MINISTRY OF CONSTRUCTION

GOVERNMENT OF THE REPUBLIC OF KOREA

SURVEY REPORT
ON
THE LONG-TERM MULTIPURPOSE DAM SCHEMES

(FIRST STAGE)

APPENDIX II GEOLOGICAL SURVEY

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JAPAN INTERNATIONAL COOPERATION AGENCY

SURVEY REPORT

ON

THE LONG-TERM MULTIPURPOSE DAM SCHEMES

APPENDIX II

GEOLOGY

C O N T N T S

1. PREFACE AND SUMMARY

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Geological study on twenty-four proposed dam sites and some of their alternatives was carried out to find out the possibility of the construction of the above proposed dam based on 1/25,000 scale map. The study covered the reservoir area, the power station site and the quarry and the borrow sites as well to obtain geological information to be required for the project study.

As the geological study was made only in a field reconnaissance grade and, in addition, with review of existing data in some of the proposed sites, the result may still involve uncertainty on the location of the sound rock line, quality and quantity of construction materials, which were here assumed empirically by observation of the outcrops of the rock.

For grading up precision, the following such normal investigation procedure should be undertaken by steps as

(1) Geological mapping in and around the dam and the reservoir area based on 1/1,000 - 1/25,000 scale map.

(2) Seismic investigation on the dam site, the major structure site and the quarry site.

(3) Drilling investigation at the dam, the major structure and the quarry sites.

(4) Lugeon test by using drilled holes at the dam site.

(5) Adit excavation on the dam and the quarry sites.

(6) Detailed geological mapping combined with adits, drillings and other records based on 1/500 scale map at the dam, the major structure and the quarry sites.

(7) In-situ rock shearing test on the foundation of a concrete gravity dam.

(8) Test pits for the borrow sites.

(9) Laboratory test on the construction materials.

On the above study concerning to the proposed dam site as due course, special attentions should be placed on the problems which were realized by the field reconnaissance as described in this report.

Summary of geological reconnaissance

No. & Name of Site	Description
Han Gang	
1-32 Bamseonggol	An alternative site is selected 1.5 km upstream because of economical reason. The left abutment is covered with thick talus deposit, but firm granite gneiss exist underneath and crops out the right abutment and the riverbed, being suitable for both a rockfill and a concrete gravity dam. Impermeable core material is poor nearby. It is to be investigated in western hills in wide area. A saddle of the left bank will limit H.W.L.
2-23 Hupyeon	The site is moved about 15 km upstream due to economical reason. The left abutment and the riverbed here is underlain with firm granite gneiss beneath thin overburden. The right abutment is a narrow ridge on which firm granite gneiss crops out on mid slope. The site is suitable for a rockfill dam. The dam axis is to be selected carefully considering complicated topographic feature.

3-22 Inje	An alternative site is selected 4 km upstream because of economical reason. The site will provide suitable foundation of firm granite after thin stripping in the right abutment and the riverbed. The left abutment is a thin ridge, so careful investigation will be needed for the foundation, even firm granite exists. The site is suitable for a rockfill dam, but core material has to be investigated in upstream in wide area.
4-30 Woelhak	The left abutment is overlain with thick talus deposits. The riverbed and the right abutment with thin overburden will provide an adequate foundation. However, a saddle of the left bank formed by a broad sheared zone of a fault will permit a considerable seepage which may cause a land slide on the outside slope. The proposed H.W.L 330 m is recommended to be lowered somewhat.
5-A3 Hongcheon	The proposed site is the only suitable site nearby. Both the left and the right abutments will provide a firm foundation for a concrete gravity dam. The river deposit will be more than 10 meters thick. The base rock beneath the river deposit may have a fault assumed by the difference of strikes of strata in both abutment. The concrete aggregate will be quarried nearby. H.W.L EL.124.8 m will be the maximum due to the height of the ridge of the right abutment.
6-3 Gujeol	At the original proposed site, the existing coal mine would be prohibitive against the construction of the dam. An alternative site is selected upstream where the bed rock of sandstone will privide a good foundation for a concrete gravity dam or rockfill dam even though a talus deposit occurs at the left abutment.

7-9 Pyeongchang	The proposed site will give a suitable foundation for a rockfill type dam. H.W.L. will be expected to be a few meter high above the proposed height EL. 420.0 m.
8-10 Panun	The geological condition is good for a rockfill type dam. H.W.L. will be expected to be a few meter higher than the proposed height EL. 280.0 m.
9-13 Suju	The proposed site will appear suitable for a rockfill type dam, though the slope wash occurs at the right abutment. However, the quantity of the impervious core materials should be examined before the construction.
10-12 Dogog	The geological condition will be suitable for rockfill dam. However, sub-dam will be needed at saddle of the ridge at the proposed H.W.L. 325 m. The lower H.W.L. is recommended.
11-A1 Dalcheon	The base rock from the right abutment to the riverbed will provide an adequate foundation of a rockfill dam. The left abutment is comprehensive in geology and geomorphology. The proposed H.W.L. EL. 115 m will be the maximum at the site.
12-A2 Ganhyeon	The geological condition will be suitable for a gravity dam. H.W.L may possibly rise a few meters up to the saddle of the left bank above the proposed H.W.L. EL. 111.4 m.
Naktong gang	
13-35 Bonghwa	The left abutment and the riverbed will provide a suitable foundation. However, the right abutment is formed of very cracky rock, which might slide after impounding in the worst case.

	An alternative site is found about 2.7 km downstream suitable for a rockfill type, though talus is developed in the left abutment. H.W.L. of the alternative site will be allowed to rise 10 meters higher than the proposed H.W.L. EL. 303 m at the original site.
14-43 Imha	Very suitable site for both a rockfill and a concrete gravity dam with the firm foundation beneath thin overburden in both abutment and the riverbed. The proposed H.W.L. EL. 192.0 m will be masimum at the site because of the presence of saddles at the right bank.
15-36 Chibo	The site is moved about 5 km downstream due to economical reason. As granite gneiss at the left abutment is weathered deeply, intrusive rock of diorite will be expected for foundation. The riverbed is underlain with granite gneiss beneath sand deposit with about 10 meters thickness. The right abutment will provide firm foundation of granite gneiss suitable for concrete gravity dam.
16- Hamyan	Left and right abutments are overlain with thin slope wash. Fresh granite mass crops out at the riverbed. The bedrock may offer a firm foundation for a concrete gravity dam. However, some faults exist at the site. Concrete aggregate will have to be quarried nearby. An alternative site, shinimwoel, is located about 6.5 km upstream suitable for a rockfill dam with H.W.L. EL. 380.5 m.
17-53 Dogsan	The left abutment is covered with top soil and weathered material of the base rock. Unconsolidated gravel with 2 - 3 m thick rests on the base rock at the riverbed. The right abutment is overlain with slope wash. The selected site is suitable for a rockfill dam

	and no other alternative site is seen nearby. H.W.L. EL. 158.4 m will be the maximum by the topographic feature.
Guem gang	
18-62 Yongdam	Two alternative centers are considered at the proposed site. Both will be suitable for a rockfill dam. H.W.L. can be higher than the proposed EL. 269.7 m, however, that will depend on the leakage problem through saddle of left bank in case of the downstream center and that of the right bank in case of the upstream center.
19-63 Sutong	The proposed site will be suitable for a rockfill dam. A firm foundation of the base rock will be provided after thin stripping. H.W.L. EL. 200 m will almost be the maximum because of the presence of a saddle of the left bank.
20-64 Myeongcheon	The proposed site will be suitable for a rockfill dam. The proposed H.W.L. EL. 150 m will almost be the maximum because of the presence of a saddle of the left abutment.
21-69 Simcheon	Geological situation will be suitable for a rockfill dam. H.W.L. can be rise a few meters up to the height of a saddle of the right abutment.
Seumgin gang	
22-77 Jeokseong	The right abutment is covered with talus deposit. The left abutment and the riverbed is formed almost of fresh gneiss. The proposed site will be suitable a concrete gravity type. Concrete aggregate material will be poor in the riverbed. A quarry site should be investigated.

23-82 Juam	The site will be suitable for both rockfill and concrete gravity. The left abutment is covered party with talus deposits, therefore, the dam axis should carefully be selected there. The right abutment lies thin weathered materials and the riverbed is covered a few meter thick gravel. H.W.L. will be expected a few meter higher above the proposed EL. 124.5 m.
24-A4 No.2 Boseonggang	The right abutment is rather weathered deeply. The river bed will be underlain with firm bedrock beneath gravel. The left abutment is formed of hard gneiss with thin top soil. The site will be suitable for a rockfill type. H.W.L. EL. 145.0 m will be the maximum because of the presence of a saddle at the right bank.

2. GENERAL GEOLOGY

2. GENERAL GEOLOGY

Topography of the Korean peninsula is characterized with a major mountain range named "Daebeak" extending north-south direction at the east side of the peninsula, which divides drainage eastward to the Sea of Japan with a steep slope and westward to the Yellow Sea with a gentle slope.

Some branch mountain ranges extends southwestward from the Daebeak Mountain Range subject to the geological structure in NE-SW direction.

These mountains are composed mostly of various rocks formed from Pre-cambrian to the Mesozoic.

Tertiary system is limited in its distribution in small areas along the east coast.

Quarternary system is developed in valley plains and coastal plains as unconsolidated deposits.

Korean standard stratigraphy is shown in the following Table.

Korean Standard Stratigraphy

Age	System		Igneous activity
	Series	System	
Quarternary			
Cretaceous Upper Jurassic	Silla Naktong	Kyeongsang	Granite, Diorite, Porphyry
Lower-Mid Jurassic		Daedong	Schistose granite
Triassic	Nokam Kobangsan Sadong	Pyongan	
Upper Carboniferous	Hongjum		

Ordovician	Great limestone	Chosun
Cambrian	Yangduk	
Proterozoic		Sangweon
Archaeozoic		Granite Gneiss Crystalline Schist

2-1 North Han River Basin

(1) Topography

The upper reach of the North Han River shows an matured steep mountains ranges in which narrow valley plains exist along the dissecting rivers.

Along the middle and the lower reaches downstream of the Cheonpyeong dam, wide valley plains are developed among rounded hill masses of old stage.

(2) Geology

The mountains in the upper reach of the North Han river are composed mostly of granite gneiss and granite. In the middle reach crystalline schist appears in the area around the Hwacheon dam and the city of Chungcheon. These metamorphic rock masses extend as a belt extending in NE-SW direction governed by general geological structure in the Korean peninsula. The fresh rock of them is firm and watertight.

Quarternary deposits are present in the valley plains as unconsolidated coarse materials of sand and gravel, and in the coastal plains as unconsolidated fine materials.

The geology of each proposed damsite is as follows.

Damsite	Foundation rock
Bamseonggol	Granite gneiss
Hupyeong	Granite gneiss
Inje	Granite
Weolhak	Granite gneiss
Hongcheon	Granite gneiss, crystallin schist and quartzite

2-2 South Han River Basin

(1) Topography

According to the report of Han River Basin prepared by the joint survey team consisted of Korean Government (MOC and ISWACO) and Government of United States of America (Department of the Interior, Bureau of Reclamation and Geological Survey), the general topography in south Han river basin is explained as follow.

The South Han River drains a very mountainous area of about 12,000 square kilometers. The river begins about 160 kilometers east of Seoul and 40 kilometers from the east coast of Korea. The river follows a very crooked course, generally southwestwatd for 180 river kilometers to Tanyang, thence westward and northwestward for 150 river kilometers to its junction with the North Han River.

Among the steep-sided and sharp-crested ridges and spurs, the river and its tributaries wind sharply, flowing in narrow canyons which make many loops and long, sharp hairpin bends. Evidently the river meandered greatly over a peneplain before the present erosion cycle began, but the region is so thoroughly dissected that little evidence of the peneplain is discernable.

Although the mountains are steep, much of the bedrock is covered with silty to clayey soil or with angular rock fragments of various sizes. Wherever a patch of silty or clayey soil can

be found, it is cultivated. Small villages or clusters of houses can be seen, hundreds of feet above the river, in a great number of gullies throughout the basin. Whether the creeks and tiny streams which furnish the water supply for the people are perched streams fed chiefly from rainwater in the overburden, or whether they are perennial streams fed from a high water table in the bedrock is not definitely known.

(2) Geology

Generally speaking, the geology of the south Han river basin is divided into three belt zones having the direction of NE-SW. The first belt located on the northern part of the basin is mainly consisted of granite, the second one located on the middle part of the basin is metamorphic rock complex and the third one located on the southern part is sedimentary rocks zone including calcareous rocks.

Granite on the first belt, roughly speaking, belongs to Mesozoic Era (Cretaceaus-Jurassic) and it intruded the earlier rocks, for instance, in metamorphic rocks complex on the second belt and partly in sedimentary rocks on the third belt, Granite forms the low and the gentle slope hills in the project area.

Metamorphic rock complex belongs to Pre-Cambrian period and they are consisted various kinds of gneiss, schist and phyllite etc. Metamorphic rocks forms more steep mountain because of their resistance for erosion.

