3-9 Suju

(1) Outline of Project

Dam type : Rockfill
Dam height : 107 m
H.W.L. : 432 m
Power station : Dam and Tunnel

(2) Topography and Geology of Reservoir Area

Overall, river deposit is wide and thick, while at the river banks there are large scale river terraces above which there are talus deposits prominently developed. The topography at the right bank 3 to 4 km upstream from the damsite is surmised to be that of an old landslide or rock fall area. However, it is presently stable, and it is in inconceivable that creep will occur due to impoundment of water in the reservoir. The mountain area is stable as a whole, but at relatively swift tributaries within the catchment area there is much discharge of sand-gravel.

With regard to geology, since practically the entire area consists of metamorphic rocks (mainly gneiss) there is no fear of leakage.

(3) Topography and Geology of Damsite

Topography

The river which meanders widely directly upstream of the site becomes a straight line flow from roughly northwest to southeast in the vicinity of the damsite.

The right bank abutment is at a slope of 20° to 30° and is covered wholly by slope wash. The dam axis is located at a little ridge with small gullies both upstream and downstream. The riverbed has a width of approximately 70 m with a small scale sand bank developed toward the right-bank, while the left bank side is a flow channel strewn with boulders. At the left abutment a slope of approximately 30° continues from the riverbed to a relative height of 20 to 30 m, above which a steep cliff of approximately 50° is formed. Slope wash can be seen to a thickness of about 1 m at the gently sloped portion.

Geology

Left Abutment: The gentle slope from the riverbed to a relative height of around 20 m is covered by rock fragments of cobble size or larger. At the heigher cliff portion, gneiss which is the basement rock is exposed. The gneiss is extremely hard but has many cracks, and particularly, since those at the surface portion of the cliff are open cracks, that portion is unstable.

Riverbed: The riverbed is entirely covered with river deposits and outcrops of the basement rock cannot be seen, but judging from the geology of the surrounding area, it is probably gneiss. The thickness of the deposit is estimated to be about several meters at the sand bank toward the right bank.

Right Abutment: The entire abutment is covered by slope wash estimated to have a thickness of 2 to 3 m and outcrops of the basement rock cannot be seen. However, judging by the geology of the surrounding area, it should be gneiss similarly to the riverbed.

(4) Geology of Appurtenant Structure Site

The location of the powerhouse is undecided as yet. However, since the rivers in the surrounding area of the Suju site have comparatively steep gradients, it should be feasible to plan a dam and tunnel type power station. Regardless of whether the tunnel and power station are selected to be on the right or left bank the foundation rock of the structures will be gneiss and there will be no problems involved geologically.

(5) Material

A fill-type dam is planned for this Suju site. With respect to rock materials, good-quality gneiss is available in the surroundings of the site, while there are also river deposit and river terrace deposit in the reservoir area. However, there are few locations where satisfactory impervious core materials, both qualitatively and quantitatively, can be found. On the whole, there are no places in the surrounding area of the damsite where significant quantities are available. According to the reconnaissance made this time, it was

judged that the gentle slopes at the left and right banks 2 to 4 km upstream from the damsite would probably be the objective sites for investigations.

