Bank)	Yes small in January	Formation B
5) Huai Tong Thai (600 m downstream) (Right Bank)	Yes in the Formation B area (higher El. 500 m) No in Rat Buri LS area (lower El. 420 m)	
6) Huai Nam Chon (2 km downstream) (Left Bank)	Yes	Formation B & C
7) Huai Dun Ngae (2.5 km downstream)	Yes at higher El. 600 m No at lower El. 600 m	Formation B Formation D
8) Huai Pachi (Branch of Dun Gae)	No at lower El. 680 m	Formation D

Km shows the distance from the Nam Chon damsite.

9. Chemical Analyses of Running Water

Chemical analyses were carried out on seven samples of river water and spring water taken from the vicinity of the damsite. The locations from which samples were collected and the results of the analyses are shown in Table 1-3 and Fig. 1-6. The following were disclosed as a result of these chemical analyses:

a) On looking at the relation between the geology of the flow channel and the Ca^{++}, Mg^{++} and HCO_3^- contents of the water samples, the sample from Locality No. 6 passing through Formation D contains the above-mentioned chemical components the mo-t, followed by Locality No. 9 (mainstream - Formation B, C, D) and Locality No. 12 (Huai Phra - Formation C). With Sample No. 12 as an exception, on the whole, samples from Formation B and C (Localities No. 5, 8, 10 and 11) do not have great differences in their contents of the above-mentioned components, and they are distinctly less than for the samples of Formation D.

b) Regarding the two samples from Huai Tong Thai on making comparisons of the above components, a great difference between the sample (No. 8) from

Formation B and the sample (No. 6) infiltrated through Formation D was indicated.

c)   With regard to pH, except for Sample No. 6, all samples indicated alkalinity with pH = 8.0 - 8.4, whereas No. 6 indicated pH = 7.63. On comparison of the two samples from the Huai Tong Thai, No. 8 and No. 6, the pH of the sinking Sample No. 8 of 8.18 is changed to pH = 7.63 of Sample No. 6 springing out. This phenomenon indicates that at present there are still resolution reactions of calcareous rocks going on at the under flow section in Formation D.

10.   Chemical Analysis of Rock

With the purpose of finding the carbonate mineral contents of rocks distributed in the Project area, quantitative analyses were made of rocks collected from the vicinity of the damsite. The samples analyzed were six from Formation D, three from Formation B, and one each from Formation C and A.

The components analyzed were CaO, MgO and SiO_2, with Al_2O_3 also analyzed for a number of samples. The results of the analyses are indicated in Table 1-4.

The samples from Formation D consisted 93 to 99% (by weight) of the two minerals of $CaCO_3$ and $CaMg (CO_3)_2$, with almost no other minerals contained, and especially, the content of SiO_2 was less than 1%. Formation B consists of 74 to 90% $CaCO_3$ and $CaMg (CO_3)_2$, and of the other minerals amounting to 26 - 10%, the quantity of SiO is 6 - 20%, a sudden increase compared with the samples from Formation D. According to field observations, Formation B consists of calcareous sandstone and sandy limestone of banded structure.

This banded structure of around several millimeters is due to the mineral arrangement of SiO_2 and $CaCO_3$, and the stratified arrangement of quartz particles, compared with Formation D, may be judged to have considerable influence on resistance against karstic erosion. The difference in resistance is prominently shown in the degrees of development of dolines and other karstic phenomena in the areas of Formation D and Formation B.

Appriximately 90% of Formation A consists of SiO_2, and the content of calcium carbonate is zero.

Microphotographs of rocks representing the various formations have been attached as references.

DAMSITE SECTION

1.   Introduction

Before starting the feasibility study, twelve (12) alternative sites were planned as the damsite for the Upper Quae Yai Project and they were evaluated from geological and civil engineering viewpoints during the preliminary and the pre-feasibility stage. Finally, No. 6 site (Nam Chon site) and No. 9A site were selected as comparative damsites for this Project and the pre-feasibility report concluded that Nam Chon damsite is superior to No. 9A site.

During the study mentioned above, the full attentions from geological viewpoints were paid to the comparison between the Nam Chan and No. 5 sites, because No. 5 site where is located about 1 km downstream of the Nam Chon site has the similar topographic conditions with the Nam Chon site.

However, as the conclusions of the comparisons between both sites, the Nam Chon site which has less unknown geologic problems was judged to be superior to No. 5 site.

The unknown geologic problems at No. 5 site are as follows:

2.   Limestone Mass at Right Abutment of No. 5 Damsite

The large limestone mass continuing from the upstream area and extending to the downstream area bordering with a fault distributes at the right abutment of No. 5 site. Caves and corrosion open cracks were often found in this rock mass by the field survey.

The limestone mass, if selected as a damsite, has serious foundation problems for the permeability and, to verify karstic erosions in the limestone mass, the ground water in this rock mass must be confirmed by drillholes. However, according to the drilling data at the Nam Chon site (No. 6 site), no groundwater has been confirmed in the same limestone mass located at the upstream area.

Moreover, judging from the surface geological conditions around No. 5 damsite, there are large possibilities so that remarkable karstic erosions such as underground

channels may be formed in the limestone mass.

Accordingly, fairly quantities of investigation works shall be executed on this rock mass and also, as mentioned in the IBC Report No.1 dated Feb. 1979, a treatment to prevent leakage must be considered for the wide area faced to Huai Tong Thai.

3. Underflow at Vicinity of Huai Tong Thai

Remarkable underflows are found along Huai Tong Thai and Huai Du Ngae, the submerging point (swallet) at Huai Tong Thai and at Huai Du Ngae are located at El. 420 m and El. 600 m respectively. The spring point of Huai Tong Thai has been confirmed at El. 200 m and the spring point was not found at Huai Du Ngae so far.

However, EGAT (Survey Division, Planning Department) carried out very useful test to survey underground channels by using Fluorescence on Feb. 9, 1980 and the following informations have been obtained.

a) The submerging water at Huai Du Ngae and Huai Pa Chi are joining to the spring point at Huai Tong Thai.

b) The linear distance between the submerging point at Huai Du Ngae and the spring point at Huai Tong Thai is about 5 km (shortest distance between two streams in about 2.5 km) and the travelling times of Fluorescence for about 5 km are 35 hours.

c) According to the following discharge data, the discharge (B) at the spring point is 50% to 90% larger than the total quantity (P + D + T) of three sub-merging points.

Flow Measurement at Huai Pa Chi, Huai Du Ngae & Huai Tong Thai

Period Jan. - Feb. 1980

Discharge - Litre/Sec.

Date	Huai Pa Chi (P)	Huai Du Ngae (D)	Upper Huai Tong Thai (T)	Total P-D-T	Lower Huai Tong Thai (B) (Spring point)	Remarks
Jan. 24, 1980	85	9	167	261	401(-54%)	Current
Jan. 27, 1980	79	8	155	272	407(-50%)	Meter :
Feb. 3, 1980	79	5	117	201	365(-53%)	Pigmy Type
Feb. 9, 1980	80	5	102	187	357(-90%)	
Feb. 10, 1980	79	6	111	196	369(-88%)	

4.   Estimation and Consideration for No. 5 Damsite

Judging from the above-mentioned data, the following estimation for the underground channels around Huai Tong Thai is obtained.

a)   Huai Du Ngae located at the downstream area of No. 5 damsite and Huai
      Tong Thai located in the reservoir of No. 5 dam are mutually connected
      with the underground channels.

b)   Judging from the travelling hours of Fluorescence, the gradient of the
      underground channels between both Huais is estimated to be very gentle
      and there are no any evidences that the elevation of the channels may be
      higher than the reservoir high water level of El. 370 m. Accordingly, a
      possibility to may leak the reservoir water through the underground
      channels can not be solved unless the route and the elevation of the channels
      are completly elucidated.

c)   Judging from the discharge at the spring point of Huai Tong Thai, the water
      is estimated so as to be gathered from many underground channels con-
      necting to the upstream and the downstream areas.

In addition to the underground channels, the limestone mass at the right abutment of No. 5 site is also important subjects which should be made clear as mentioned previously.

Therefore, considering geological problems remained at No. 5 site, the Nam Chon damsite (No. 6 site) which can avoid such problems was judged to be superior to No. 5 site and selected as the damsite of which the geological investigation works for the feasibility study shall been commenced.

Table 1 – 1   General Geologic Sequence of Upper Quae Yai Project Area

Era	Stratigraphic Unit	Rock	Main Distribution	Characteristic
Cenozoic	Quaternary to Tertiary System	Gravel, Sand, Silt and Clay	Junction between Mae Chan & Quae Yai	Moderately consolidated, horizontal bedding
	∿∿ Unconformity ∿∿			
Mesozoic	Intrusive rock Intrusion	Granite	at eastern & western divide	Medium to coarse biotite Granite
	Formation D	Massive pure LS (locally bedded), cataclastic Dolomite, Dolomitic LS, near base often Red Conglomerate	Many places, especially eastern half of catchment area, except both divides	Remarkable karstic phenomena, folded
	∿∿ Unconformit or Disconformity ∿∿			
Palaeozoic	Formation C	Shale, Sandstone, calcareous Sandstone, Conglomerate and thin impure LS. locally alternation	Whole project area	Thick deposit, folded
	Formation B	Banded calcareous Sandstone, banded sandy LS. alternation of Sandstone & Shale and locally lenticular LS.	Along main river including proposed damsite and other many places	Massive, folded, partially strongly folded and rock like Schist locally
	Formation A	Quartzite, Sandstone, Slate and like Schist	Along eastern divide and continuously from Srinagarind reservoir area	Very hard, thick deposit
	Metamorphic rocks	Schist and semi Schist	At both divides and about 20 km downstream of damsite	Locally show gneissose structure

Table 1-2　Data of Running and Ground Water

Locality No.	Distribution of Water	Topographic Situation and Name of River 1/	Elevation 2/ (m)	Geology	Date of Observation	Chemical Analysis	Remarks
①	Running water	Downstream, left bank, Huai Ong Thang Yai	Lower than 230*	Formation B, C	DEC 1978		Much water
Other	Spring and running water	Huai Ong Thang Lek, tributary of Huai Ong Thang Yai	SP. P. 220 / Lower than 220	'' B / '' C	'' / ''		''
Other	Running water	Tributary of Huai Ong Thang Yai	Upper than 230	'' A	''		A little water
②	Spring	About 20 km Downstream, right bank, stream of Quae Yai river	SP. P. 250	'' B	JAN 1979		Too much considering C.A. 3/
③	Spring and running water	Downstream, right bank, Huai Phru	SP. P. 340 / Lower than 340	'' B	'' / ''		Much water
Other	Running water	Downstream, left bank, Huai Thi Khong	Lower than 640	'' C	''		A little water
④	Running water and swallet	Downstream, right bank, Huai Du Ngae	Upper than 600 / SW. P. 600	'' C / '' D	'' / ''		Can not find SP. P.
⑤	Running water and swallet	Huai Pachi, tributary of Huai Du Ngae .	Upper than 690 / SW. P. 690	'' C / '' D	'' / ''	O	Much water / Can not find SP. P.
⑥	Spring and running water	Downstream, right bank, Hui Tong Thai	SP. P. 200 / Lower than 200	'' D / '' D	'' / ''	O	More water than ⑦ SW.P. & milky
⑦	Running water and swallet	''	Upper than 425 / SW. P. 425	'' C / '' D	'' / ''		Much water
⑧	Spring and running water	''	SP. P. 480 / Lower than 480	'' B / '' B	'' / ''	O	Much water
Other	Running water	Downstream, left bank, Huai Nam Chon	Lower than 300*	'' B	''		A little water
⑨	''	Quae Yai river at Nam Chon Damsite		'' B, C, D	APR 1979	O	
⑩	''	Upstream, right bank, Huai Yai	Upper than 250	'' B, C	JAN 1979	O	Much water
⑪	''	''	Lower than 550*	'' B, C	MAR 1979	O	''
⑫	''	Upstream, left bank, Huai Phra	Lower than 400*	'' C	JAN 1979	O	''

1/　Downstream & upstream show the location from the Nam Chon damsite.

　　Right bank & left bank show the location on the main river.

2/　SP. P. shows spring point.

　　SW. P. shows swallet point.

　　* ; No survey at more upstream than the elevation in the Table.

3/　C.A. shows catchment area.