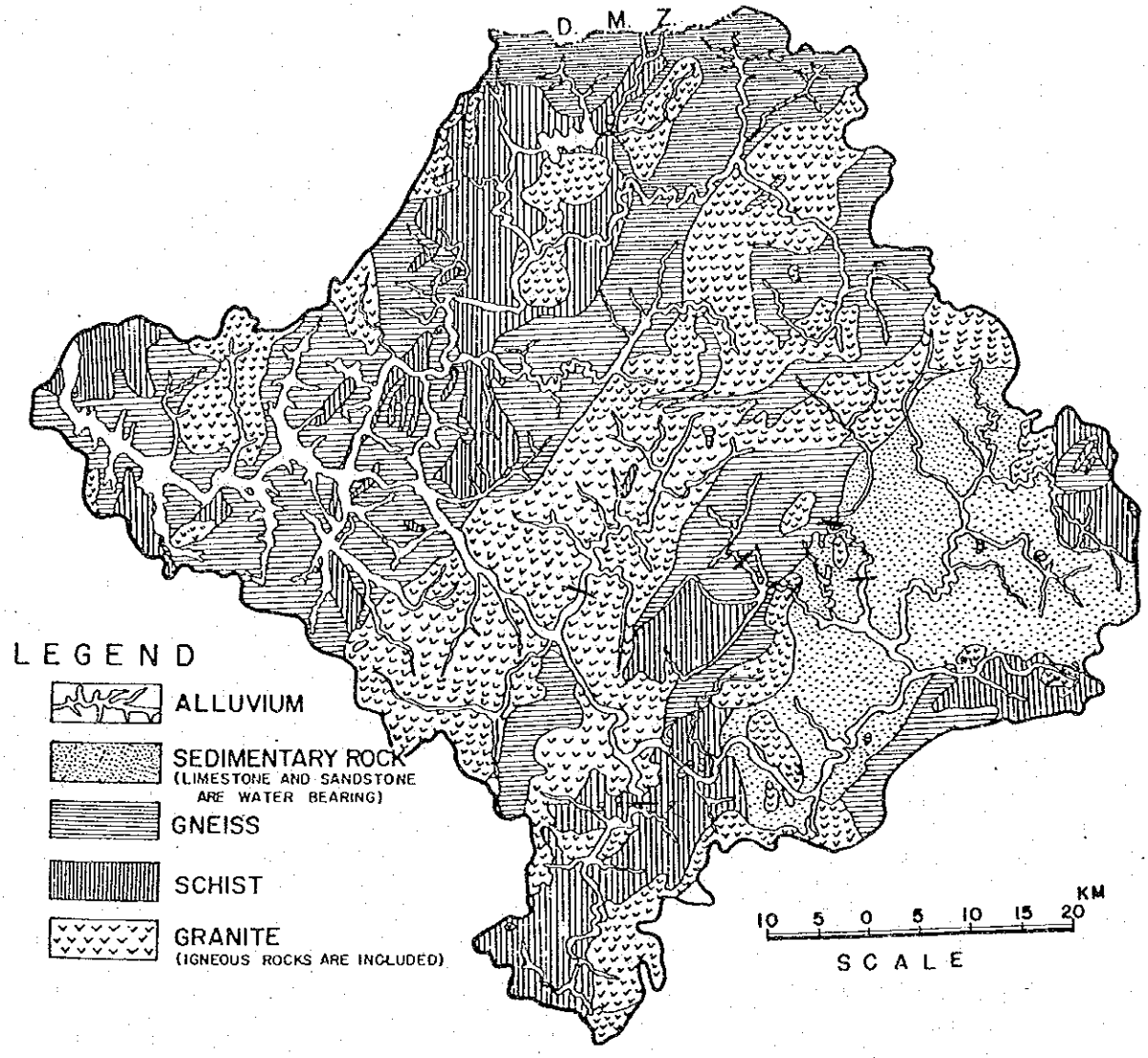
There are many kinds of sedimentary rocks belonging to various geologic ages from Cretaceous to Cambrian period. Limestone named Great Limestone Group is included in this sedimentary rocks and according to the report on Han River Basin prepared by the joint survey team of Korea and United States of America, the limestone are explained as follows;

> Between period of marine deposition the land was uplifted and exposed to erosion; so large gaps occur within the stratigraphic colum, and several series of rocks rest unconformably upon the order rock bodies. During these periods of erosion,

solution channels were formed within the limestone bodies, and a karst topography developed in some of the limestone area.

The sites reconnoitred by the Japanese mission on this time are located at the three belt zones as follows;

Damsite	Foundation rock
Ganhyeon site	On first belt (Granite area)
Dalcheon site	On boundary between first belt and second belt (Granite and metamorphic rocks area)
Suju site	On second belt (Metamorphic rocks area)
Dogog and Pyeongchean sites	On boundary between second and third belt (Metamorphic rocks and sedimentary rocks area)
Gujeol alternative site	On boundary between first belt and third belt (Granite and sedimentary rocks area)
Panun and Gujeol sites	On third belt (Sedimentary rocks area)



This geologic map is quoted from the Appendixes-volume 3 of HAN RIVER BASIN report prepared by MOC and ISWACO in cooperation with United States Department of Interior Bureau of Reclamation and Geological Survey on 1971

GENERALIZED GEOLOGIC MAP HAN RIVER BASIN	
Feb. 20. 1978	Fig.- 1

2-3 Naktong River Basin

(1) Topography

The Naktong river basin is sorrounded with the matured steep mountain range, especially from north to west, in the upper reach.

Wide valley plains among hill masses of old stage is intensely developed from the middle reach to the lower reach of the basin.

(2) Geology

In the western zone of the Naktong river basin granite gneiss is developed widely as a belt orientating its direction in NNE-SSW, and, in the east of it, the Kyeongsang system is distributed, overlying the said granite gneiss.

Granite gneiss and crystalline schist which is scattered as small masses were formed in Pre-cambrian era.

Small masses of Palaeozoic sedimentary rock appear in the north and the northwest areas of the basin. Later, great masses of granite were formed and, at present, distributed mainly in the belt of granite gneiss. Some of granite appear in the hills in the eastern area. In the mean time, basic rocks such as diorite, gabbro and anorthosite were intruded into the older rock masses.

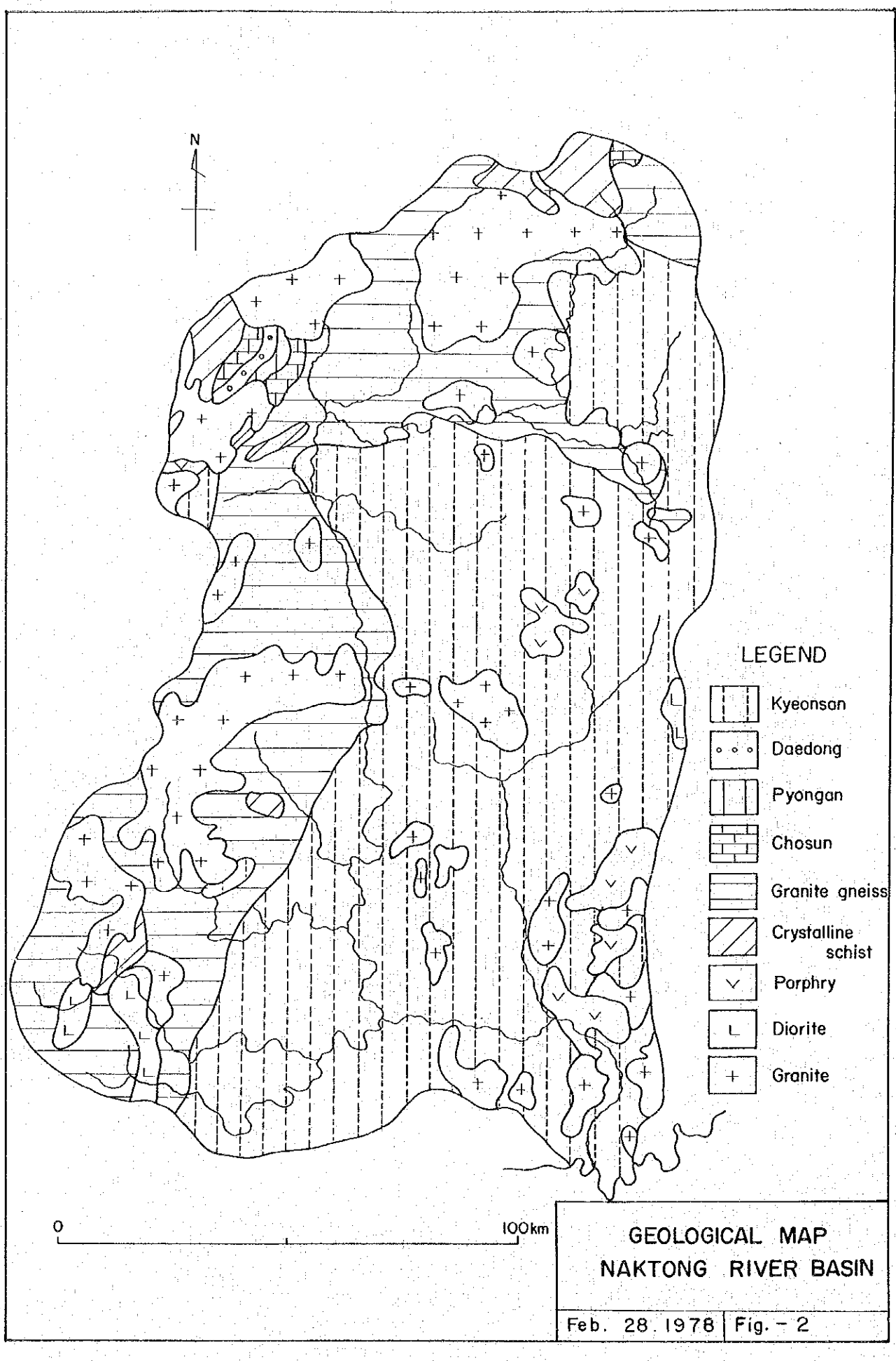
In the late of Mesozoic, a series of sedimentary rocks, named the Kyeongsang system, the lower part of which is called the Naktong series and the upper part, the Silla series, was deposited in the south of the Korean peninsula. The Naktong series appear in the west side and the Silla series are developed extensively over the middle and the lower reaches of the Naktong river.

Quarternary system exists in the valley plain and small coastal plain.

Geology of each proposed damsite is as follows.

Damsite	Foundation rock
Bonghwa	Alternation of sandstone, conglomerate, slate of the Silla series of the Kyeongsang system

Imha	Granite
Chibo	Granite gneiss and diorite
Hamyand	Diorite
Dogsan	Granite gneiss and anorthosite



GEOLOGICAL MAP
NAKTONG RIVER BASIN

Feb. 28. 1978 | Fig. - 2

2-4 Geum River Basin

(1) Topography

According to the Report on the Geum River Basin Overall Development Project prepared by Nippon Koei Co., Ltd., the general topography in Geum river basin is explained as follow;

> The main Geum river has a length of 401 km and a catchment area of 9,886 km^2. It originates in the Sobaeg mountain ranges at Mt. Dogog and flows into the Yellow sea at Gunsan. Through the long river course, it gathers many tributaries. Among them, the biggest tributary is the Miho river. The Geum river flows down dissecting the mountainous topography of mature stage in its upstream region. The mountainous area shows disposition of NE-SW direction, so called Sinian direction. But the river course is not always subject to the disposition. On the contrary, it flows northward in its upper basin, transversely to mountain ridges. In its lower-middle basin near the confluence with the tributary Miho river, it flows conforming to relief topographic of the mountain range. Most of the Geum river basin is occupied by mountainous area, and flatland spreads in the lower basins have developed around Daejon, Geumsan, Ogcheon, Boeun, and in the Miho river.

(2) Geology

The geology of the Geum river basin is roughly divided into three belt zones. The first and the third belt located on the northern part and the southern part of basin respectively are mainly consisted of gneiss intruded by granite partially. The second belt located on the middle part of the basin is consisted of crystalline schist as a basement rock and granite as a big intrusion rock mass. Sedimentary rocks is also found, however it distributes locally on the boundary area between the first and second belt or between the second and the third belt.

Metamorphic rocks composed of gneiss on the second belt and crystalline schist on the other two belts belong to Precambrian period.

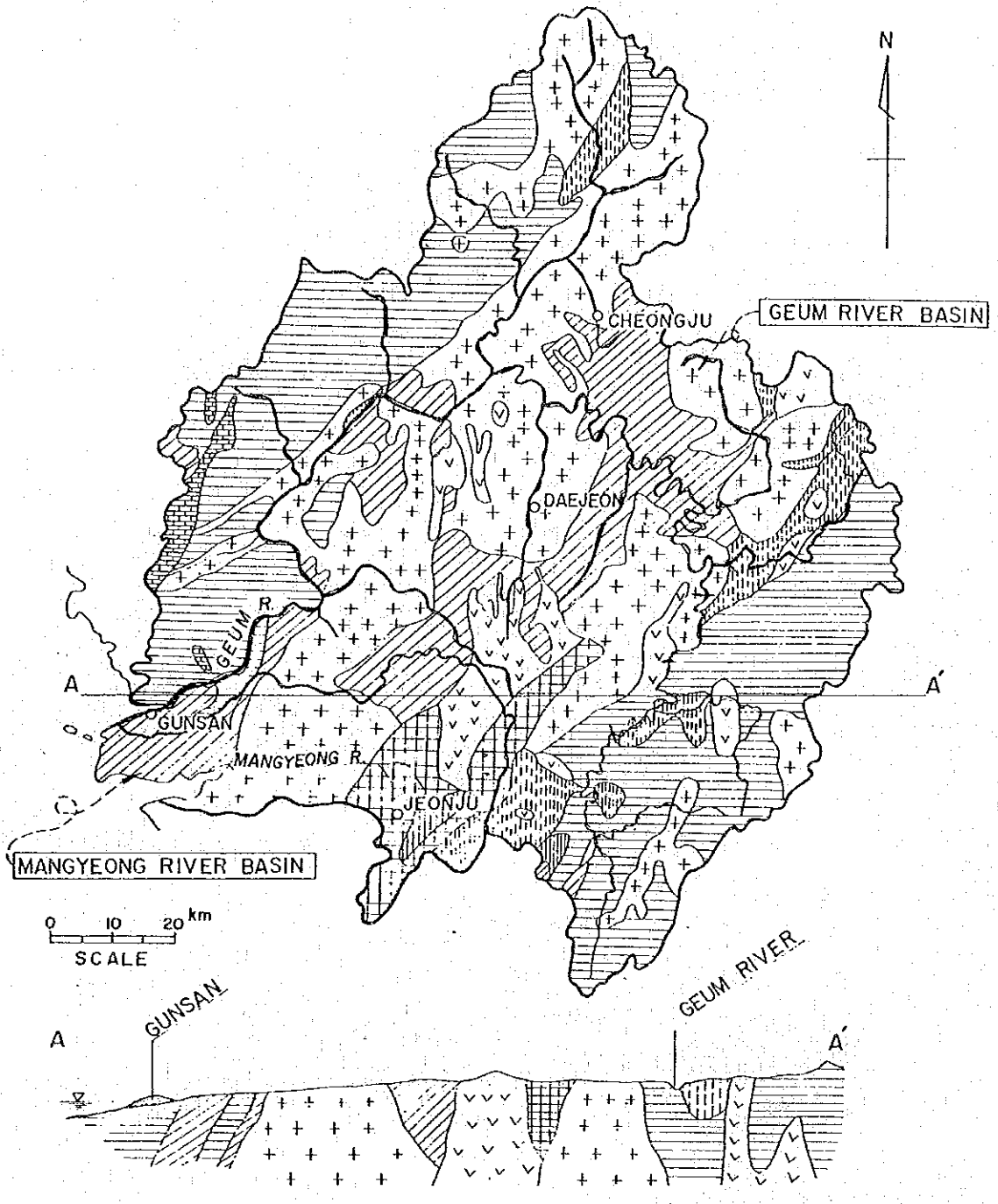
The report on the Geum river basin explain for these Pre-cambrian rocks as follows;

> They are well consolidated, and their general schistosity or gneissosity is N40°=60°E, with steeply eastward or vertical dips, in accordance with the "Shinian Direction". They are overlaid unconformably with the Pyongan system of Triassic-upper Carboniferous.

The Granite on the second belt is a intrusion rock mass belonging to Mesozolic Era (Pre-cretaceous) and it also intruded in accordance with "Shinian Direction" having the NE-SW direction.