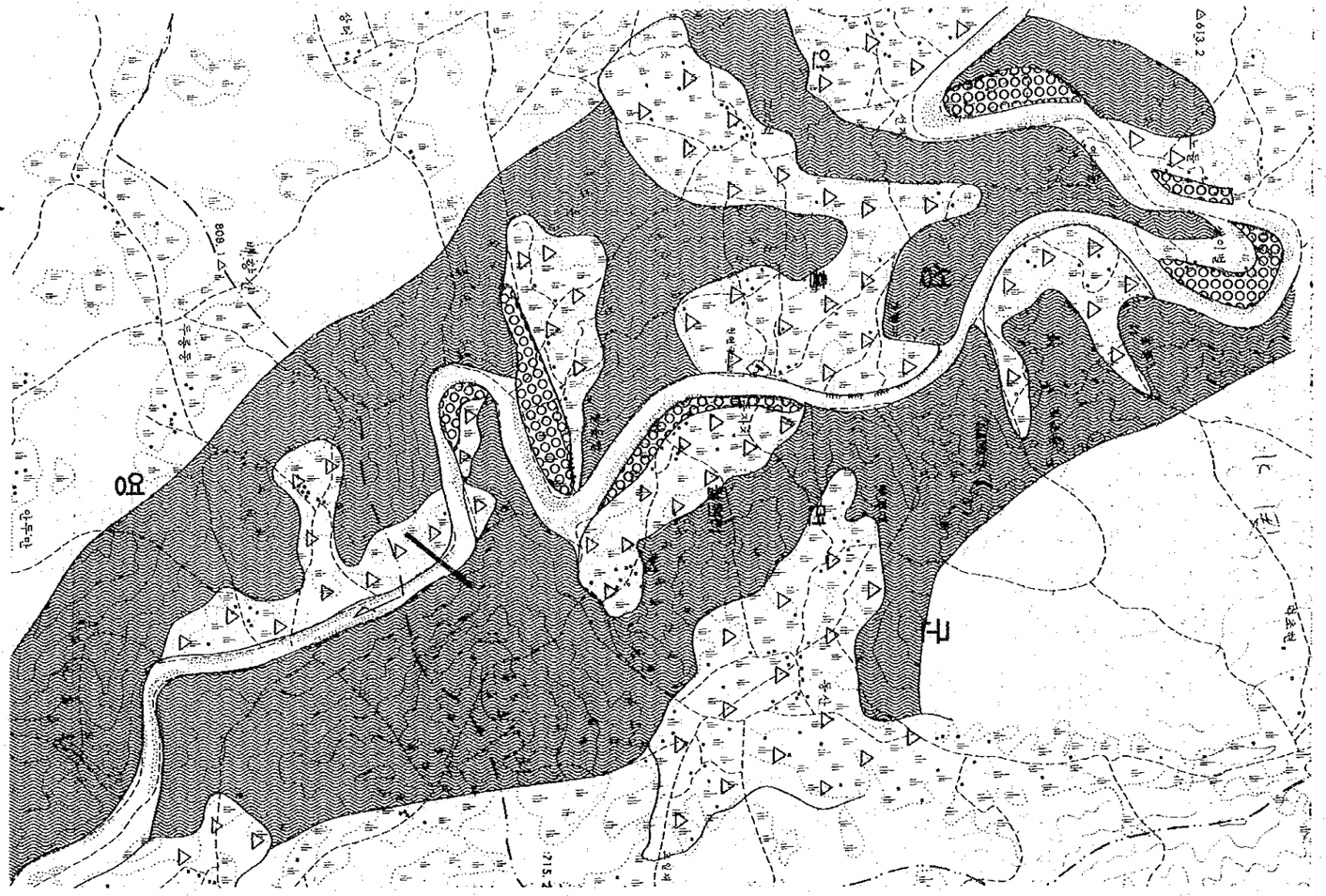
(6) Comments

A) The foundation rock at the damsite is suitable as the foundation for the proposed dam.

B) However, it will be necessary for drill holes to be provided to confirm the thickness of the slope wash at the right bank and the degree of development and permeability of the cracks at the left bank.

C) In this reconnaissance, tectonic lines which would affect dam construction were not recognized. However, topographically, since it is anticipated that there will be a fault from the saddle at the left bank immediately upstream of the dam which passes the middle slope of the right bank of the damsite, when making the investigations of B) above, it will be necessary for inclined drill holes to be planned at the slope to the side of the mountain along the dam axis.

D) Investigation for impervious core material should be made with the slope wash at the mountain skirts as the objectives. However, due to the mother rock at this area being gneiss, it appears that the weathered residual soil is silty clay (CL-MH) containing mica.
In any event, since almost all of the gentle slope area is cultivated land, it will be necessary for investigation by trench cuts or pits at 1 to 2 locations at each proposed site to be made at the next stage.