Table 1-3   Chemical Analysis of Water Samples in Reservoir Area

Locality No.		⑤	⑥	⑧	⑨	⑩	⑪	⑫
Date of sampling		JAN 1979	JAN 1979	JAN 1979	APR 1979	JAN 1979	MAR 1979	JAN 1979
Locality		Huai Pachi EL.690 m	Huai Tong Thai EL.200m	Huai Tong Thai EL.480 m	Nam Chon damsite	Huai Yai EL.280m	Huai Yai EL.510m	Huai Phra EL.290m
PH		8.40	7.63	8.18	8.25	8.37	8.26	8.03
Carbonate (CO_3^{--})	p.p.m	4.8	0	2.4	4.8	7.2	4.8	1.2
	e.p.m	16.00×10^{-2}	0	8.00×10^{-2}	16.00×10^{-2}	24.00×10^{-2}	16.00×10^{-2}	4.00×10^{-2}
Bicarbonate (HCO_3^{-})	p.p.m	83	361	146	222	137	146	181
	e.p.m	1.36	5.92	2.39	3.64	2.25	2.39	2.97
Sulfate (SO_4^{--})	p.p.m	0.75	1.9	1.7	2.3	2.3	0.9	13.6
	e.p.m	1.56×10^{-2}	3.96×10^{-2}	3.54×10^{-2}	4.79×10^{-2}	4.79×10^{-2}	1.87×10^{-2}	28.32×10^{-2}
Chloride (Cl^{-})	p.p.m	2.0	3.0	3.0	2.0	3.0	2.0	3.0
	e.p.m	5.64×10^{-2}	8.46×10^{-2}	8.46×10^{-2}	5.64×10^{-2}	8.46×10^{-2}	5.64×10^{-2}	8.46×10^{-2}
Calcium (Ca^{++})	p.p.m	20.82	66.47	42.45	40.04	33.64	38.44	32.04
	e.p.m	1.04	3.32	2.12	2.00	1.68	1.92	1.60
Magnesium (Mg^{++})	p.p.m	4.37	13.60	5.34	21.86	8.74	6.80	20.46
	e.p.m	0.36	1.12	0.44	1.80	0.72	0.56	1.68
Hydroxyl radical (OH^{-})	p.p.m	0	0	0	0	0	0	0
	e.p.m	0	0	0	0	0	0	0

Table 1-4　Quantitative Analysis of Calcareous Rock

Locality No.	Locality	Rock Name	Result of analysis Composition	% (wt)	1/ Result of norm calculation Composition	% (wt)	2/ Result of norm calculation Composition	% (wt)	4/
①	Right bank near No. 8 site	Dolomitic limestone	CaO	51.6	CaCO₃	92.0	CaCO₃	87.2	1
			MgO	2.4	MgCO₃	4.5	CaMg(CO₃)₂	9.3	
			SiO₂	2.3	—	—	SiO₂	2.3	
			Al₂O₃	0.36	—	—	Al₂O₃	0.36	
		(Formation D)	Total	56.66	Total	96.5	Total	99.16	
②	Sink hole at left bank of Huai Tong Thai	Calcitic dolomite	CaO	35.1	CaCO₃	62.64	CaCO₃	19.93	2
			MgO	17.2	MgCO₃	35.98	CaMg(CO₃)₂	78.69	
			SiO₂	0.2	—	—	SiO₂	0.2	
	EL.470m	(Formation D)	Total	52.5	Total	98.62	Total	98.64	
③	Right bank of Huai Tong Thai	Dolomite	CaO	32.3	CaCO₃	57.64	CaCO₃	8.72	
			MgO	19.7	MgCO₃	41.21	CaMg(CO₃)₂	90.13	
			SiO₂	0.1	—	—	SiO₂	0.1	
	EL.250m	(Formation D)	Total	51.6	Total	98.85	Total	98.86	
④	Right bank of Huai Tong Thai	Dolomite	CaO	30.9	CaCO₃	55.14	CaCO₃	2.75	
			MgO	21.1	MgCO₃	44.13	CaMg(CO₃)₂	96.52	
			SiO₂	0.2	—	—	SiO₂	0.2	
	EL.430m	(Formation D)	Total	52.2	Total	99.27	Total	99.47	
⑤	Huai Du Ngae	Calcitic dolomite	CaO	30.8	CaCO₃	55.0	CaCO₃	14.6	
			MgO	20.3	MgCO₃	38.1	CaMg(CO₃)₂	78.5	
			SiO₂	1.3	—	—	SiO₂	1.32	
			Al₂O₃	0.33	—	—	Al₂O₃	0.33	
	EL.590m	(Formation D)	Total	52.73	Total	93.1	Total	94.73	
⑥	Left bank near No. 2 site	Dolomite	CaO	30.6	CaCO₃	54.61	CaCO₃	1.72	
			MgO	21.3	MgCO₃	44.55	CaMg(CO₃)₂	97.44	
			SiO₂	0.1	—	—	SiO₂	0.1	
		(Formation D)	Total	52.0	Total	99.16	Total	99.26	
⑦	Huai Pachi	Calcareous shale	CaO	2.2	CaCO₃	3.9			5
			MgO	1.8	MgCO₃	3.4			
			SiO₂	58.8	—	—			
			Al₂O₃	19.20	—	—			
	EL.790m	(Formation C)	Total	92.0	Total	7.3			
⑧	Left bank at Nam Chon damsite	Banded sandy limestone	CaO	39.3	CaCO₃	70.13	CaCO₃	65.42	7
			MgO	1.9	MgCO₃	3.97	CaMg(CO₃)₂	8.68	
			SiO₂	20.2	—	—	SiO₂	94.3	
		(Formation B)	Total	61.4	Total	74.1	Total	94.3	
⑨	Left bank near Nam Chon damsite	Banded sandy limestone	CaO	2.2	CaCO₃	64.6	CaCO₃	78.6	
			MgO	1.2	MgCO₃	2.3	CaMg(CO₃)₂	4.66	
			SiO₂	7.3	—	—	SiO₂	5.16	
			Al₂O₃	3.43	—	—	3/ CaAl₂Si₂O₈	9.45	
		(Formation B)	Total	59.33	Total	86.9	Total	98.07	
⑩	Huai Tong Thai	Banded sandy limestone	CaO	49.9	CaCO₃	89.1	CaCO₃	87.9	
			MgO	0.6	MgCO₃	1.13	CaMg·CO₃)₂	2.33	
			SiO₂	5.9	—	—	SiO₂	5.9	
			Al₂O₃	1.54	—	—	Al₂O₃	1.54	
	EL.480m	(Formation B)	Total	57.94	Total	90.23	Total	97.67	
⑪	Huai Ong Thang Yai (downstream of Nam Chon damsite)	Quartzite	CaO	0.0					10
			MgO	0.6					
			SiO₂	89.1					
			Al₂O₃	4.44					
	EL.250m	(Formation A)	Total	94.14					

1/　All CaO are calculated as CaCO₃ and all MgO are calculated as MgCO₃.

2/　All MgO are calculated as CaMg(CO₃)₂ and remaining CaO are calculated as CaCO₃.

3/　Al₂O₃ is calculated as CaAl₂Si₂O₈ (Anorthite) by way of example.

4/　Locality No. for micrograph of rock sample.

Quantitative Analysis of Limestone at Khao Laem Damsite (Quae Noi River)

Locality	Rock Name	Result of analysis Composition	% (wt)	Result of norm calculation Composition	% (wt)	Result of norm calculation Composition	% (wt)
Inside of gallery at right bank	Limestone	CaO	54.2	CaCO₃	96.72	CaCO₃	94.24
		MgO	1.0	MgCO₃	2.09	CaMg(CO₃)₂	4.57
		SiO₂	0.2	—	—	SiO₂	0.2
	(Formation D)	Total	55.4	Total	98.81	Total	99.01

Table 1-5　Micrograph of Typical Rock Sample

Locality No.	Locality	Rock Name	Remarks	1/
1	Near No. 8 site, 7 km upstream from Nam Chon damsite, right bank	Dolomitic limestone (Formation D)		①
2	Sink hole at left bank of Huai Tong Thai　　　　EL. 470 m	Calcitic dolomite (Formation D)		②
3	Right bank between No. 7 & No. 8 site	Limestone (Formation D)	Tiny fossil remains	
4	16 km downstream from Nam Chon damsite, left bank of Quae Yai R.	Calcareous sandstone (Formation C)		
5	Huai Pachi　　　　　　EL. 790 m	Calcareous shale (Formation C)		⑦
6	Huai Phra, 11 km upstream from Nam Chon damsite　　　　EL. 290 m	Conglomerate (Formation C)	Calcareous	
7	Left bank of Nam Chon damsite	Banded sandy limestone (Formation B)		③
8	Near No. 7 site, 4 km upstream from Nam Chon damsite, right bank	Phyllite (Formation B)	Original rock is alternation of sandstone & shale	
9	26 km downstream from Nam Chon damsite, right bank of Quae Yai R.	Slate (Formation A)	Non calcareous	
10	Huai Ong Thang Yai　　EL. 250 m 25 km downstream from Nam Chon damsite	Quartzite (Formation A)	Non calcareous	⑪
11	Upstream of Huai Yai	Schist (Metamorphic rock)	River gravel,	
12	22 km downstream from Nam Chon damsite, right bank of Quae Yai R.	Phyllite (Metamorphic rock)		
13	29 km downstream from Nam Chon damsite, river bank of Quae Yai R.	Granite		

1/　Number shows locality No. in Table-1-4

Locality: [1]

> Right bank of Quae
> Yai R. near No. 8
> site

Rock name:

> Dolomitic limestone
> Formation D
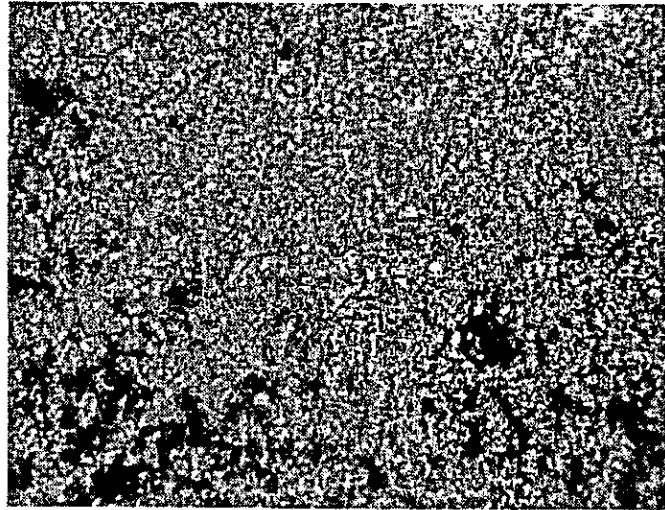
0   0.3mm   (open nicols)

Petrographic description:

> Light grey massive carbonate rock having white carbonate veins.

Locality: [2]

> Sink hole at left bank
> of Huai Tong Thai,
> EL. 470m

Rock name:

> Calcitic dolomite
> Formation D
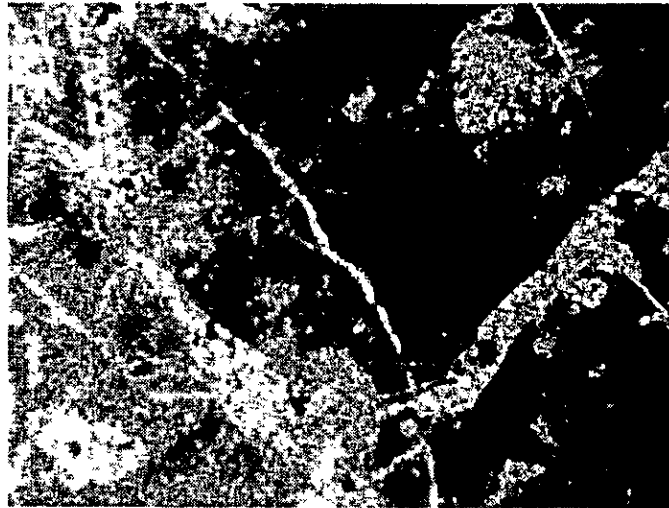
0   0.3mm   (crossed nicols)

Petrographic description:

> Grey massive carbonate rock having white carbonate veins, a few bearing
quartz.

Locality: 3

Between No. 7 and No. 8
site, right bank of Quae
Yai R.

Rock name:

Limestone
Formation D
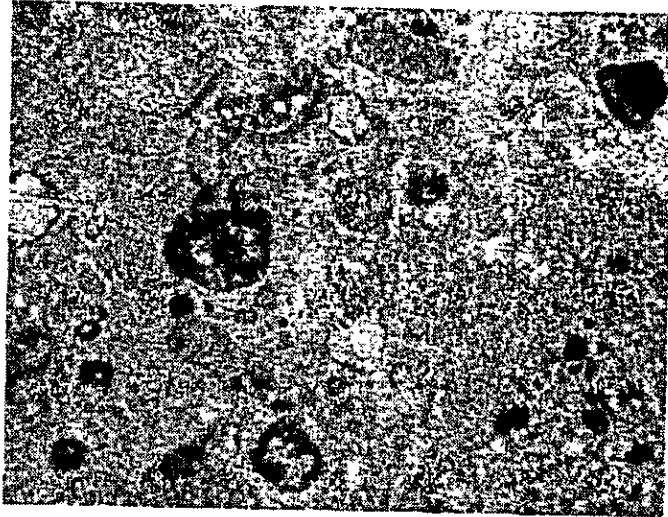
0   0.3mm   (open nicols)

Petrographic description:

Grey massive carbonate rock with some white carbonate veins and tiny fossil
remains.   Carbonate $\gg$ quartz

Locality: 4

16 Km down stream from
Nam Chon dam site, left
bank of Quae Yai R.

Rock name:

Calcareous sandstone
Formation C
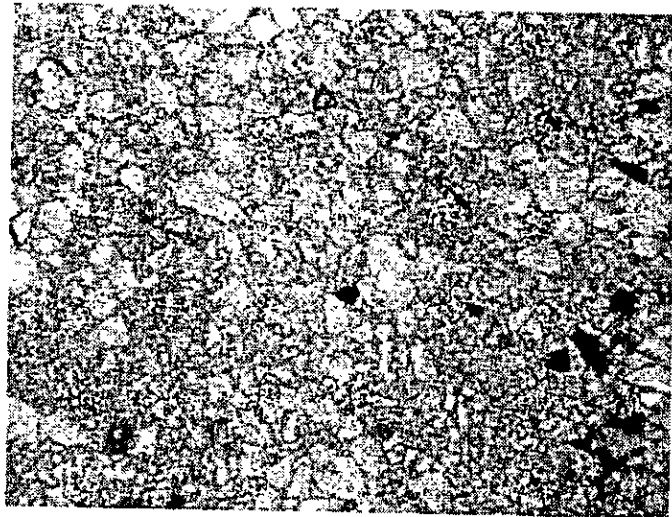
0   0.3mm

(open nicols)

Petrographic description:

Light brown carbonate-quartz clastic sediment.
Calcite = quartz $\gg$ hematite and chlorite

Locality: [5]

Huai Pachi, river bed

EL. 790m

Rock name:

Calcareous shale

Formation C
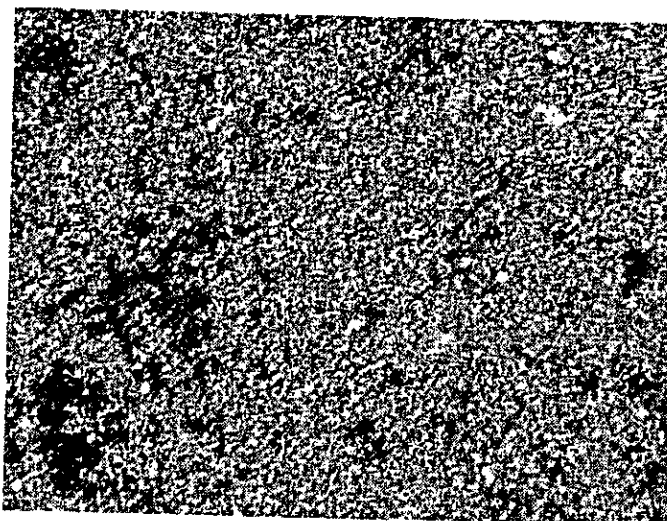
0   0.3mm   (open nicols)

Petrographic description:

Dark grey calcareous shale mainly composed of fine-grained quartz, chlorite, sericite and graphite.