The sites reconnoitred on this time are located at three belt zone as follows;

Damsite	Foundation rock
Yongdam site	On third belt (Gneiss area)
Sutong site	On boundary between second and third belt (Quartz-porphyry and gneiss area)
Myeongcheon site	On second belt (Granite area)
Simcheon site	On boundary between second and third belt (Granite and sedimentary rock area)



LEGEND

- Porphyry
- Granite
- Shisfose Granite
- Gyeongsang system (sedimentary rock)
- Daedong system (sedimentary rock)
- Pyeongan system (sedimentary rock)
- Granite Gneiss
- Crystalline Shist

This geological map is quoted from the report of the Geum River Basin Overall Development Project prepared by NIPPON KOEI on Feb. 1972

GEOLOGIC MAP OF GEUM AND MANGYEONG RIVER BASIN

Feb. 20. 1978 | Fig.-3

2-5 Seumjin River basin

(1) Topography

Topography of the Seumjin river basin is characterized with wide valley plains developed among hill masses of old stage in the middle and the lower reaches. The matured mountain area is limited in the uppermost of the river basin.

(2) Geology

The Seumjin river basin is widely covered with granite gneiss which is the extension of the belt of granite gneiss in the Naktong river basin. Crystalline schist exists in a small spot in the upper reach.

Palaeozoic sedimentary deposits are seen as belts orientating their direction in NE-SW in the western area of the basin.

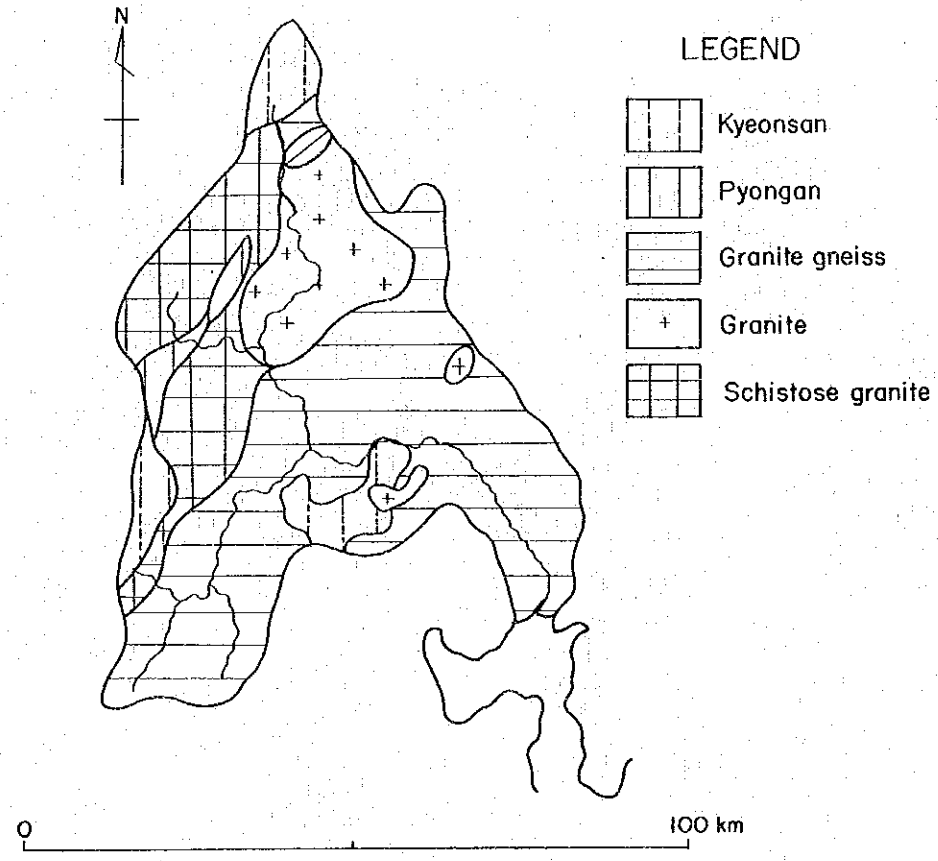
Granite and gneissose granite formed in Mesozoic appear as big masses in the western part of the basin, as small masses in the hills of the middle reach.

The Kyeongsang system, the alternation of sandstone, conglomerate and slate formed in late Mesozaic, is distributed in places in the upper and the lower reaches, covering base rock of granite gneiss.

Quarternary system is seen in terrace and alluvial plain valley plains.

Geology in each proposed damsite is as follows.

Damsite	Foundation rock
Jeokseong	Gneissose granite
Juam	Granite gneiss
No.2 Boseonggang	Granite gneiss



GEOLOGICAL MAP
SEUMJIN RIVER BASIN

Feb. 28. 1978 | Fig.-4

3. GEOLOGY OF THE PROPOSED DAMSITES

3. GEOLOGY OF THE PROPOSED DAMSITES

3-1 Bamseonggol

The originally proposed damsite has been shifted to upstream alternative site, 1.5 km north northeast, in view of economical appraisal.

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 88 m
H.W.L.	: El. 300 m
Power station	: Dam and Tunnel

(2) Topography and Geology of Reservoir Area

The reservoir area comprises rather steep hills of mature stage of topography. Valley plains of small-scale develop only in main stream. Most of the basin consists of granitic gneiss and has no possibility of leakage out of reservoir water. Shrubs and grass cover all over the basin. Steep slopes in the basin produce much clastic materials to the river, especially from the left bank side slopes. An example of clastic deposits in recent flood is observed at the upstream end of the reservoir area. Thus, clastic materials are often washed out to the river channel, but there is no landslides or rock slide in the area. Riverbed gradient in the reservoir area is about 1/200. Narrow flood plain and low river terrace develop in the valley plain.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at transition from valley plain to gorge channel. Left bank slope is a nose of hill ridge of 35°, with talus slope of 22° in its lower portion. The thickness of the talus increases at the downstream side. Left bank ridge is followed by a saddle ridge in its extension. High water level and the elevation of the saddle should be carefully studied for possible leakage of impounded water.

Flat base rock is exposed on the riverbed of 70 m width. Right bank slope is steep 38°.

Geology

A talus deposits of 20 m high on the left bank is rather thick (5 ~ 6 m) and laid on the base rock of granite gneiss, which is hard and sound with covering of weathered surface. Firm and fresh granite gneiss is exposed all over the riverbed. It is jointed but has no fault.

Steep slope on the right bank is mostly covered by surface soil. Base rock is exposed partly. Hard and fresh rock is available after thin excavation of the overburden. Big fault or fractured structure is not found around the site.

(4) Geology of Appurtenant structure site

Spillway: Spillway should be selected to lay on the right bank side, because thick talus is covering downstream side on the left bank.

Tunnel: Intake of the tunnel will be opened on the left bank. Tunnel of about 2.2 km length is crossing through granite gneiss. The gneiss is rather massive with fault and joints of small scale. Big spouting of ground water may not occur during tunnel driving.

Penstock and Power station: Penstock line will be laid on the rocky ridge of granite gneiss, no problem in anchoring the penstock pipe. Power station will be built on the foot of thin ridge of granite gneiss. No flat ground is available and rocky ground has to be excavated for installation of turbine and generator. Excavated rock wall should be carefully protected against rock fall.

(5) Material

Impervious material: Impervious soil material will be difficult to obtain nearby. Only possible source can be expected in weathered zone of granite gneiss in the low hill on the upstream right bank. Its thickness is estimated at 1 - 2 m. The soil is high in clay contents and contains much rock fragments. Future study in up and downstream reaches is necessary to find out suitable materials.

Filter material: Filter material is also unavailable nearby. Long distance transportation will be required.

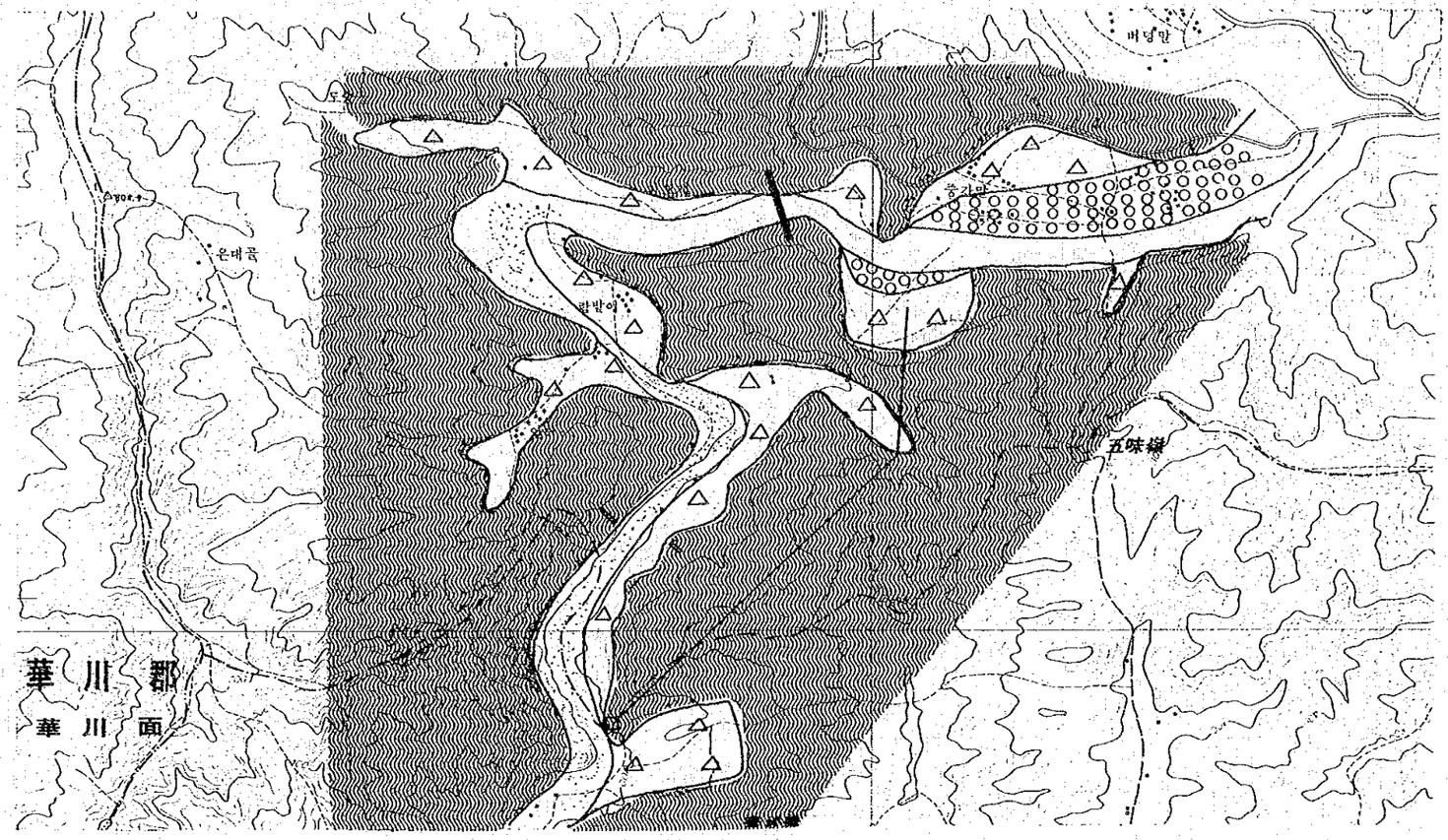
Rock material: A mass of granite gneiss is exposed on the left bank, 1000 m upstream of the damsite. It is sufficient enough for rock material in quality and quantity.

(6) Comments

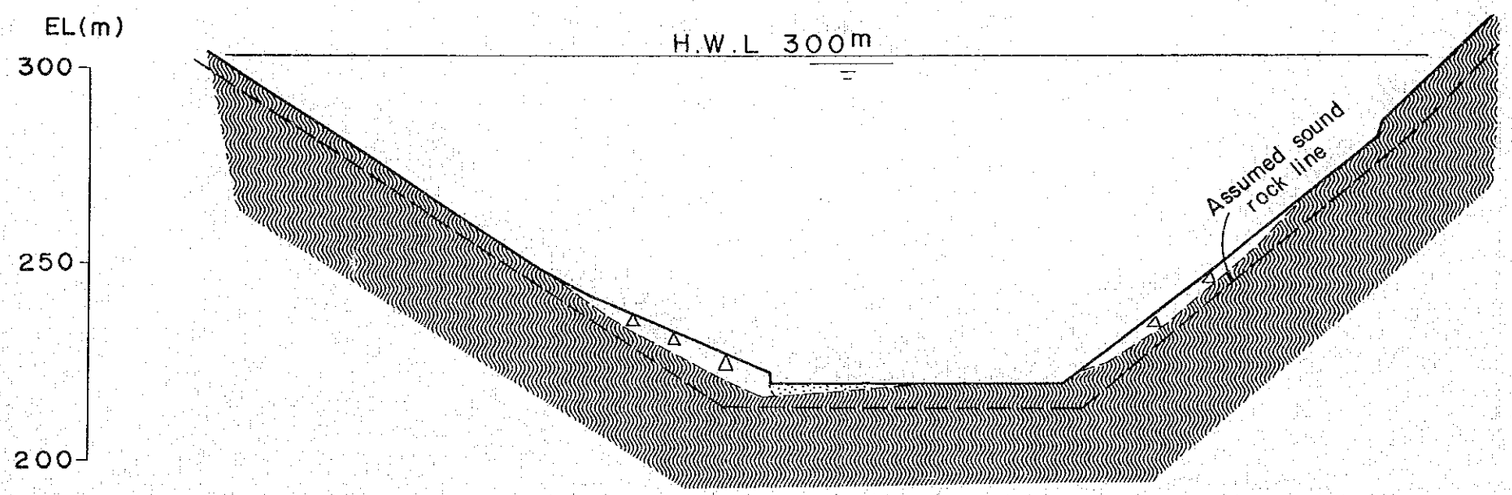
A) River channel is meandered in flood plain in its upper reach and a damsite is selected at rocky gorge section at just end of the meandered channel. Left bank talus, on the other hand, increase its thickness in the downstream side. Layout of dam base in confined in narrow area. Design and layout of dam body should be carefully studied.

B) Most important problem is to find out supply source of impervious material. A series of valley plains in the upper reaches should be surveyed again to find out suitable soil material. Another possible source can be expected in the weathered granite area, 5 km east of the damsite.

C) A concrete gravity dam is also adoptable, if geological condition on the left abutment is favourable after detailed investigation.



PLAN



PROFILE

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Gneiss
- Damsite

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
I-32 BAMSEONGGOL

Feb. 28. 1978 | Fig.-5

3-2 Hupyeong

There have been several alternative damsites on the upper Soyanggang. After economical comparison each other, Hupyeong site is finally selected at 15 km upstream of original damsite.

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 88.4 m
H.W.L.	: El. 566.4 m
Power station	: Dam and Tunnel

(2) Topography and Geology of Reservoir Area

The reservoir area is steep hills of granite gneiss, presenting mature stage of topography. Upper Soyanggang in the reservoir area is generally narrow erosional valley, through a series of narrow valley plains develop in some parts of the river. The basin is well-forested, except small talus slope. No landslide in the hill slopes and no permeable rock beds in the reservoir area.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at downstream of a sharp bend of the gorge channel in an incised meander reach. Left bank is steep and slope of 40° is running to southward. Riverbed is narrow --- 50 m in width, and covered with gravel. The gravel deposits seem to be rather thin. There is low river terrace of 5 m high close to right bank. The right bank is a nose of thin ridge. Its slope is 30°, standing on the river terrace as high as 60 m. There is a saddle ridge of about 200 m length coming in extension of the dam crest. Special device in the detailed design of abutment will be required.