Foliation has the direction from upper right to lower left in microphoto.

Locality: [6]

Huai Phra

EL. 290m

Rock name:

Conglomerate

Formation C
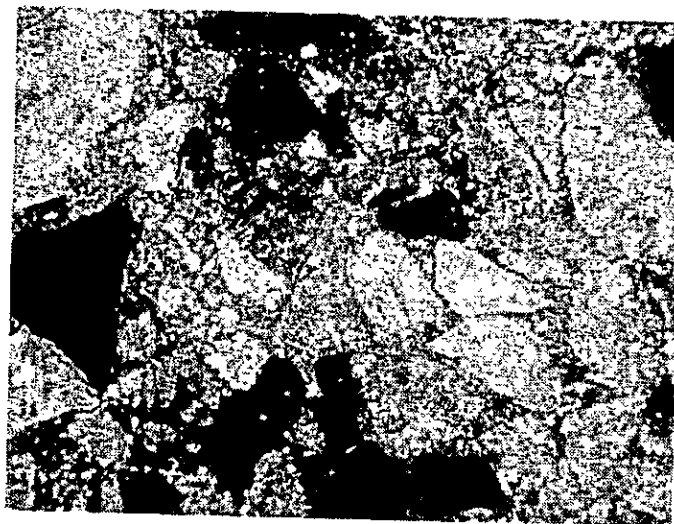
0   1.0mm

(crossed nicols)

Petrographic description:

Light grey brecciated rock composed of compacted fragments of limestone, carbonate-quartz sandstone and calcareous shale.

Locality: $\boxed{7}$

Nam Chon dam site;

left bank of Quae

Yai R.

Rock name:

Banded sandy limestone

Formation B
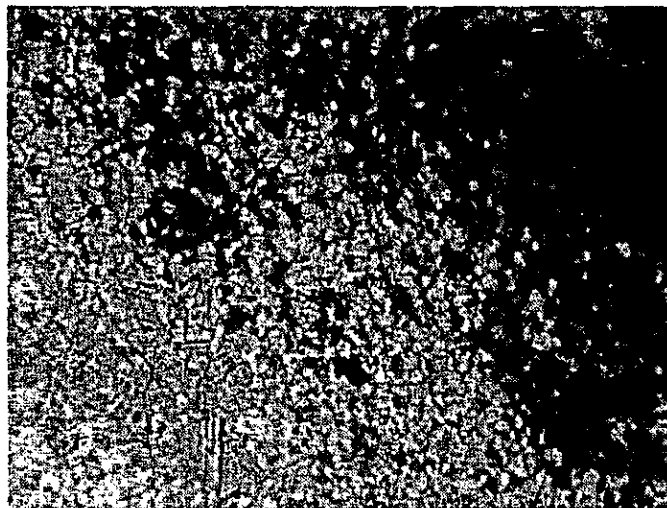
0   0.1mm

Petrographic description: (open nicols)

Pale grey banded sandy limestone composed of coarse sandy limestone part ($\phi \doteq 70\ \mu$, calcite $\gg$ quartz) and fine calcareous sandstone part ($\phi \doteq 20\ \mu$, calcite $\doteq$ quartz). Wholly altered at hydrothermal conditions with following results; recrystallization and equi-granulation of calcite, sericitization.

Locality: $\boxed{8}$

Near No. 7 site,

right bank of Quae Yai R.

Rock name:

Phyllite

Formation B
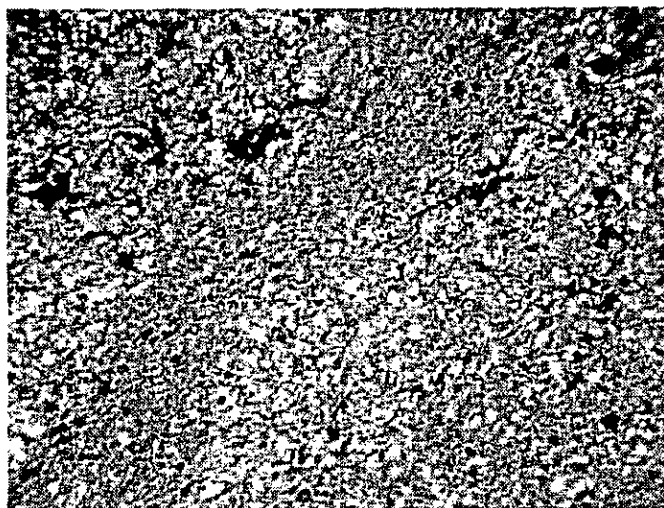
0   1.0mm

Petrographic description: (open nicols)

Original rock is alternation of sandstone and shale. Alternated phyllite composed of greenish grey slate (carbonate, chlorite, quartz $\gg$ graphite, sericite) and pinkish grey slate (carbonate $>$ quartz $\gg$ sericite, hematite). Foliation is observed from upper right to lower left in microphoto.

Locality: 9

26 Km downstream from
Nam Chon dam site, river
bank of Quae Yai R.

Rock name:

Slate

Formation A
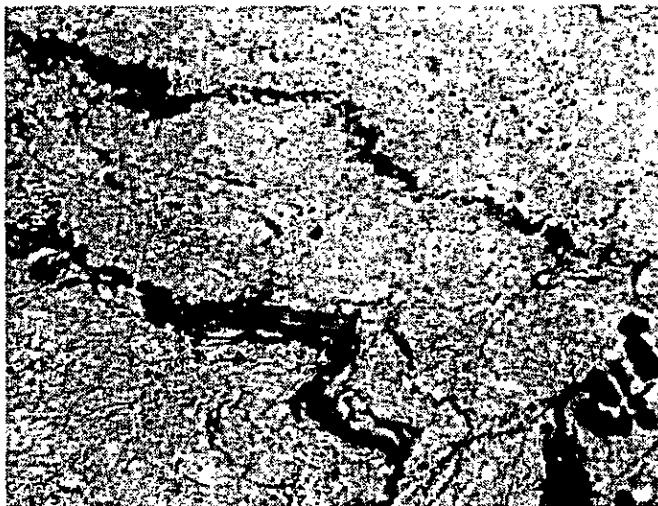
Petrographic description:

0 |___|___|___| 0.3mm   (open nicols)

Grey slate chiefly consisting of fine-grained quartz and sericite with small amounts of graphite, chlorite and plagioclase. No carbonate is observed.

Locality: 10

Huai Ong Thang Yai
EL. 250m

Rock name:

Quartzite
Formation A
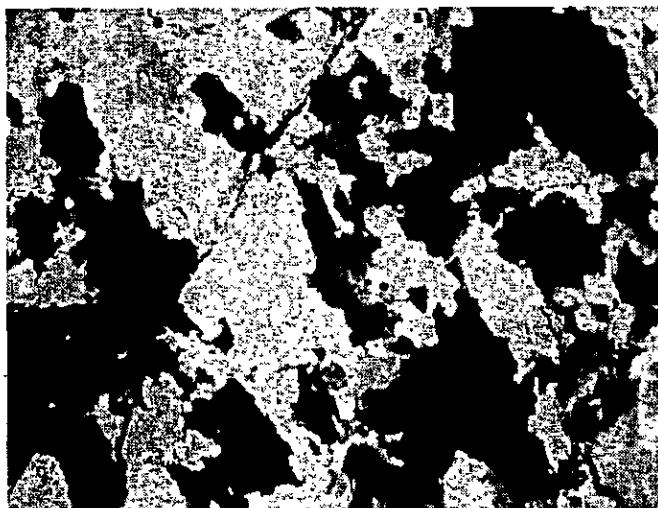
Petrographic description:

0 |_____|_____| 1.0mm   (crossed nicols)

Light grey hard siliceous rock. Chief constituting minerals are quartz ≫ plagioclase > sericite, chlorite.

Foliation formed by recrystallization is clear; indicating a type of siliceous metamorphic rock.

Locality: [11]

    Upstream of Huai Yai

Rock name:

    Schist (River gravel)

    Metamorphic rock

0   0.3mm

Petrographic description: (open nicols)

Greenish siliceous sediment having clear foliation (schistosity) and recrystallization texture.

Schistosity runs from upper right to lower left in microphto. Quartz $\gg$ chlorite, sericite, plagioclase > apatite

Locality: [12]

    22 Km downstream from

    Nam Chon dam site, right

    bank of Quae Yai R.

Rock name:

    Phyllite

    Metamorphic rock

0   0.3mm

Petrographic description: (open nicols)

Grass green phyllite composed of thin layers of calcareous band (carbonate, quartz $\gg$ chlorite, sericite) and siliceous band (quartz > chlorite, sericite, plagioclase, actinolite > graphite).

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Locality: [13]

29 Km downstream from
Nam Chon dam site, river
bank of Quae Yai R.

Rock name:

Biotite granite
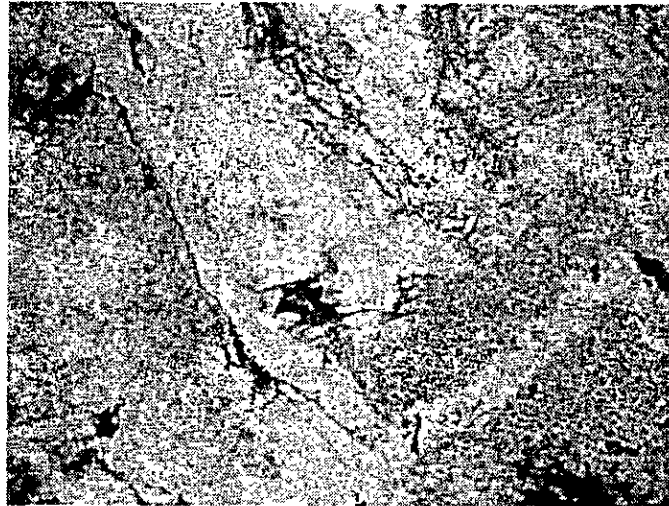
Petrographic description:

0   1.0mm   (open nicols)

Brownish hydrothermally altered biotite granitic rock. Wholly sheared and altered at hydrothermal conditions with the following results; chloritization of biotite, sericitization of K-feldspar, albitization of plagioclase, deformation and recrystallization of quartz.

Index map of
Upper Quae Yai Project

Nam Chon Damsite

Quae Yai River

Hual Thi Wo Su

Nam Wo Cha

NO.10
NO.9
NO.5
NO.8
NO.11
NO.0

LEGEND

Route of Geologic Mapping

2   Locality of Rock Sample for Micrograph

7   Locality of Rock Sample for Quantitative Analysis

5   Locality of Water Sample

Area of Aerialphoto Interpretation

NO.10   Location of Alternative Damsite

UPPER QUAE YAI PROJECT
GENERAL PLAN FOR ROUTE OF GEOLOGIC MAPPING AND LOCALITY OF SAMPLING

Fig. 1-1	Sep. 1979

Topographic Division	Group of Subdivision
I	A, B & C
II	D, E, F, G & H
III	I, J, K, L & M

Quae Yai River

Huai Thi Wa Su

Nam Mae Chon

Nam Chon Dam Site

◄ Z ◄

Distance from Nam Chon Damsite

Ban Thi Mong Kha

Nam Mae Chon

NO 11 Site

NO 9 & 10 Site

NO 8 Site

Nam Chon Dam Site

Camp Site

▽ 380 m

Elevation of Summit Level
(along the Quae Yai River)

Elevation of Present River Profile
(along the Quae Yai River)

Elevation

UPPER QUAE YAI PROJECT

TOPOGRAPHIC DIVISION
ON SUMMIT LEVEL

| Fig. 1-2 | Sep. 1979 |

3 — 35

LEGEND

Cenozoic	Tertiary system	Gravel, sand, silt and clay
Mesozoic	Granite	
Paleozoic	Formation D	Pure limestone, dolomite and dolomitic limestone, near base often red conglomerate, karst in some places
	Formation C	Shale, sandstone, calcareous shale, calcareous sandstone, conglomerate and thin impure limestone, locally alternation
	Formation B	Banded calcareous sandstone, banded sandy limestone and alternation of sandstone and shale
	Formation A	Quartzite, sandstone, slate and schist
	Metamorphic rocks	Schist and semischist

Strike and dip of strata
Strike and dip of fault
Fault (Assumed)
Axis of anticline
Axis of syncline
Axis of fold (assumed)

Geologic boundary
Sink hole
Swallet
Spring
Running water (This mark shows the locality number in the table of the report)

0   5   10km

UPPER QUAE YAI PROJECT

GEOLOGY

RESERVOIR AREA PLAN

| Fig 1 - 3 | March, 1980 |

3 — 37

SECTION A - A

Watershed
510
Huai Mae Lamung Tai
Quae Yai River
Nam Mae Chan
Watershed
460

SECTION B - B

Huai Phai Lom
Watershed
510
Quae Yai River
Nam Mae Chan
Watershed
470

SECTION C - C

Huai Ka Dam
510
Watershed
Quae Yai River
Watershed
470

SECTION D - D

510
Huai Ong Tong
Watershed
Quae Yai River
Huai Tong Thai
Huai Yai
Watershed
470

SECTION E - E

510
Huai Ong Thang
Quae Yai River
480

LEGEND

Cenozoic	○ ○	Tertiary system	Gravel, sand, silt and clay
Mesozoic	+ +	Granite	
		Formation D	Pure limestone, dolomite and dolomitic limestone, near base often red conglomerate, karst in some places
Palaeozoic		Formation C	Shale, sandstone, calcareous shale, calcareous sandstone, conglomerate and thin impure limestone, locally alternation
		Formation B	Banded calcareous sandstone, banded sandy limestone and alternation of sandstone and shale
		Formation A	Quartzite, sandstone, slate and schist
		Metamorphic rocks	Schist and semischist

Geologic boundary
Fault (actual)
(assumed)

0   5   10km
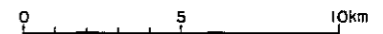
Note . The geologic section is drawn on a different scale for vertical and horizontal. The real topographic profile in natural scale is shown below each geologic section.