Geology

Base rock of granite gneiss on the left bank has thin covering of surface soil and weathered zone --- 3 - 4 m thickness, providing firm

foundation for the dam. In the riverbed, rather thin deposits of gravel are covering hard and sound base rock of granite gneiss underneath.

Granite gneiss is exposed on the lower half of the right bank slope. The gneiss has thicker weathered zone in the upper half of the slope. Further detailed investigation is required on the top of the ridge, especially on permeability of the ground.

(4) Geology of Appurtenant structure site

Spillway: Spillway can be laid either on left bank or on right bank side from the geological point of view. However it is better to lay on the right bank side under the topographical conditions --- using the thin ridge as an overflow crest.

Tunnel: Tunnel of 11.5 km length is passing through granite gneiss mass on the right bank side. The gneiss is firm and sound. There may be no big fractured zone that may cause spouting of ground water.

Penstock and Power station: The ridge slope of granite gneiss where penstock pipe would be laid on, is sound enough to be anchored the pipe line. Power station will be built in the narrow space at the foot of ridge slope, having talus deposits on its both up and downstream sides. Power house should be well protected from downstream gully water. Special consideration should be paid for layout of the powerstation.

(5) Material

Impervious core material: Impervious material can be expected in a gentle slope on the right bank of the left tributary joined at just upstream of damsite. Exploitable thickness should be determined on further investigation.

Filter material: Gravels in the riverbed nearby is too big in size for the embankment of filter zone. It may be necessary to transport the material of suitable size from a distant borrow pit.

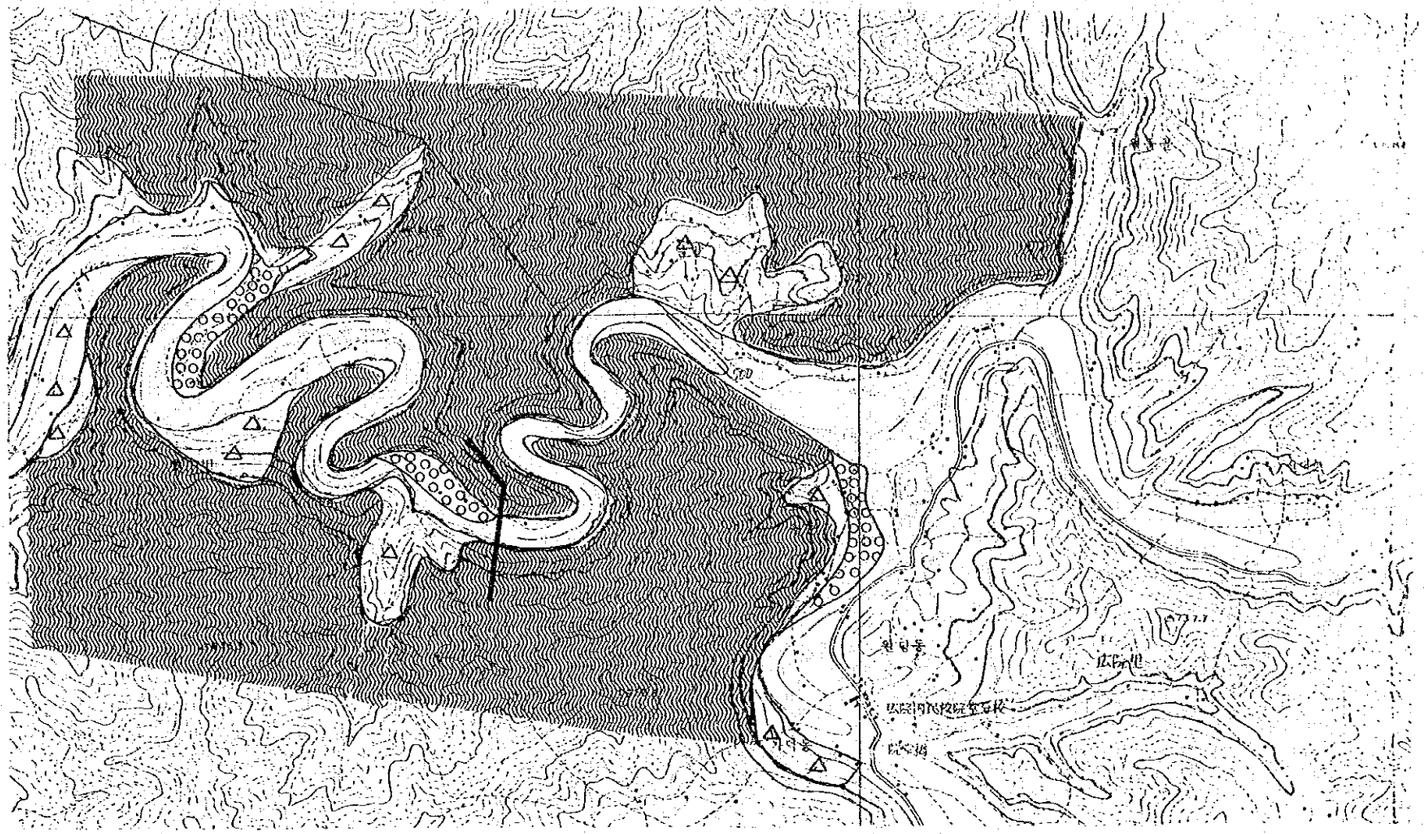
Rock material: Hard granite gneiss is exposed on both bank sides, 1000 m upstream of the damsite. A quarry can be opened in this gneiss and can supply sufficient rock materials.

(6) Comments

A) Base rock in the project area is a sound granite gneiss, providing firm foundation for all structures.

B) Special investigation will be necessary on the thin ridge on the right bank side. Bearing strength and permeability on the ridge ground should be carefully confirmed.

C) It is required that confirmation and selection of borrow pit for exploitation of impervious materials.



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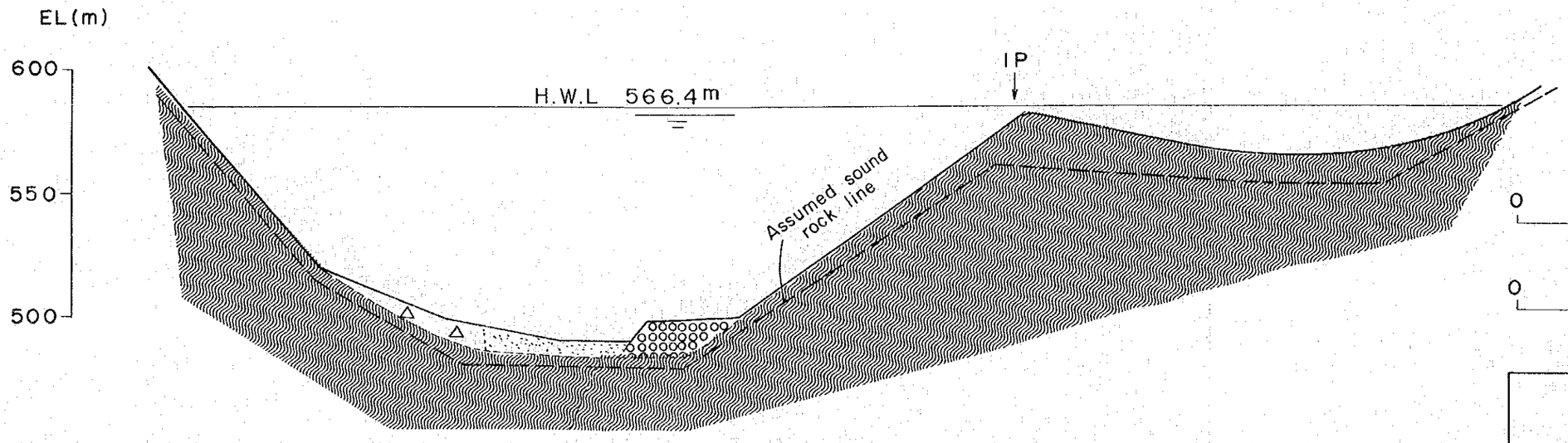


PROFILE

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Gneiss
- Damsite

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY

2-23 HUPYEONG(後坪)

Feb 28.1978 | Fig-6

3-3 Inje

After economical appraisal, original damsite has been shifted 3.5 km upstream to the present damsite.

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 125 m
H.W.L.	: El. 344 m
Power station	: Dam and Tunnel

(2) Topography and Geology of Reservoir Area

Reservoir area comprises steep gentle hills of mature stage of topography. A new damsite is selected in narrow gorge of incised meandering course. A series of narrow valley plains develop in several kilometers upstream reach of the damsite, furnishing big impound capacity of the reservoir. Riverbed gradient in the area is 1/700. Forestation is well preserved all over the area, except talus slopes on the hillside. There is few landslide topography in the area. There is no rock or strata that leaks impounded water outside the basin area.

(3) Topography and Geology of Damsite

Topography

Valley wall on both sides of the dam is one of the small ridges divided by several parallel gully notches. Left bank is steep cut slope of 38°. Riverbed is narrow, having a width of 50 m and covered with gravel. The gravel deposit seems to be not so thick, because several outcrops of base rock appear in the up and downstream riverbed. Right bank slope is about 40°, having talus deposits on its lower half.

Geology

Base rock is generally composed of hard granite. Granite rock is exposed on most of the left bank slope. Surface weathered zone may be 3 - 4 m thickness. There may be some seepage through joints or cracks. Riverbed gravel sometimes contain big boulders. But firm and sound granite rock can be expected beneath thin deposits. Right bank slope

is covered by surface soil of 1 - 2 m thickness, and talus deposit at the foot of the slope, except granite exposure at water's edge and road cut portion. Dambody can be abutted directly on the fresh and sound granite after excavation of these overburden. There is no evidence of big fracturing or fault around the damsite.

(4) Geology of Appurtenant Structure Site

Spillway: Spillway can be laid on sound base rock in either side of the river.

Tunnel: Intake tunnel will be opened on the left bank just upstream of the dam. Tunnel of 5.2 km length is extended to the back water of the existing Soyanggang Reservoir. Tunnel route will pass through granite and granite gneiss. There may be some fractured zone encountered at the boundary of granite and gneiss in the middleway of the route. Tunnel driving through the fractured zone will accompany some troubles such as groundwater spouting or cave-in.

Penstock and Power station: Penstock line will be laid on the rocky slope of granite gneiss which will provide firm and sound foundation of anchoring the pipe line. Power station will be built on the riverside slope which had submerged by the backwater of the Soyanggang Reservoir. A large excavation of rock is required to prepare the building space. High cut rock face behind the station should be carefully protected against rock fall.

(5) Material

Impervious core material: Impervious core material is not available nearby. Future reconnaissance in further upstream area is required to find out low gentle hill of decomposed granite area.

Filter material: Sandy materials are also unavailable nearby. Sand and gravel bars around Inje town located along the backwater of the Soyanggang Reservoir may be served as supply source, though transportation is very long - 10 km.

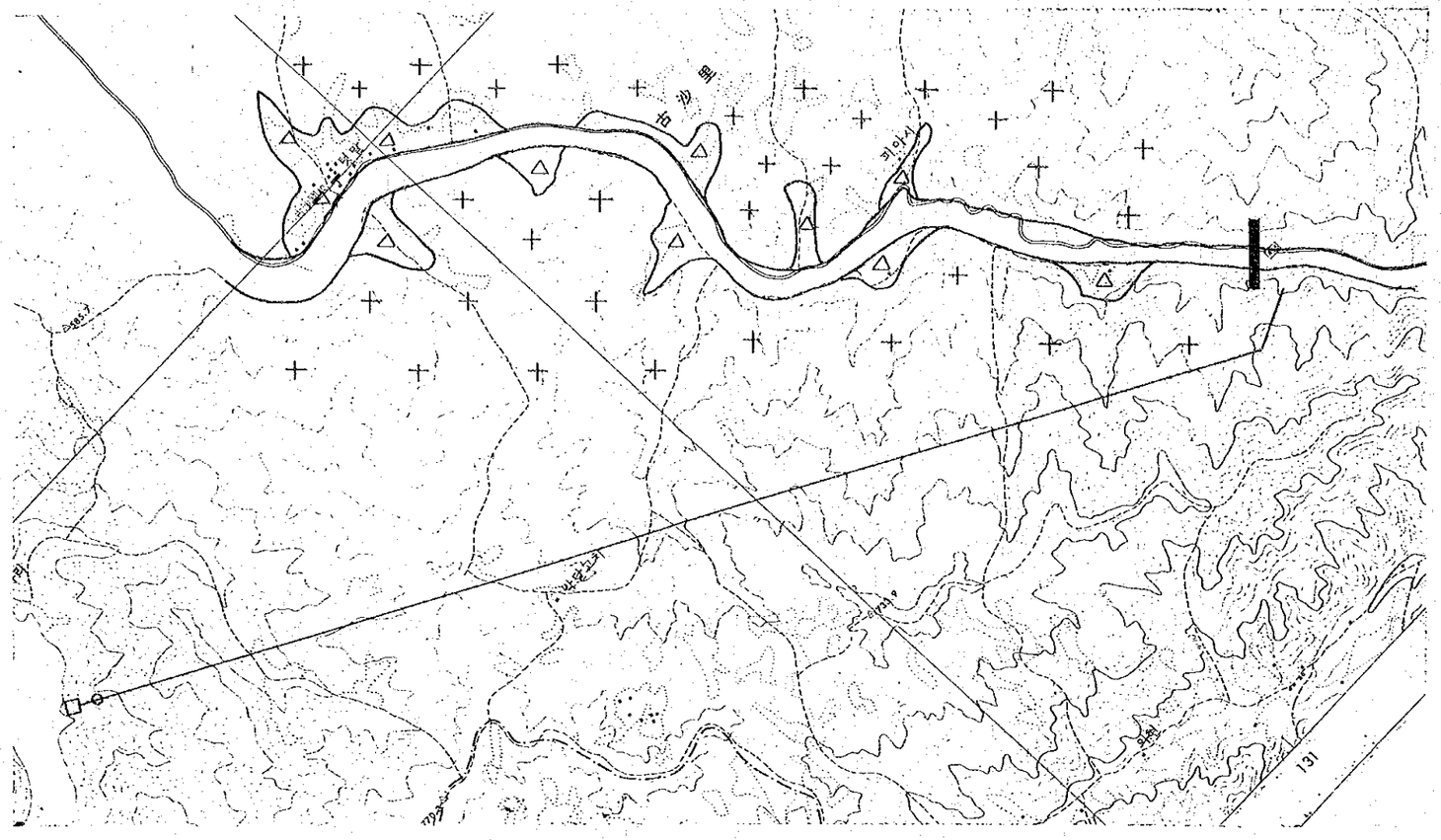
Rock material: There are several big outcrops of granite around the damsite. A quarry can be opened at one of these outcrops.

(6) Comments

A) Hard and fresh rock of granite distributed extensively exposed around damsite, providing favourable site. Selection of dam axis on the rugged valley wall should carefully be done after detailed study of topography and geology.

B) Possible leakage through joints and cracks at the left abutment should be carefully studied.

C) Location of impermeable core material in case of rockfill dam is not established yet. Wide area survey to find out suitable borrow area for the material is urgently needed.



PLAN

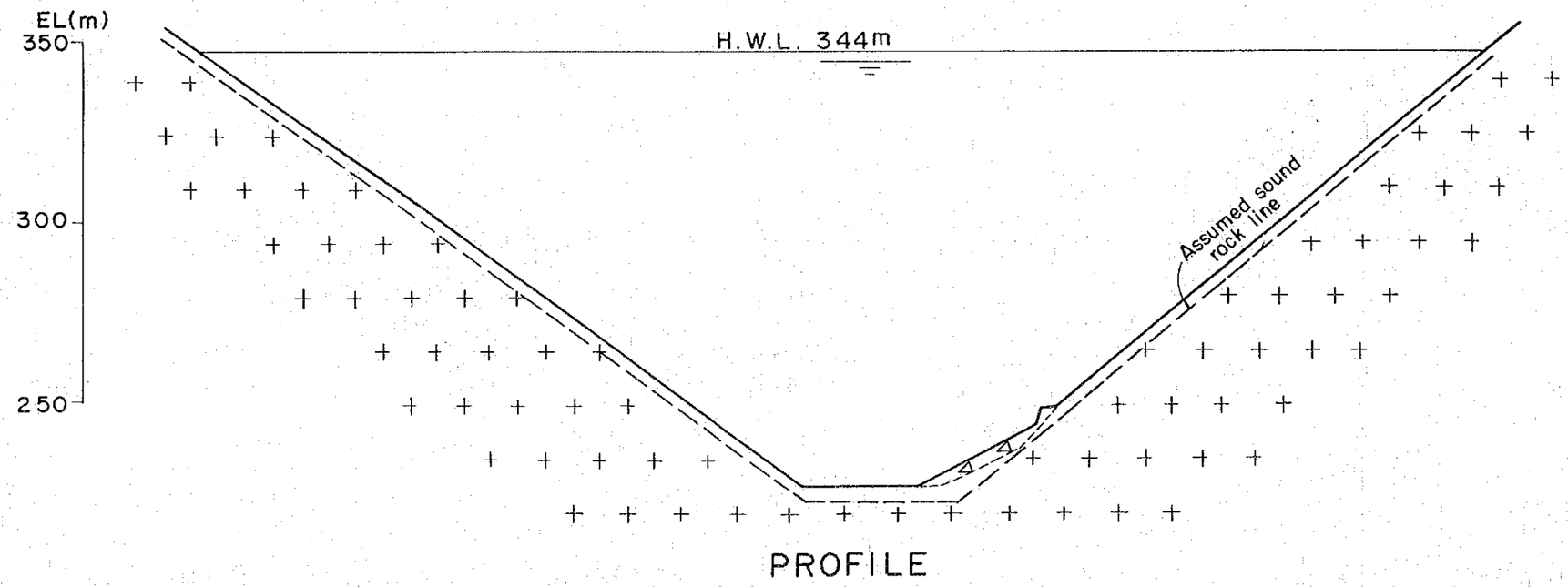
TEGEND

Talus

Sand and Gravel

Granite

Damsite



PROFILE

0 1000m

PLAN

0 100m

PROFILE

GEOLOGY

3-22 INJE (麟蹄)

Feb 27. 1978 | Fig.-7

3-4 Weolhak

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 81 m
H.W.L.	: El. 300 m
Power station	: Attached to the dam

(2) Topography and Geology of Reservoir Area

The reservoir area of the Weolhak dam is underlain and enclosed with hard granite gneiss showing rather steep hill masses covered with vegetation of bush and dissecting channels in late matured stage.

No sign of large land slide is assumed in the reservoir area. However, a large fault is present along the Inbuk cheon crossing Woentongri path where strike and dip of it are N 10°W and 20°W, respectivety, and width of sheared zone is about 60 meters.

The southern slope of the path (saddle) is 30° in gradient and water table seems to be low at present. When impounded, leakage through the sheared zone will probably cause landslide on the southern slope, therefore, the countermeasures against leakage should be needed based on the detailed investigation.

(3) Topography and Geology of Damsite

Topography

The damsite is selected at an elbow to the left of the river course where the river stream is attaching the right bank forming a steep slope of rock with gradient of 35°. A tributary bounds the steep slope at about 200 m downstream of the right bank.

The river bed is about 100 meters in width. At the left bank, a terrace occurs about 10 meters above the riverbed. A gentle slope of talus is present over the left side of the terrace and becomes steeper toward a hill side of the left abutment.

No prominent fault is considered in geomorphological feature around the damsite.

Geology

The left abutment is formed of a low terrace field, a talus slope and a hill slope in ascending order. The terrace gravel is overlain with the base rock of granite gneiss with thickness about 10 meters. The talus deposit covers the said terrace gravel at the hill foot with about 10 meters thickness in maximum. The hill is formed of granite gneiss covered with top soil. The weathered zone of granite gneiss is assumed to be about 5 meters. Talus deposit, terrace gravel and weathered rock should be dug out at the foundation of the impervious core of the dam.

The river bed is covered with gravel, mostly cobble in size. The thickness of it is assumed to be 1 - 2 meters at the right side and 5 - 6 meters at the left side. The base rock of granite gneiss is present beneath the gravel.

The right abutment is an outcrop of firm granite gneiss where no fault exists.

(4) Geology of Appurtenant Structure Site

Spillway: The spillway is to be installed at the right abutment where firm foundation is expected.

Penstock and power Station: The penstock is to be constructed at the left bank formed of granite gneiss. On the slope of the hill. The firm foundation will be found beneath the wheathered zone, however, at the slope end, deep excavation of talus deposit will be needed to reach the foundation. The power station will be placed on the terrace ground where the firm foundation exists deeply.

(5) Material

Impervious core material: Impervious core material will be present at gentle slope in tributaries about 1 km upstream of the left bank where sufficient volume of soil covers on the base rock with about 3 meter thickness.

Filter material: Coarse material can be collected in the river bed nearby, however, sand will be transported from other borrow site.

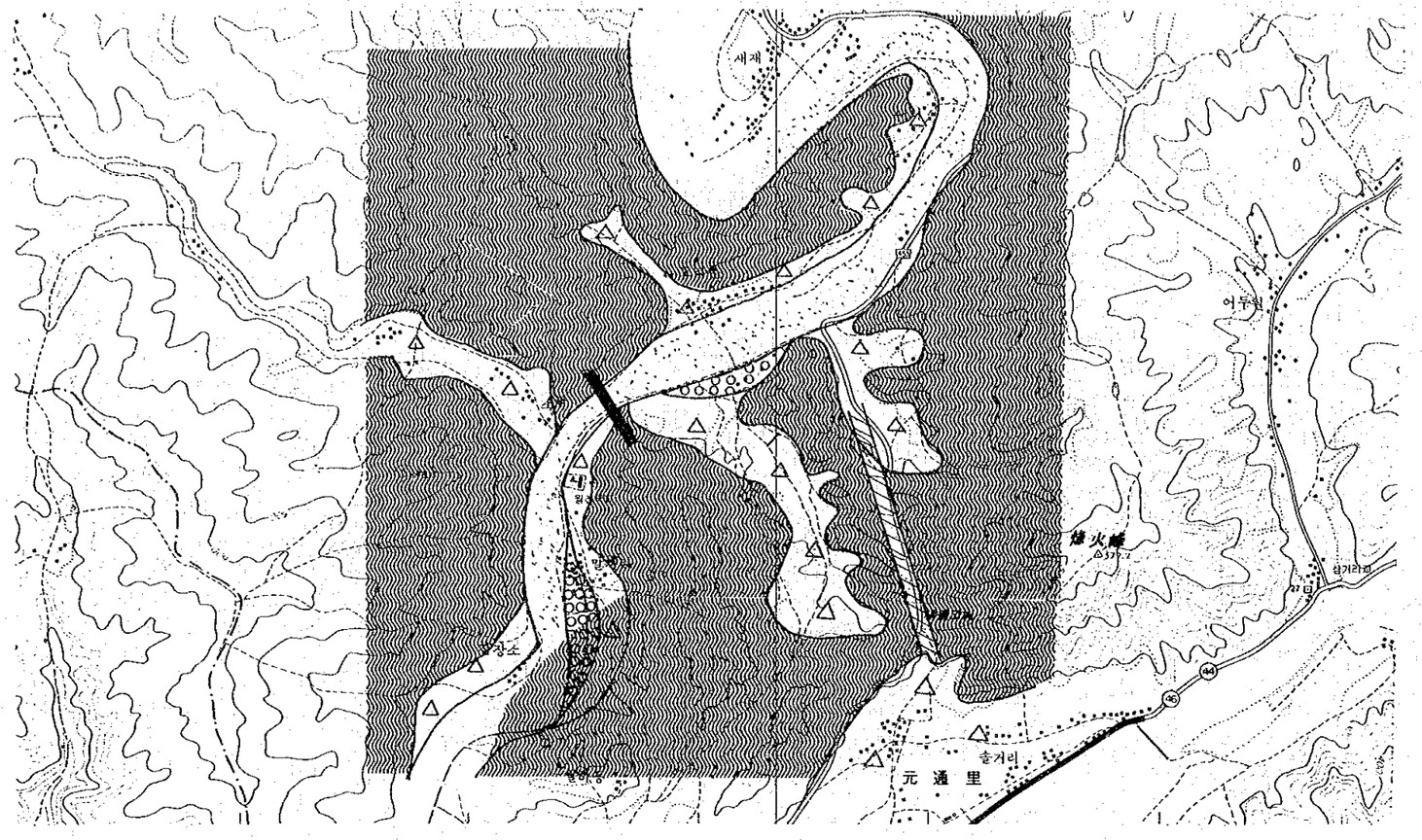
Rock material: Sufficient rock will be obtained from a hill slope of granite gneiss at about 1 km upstream of a tributary located in the right bank immediately downstream of the proposed damsite.

(6) Comments

A) The saddle, where a great sheared zone occur, will give a serious problem of leakage at the left bank of the reservoir. It is better to lower the high water level.

B) Talus and terrace deposits will be thick at the left abutment. Detailed geological investigation will be needed to confirm a suitable firm foundation.

C) Topographically, the proposed dam axis will be acceptable at the present surveyed line.



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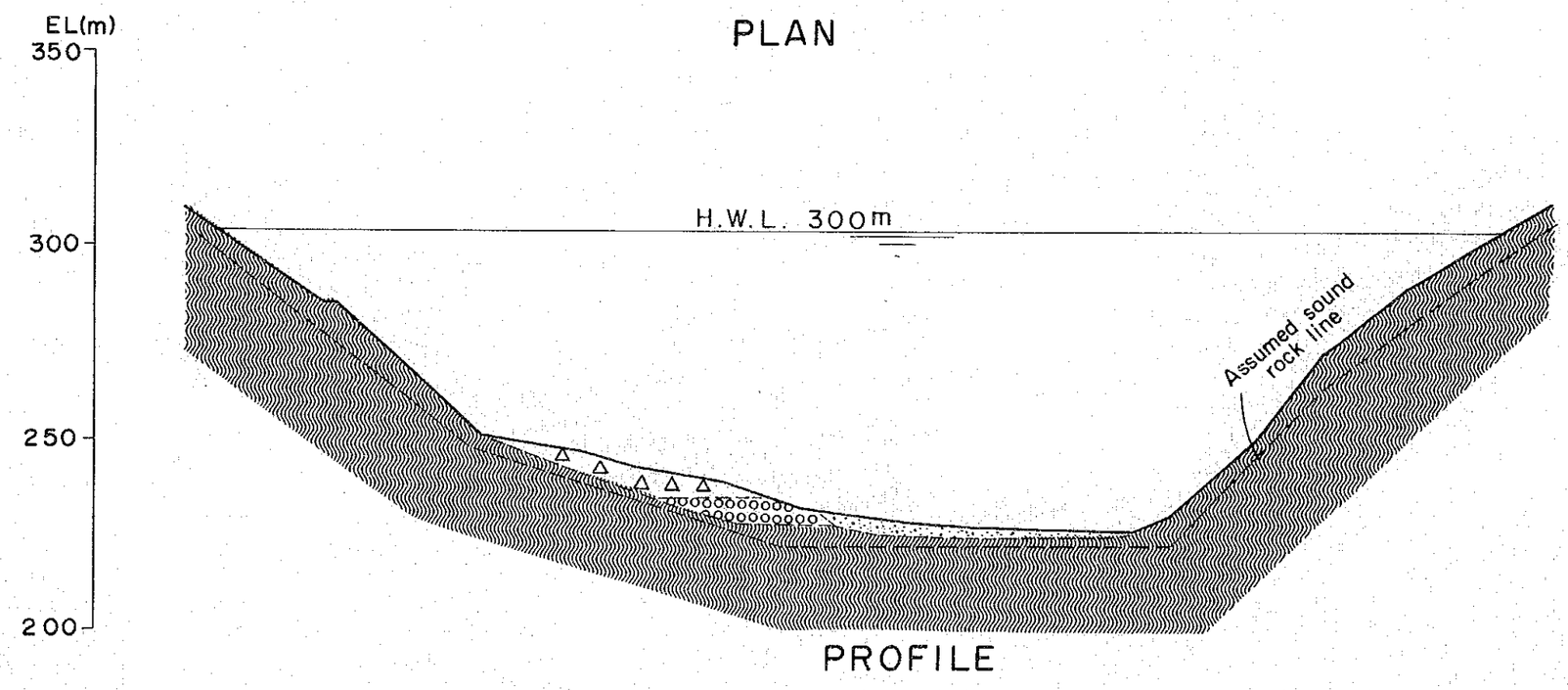


PROFILE

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Gneiss
- Sheared zone
- Damsite

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
4-30 WOELHAK(月鶴)

Feb 27.1978 | Fig.-8

3-5 Hongcheon

(1) Outline of Project

Dam type	: Concrete gravity
Dam height	: 85 m
H.W.L.	: El. 120 m
Power station	: Attached to the Dam

(2) Topography and Geology of Reservoir Area

The reservoir area comprises of chart, crystalline schist and gneiss and enclosed with well-dissected hilly topography. No landslide is found in the area. Riverbed gradient is around 1/850. A series of valley plains are well-developed.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at a bending channel where Hongcheon Gang changes its course from westward to northward. The left bank is an undercut face of the stream and shows rather steep slope of 35°. A hard chert outcrop is standing with 50° dip at downstream of the damsite.

Riverbed is wide -- 150 m in width, and the river is flowing close to left bank, leaving sand and gravel bar on the right bank.

A thin ridge of NNE-SSW forms right abutment of steep slope of 40°. After impound of reservoir the ridge will be a natural dam of 250 m width and 750 m length.