UPPER QUAE YAI PROJECT

GEOLOGY

RESERVOIR AREA PROFILE

Fig. 1 - 4   March, 1980

Fig. I-5 Numbers of Sink Holes

Top of Karst
EL. m

Numbers of Sink Holes
in Catchment Area
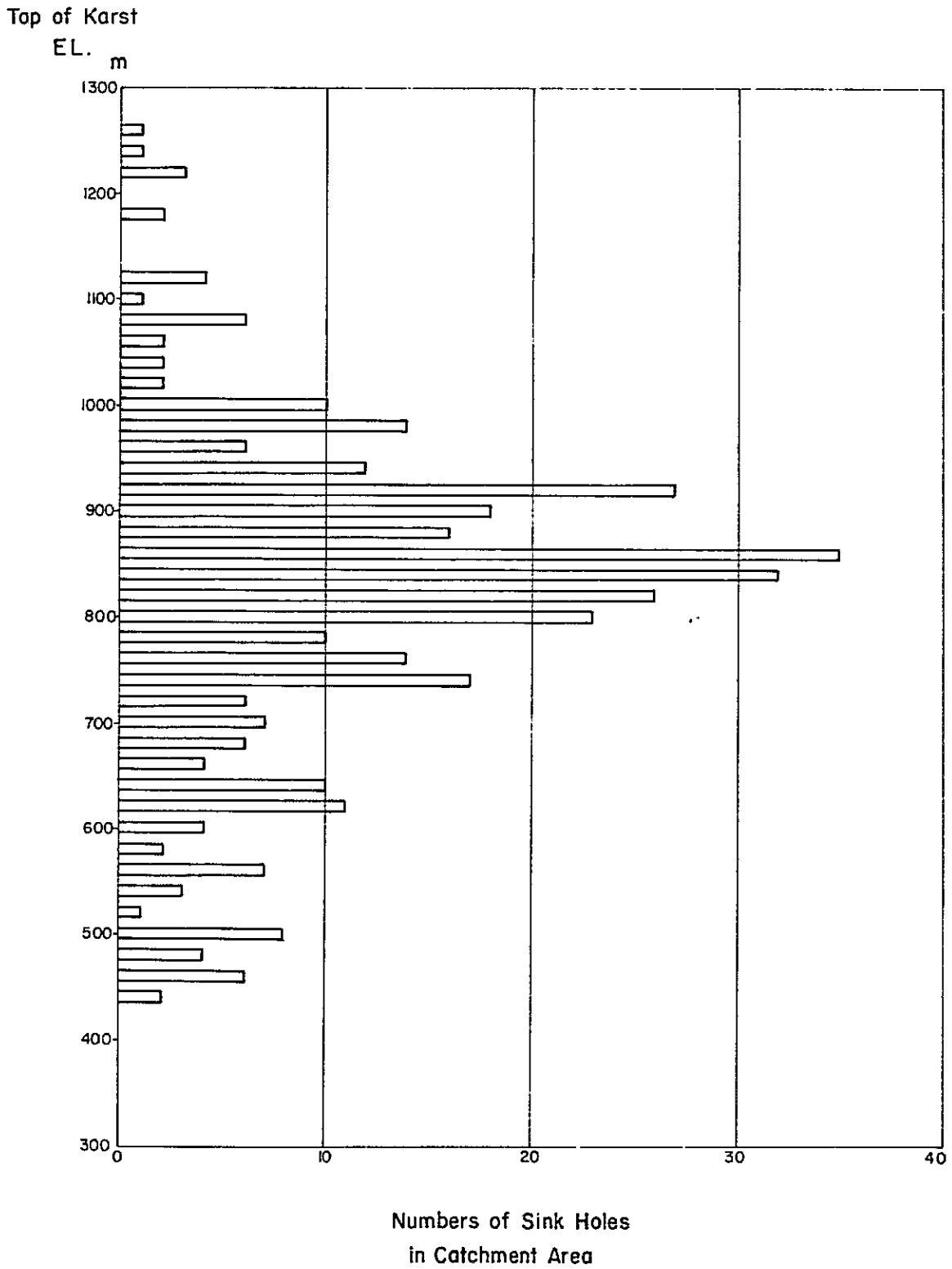
Fig. I-6. Chemical Character of Water Sample

500

LEGEND

Mesozoic	Formation D	Pure limestone, dolomite and dolomitic limestone, near base often red conglomerate, karst in some places
	Formation C	Shale, sandstone, calcareous shale, calcareous sandstone, conglomerate and thin impure limestone, locally alternation
	Formation B	Banded calcareous sandstone, banded sandy limestone and alternation of sandstone and shale
Paleozoic	Formation A	Quartzite, sandstone, slate and schist (This formation doesn't crop out in this mapped area)
	Metamorphic rocks	Schist and semischist

Strike and dip of strata

Strike and dip of fault

Fault (assumed)

Axis of anticline

Axis of syncline

Axis of fold (assumed)

Geologic boundary

Sink hole

Swallet

Spring

Running water (This mark shows the locality number in the table of the report)

Formation D at the vicinity of Nam Chon dam site

Huai Lel
Thi Khong Dam Site
Nam Chon Dam Site
EL 200 m
EL 425 m
EL 600 m EL 690 m
EL 460 m

SECTION A - A
1500m 1000 500 0
499
Huai Phra
Quae Yai River
Huai Tong Thai
482
1500m 1000 500 0

SECTION D-D
1500m 1000 500 0
Quae Yai River   Quae Yai River   E
A   B
1500m 1000 500 0

SECTION B - B
1500m 1000 500 0
499
Huai Phra   Huai Nam Chon   Quae Yai River   Huai Tong Thai
482
1500m 1000 500 0

SECTION C - C
1500m 1000 500 0
499
Quae Yai River   Huai Pa Chi Huai Du Ngae
482
1500m 1000 500 0

UPPER QUAE YAI PROJECT

GEOLOGY
PLAN AND PROFILE
VICINITY OF DAMSITE

Fig I - 7   March, 1980

3 - 43

LINE IV

LINE III

LINE II

LINE V

LINE VIII

LINE VI

LINE III'

LINE I

LINE VII

LEGEND

Talus deposit

Thickness of layer (m)
Distance marks
Geophone station
Seismic velocity (km/sec)

0   200 m
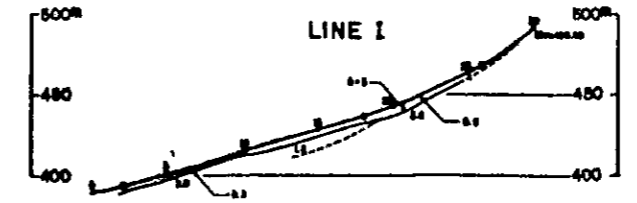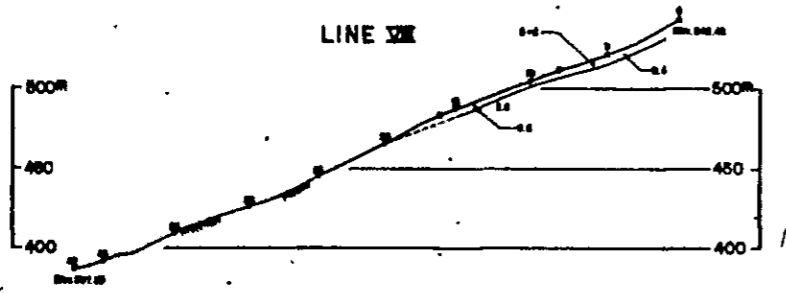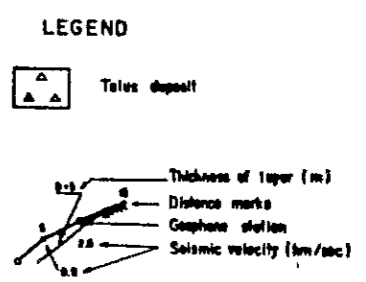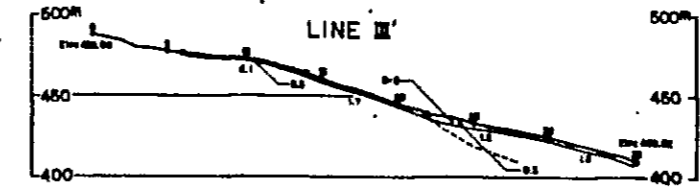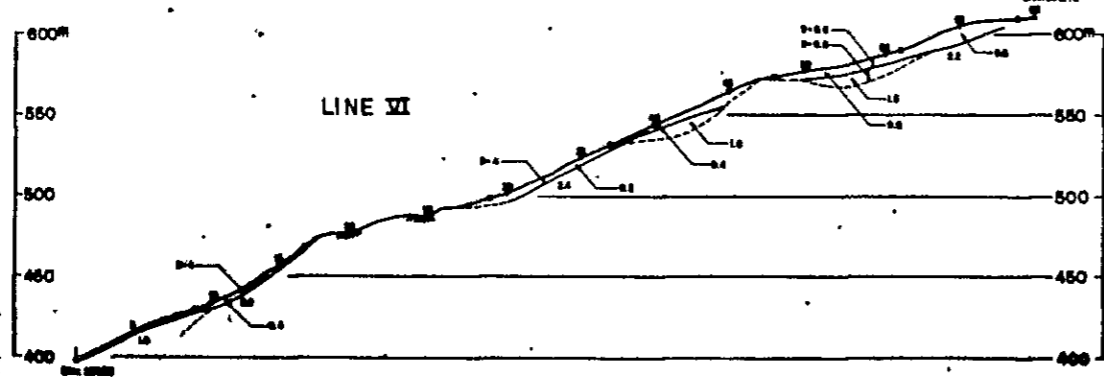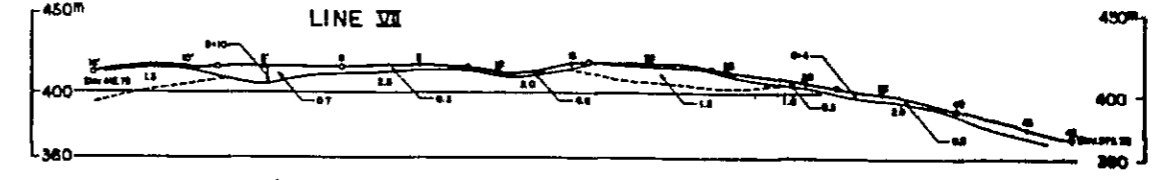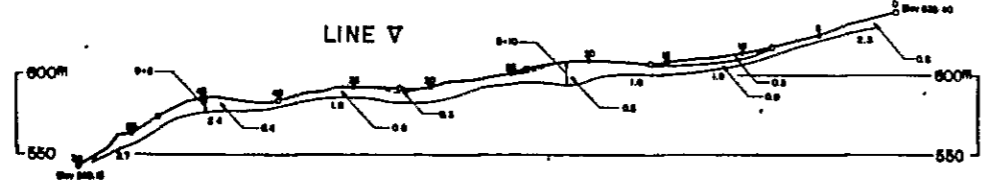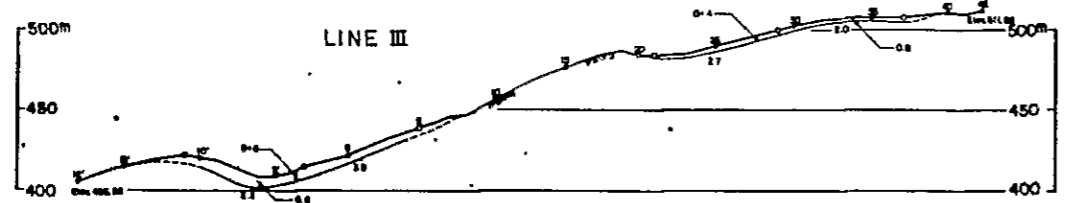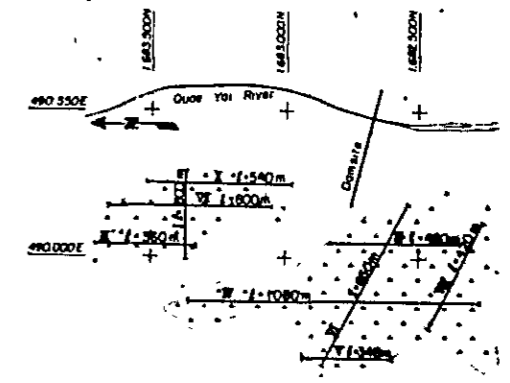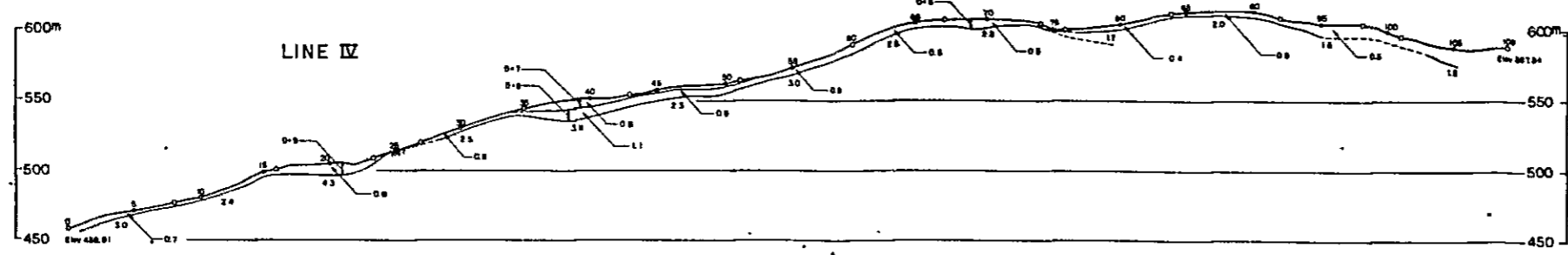
Note.