Geology

Left bank abutment of dam is biotite schist and chert. The former is laid conformably on the latter. Their strike is NS and dips 70 eastward. Steep cliff on the left bank at downstream of dam center is an outcrop of chert. Most of dambody will abut on the chert rock, and uppermost part of dam will abut on the biotite schist. Chert rock is very hard with little weathered portion. Thus, left bank slope has a little slope wash on its chert portion, and rather thick surface soil and weathered rock on its biotite schist portion.

A small gully on the left bank just upstream side is burried with debris. The gully may possibly be a small fractured zone of N75E direction.

Riverbed is filled with sandy deposits. Its thickness cannot be confirmed yet at present. It may be supposed 10 m thickness. Under these sandy deposits biotite gneiss may be expected, though 10 m thickness of intercalated chert in gneiss (N20W, 50W) is found on the right bank. Extension of the intercalated chert expose again in riverbed at 350 m downstream of the dam axis. Dips and strikes of the chert and gneiss are not coincid each other. Chert and gneiss are likely contacting with fault as shown in the geological map of 1/50,000.

Long north-south ridge on the right bank comprises of gneiss with thin covering of slope wash of less than one meter and weathered zone of 2-3 m thickness. Talus debris in the skirts on right bank slope seems to be an extension of small-scale fractured zone found at the downstream toe on the left bank. Thus, a series of northsouth fractured zone of small-scale is presumably running along the river channel. Nevertheless, there is no fault or fracture crossing the right bank ridge. The ridge will have no leakage after impound of the reservoir.

(4) Geology of Apurtenant structure Site

Penstock and Power station: Power station will be built at just downstream of the dam. Fresh and hard base rock can be expected under the sand & gravel of the riverbed. A series of small fractured zone is presumably running close to the left bank. It is better to build power station on the right bank side.

(5) Material

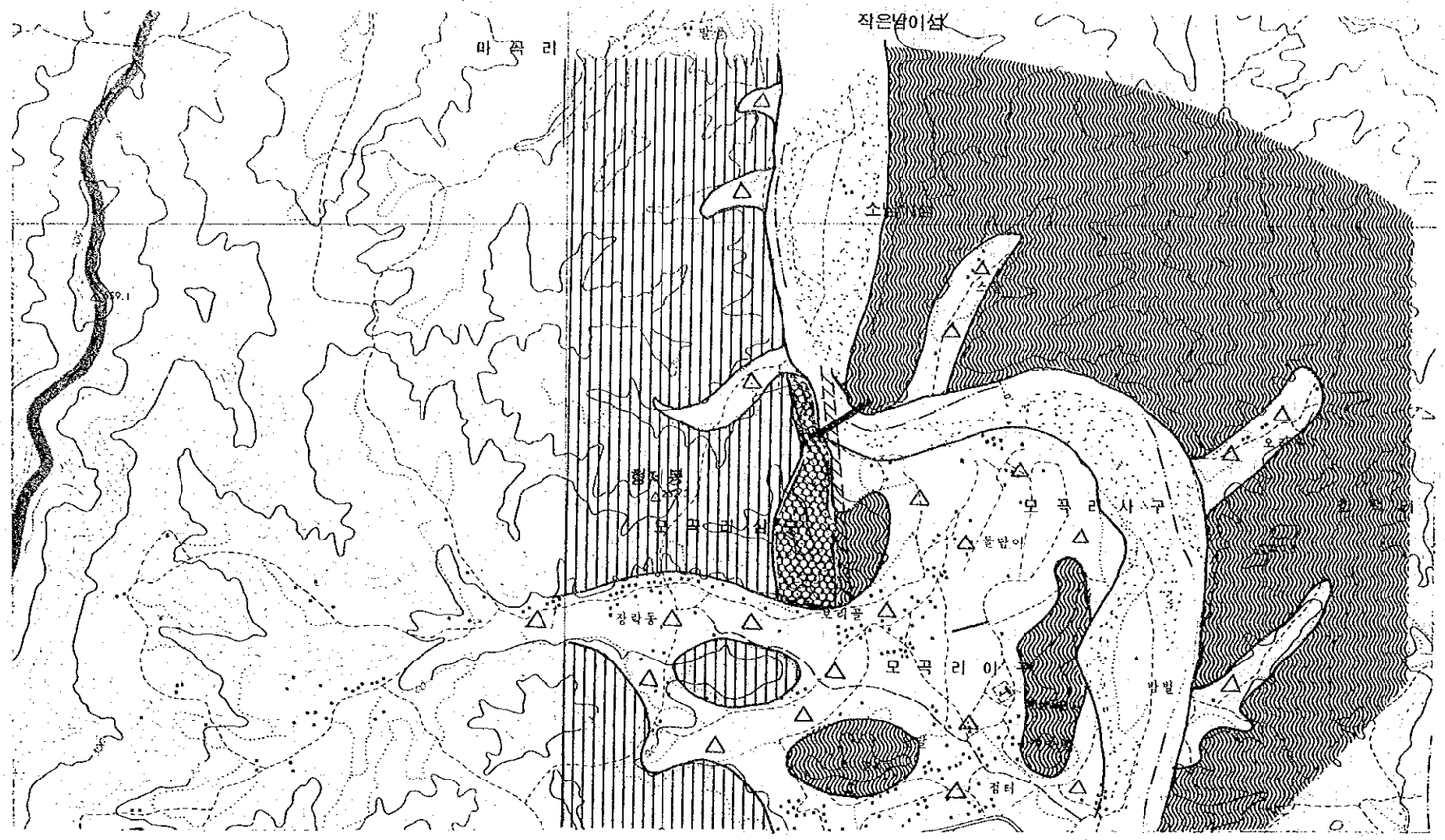
Concrete aggregates can be obtained from sand and gravel deposits on the riverbed. Sandy material is mostly obtained in the damsite riverbed and gravel material is deposited on the right bank shore and upstream and downstream reaches. Required sand and gravel can be exploited within 4 km length of the river channel around the damsite.

(6) Comments

A) The Hongchon damsite is only one favourable site all aong the river course.

B) Selection of dam axis is also limited in narrow range because of its characteristic topography.

C) Major geological problems in this project are thickness of riverbed gravels, fault or fractured zone underneath the gravel deposits and leakage problem through long ridge on the right bank side. Further investigation should include seismic exploration, test borings and permeability tests to study the above mentioned problems.



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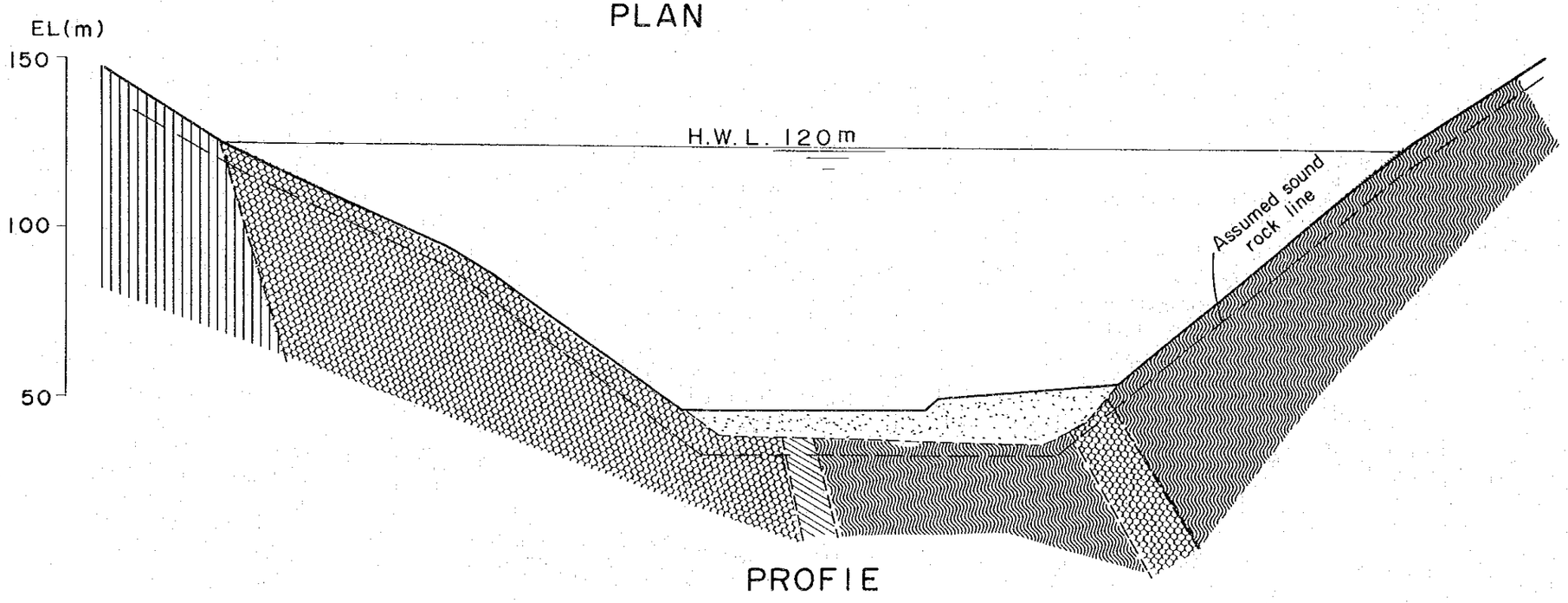


PROFIE

LEGEND

- Talus
- Sand and Gravel
- Quartzite
- Gneiss
- Schist
- Sheared zone
- Strike, dip
- Damsite

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
5-A3 HONGCHEON(洪川)

Feb 27. 1978 | Fig. - 9

3-6 Gujeol and Gujeol Alternative Site

The geology of the Gujeol Site basin planned on the tributary Songcheon River at the most upstream part of the South Han River is comprised of the Palaeozoic Era Gobangsan group consisting of sandstone, shale, coaly shale and coal, and the Mesozoic Era Norgam group consisting of sandstone and shale. The topography of the catchment area is an extremely rugged mountain terrain, and the river gradient is steep at approximately 1/90.

In addition to the site requiring various considerations in planning, the reservoir area including damsite is extremely desolate. Furthermore, the reservoir area is a coal mining area where coal is actively being mined at present. Since Gujeol is such a site involving various problems in this manner, the Doam site has been selected as an alternative in the present investigation.

Doam

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 54.5 m
H.W.L.	: EL. 742.5 m
Power station	: Dam and Tunnel

(2) Topography and Geology of Reservoir Area

Although located at the most upstream part of the Songcheon river, since the entire reservoir consists of weathered granite, it is a gently sloped hilly topography as a whole. There are river terraces at various places along the river bank with talus deposits above. In the vicinity of where the granite changes to sedimentary rock, the river valley suddenly becomes a gorge. The damsite has been selected at this gorge.

There is no fear of leakage since the geology is granite. Also, in addition to the whole being a hilly topography, since the river gradient is gentle, it is thought there will be little sand-gravel discharged in the future.

(3) Topography and Geology of Damsite

Topography

The dam axis has not yet been finally decided on. An axis has been temporarily selected in the present investigations, but in the end it will be necessary for the axis to be selected on carrying out detailed geological surveys based on an actually topographical map of the surroundings.

The river in the vicinity of the site maintains a straight-line flow in roughly the NNE-SSW direction. The right bank comprises a steep cliff with a slope of about 50°, and rock is exposed over more or less the entire surface. The river bed has a width of approximately 40 m, and although a sand-gravel deposit about 25 m in width exists at the left-bank side, base rock is exposed at the river bottom of the right-bank side. The left bank forms a ridge as a whole. The slope where the abutment would be located has a gradient from 20° to 40°, and from a road there to the vicinity of the top of the ridge, more or less the entire surface is covered by talus deposits. Although not distinct because of the covering of talus, there probably exists an old terrace deposit under the talus near the road.

Geology

Left Abutment: The abutment is entirely covered by a thick slope wash and there is no exposure of base rock. This slope wash is widely distributed from the vicinity of the temporary axis to the downstream area. Base rock at the left bank is exposed near the tip of the ridge several tens of meters upstream of the temporary axis. Sandstone at this outcrop is massive, dense, and very hard.

Riverbed: The present riverbed, as previously mentioned, has a width of approximately 40 m with base rock exposed at the right-bank side while the thickness of the sand and gravel at the left-bank side is probably not more than 1 to 2 m. However, there is an old terrace deposit at a height of about 5 m from the present riverbed which is not exposed being covered by slope wash. The basement rock of the riverbed probably is sandstone as at both banks. This is expected to be very hard and good-quality rock.

Right Abutment: The right bank consists of massive sandstone. There is practically no deposition of slope wash. Although cracks are conspicuous at the surface of the bed rock, it is a sound, good-quality foundation rock as a whole. Gullies can be seen to be developed at high locations (100 m or more from the riverbed) downstream from the temporary axis.

(4) Geology of Appurtenant Structure Site

Tunnel: It was not possible to investigate the entire tunnel route. However, the geology of the sector consists of so-called coal-bearing sandstone and shale. Going by the lithological character the rock involves no problem as tunnel foundation. However, since the topography is complex, investigations must be made hereafter regarding weak zones such as faults. Since this is a coal mining area, it is believed detailed geological investigations will have already been made. It will be necessary to fully utilize existing data prior to embarking on investigations.

Penstock and Power station: The two sites are located near Hajapyeon, the junction point of the Songcheon River and a tributary. (The final locations are undecided.) In lithological character, the bed rock consists of alternations of very hard sandstone and shale, and there are no problems involved as foundation rock for the two structures. Attention must be paid to the fact that rock falls are frequent in this area. Consequently, the sites should be selected at locations which are topographically stable.

(5) Material

Rock fill material will be expected from the mountain near the damsite. Impervious core material shall be investigated at the gentle slopes in the upstream area of the damsite.

(6) Comments

A) Selection of the dam axis should be made within the stretch from the present temporary axis upstream to the vicinity of an inflowing stream found at the left bank.