1) Seismic survey was carried out by Department
of Mineral Resources in Thailand on Feb, 1979.

2) This map was compiled from the data of EGAT
abutted by Department of Mineral Resources

UPPER QUAE YAI PROJECT

GEOLOGY
PLAN AND PROFILE
SEISMIC SURVEY

| Fig. 1-8 | March 1980 |

LIST OF CORE BORING IN UPPER QUAE YAI PROJECT

Hole No.	Location	Elevation of top of hole(m)	Coordinate	Direction of hole	Length of hole (m)	Remarks
L - 1	Dam, Left Bank	381.8	1 682 575.6 N 490 629.8 E	N85°E, 45°	80.0	*
" - 2	"	336.1	1 682 570.5 N 490 579.0 E	N85°E, 60°	100.0	*
" - 3	"	293.9	1 682 565.6 N 490 528.2 E	N85°E, 70°	100.0	*
" - 4	"	201.2	1 682 564.6 N 490 461.2 E	S 85°W, 60°	120.0	*
" - 5	"	279.7	1 682 613.1 N 490 548.6 E	N85°E, 60°	90.0	*
" - 6	"	213.3	1 682 630.4 N 490 481.0 E	N85°E, 60°	60.0	*
R - 1	Dam, Right Bank	222.7	1 682 549.8 N 490 391.1 E	N85°E, 70°	102.0	*
" - 2	"	285.0	1 682 546.1 N 490 323.9 E	Vertical	70.0	*
" - 3	"	379.8	1 682 531.8 N 490 207.4 E	"	100.0	*
" - 4	"	416.7	1 682 518.0 N 490 127.2 E	"	50.0	*
" - 5	"	256.7	1 682 618.1 N 490 373.8 E	"	90.0	*
" - 6	"	338.1	1 682 615.0 N 490 261.3 E	"	82.0	*
" - 7	"	476.7	1 682 662.7 N 490 062.9 E	"	35.0	"
" - 8	"	426.7	1 682 726.2 N 490 139.7 E	"	45.0	"
P - 1	Penstock	403.2	1 682 330.6 N 490 750.0 E	"	140.0	*
" - 2	"	380.8	1 682 274.2 N 490 653.3 E	"	180.0	*
" - 3	"	292.6	1 682 224.5 N 490 563.8 E	N57°E, 60°	80.0	*

Hole No.	Location	Elevation of top of hole(m)	Coordinate	Direction of hole	Length of hole (m)	Remarks
S - 1	Spillway	376.1	1 682 417.5 N 490 216.3 E	Vertical	40.0	
" - 2	"	316.3	1 682 151.1 N 490 230.5 E	"	46.0	
PH - 1	Powerhouse	200.7	1 682 206.4 N 490 459.8 E	"	30.0	*
" - 2	"	223.9	1 682 135.7 N 490 500.9 E	"	36.0	*
" - 3	"	211.4	1 682 149.0 N 490 485.3 E	"	28.0	*
" - 4	"	242.8	1 682 023.5 N 490 686.6 E	S 50° W, 70°	50.0	
" - 5	"	222.0	1 682 033.6 N 490 576.2 E	N 20° E, 60°	40.0	
Q - 1	Quarry, Right Bank	No data	No data	Vertical	50.0	
" - 2	"	"	"	"	50.0	
" - 3	"	"	"	"	50.0	
LL - 1	Thi Khong Site, Left Bank	189.0	"	"	35.0	*
" - 2	"	216.0	"	"	30.0	*
RR - 1	Thi Khong Site, Right Bank	187 0	"	"	30.2	*
" - 2	"	198.0	"	"	30.6	*
Total					2 069.8	

* Permeability test hole

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-1   (SHEET 1 OF 4)

LOCATION Dam Left Aubutment	DEPTH OF HOLE 80 0 m	COMMENCED May 14 1979
ELEVATION 381 8 m	DEPTH OF OVERBURDEN 0 0 m	COMPLETED May 25 1979
COORDINATE 1682 575 6N 490 629 8E	LENGTH OF ROCK DRILLING 80 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 45°	TOTAL LENGTH OF CORE 78 0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N 85°E	CORE RECOVERY 97 5 %	

Column headers: DEPTH | ROCK NAME | LOG | CORE RECOVERY | CEMENTATION KIND OF BIT CASING | OBSERVATION OF CORE (COLOR | WEATHERING | HARDNESS | CORE CUTTING | DESCRIPTION) | WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON 50 (ℓ/min)) | DEPTH | ELEVATION

ROCK NAME: Calcareous SANDSTONE

Depth	Color	Weathering	Hardness	Core cutting	Description
0–6.0	gry~brn.	3	3	3	Cracks wethd. brn but not remarkable.
6.0–8.1					Recemented shd. zone.
8.1–16.0	brn.	4	4	3 / 1 / 4 / 3 / 1 / 4	all cracks brn with seam.
16.0–18.0	White gry	3	3	3 / 1 / 2	Generally good, but Somewhat shd.
18.0–20	gry.	3 / 4	4	Shd zone with soft breccia No brn. material.

Water pressure test: No Test (0–6); Lu = 3.9; Lu = 4.0; Lu = 17.9

Supply / Leakage

Elevation: 381 8 m (top) ... 367.7 (bottom at 20)

core loss — RQD

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE
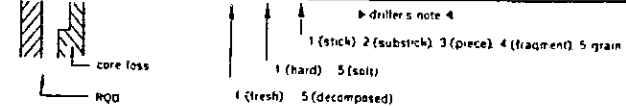
Upper Quae Yai	PROJECT		HOLE No L - 1 (SHEET 2 OF 4)
LOCATION Dam Left Abutment	DEPTH OF HOLE	80.0 m	COMMENCED May 14 1979
ELEVATION 381.8 m	DEPTH OF OVERBURDEN	0.0 m	COMPLETED May 25 1979
COORDINATE 1682,575.6 N 490,629.8 E	LENGTH OF ROCK DRILLING	80.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 45°	TOTAL LENGTH OF CORE	78.0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY	97.5 %	

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100	CEMENTATION KIND OF BIT CASING	COLOR	WEATHER-ING	HARD NESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
2 0m										0 ... 40 20m		367.7 m
	SANDSTONE / Calcareous				gry.	3	4	4	Shd zone with soft breccia. No. brn. material. 25.0	Lu=4.7 Supply		
					dark gry.	3	3		No brn. cracks, but all cracks coated by white seam. 26.4	Leakage		
									Core loss. 26.9	No Test		
									Breccia. 27.0			
									No core. Fault zone. 28.5			
									Shd zone with soft breccia. 29.8			
30						2	2	2	Recemented Shd. zone. Generally good. 32.0	Lu=3.1	30	
					gry.	3	4 1 5	3	Remarkable banded structure and white seams remarkable along band structure. Shd. and cracky generally. 37.0	Lu=3.5		
40						3 1 2	3 1 4		Shd. generally, but recemented. No brn cracks.		40	353.5

▶ driller's note ◀

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L - 1   SHEET 3 OF 4

LOCATION Dam Left Abutment	DEPTH OF HOLE 80.0 m	COMMENCED May 14 1979
ELEVATION 381.8 m	DEPTH OF OVERBURDEN 0.0 m	COMPLETED May 25 1979
COORDINATE 1682 575.6 N 490 629.8 E	LENGTH OF ROCK DRILLING 80.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 45°	TOTAL LENGTH OF CORE 78.0 m	LOGGED BY Y. Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 97.5 %	

Rock Name: Calcareous SANDSTONE.

Color: grey.

Descriptions:

41.0 — Shd. with seams.

44.0 — Remarkable banded structure. all cracks along band structure coated by white seams. Shd in general.

48.7 — Generally good, but cracks coated by white seams.

51.5

52.0 — Cracky (Shd zone)

Remarkable band structure. Generally good.

Water table ∇

Leakage / Supply

Lu = 3.7

Lu = 5.6

Lu = 3.4

Lu = 3.1

Elevation: 353.5 (at 40m), 339.4 (at 60m)

Legend:

▶ drillers note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) 5 (soft)
1 (fresh) 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L - 1 (SHEET 4 OF 4)

LOCATION Dam Left Abutment	DEPTH OF HOLE 80 0 m COMMENCED May - 14 - 1979
ELEVATION 381 8 m	DEPTH OF OVERBURDEN 0 0 m COMPLETED May - 25 - 1979
COORDINATE 1682 5756N 490 6298E	LENGTH OF ROCK DRILLING 80 0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 45 °	TOTAL LENGTH OF CORE 78 0 m LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 97.5 %

Rock Name: Calcareous SANDSTONE.

Core Recovery: 0 → 100

COLOR: gry.

OBSERVATION OF CORE:

63.0 — Remarkable band structure. Cracky. 63.8

Generally good. but brn cracks at 64.0 65.0, 65.6, 66.5, 68.4 68.9, 69.1, 73.1, 77.0. Some of cracks are dissolved.

80.0

WATER PRESSURE TEST — LUGEON 50(ℓ/min)

Lu = 2.3   Leakage Supply

Lu = 1.6

Lu = 1.0

Lu = 0.7

Depth 60m Elevation 339.4 m

Depth 80 Elevation 325.2

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
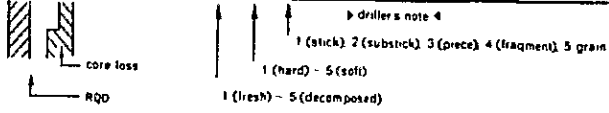1 (hard) - 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-2 (SHEET 1 OF 5)

LOCATION Dam Left Abutment
ELEVATION 336 1 m
COORDINATE 1682 570 5 N 490 5790 E
ANGLE FROM HORIZONTAL 60°
BEARING OF ANGLE HOLE N85°E

DEPTH OF HOLE 100 0 m
DEPTH OF OVERBURDEN 1 0 m
LENGTH OF ROCK DRILLING 99 0 m
TOTAL LENGTH OF CORE 100 0 m
CORE RECOVERY 100 0 %

COMMENCED Apr 29 1979
COMPLETED May 7 1979
DRILLED BY FONDISA
LOGGED BY Y Fukutake

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100 %	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
0m											0m	336.1
1	O.B.	△							Overburden.		1	
					reddish	4	3	4-5	Fault zone. 1.0	Leakage		
2					brn	4-5	4	3	2.0	No Test	2	
							3	4	Small cavities filled with soil 2.5	Supply		
3									Shd. zone. 3.0		3	
4									Banded structure remark.		4	
5	SANDSTONE.				gry~brn.		3-4	3	Generally wethd. and most cracks brn. or Solution Shd. at 5m.	No Leakage	5	
6										Lu=33.0	6	
7											7	
8						4			8.0		8	
9	Calcareous								Fault zone. Partially recemented and partially Soft.		9	
10											10	
11											1	
12					brn.		4	4		Lu=39.7	2	
13											3	
14											4	
15									15.6		5	
16									Calc. SS and thin SH. Massive and good core generally.		6	
17										Lu=24.8	7	
18					gry.	2	2	2			8	
19											9	
20											20	318 8

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
1 (fresh) 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT	HOLE No L-2 (SHEET 2 OF 5)

LOCATION Dam Left Abutment	
ELEVATION 336 1 m	DEPTH OF HOLE 100 0 m COMMENCED Apr - 29 - 1979
	DEPTH OF OVERBURDEN 1 0 m COMPLETED May - 7 -1979
COORDINATE 1682 570 5N 490 5790E	LENGTH OF ROCK DRILLING 99 0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 100 0 m LOGGED BY Y Fukutoke
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION	KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
20m			0→100								LUGEON 50(ℓ/min)	20m	318.8 m

Core observations (reading top to bottom):

- Calc·SS and thin SH. Massive and good core generally.
- Brn cracks only at 22.9~23.1. (Core cutting: 2)
- Color 2, Weathering 2, Hardness 2
- 25.0
- Recemented shd. zone. Cracks brn. (3 / 1 / 2)
- 26.7
- Fresh and hard, good core, but a few cracks brn. and thin opening.
- Color 2/1/1, Hardness 2/1/1, Core cutting 2

Rock name (vertical): Calcareous SANDSTONE.
Color (vertical): gry.

Water pressure test values:
- Lu=10.5
- Lu=12.8
- Lu=3.8
- Lu=8.2

Water/leakage notes: Supply, No leakage

Bottom depth: 40 / 301.5

▶ drillers note ◀

1(stick) 2(substick) 3(piece) 4(fragment) 5 grain

1 (hard) – 5 (soft)

1 (fresh) – 5 (decomposed)

core loss

RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai   PROJECT   HOLE No L - 2   (SHEET 3 of 5

LOCATION Dam Left Abutment	DEPTH OF HOLE 100 0 m COMMENCED Apr - 29 - 1979
ELEVATION 336 l m	DEPTH OF OVERBURDEN l 0 m COMPLETED May - 7 - 1979
COORDINATE 1682 570.5N. 490 579 0E	LENGTH OF ROCK DRILLING 99 0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 100 0 m LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION / KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
40m			0→100							LUGEON (50ℓ/min)	40m	301 5
	Calcareous SANDSTONE.				gry.	2 / l	2 / l	2	Fresh and hard, good core, but a few cracks brn and thin opening.	Lu=24.5 Supply No Leakage Lu=5.6 Lu=8.2		
50									52.0		50	
60					gry.	2 / l	2 / l	2	Like chert, very hard good core, but a few cracks brn.	Lu=7.0	60	293.7
									60.0			

▶ driller's note ◀

▯ core loss   l (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

▮ RQD   l (hard) - 5 (soft)

l (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-2   (SHEET 4 OF 5)

LOCATION   Dam Left Abutment   DEPTH OF HOLE   100.0 m   COMMENCED Apr - 29 - 1979
ELEVATION   336 1 m   DEPTH OF OVERBURDEN   1.0 m   COMPLETED May - 7 - 1979
COORDINATE 1682 570.5N. 490 579.0E   LENGTH OF ROCK DRILLING 99.0 m   DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°   TOTAL LENGTH OF CORE 100.0 m   LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E   CORE RECOVERY 100.0 %

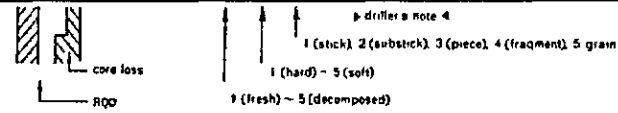| DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
60m			0→100						60.0	LUGEON 50(ℓ/min) to 60m		293.7 m
					reddish brn ~ gry.	2	2	2 1 3	64.0 Completed recemented shd zone. No brn cracks.	Lu=4.7 Supply No Leakage		
70	Calcareous SANDSTONE.				gry.	3	3 1 2	3	70.0 Somewhat banded. Generally shd with chlorite material, but no brn. cracks. Cracky at 74.4~75.0.	Lu=18.2 Lu=5.3 Lu=3.9	70	
80											80	266.8

▶ driller's note 4

core loss
RQD

1 (stick). 2 (substick). 3 (piece). 4 (fragment). 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT HOLE No L-2 SHEET 5 OF 5

LOCATION Dom Left Abutment	DEPTH OF HOLE 100.0 m	COMMENCED Apr. 29. 1979
ELEVATION 336.1 m	DEPTH OF OVERBURDEN 1.0 m	COMPLETED May 7 1979
COORDINATE 1682 570.5 N 490 5790 E	LENGTH OF ROCK DRILLING 99.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 100.0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %	

OBSERVATION OF CORE

Columns: DEPTH | ROCK NAME | LOG | CORE RECOVERY | CEMENTATION / KIND OF BIT / CASING | COLOR | WEATHERING | HARDNESS | CORE CUTTING | DESCRIPTION | WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER | DEPTH | ELEVATION

CORE RECOVERY: 0 → 100

Rock name: Calcareous SANDSTONE

Color: gry. / dark gry ~ greenish gry.

Hardness: 3

80m 266.8 ELEVATION

LUGEON 50 (ℓ/min) 40

Descriptions:
- 81.0
- Shd. zone with breccia. (4-1-5 / 3)
- 84.0
- Generally shd and cracky.
- Most of cracks coated by chlorite material.
- Strongly cracky zone at 92.3~92.5, 93.5~94.0, 94.3~95.3, 96.0~97.3, 98.5~98.7.
- 100.0

Water pressure test:
- Lu = 1.4 Supply No Leakage
- Lu = 5.9
- Lu = 7.9
- Lu = 7.0 0L-97.0
- Lu = 6.4

Elevation at 100: 249.5

Legend:
- core loss
- RQD
- ► driller's note ◄
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- 1 (hard) 5 (soft)
- 1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT		HOLE No L-3 (SHEET 1 OF 5)
LOCATION Dam. Left Abutment	DEPTH OF HOLE 100.0 m	COMMENCED May - 9 - 1979
ELEVATION 293.9 m	DEPTH OF OVERBURDEN 0.0 m	COMPLETED May - 18 - 1979
COORDINATE 1682 565 6 N 490 528 2 E	LENGTH OF ROCK DRILLING 100.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 100.0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %	

ROCK NAME: Calcareous SANDSTONE.

DESCRIPTION:

wethd. as a whole and some solution cavities are found.

Solution at 6.4, 7.0 14.0 ~ 14.1.

shd. at 12 ~ 13.0 (re-cemented)

COLOR: brn   4 1 3

15.2

Cracks brn, but generally good.

COLOR: gry ~ brn.   3 2 2

20.0

WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER:
LUGEON 50 (ℓ/min)

No Test
Leakage
Supply
Lu = 28.1
Lu = 28.8
Lu = 5.0

ELEVATION: 293.9 (0m)   275.1 (20)

| Om | 293.9 |
| 20 | 275.1 |

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-3 (SHEET 2 UF 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 100.0 m COMMENCED May 9 - 1979
ELEVATION 293.9 m	DEPTH OF OVERBURDEN 0.0 m COMPLETED May 18 - 1979
COORDINATE 1682 565 6N 490 528 2E	LENGTH OF ROCK DRILLING 100.0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 100.0 m LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %

Rock Name: SANDSTONE. Calcareous

Color: gry. / brn.

Weathering / Hardness / Core cutting: 2 2 2 ; 4 3 4-5

Description:
Good core.
Brn. cracks a few.

32.4
Fault breccia.
Solution Cracks at 32.9. 33.85

Many brn. cracks with seam.
Some cracks are dissolved.

Water Pressure Test / Leakage of Drilling Water (LUGEON):
Lu = 1.7
Leakage
Lu = 3.7
Lu = 12.6
Supply
Lu = 15.5

Elevation: 275.1 m (top) ... 256.3 m (40m)

drillers note
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
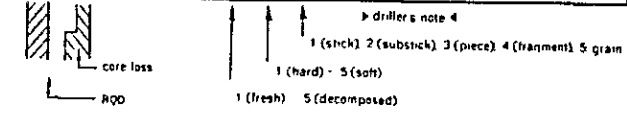1 (fresh) 5 (decomposed)
core loss
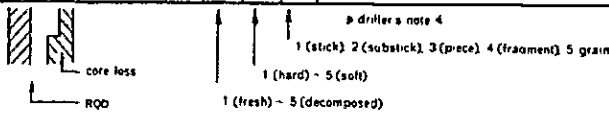RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-3   (SHEET 3 OF 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 100.0 m	COMMENCED May-9-1979
ELEVATION 293.9 m	DEPTH OF OVERBURDEN 0.0 m	COMPLETED May-18-1979
COORDINATE 1682 565 6N 490 528 2E	LENGTH OF ROCK DRILLING 100.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 100.0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %	

Rock Name: Calcareous SANDSTONE.

OBSERVATION OF CORE

Color: gry.
Weathering: 3
Hardness: 2
Core cutting: 4 1 5 / 3 1 4

DESCRIPTION:

40.1

Shd. as a whole.
Many thin Shd. zone
with 1~5 cm.
Clay are found every
10~30 cm.

48.0

Generally good,
but all cracks wethd.
and brn.

WATER TABLE —/\/—
WATER PRESSURE TEST
LEAKAGE OF DRILLING WATER

LUGEON 50(ℓ/min)

Lu=1.9   Supply
         No Leakage

Lu=2.5

Lu=3.6

Lu=2.1

DEPTH	ELEVATION
40.0m	256.3 m
60	237.5

core loss
RQD

› driller's note 4
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai   PROJECT   HOLE No L - 3   'SHEET 4 of 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 100.0 m	COMMENCED May - 9 - 1979
ELEVATION 293.9 m	DEPTH OF OVERBURDEN 0.9 m	COMPLETED May - 18 - 1979
COORDINATE 1682 5656N 490 5282E	LENGTH OF ROCK DRILLING 100.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 100.0 m	LOGGED BY Y. Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 ,	

Core log column observations (SANDSTONE, Calcareous):

- Color: gry; dark gry.; gry.~ dark gry.
- Depth 60 m — Elevation 237.5 m

65.0 — Generally good, but all cracks wethd. and brn. (hardness 2, core cutting 3,1,4)

Lu = 2.8   Supply No Leakage   GL-63.5

74.0 — Shd. as a whole. Breccia every 10~30 cm. No brn. cracks, but chloritization. (hardness 3, core cutting 3,4)

Lu = 1.3

Lu = 1.6

76.0 — Many cracks, but no brn. cracks. all cracks coated by calcite film. (core cutting 5)

Generally good. No brn cracks, but some cracks coated by calcite film. (hardness 2, core cutting 3)

Lu = 0.5

Depth 80 — Elevation 218.7

Legend:
- core loss
- RQD
- ▶ driller's note 4
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- 1 (hard) 5 (soft)
- 1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT HOLE No L - 3 (SHEET 5 OF 5)

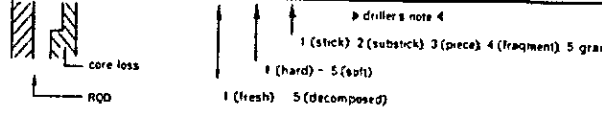|		
LOCATION Dam Left Abutment	DEPTH OF HOLE 100.0 m	COMMENCED May 9 1979
ELEVATION 293 9 m	DEPTH OF OVERBURDEN 0 0 m	COMPLETED May 18 1979
COORDINATE 1682 565 6N 490 528 2 E	LENGTH OF ROCK DRILLING 100 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 100 0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 %	

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100%	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
80m										0	80m	218.7
	Calcareous SANDSTONE.				gry ∼ dark gry.	2		3	Generally good. No brn. cracks, but Some cracks coated by calcite film	Lu=0.7 Supply No Leakage		
						3			87.0	Lu=1.3		
							4 ǀ 5		Cracky, but nobrn. cracks. all cracks coated by Calcite film. 88.4			
							3 ǀ 2	3 ǀ 4	No brn. cracks, but cracks coated by calcite			
					gry		3 ǀ 2	5	92.3 Cracky zone, but no brn. cracks. 93 1	Lu=7.2		
						3	2	3 ǀ 4	Generally good. No brn. cracks, but Coated by calcite.	Lu=2.2		
100									100.0		100	199.9

▶ driller's note 4

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

core loss   ǀ (hard) - 5 (soft)

RQD   1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT	HOLE No L-4 (SHEET 1 OF 6)

LOCATION Dam Left Abutment	DEPTH OF HOLE 120.0 m	COMMENCED Feb-13-1979
ELEVATION 201.2 m	DEPTH OF OVERBURDEN 3.0 m	COMPLETED Mar.-23-1979
COORDINATE 1682 564 6N 490 461 2 E	LENGTH OF ROCK DRILLING 117.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 115 2 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY 96 0	

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
0m											0m	201.2 m
	River Deposit	△ △ △			brn				0~0.4 medium grained Sand.			
									0.4~3.0 Sand with sub angular gravel (max diameter 3cm)			
									3.0			
	SANDSTONE. Calcareous				brn.				Fault clay with breccia Sized max. 10cm.			
					greenishgry				5.25	GL -4.25		
									Clay with fine grained breccia.			
									6.85			
					brn green.				Breccia. 71			
									Clay with fine grained breccia.	NO Test		
									91			
					greenish gry.				Fault clay with breccia.			
									Original rock, banded Cal. SS.			
									16.0			
					yrg-greenish gry.	2 2 1 3	2	3 1 4	Many hair cracks. Cracks no brn Clay seam at 16.4~16.5.	Leakage Supply		
						2	2	18.6	Lu = 3.2		
									Core loss. 190			
						2	3 1 2	4	Many hair cracks.		20	183.9

core loss
RQD

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) 5 (soft)
1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai	PROJECT		HOLE No L – 4	(SHEET 2 OF 6)
LOCATION Dam Left Abutment	DEPTH OF HOLE	120.0 m	COMMENCED	Feb – 13 – 1979
ELEVATION 201 2 m	DEPTH OF OVERBURDEN	3.0 m	COMPLETED	Mar – 23 – 1979
COORDINATE 1682 564 6N 490 461 2 E	LENGTH OF ROCK DRILLING	117 0 m	DRILLED BY	FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE	115.2 m	LOGGED BY	Y Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY	96 0 %		

OBSERVATION OF CORE

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100%	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
20m										0	20m	183.9 m
1						2-3	3	4	clay film hair cracks. 20.4		1	
									Core loss. 21.35	Supply		
2						3	2/4	2/5	Shd. with seams at 21.55-21.72, 21.85-22 15. 22.15	No Test / Leakage	2	
3						2/1/1	2	2	Fresh and hard. Clay film at 23.85~23.9.		3	
4									24.5		4	
5						2	3/1/2	4/1/3	Cracky. Cracks coated by clay film.		5	
6											6	
7						2-1	2	3		Lu = 1.4	7	
8	SANDSTONE.				gray	2	3	4/5	28.4		8	
9						2/1/1	2	2/1/3	Good core.		9	
30					greenish				31.0		30	
1						2	3	3/1/2	Many hair cracks. Cracks coated by clay film. 32.2	Lu = 1.1	1	
2	Calcareous					2/1/1	2	2/1/3	Good core. 33 55		2	
3						4-3		5	Gravelly core with clay. 33.9		3	
4						3		4	Cracky, but no brn. cracks.		4	
5						2	3/1/2	3/1/4			5	
6									36.8	Lu = 0.9	6	
7						2/1	3	4	Many hair cracks. Brn. Cracks a few, but coated by chlorite material. 38.15		7	
8						3	4	5/1/4	Shd. zone. clayey. 39.0		8	
9						2	3	3/1/4	Recemented Shd. zone. 39.9		9	
40											40	166.6

▶ driller s note ◀

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
core loss
1 (hard) ~ 5 (soft)
RQD
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-4   (SHEET 3 OF 6)

LOCATION Dam Left Abutment	DEPTH OF HOLE 120 0 m COMMENCED Feb - 13 - 1979
ELEVATION 201 2 m	DEPTH OF OVERBURDEN 3 0 m COMPLETED Mar - 23 - 1979
COORDINATE 1682 564 6N 490 461 2 E	LENGTH OF ROCK DRILLING 117 0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 115 2 m LOGGED BY Y. Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY 96.0 %