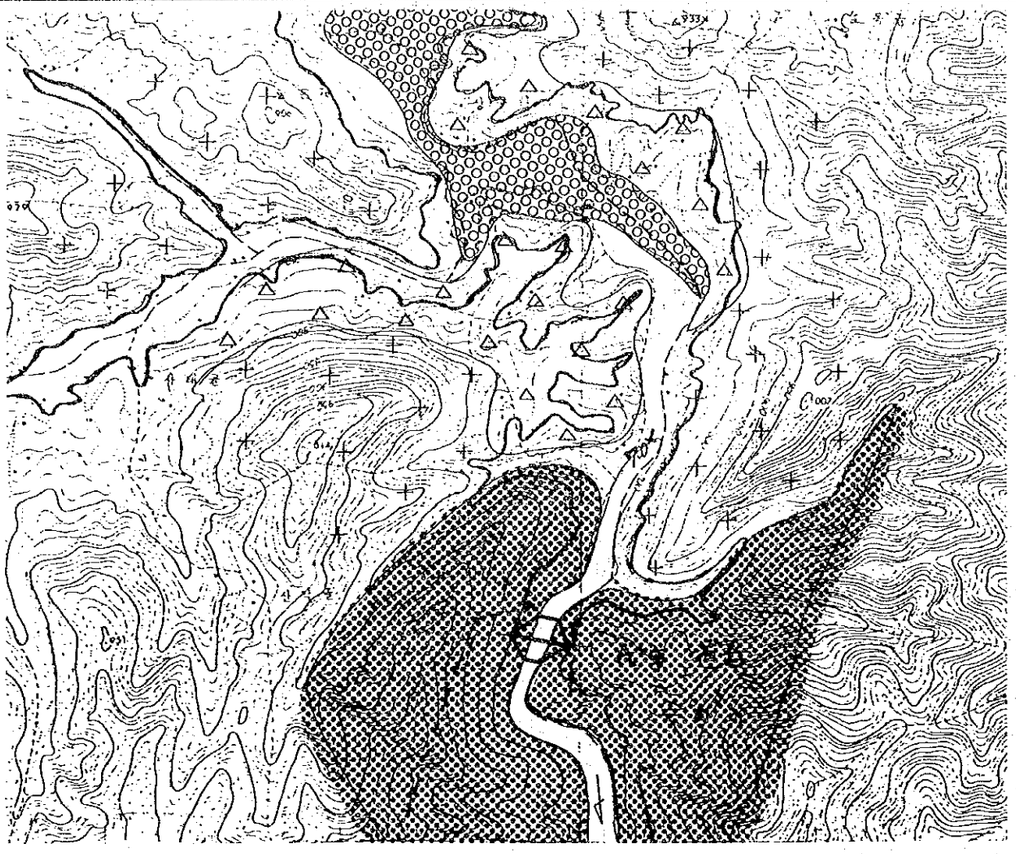
B) Topographically, the talus area at the left bank is considered to be an old rock sliding area. Further, since an old river terrace deposit exists underlying this talus deposit, the valley width in the vicinity of the temporary axis will become wider than at present in construction of the dam. Accordingly, it would be better to move the axis in the upstream as much as practicable.

C) In such case, it will be necessary to investigate by a detailed topographical map whether the topography of the right abutment will be satisfactory for the proposed dam.

D) The geological investigation should consist of first carrying out a surface geological survey based on a topographical map of scale of around 1/1,000 to select the dam axis, and the principles for subsequent investigations should be established according to the geological conditions of that site.

E) With respect to the investigations of the tunnel area, efforts should be made to obtain geological map of the coal mining area as it would be extremely useful if investigations are made using such material as references.

F) When investigating river terrace deposits in the reservoir as possible concrete aggregate source, it will be necessary to pay attention not only to gradation, but also quality (degree of weathering, strength, etc.) of sand and gravel.



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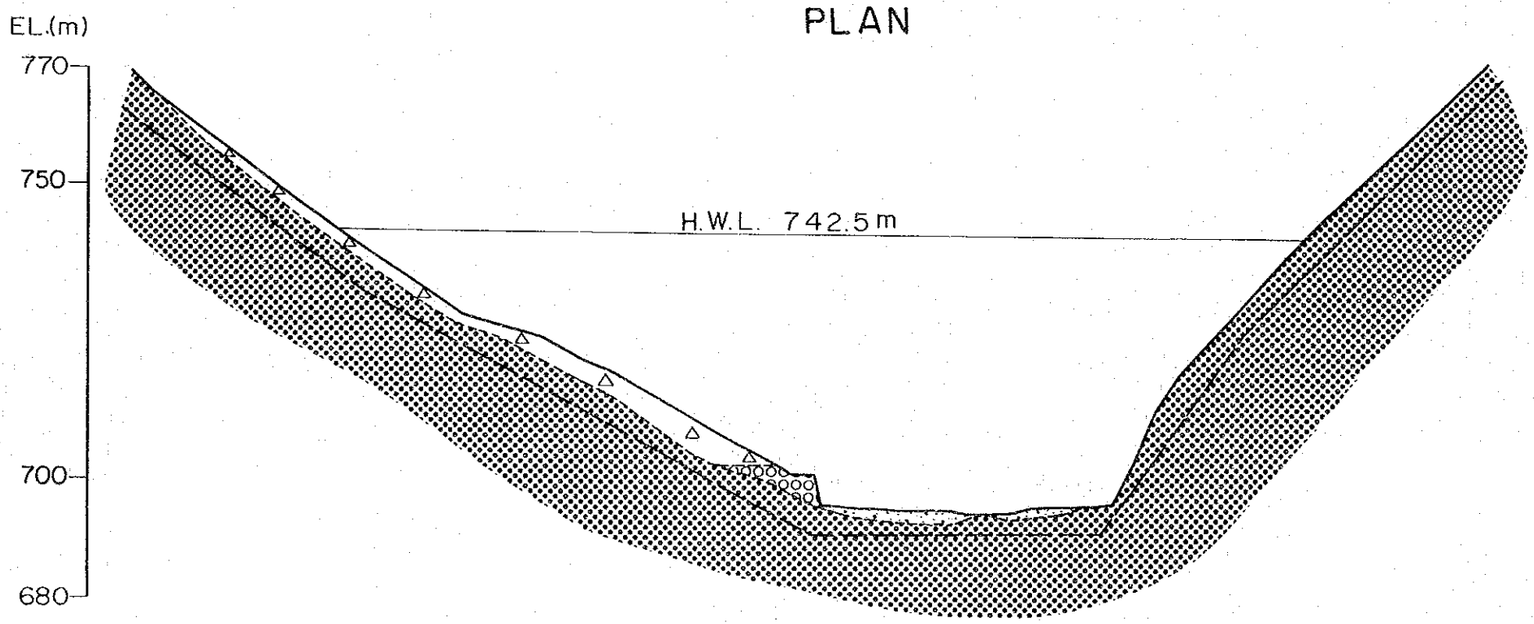


PROFILE

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist

0 1000 m
PLAN

0 50 m
PROFILE

GEOLOGY
6-3. GUJEOL (九切)
(Alternative site)

Feb. 20. 1978 | Fig.- 10

3-7 Pyeongchang

Regarding the Pyeongchang Project site, in addition to the original proposed site, the Survey Mission selected on a map a site thought suitable from the standpoint of a hydro power project. Field reconnaissances were made of the two sites (original site and alternative site). Topographical surveying has been done on the original site only.

(1) Outline of Project

	Original Site	Alternative Site
Dam type :	Rockfill	Rockfill
Dam height :	102 m	
H.W.L. :	EL. 420 m	
Power station :	Dam and Tunnel	Dam and Tunnel

(2) Topography and Geology of Reservoir Area

The topography of the reservoir area form the original damsite to the vicinity of the alternative site is on the whole a narrow, steep mountain topography due to the geology (metamorphic rocks, mainly gneiss). However, the topography in the reservoir upstream from the junction of the Pyeongchang river and a tributary from the left-bank side at Panrin Ri, approximately 1 km above the alternative site, is that of mature and aged topographies where river terraces and talus deposit are developed at mountain skirts.

Although large-scale rock falls and landslides are not seen, there are many small rock falls, and these are especially prominent at the banks of swift tributaries flowing into the Pyeongchang river. At this reservoir where the river gradient is steep compared with the mainstream South Han River, it will be advisable to consider to an extent sedimentation after completion of the reservoir.

There are two topographical features in this reservoir area which are worthy of note. One is a very thin saddle along a tributary at the upstream left bank. Since the downstream slope of this saddle faces the Pyeongchang river, in case the dam is planned at the alternative site, the site of this saddle should be investigated from the

standpoint of leakage. The flat area downstream of this saddle is judged to be an old channel (meandering part) of the Pyeongchang river. The other distinct topographical feature is the canyon at which a section of road approximately 5 km in length leads from Panrin bridge in the reservoir to Pyeongchang Ri. This canyon is thought to be topographically a tectonic valley. The distance between the reservoir at this canyon and the downstream side is approximately 800 m at high water level.

The geology within the reservoir can be broadly divided into two. One is the metamorphic rocks (mainly gneiss) distributed at the two damsites and along the right-bank of the tributary, the other is the limestone distributed upstream of the conjunction of the Pyeongchung river and the left-bank tributary, along the planned tunnel rute and at the proposed powerhouse site area. This limestone is extremely hard and there are parts locally which can be considered as being lime-sillicate gneiss. Although there is small-scale corrosion seen at the surfaces of outcrops in the above-mentioned canyon, on the whole there are practically no large scale caves seen, and even at large outcrops secondary deposits of corroded limy material peculiar to limestone cannot be seen.

(3) Topography and Geology of Original Damsite

Topography

The damsite is located at a meandering part where the river bends from northeast to southeast. The right bank is a steep cliff sloped 60° to 80° which directly rises from the river. The width of the present riverbed is approximately 60 m, while there is a river terrace about 20 m in width at a height of about 5 m from the riverbed on the left-bank side. The left bank is a gentle slope of a gradient of 20° to 30° and forms a ridge as a whole.

Geology

Left Abutment: The foundation rock is a hard and dense gneiss. Slope wash is deposited to a relative height about 20 m from the top of the river terrace in a thickness of several meters. There is little cracking of the foundation rock on the whole.

Riverbed: The thickness of the deposits at the present riverbed is estimated to be not more than several meters. However, there is a river terrace deposit approximately 40 m in width of relative height of 10 to 15 m from the riverbed existing on the left-bank side. The foundation rock of the riverbed is thought to be comprised of gneiss.

Right Abutment: The foundation rock is comprised of hard, dense gneiss. Slope wash cannot be seen. There are many open cracks and unstable rock blocks at the surface of exposed rock.

(4) Topography and Geology of Alternative Damsite

The axis for the alternative site has not yet been decided on. The location which was roughly selected in the present reconnaissance is at the vicinity of a point about 1 km downstream from the junction of the left bank tributary and the Pyeongchang river. Hereafter, the axis should be finally decided based on an actually-surveying topographical map and the geological conditions of this vicinity.

Topography

The river flows in a roughly straight line from north to south in the vicinity of the damsite and immediately downstream meanders to right and left. The characteristic of the topography in the surroundings of the site is that a large-scale talus deposit can be seen at the right bank. The top of the talus topography is at a relative height of approximately 40 m from the riverbed and continues for 700 to 800 m along the river. It is estimated that this talus area is the remainder of a large-scale rock sliding area of the past.

The right bank at the proposed dam axis comprises a cliff of cracky bed rock with the upstream side being the above-mentioned talus area. The riverbed width is approximately 50 m with the entire surface covered by sand-gravel. The left bank shows a stable topography of a slope of about 30°. A river terrace is widely formed at the right bank at the meandering part downstream of the dam axis, while at the left bank there is a small-scale terrace downstream of the axis.

Geology

Left Abutment: The foundation rock is mainly gneiss, and schistose gneiss is partially seen. The surface portion of the foundation rock is covered thinly by slope wash. Exposed foundation rock is slightly remarkable in cracking and has been subjected to weathering.

Riverbed: The entire width of the river is covered by sand-gravel estimated to have a thickness of around 5 m. Estimating by the geology of both banks, the foundation rock is thought to be gneiss. From a topographical judgment, it is inconceivable that a large-scale weak zone exists at the riverbed.

Right Abutment: The abutment consists of hard gneiss, but has numerous open cracks and is unstable as a whole.

(5) Geology of Saddle Site

In case the alternative damsite is selected, there is a risk of leakage at the saddle. This saddle has a width of about 300 m at El. 420 m on a 1/25,000 topographical map. The foundation rock at the surface consists of hard but cracky gneiss. The reservoir side slope is approximately 30°, and the downstream side slope is a steep 35° to 45°. The reservoir side slope is covered by a thin slope wash, but the downstream side has numerous outcrops of bedrock, and moreover, there are rock falls (gullies) at places.

(6) Geology of Appurtenant Structure Site

The appurtenant structures are the spillway, pressure tunnel, penstocks and powerhouse. None of the locations has been decided on as yet. However, from a topographical judgment, the ridge at the left bank is conceivable as the spillway site for the original damsite, and the above-mentioned saddle for the alternative site. In either case, there are no problems geologically as spillway foundation.

The geology of the tunnel site including the intake structure will mainly consists of limestone. Whether gneiss or limestone, these rocks are of sufficiently good quality as structure foundations, and topographically, there is no particularly large tectonic line which exists.

However, in selection of the location, when the tunnel will pass through contact planes between gneiss and limestone, it will be necessary for the conditions of these contact planes to be investigated from the ground surface beforehand.

(7) Material

Of the materials required, both gneiss and limestone will be available as rock materials from the surrounding areas of the sites. At the alternative site, moreover, in case the spillway is located at the saddle, the excavated material from this location will be of lithological character such that it can be used as rock material. Further, it will be possible to obtain large quantities of river deposit and terrace deposit materials from within the reservoir area.

Investigations have not yet been carried out for impervious core materials, and it should be difficult to obtain. It is necessary for large-scale talus deposits to be investigated hereafter. As for the talus deposit at the right bank of the alternative site, it is not suitable as core material since it is mainly comprised of rock fragments.

Concrete aggregate should be obtainable from river deposits.

(8) Comments

A) According to judgments based on topographical and geological conditions of the both damsites, the original site is more stable than the alternative site.

B) In case of the original site, it will be necessary for the thickness of the terrace deposit at the left bank to be investigated, together with which it will be necessary for investigations of terrace materials to be made whether it will be permissible for the terrace deposit to be left in the rockfill zone.