OBSERVATION OF CORE

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100 %	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARD NESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
40m											40m	166.6
	SANDSTONE.				greenish gry.	2	3-1-2 / 2	2 / 1 / 3	Hair cracks a few. 40.7 Fresh and hard. clay seams at 41.3~41.32, 42.95~42.99.	Lu = 1.7 Supply Leakage		
						2-3	4-3	2	45 1 Many hair cracks. 45.5	Lu = 0.4		
						2	3/1/2	2/1/3	Generally fresh and hard. clay at 46.75~46.8. Cracky at 47.25~47.3, 47.4~47.5, 47.4~47.5, 47.95~48.25, 49.3~49.6. 50.25		50	
50m	Calcareous				greenish gry.	4 / 2	4 / 2-3	5 / 4-3	Clayey. 51.25			
							2 / 3	3/1/4	Core loss 51.55 Many hair cracks. Cracks coated by chlorite material. 53.3	No.Test		
							4	4/1/5	Breccia with clay. Clay at 53.5~54.4. 54.9			
		gry.			gry.	2	2/2-3/2/2-3/2	2/3 4 2/3 4	Fresh and hard. Partially many hair cracks. Recemented Shd. zone at 57.5~57.6. Cracky at 57.9~58.0. clay seam at 58.95~58.97.	Lu = 0.6		
60								2/1/3			60	149.2

► driller's note ◄

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) - 5 (soft)

1 (fresh) 5 (decomposed)

core loss

RQD

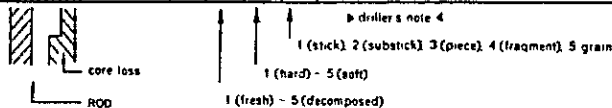# GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L - 4   (SHEET 4 OF 6)

LOCATION Dam Left Abutment	DEPTH OF HOLE 120 0 m	COMMENCED Feb - 13 - 1979
ELEVATION 201 2 m	DEPTH OF OVERBURDEN 3 0 m	COMPLETED Mar - 23 - 1979
COORDINATE 1682 564 6N 490 461 2E	LENGTH OF ROCK DRILLING 117 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 115 2 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY 96 0 %	

OBSERVATION OF CORE

Columns: DEPTH | ROCK NAME | LOG | CORE RECOVERY | CEMENTATION / KIND OF BIT / CASING | COLOR | WEATHERING | HARDNESS | CORE CUTTING | DESCRIPTION | WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER | DEPTH | ELEVATION

ROCK NAME: Calcareous SANDSTONE.

Depth 60m — Elevation 149.2 m

COLOR: gry. (grey), greenish gry., gry.

DESCRIPTION:

Fresh and hard.

clay seam at 63.85 ~ 63.9.

Cracky at 65.4~65.5, 65.8~65.9.

67.4

Cracky, but cracks not brn

69.5

Fault breccia with clay.

clay at 69.5~69.83, 70.2~70.4.
Clayey at 73.3~74.3.

Fresh and hard, but somewhat cracky.

Cracks coated by chlorite material.

Hardness / Core cutting values:
- 2 | 3
- 3 | 4-5
- 2 | 3
- 2-3 | 4
- 2 | 3
- 2-3 | 4
- 3 | 1-2
- 4-5 (3)
- 2 | 3-1-4

WATER PRESSURE TEST:
Supply / Leakage
Lu = 1.4
Lu = 0.9
Lu = 0.2
Lu = 1.0

LUGEON 50 (ℓ/min)

Depth 80 — Elevation 131.9

core loss
RQD
driller's note
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT HOLE No L - 4 (SHEET 5 OF 6)

LOCATION Dam Left Abutment	DEPTH OF HOLE 120.0 m	COMMENCED Feb - 13 - 1979
ELEVATION 201.2 m	DEPTH OF OVERBURDEN 3.0 m	COMPLETED Mar - 23 - 1979
COORDINATE 1682 5646N 490 4612E	LENGTH OF ROCK DRILLING 117.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 115.2 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY 96.0 %	

Rock Name column: **Calcareous SANDSTONE.**

Color: **gry.**

Hard/Core	Description
3-4 / 2 ? / 2	Hard and fresh, but somewhat cracky.
2 / 3 / 2	835~836 fragment ~ grain core. 84.15
2 4 4 / 3 3 5	Shd. Cracks coated by chlorite material. Clay at 86.8~86.95. 87.0
4 5	Breccia with clay. 87.5
2-3 3	Cracks coated chlorite material. 88.0
2 2 / 3	Fresh and hard. Cracky at 88.2~88.4 88.9~89.15, 89.55~89.7 90.45~90.65. 91.2
3 4 / 4 1 5	Shd. zone. clayey 92.0
2-3 3-2	
3 4	Somewhat cracky. Partially cracks coated by chlorite material. clayey at 93.5~93.8. 94.7~94.8, fragment ~ grain core 98.7
2 3 / 3-2 3-4 / 3 4	Many hair cracks. Brittle. Clay at 98.7~98.8.

Water pressure: Lu=1.7, Lu=1.1, Lu=0.6, Lu=0.3, Lu=0.7

Supply / Leakage

Elevation: 131.9 m (top) ... 114.6 m (bottom at 100m)

Legend:
- core loss
- RQD
- ● driller's note
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- 1 (hard) - 5 (soft)
- 1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT		HOLE No L-4 (SHEET 6 OF 6)
LOCATION Dam Left Abutment	DEPTH OF HOLE 120.0 m	COMMENCED Feb-13 -1979
ELEVATION 201 2 m	DEPTH OF OVERBURDEN 3 0 m	COMPLETED Mar-23 -1979
COORDINATE 1682 5646 N 490 4612 E	LENGTH OF ROCK DRILLING 117 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 115 2 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE S85°W	CORE RECOVERY 96 0 %	

Rock Name: Calcareous SANDSTONE.

Color: gry.

Observation of core / Description:
- 100.15
- Core loss. 100.5
- Shd. zone.
- clay with breccia at 106.65~109.7.
- 111.65
- Core loss. 112.0
- 113.6
- Core loss. 114.6
- 115.0
- Core loss. 116.4
- Cracky.
- Many hair cracks.
- Brittle.
- Cracks coated by chlorite material.
- 120.0

Water Pressure Test: Lu = 0.5, NoTest, No Test
Leakage of drilling water: Supply, Leakage

Elevation: 114.6 (top), 97.3 (bottom)

Legend:
- core loss
- RQD
- drillers note
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
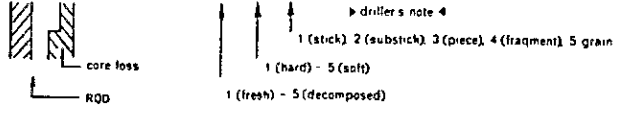- 1 (hard) - 5 (soft)
- 1 (fresh) - 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT		HOLE No L - 5 (SHEET 1 OF 5)
LOCATION Dam Left Abutment	DEPTH OF HOLE 90 0 m	COMMENCED Apr - 24 - 1979
ELEVATION 279 7 m	DEPTH OF OVERBURDEN 0 0 m	COMPLETED May - 5 - 1979
COORDINATE 1682 613 I N 490 548 6E	LENGTH OF ROCK DRILLING 90 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 90 0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 '	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTA TION KIND OF BIT CASING	COLOR	WEATHER ING	HARD NESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
0m			0→100 %							LUGEON 50 (ℓ/min)	0m	279.7 m
					brn.	4	3	5	wethd. and many cracks. 23	No Test / Leakage / Supply		
	SANDSTONE. Calcareous				gry ~ reddish brn.	3	2	3	Cracks brn inclined cracks remark. 30 / Good core in general, but all cracks brn. 7.3	Lu=11.0		
8					? 4	3	4 5	Cracky zone (gravelly core) all cracks brn 80		8	
					gry.	3 I 2	2	3 I 4	Banded structure remarkable. all cracks wethd.and brn Some crachs dissolved and filled by soil. Solution cracks at 8~ 10.0. Soil fill cracks at 14.7.	Lu=16.9 / Lu=4.0		
20									20.0		20	262.4

▶ driller's note ◀
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
1 (fresh) - 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT **HOLE No L - 5** (SHEET 2 OF 5)

LOCATION __Dom. Left Abutment__	DEPTH OF HOLE __90 0__ m	COMMENCED __Apr - 24 - 1979__
ELEVATION __279 7__ m	DEPTH OF OVERBURDEN __0 0__ m	COMPLETED __May - 5 - 1979__
COORDINATE 1682 6131 N 490 5486 E	LENGTH OF ROCK DRILLING __90 0__ m	DRILLED BY __FONDISA__
ANGLE FROM HORIZONTAL __60__°	TOTAL LENGTH OF CORE __90 0__ m	LOGGED BY __Y Fukutoka__
BEARING OF ANGLE HOLE __N85°E__	CORE RECOVERY __100 0__ %	

ROCK NAME: Calcareous SANDSTONE.

COLOR: gry.

WEATHERING: 2 HARDNESS: 2 CORE CUTTING: 3 1 2

DESCRIPTION:
Banded structure.
Some cracks brn, but
not so many.
Partially Shd.

WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON):
Lu = 9.5 Leakage
Lu = 5.9 Supply
Lu = 12.0
Lu = 12.4

ELEVATION: 262.4 m (top), 245.1 (bottom)

Legend:
- core loss
- RQD
- ↑ driller's note 4
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- 1 (hard) - 5 (soft)
- 1 (fresh) - 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai **PROJECT**   HOLE No L-5   (SHEET 3 OF 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 90 0 m	COMMENCED Apr - 24 - 1979
ELEVATION 279 7 m	DEPTH OF OVERBURDEN 0 0 m	COMPLETED May - 5 - 1979
COORDINATE 1682 613 1N 490 548 6 E	LENGTH OF ROCK DRILLING 90 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 90 0 m	LOGGED BY Y Fukutoke
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 %	

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON	DEPTH	ELEVATION
40m		0→100 %							40.0	50(ℓ/min)	40m	245.1 m
	SANDSTONE. Calcareous				greenish gry.	3	3-4	5	Shd. zone with clay. No brn. cracks. 43.4	Lu=1.9 Leakage Supply		
					gry.	2-3	2	3	Generally good core. No brn. cracks. Shd. at 49.5~50.0 51.0, 55.7~56.4, 57.5. 58.0	Lu=2.3 Lu=6.6 Lu=13.9		
60					greenish gry.	3	3	4-5	Shd. zone with clay. No brn. cracks.		60	227.7

► driller s note ◄
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   **HOLE No. L-5** (SHEET 4 OF 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 90 0 m COMMENCED Apr - 24 - 1979
ELEVATION 279 7 m	DEPTH OF OVERBURDEN 0 0 m COMPLETED May - 5 - 1979
COORDINATE 1682 613 1N 490 548 6E	LENGTH OF ROCK DRILLING 90.0 m DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 90 0 m LOGGED BY Y. Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON	DEPTH	ELEVATION
6 0m	SANDSTONE. Calcareous		0→100 %		greenish gry	3	3	4 ¦ 5	Shd. zone with clay. No brn. cracks. 620	Lu = 3.5	6 0m	227.7 m
					dark gry.	3 ¦ 2	3 ¦ 2	3	Generally good core, but partially shd.	Lu = 3.3 Supply No Leakage		
70					greenish gry.	3	3	4	70.0 Generally good, but many small fault at 70~70.2, 71~71.5, 73~73.6, 75~77.3 Most of cracks vertical or nearly vertical.	Lu = 4.8 Lu = 3.7	70	
8 0					dark gry. gry	3 ¦ 4	4 ¦ 5	3-4	78.0 Rock is hard, but vertical solution crack. 78.5		8 0	210.4

> driller's note <

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

core loss

RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L-5 (SHEET 5 OF 5)

LOCATION Dam Left Abutment	DEPTH OF HOLE 90.0 m	COMMENCED Apr - 24 - 1979
ELEVATION 279 7 m	DEPTH OF OVERBURDEN 0 0 m	COMPLETED May - 5 - 1979
COORDINATE 1682 613 1 N 490 5486 E	LENGTH OF ROCK DRILLING 90.0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60°	TOTAL LENGTH OF CORE 90 0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100.0 %	

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100%	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
8 0m	Calcareous SANDSTONE.				dark gry.	3	3 l 4	4 l 5	NO brn. cracks, but Shd. as a whole. Most of cracks coated by calcite or chlorite material. 90.0	Lu=3.9 Lu=3.2 Lu=7.9 Supply No leakage	8 0m	210.4 m
9 0											9 0	201.8

> driller's note <
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No. L - 6   (SHEET 1 OF 3)

LOCATION Dam Left Abutment	DEPTH OF HOLE 60 0 m	COMMENCED Mar - 26 - 1979	
ELEVATION 213 3 m	DEPTH OF OVERBURDEN 14 0 m	COMPLETED Apr - 7 - 1979	
COORDINATE 1682 6304 N 490 481 0 E	LENGTH OF ROCK DRILLING 46 0 m	DRILLED BY FONDISA	
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 60 0 m	LOGGED BY Y Fukutoke	
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 100 0 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY 0→100 %	CEMENTATION KIND OF BIT CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER LUGEON 50(ℓ/min)	DEPTH	ELEVATION
0m	Overburden.				reddish brn.				Contain boulders. 7.0 Contain gravels from river. 14.0	NO Leakage No Test Supply Leakage Lu=14.3	0m	213.3 m
20	Calcareous SANDSTONE.				yellowish brn. gry - brn.	4 1 5	3 1 4	4 1 5	Banded structure. Strongly wethd. and Cracky.		20	196.0

► driller's note ◄
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT HOLE No __L-6__ (SHEET 2 OF 3)

LOCATION __Dam Left Abutment__	DEPTH OF HOLE __60 0__ m	COMMENCED __Mar - 26 - 1979__
ELEVATION __213 3__ m	DEPTH OF OVERBURDEN __14 0__ m	COMPLETED __Apr.- 7 - 1979__
COORDINATE 1682 630 4N 490 481 0 E	LENGTH OF ROCK DRILLING __46 0__ m	DRILLED BY __FONDISA__
ANGLE FROM HORIZONTAL __60__ °	TOTAL LENGTH OF CORE __60 0__ m	LOGGED BY __Y Fukutake__
BEARING OF ANGLE HOLE __N 85°E__	CORE RECOVERY __100 0__ %	

Rock Name: Calcareous SANDSTONE.

Color: gry ~ brn. / gry.

Description:
Banded structure.
Strongly wethd. and cracky.

26.0

Banded structure.
Good core, no brn.
cracks
Shd. at 29.3~29.6
30.3~30.6.

Water Pressure: Lu = 24.0, Lu = 19.4, Lu = 1.4, Lu = 3.8

Supply / Leakage

Elevation: 196.0 (top), 178.7 (bottom)

▶ driller's note ◀
1 (stick), 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)
core loss
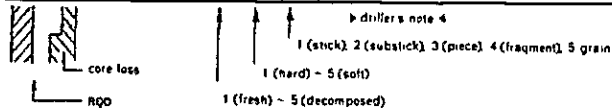ROD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT   HOLE No L — 6   (SHEET 3 OF 3)

LOCATION Dam Left Abutment	DEPTH OF HOLE 60 0 m	COMMENCED Mar - 26 - 1979
ELEVATION 213 3 m	DEPTH OF OVERBURDEN 14 0 m	COMPLETED Apr - 7 - 1979
COORDINATE 1682 630 4N 490 481 0 E	LENGTH OF ROCK DRILLING 46 0 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 60 °	TOTAL LENGTH OF CORE 60 0 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N 85° E	CORE RECOVERY 100 0 ₄	

Banded structure.
Good core, no brn.
Cracks.

46.0

Banded structure.
Cracky zone, but
no brn. cracks.
Cracks coated by
Calcite film.

Lu = 12.5

Supply

Lu = 1.4

Lu = 7.4

Leakage

Lu = 16.5

60.0

SANDSTONE.

Calcareous

grey.

dark gry.

Colors: 178.7 ... 161.3

▶ driller's note ◀

core loss
RQD

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) ~ 5 (soft)

1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai **PROJECT**   HOLE No R - 1 (SHEET 1 OF 6)

LOCATION Dam Right Abutment	DEPTH OF HOLE 102.0 m	COMMENCED Mar. - 25 - 1979
ELEVATION 222.7 m	DEPTH OF OVERBURDEN 5.3 m	COMPLETED Apr. - 4 - 1979
COORDINATE 1682 549.8N 490 391.1E	LENGTH OF ROCK DRILLING 96.7 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 98.64 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 96.7	

Observation of core log:

Rock Name: Overburden (0 - 5.3 m), Calcareous SANDSTONE

Overburden:
- Contain many boulders with 20~30cm diameters.
- Color: brn.
- 5.3

Calcareous Sandstone:
- wethd. zone. — Color: Whity gry-brn., Weathering 4, Hardness 3, Core cutting 5 — 8.0
- bm gry, Weathering 3~2, Hardness 1, Core cutting 2~3 — Generally good. Disolv. C at 8.85 — 9.0
- Brecciated zone. Somewhat recement. — Color: brn, Weathering 4~5, Hardness 4~5 — 12.25
- Weathering 4~5 — Wethd. and cracky zone (every 20~30cm cracks with soil and some c. disolved) — Color: gry — Weathering 4, Hardness 3 — 16.2
- Many cracks and all c wethd. or coated by seam. Cracky zone at 17.5~17.85, 18.0~18.4, 19.5~20.0. Disolv. at 19.1. — Weathering 3, Hardness 2, Core cutting 4~3

Water Table / Water Pressure Test / Leakage of drilling water:
- Supply / No Leakage
- NO Test
- Lu = 37.0

Elevation: Om 222.7 m ... 20 203.9

▶ driller's note ◀

— core loss
— RQD

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT		HOLE No R - ı (SHEET 2 OF 6)
LOCATION Dam Right Abutment	DEPTH OF HOLE 102.0 m	COMMENCED Mar. - 25 - 1979
ELEVATION 222.7 m	DEPTH OF OVERBURDEN 5.3 m	COMPLETED Apr - 4 - 1979
COORDINATE 1682 549.8N 490 391 1E	LENGTH OF ROCK DRILLING 96.7 m	DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 98.64 m	LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N85°E	CORE RECOVERY 96.7 %	

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
			0→100 %		COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION			

20m ... 203.9 m

SANDSTONE. / Calcareous

Color: gry. / white ~ greenish gry. / whity gry.

Weathering: 3, 3
Hardness: 2, 4
Core cutting: 4 1 5

Lu=33.2, Lu=16.7, GL-28.0, Lu=8.4, Lu=5.5

Water table elevation: 185.1

Description:

20.4

Many C. along schistosity
C wethd. and coated by seam.
C length. gravel to 5cm.
Remark. Solution at 20.7 ~ 21.0 (vert.).
Breccia at 21.65~22.25 and 25.2~25.8.

28.0

Some what shd.
brn. C at 34.5 and 35~35.4.
Other C. coated by white seam or blk. graphite.
Cracky zone at 34.3~35.25 and 35.4~35.6.

36.0

Shd. generally.
No brn. C., but all C.
coated by white seam.
Breccia at 39.5.

Supply / Leakage

LUGEON 50(ℓ/min) 40

▶ driller's note 4
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

core loss
RQD

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai PROJECT　　　　**HOLE No R-1** (SHEET 3 OF 6)

LOCATION _Dam Right Abutment_	DEPTH OF HOLE __102.0__ m	COMMENCED _Mar. 25. 1979_
ELEVATION __222.7__ m	DEPTH OF OVERBURDEN __5.3__ m	COMPLETED _Apr. - 4 - 1979_
COORDINATE 1682 549.8N 490 391 IE	LENGTH OF ROCK DRILLING __96.7__ m	DRILLED BY ___FONDISA___
ANGLE FROM HORIZONTAL __70__ °	TOTAL LENGTH OF CORE __98.64__ m	LOGGED BY _Y. Fukutake_
BEARING OF ANGLE HOLE __N85°E__	CORE RECOVERY __96.7__ %	

Observation of core (40m – 60m):

- 40.2 — Shd. zone. Brecciated core. Color: gry., Weathering 3, Hardness 3–4, Core cutting 5
- 44.5 — Core loss. 45.0
- 45.7 — Recemented shd. zone. Brn. C. at 48~48.6, 49.9~50.0. Color: blk.~ dark gry., Weathering 3, Hardness 3–4, Core cutting 2
- 52.2 — Good core, but generally shd. all cracks coated by graphite or blk. seam. Color: gry.~ whity gry.
- 55.0 — Shd. zone no brn. color. Every 20~30cm interbedded breccia. Color: white gry.~ gry., Weathering 2, Hardness 2

Rock name: Calcareous SANDSTONE.

Water pressure test / Leakage: Lu = 1.2, No Test, Lu = 1.1, Lu = 20.1, Lu = 1.0. Supply / Leakage. No Leakage.

Elevation: 40m = 185.1 m, 60m = 166.3 m

Legend notes:
- core loss
- RQD
- ▶ driller's note 4
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
- 1 (hard) – 5 (soft)
- 1 (fresh) 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

Upper Quae Yai	PROJECT		HOLE No R - 1 (SHEET 4 OF 6)
LOCATION Dam Right Abutment	DEPTH OF HOLE	102 0 m	COMMENCED Mar - 25 - 1979
ELEVATION 222 7 m	DEPTH OF OVERBURDEN 5 3 m		COMPLETED Apr - 4 - 1979
COORDINATE 1682 549 8 N 490 391 I E	LENGTH OF ROCK DRILLING 96 7 m		DRILLED BY FONDISA
ANGLE FROM HORIZONTAL 70°	TOTAL LENGTH OF CORE 98 64 m		LOGGED BY Y Fukutake
BEARING OF ANGLE HOLE N 85°E	CORE RECOVERY 96 7 %		

Core cutting column values: 2 2 3

ROCK NAME: SANDSTONE. Calcareous

COLOR: white gry ~ gry., gry ~ white gry., White gry ~ gry.

Description:

shd. zone
No brn color.
Every 20~30cm interbedded
breccia.

66.1

Generally good core.
Partially shd. at
68.2, 69.0, 72~73.0, 76.1.
Cracky zone at 66.4~
67.2.

76.4

Shd. zone.
all cores brecciated
and all gravelly cores
Coated by clay (white).
76.4~80.0 clear breccia.

WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER:

LUGEON 50(ℓ/min)

Lu = 3.0   Supply
No Leakage

Lu = 3.0

Lu = 4.5

Lu = 3.5

ELEVATION: 166.3 m (60m), 147.5 (80)

Legend:
- core loss
- RQD
- ▶ driller's note ◀
- 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
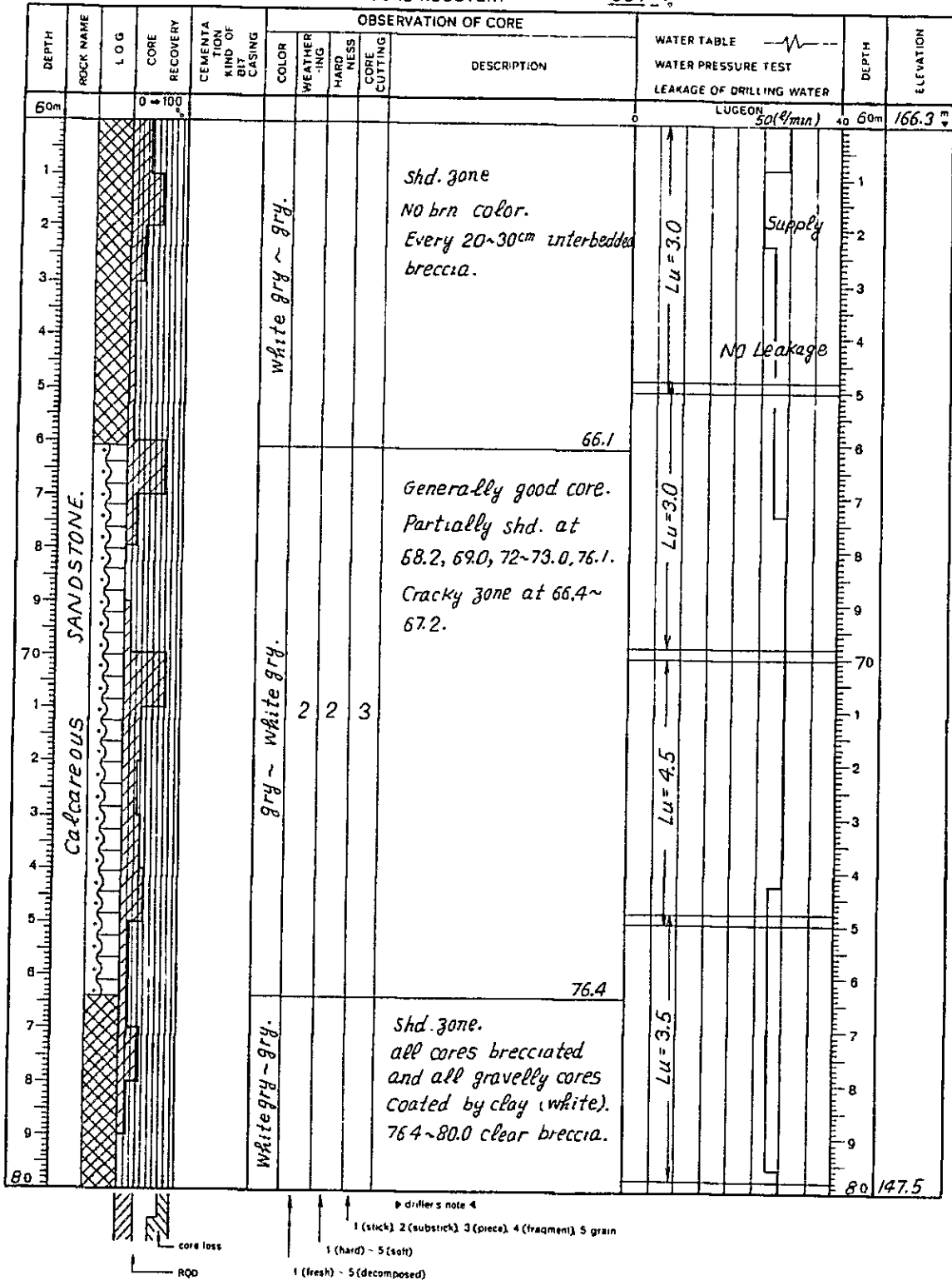- 1 (hard) ~ 5 (soft)
- 1 (fresh) ~ 5 (decomposed)

GEOLOGIC LOG OF DRILL HOLE

| Upper Quae Yai | PROJECT | HOLE No R - 1 (SHEET 5 OF 6) |

LOCATION __Dam. Right Abutment__ DEPTH OF HOLE __102 0__ m COMMENCED __Mar - 25 - 1979__

ELEVATION __222 7__ m DEPTH OF OVERBURDEN __5 3__ m COMPLETED __Apr - 4 - 1979__

COORDINATE 1.682 549 8N, 490 3911E LENGTH OF ROCK DRILLING __96 7__ m DRILLED BY __FONDISA__

ANGLE FROM HORIZONTAL __70__° TOTAL LENGTH OF CORE __98 64__ m LOGGED BY __Y Fukutake__

BEARING OF ANGLE HOLE __N85°E__ CORE RECOVERY __96.7__ %

Rock Name: Calcareous SANDSTONE.

Color: white gry ~ gry. / white~ gry. / gry ~ dark gry.

Description:

Shd. zone.
all cores brecciated
and all gravelly cores
coated by clay (white).
85.5

Good core, but shd. in
general
Breccia at 86.4, 87.3,
87.4, 88 (3~5 cm).
88.5

Shd. zone.
Breccia every 30 cm.
all gravelly cores coated
by graphite or white
clay.

Water Pressure Test: Lu = 3.0 / Lu = 16.1 / Lu = 1.6 / Lu = 1.8

Supply
No Leakage

Elevation: 147.5 (top) ... 128.7 (bottom)

> drillers note <
1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) - 5 (soft)
1 (fresh) 5 (decomposed)

— core loss
— RQD