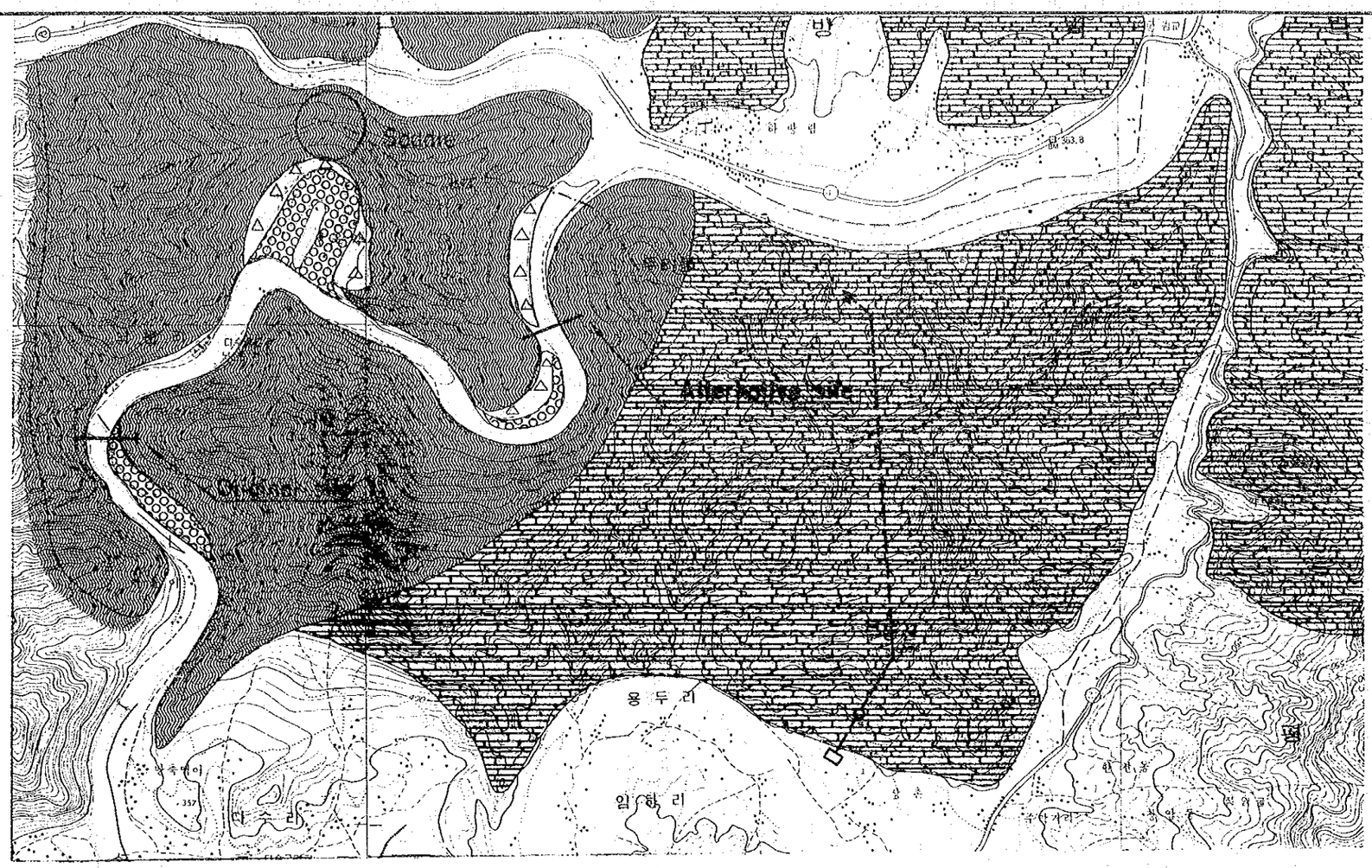
C) Since the foundation rock of both abutments of the original site is cracky at the surface portion, drill holes combining permeability tests will be required.

D) In case of the alternative site, it is necessary for the dam axis to be selected based on topographical and geological data upon detailed surface geological surveys using detailed topographical maps. When feasible as the damsite, it will be necessary for investigations to be made of the permeability of the site foundation rock by drill holes along with preparation of a topographical map of the surroundings of the saddle site.

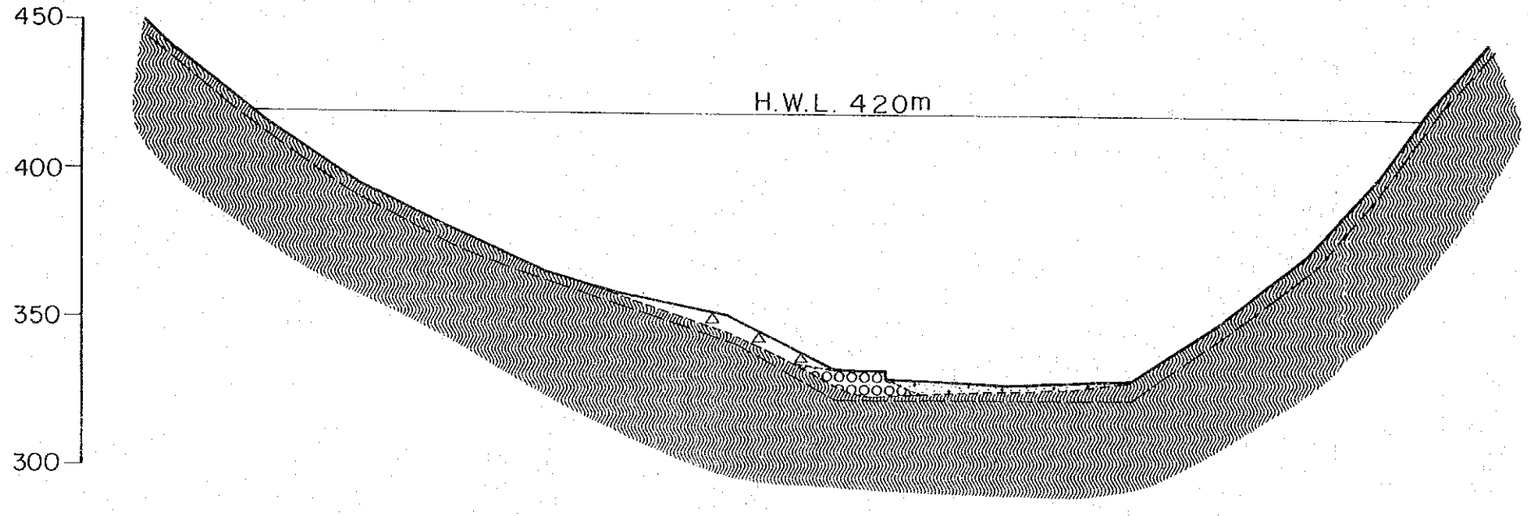
E) A fill-type dam is proposed, and it will be necessary for thorough investigations to be made beforehand of impervious core materials. The site where there is possibility of obtaining material will be limited to the gently sloped area at the skirt of the mountain. (The flat area is comprised of sand-gravel, while the steeply sloped area consists of a deposit of rock fragments.)

F) Investigations for rock materials should be carried out considering use of river and terrace deposits along with investigations of rock quarries.

G) This reservoir is in an area where limestone is distributed. Geological investigations in the reservoir area should be conducted based on 1/10,000 to 1/25,000 topographical maps. Further, when these investigations are made, investigations of rock fall areas should be carried out at the same time.



PLAN



PROFILE (Original site)

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist

0 1000 m
PLAN

0 100 m
PROFILE

GEOLOGY

7-9. PYEONGCHANG (平昌)

Feb. 20. 1978 | Fig.- 11

3-8 Panun

(1) Outline of Project

Dam type : Rockfill
Dam height : 48 m
H.W.L. : EL. 280 m
Power station : Dam and Tunnel

(2) Topography and Geology of Reservoir Area

As a whole, a rugged mountained topography is indicated. Although of small scale, rock falls and gullies are conspicuous at many places along the main river, streams and valleys. The river channels in the catchment area are desolate as a whole, and the topography generally is mature.

Investigations of the entire area were not carried out in the present reconnaissances. According to localized reconnaissances along roads and based on 1/25,000 geological maps, the geology in the reservoir area is comprised of the Yeoryang Group of unknown age consisting of green sandstone and slate, and the Paleozoic Gobangsan Group consisting of milky-white quartzose sandstone, the Yeongweol Group consisting of limestone, and granite.

(3) Topography and Geology of Damsite

Topography

The river which meanders greatly upstream and downstream of the damsite runs roughly in a straight line from north to south near the damsite. Since the dam abutments are located at cliffs slightly misaligned upstream or downstream at the right and left banks, the dam axis intersects the river flow at a slight angle.

The left bank is sloped at 50° to 60° to form a steep cliff and small scale rock falls are seen at the surface. The width of the river bed is approximately 120 m, and there is a sand and gravel bank formed at the right bank site. The right abutment is a steep cliff of 50° to 60° slope, the same as the left bank, and a small scale talus deposit is seen downstream of the axis.

Geology

At both left and right abutments, the foundation rock is comprised of green sandstone. The rock character is very hard. However, since there are numerous hair cracks weathered to brown color at the surface portion, rock falls of cobble-size gravels have occurred at the surfaces of the both abutments. Downstream of the dam axis, at the right bank, there is a deposit of a small scale slope wash, the thickness of which is around 2 m.

The riverbed is covered with a deposit estimated to be 2 to 3 m and there is no exposure of bedrock. However, judging from the geology of the surroundings of the site, it is considered that the bedrock consists of green sandstone similarly to the abutments.

(4) Geology of Appurtenant Structure Site

Intake and Tunnel: The basement rock of the intake site is green sandstone and there is no problem as the foundation rock for the structure. However, since the presently planned location (temporary site) is at the downstream end of the large-scale talus deposit at the left bank upstream of the damsite, the coverage appears thick. Investigation will be required at the feasibility stage in the future.

The geology of the tunnel route is comprised of green sandstone and limestone. Both rocks are hard and there are no problems as foundation rocks for the tunnel. However, it will be necessary for detailed investigations to be made at the part where the tunnel passes the canyon at the left bank downstream of the damsite.

Power station: The location of the power station has not yet been decided on. However, the basement rock of the surroundings is limestone and there will be no problem as the foundation for the power station.

(5) Material

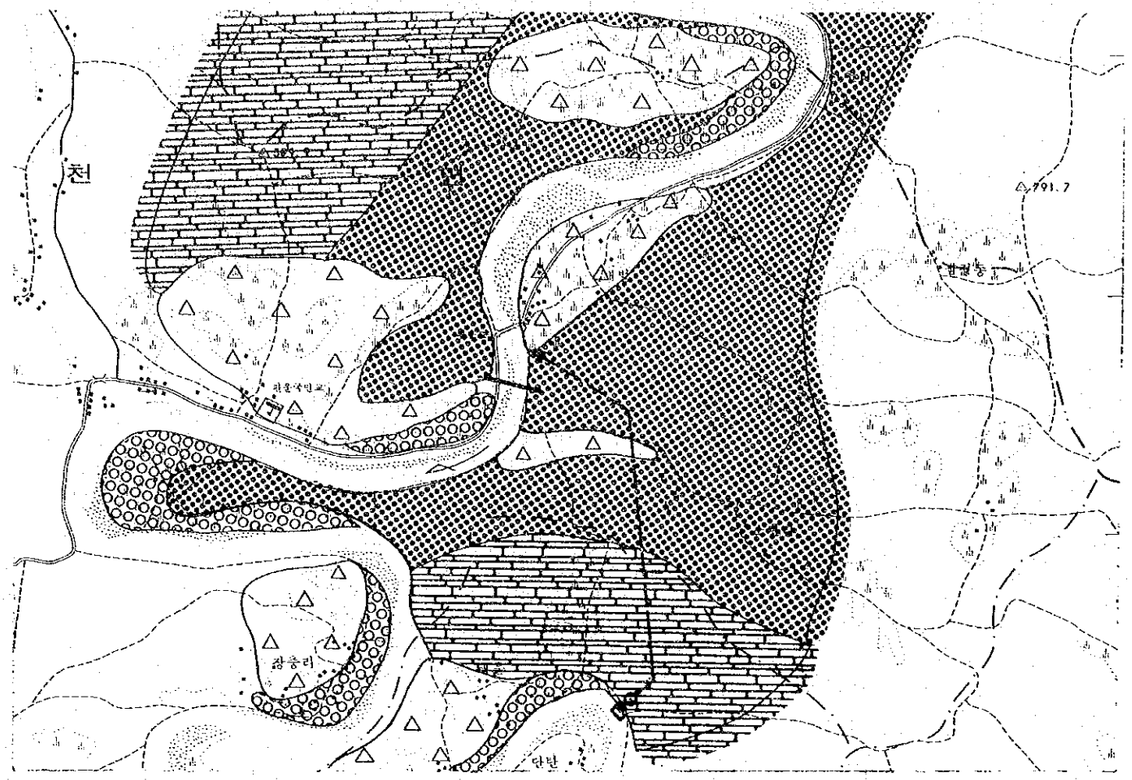
The materials for rockfill and impervious core material were not investigated on this time. Impervious core material shall be investigated more detaily on the next stage.

(6) Comments

A) The foundation rock of the site is sufficiently good as the foundation for the proposed dam.

B) Limestone of the Yeongweol Group is distributed in this reservoir area. Since the limestone mass is surrounded by non-calcareous rocks (Gyeonggi gneiss complex, granite and Yeoryang Group -- sandstone and slate), it is thought there will be little possibility of leakage to outside the reservoir. However, detailed geological investigations should be made inside the reservoir using topographical maps of at least 1/10,000 to 1/25,000 scale in regard to the limestone distribution area. In such case, it will be necessary for investigations of the rock fall areas inside the basin to be made at the same time.

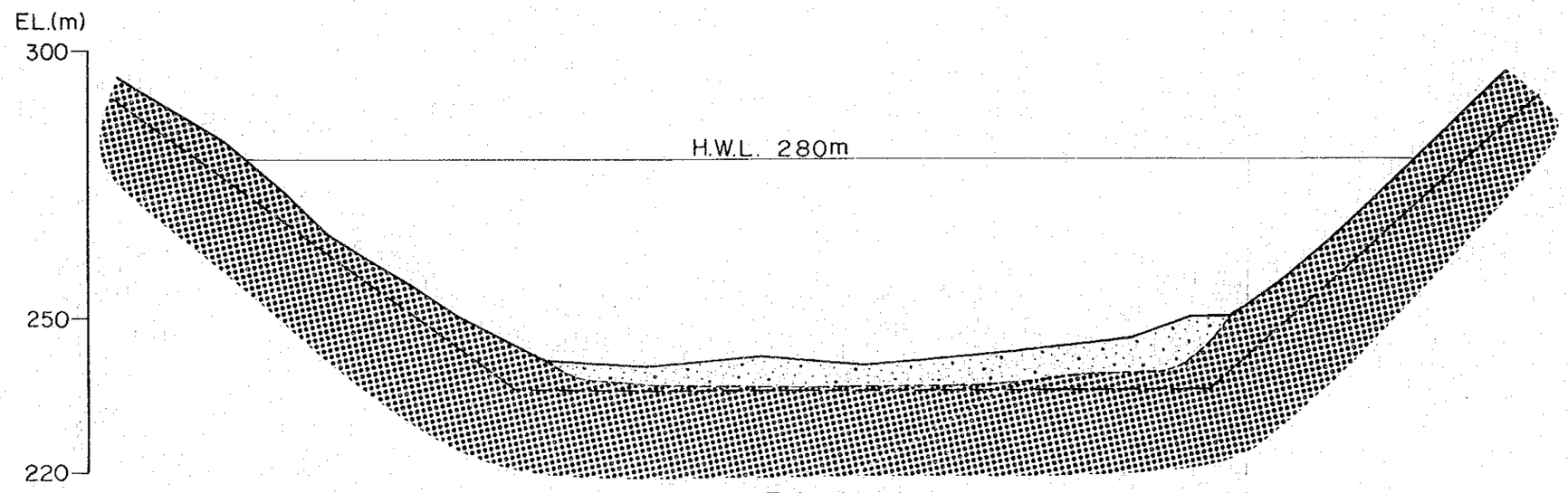
C) Since weathered cracks are numerous in the foundation rock of the damsite, it will be necessary for drill holes with the purpose of investigating the degree of development of cracks and permeability of each abutment, and for drill holes to investigate the thickness of the sand-gravel at the riverbed to be provided.



PLAN

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist



PROFILE

0 1000 m
PLAN

0 50 m
PROFILE

GEOLOGY

8-10. PANUN (板雲)

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