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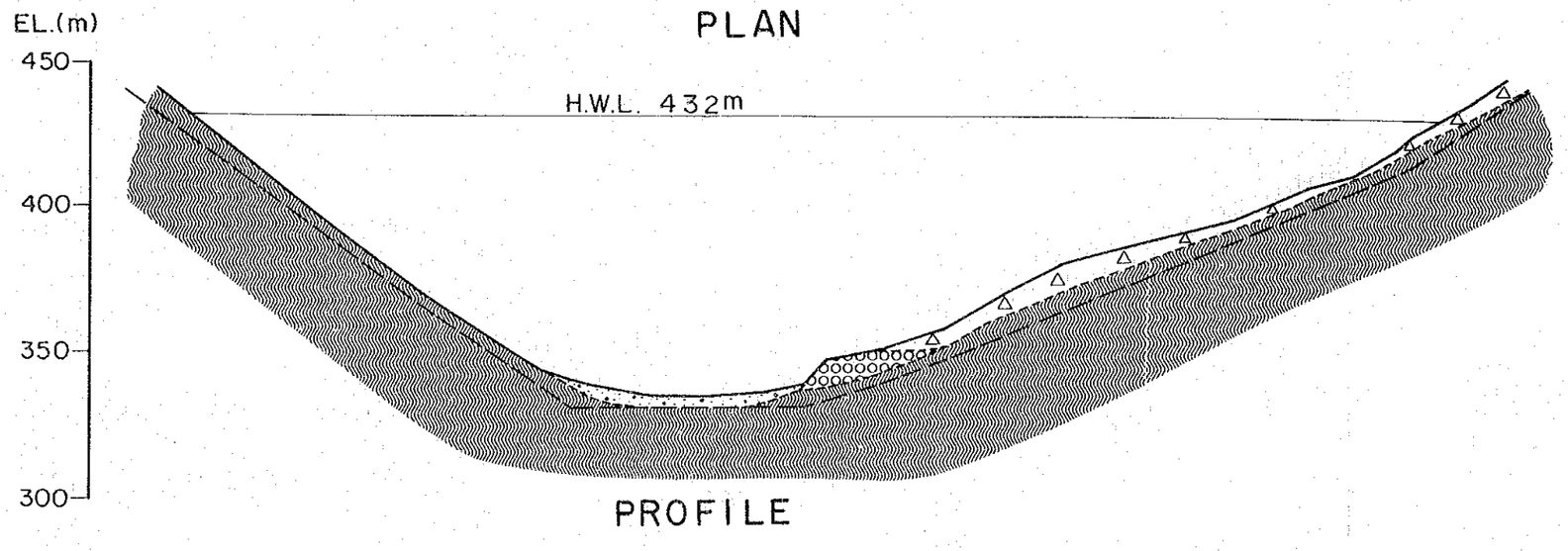


PROFILE

LEGEND

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

0 1000 m
PLAN

0 100 m
PROFILE

GEOLOGY

9-13. Suju (水周)

Feb. 20. 1978 | Fig.-13

3-10 Dogog

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 70 m
H.W.L.	: EL. 325 m
Power station	: Attached to the dam

(2) Topography and Geology of Reservoir Area

On the whole, the topography is one of a mature to old river where the width of the river channel is broad, and sand-gravel deposit and river terraces are prominent. The mountain area is stable. There are two places in this reservoir area where thin saddles exist. One of these can be seen at the left bank approximately 1.5 km upstream from the damsite. The crest of this saddle is at approximately El. 315 m (according to a 1/25,000 topographical map), and is lower than the high water level of the reservoir. The other is at the left bank approximately 2 km further upstream from the first saddle and will be about 250 m wide (according to the 1/25,000 map) at high water level of 325 m.

The geology of the surrounding of the damsite and the above-mentioned saddles consists of granite. However, according to a 1/25,000 geological map, it has been reported that there is a distribution of limestone of the Yeongweol Group between this granite and the upstream gneiss area.

(3) Topography and Geology of Damsite

Topography

The river meanders widely from south to north to southeast at the vicinity of the site.

The left bank comprises a steep cliff of 50° to 60° with basement rock exposed over the entire surface. Talus is of a degree that it is deposited on a small scale at the foot of the cliff. The riverbed, at present, is of a width of approximately 30 m, but at the right bank side there is a river terrace formed which is of a width of about 100 m

and relative height of about 10 m from the riverbed. The right bank is a gentle slope of approximately 25° which extends upward from a terrace deposit. The abutment is covered entirely by slope wash. The crest of the abutment indicates a comparatively complex topography.

Geology

Left Abutment: Very hard granitic gneiss is exposed over the entire surface. Although cracks are more or less conspicuous at the surface portion, there is no problem with respect to the foundation for the proposed dam.

Riverbed: Although outcrops of basement rock cannot be seen at the riverbed, as considered from the geological conditions at the left and right banks, good-quality granite or granitic gneiss will probably be found.

The problem at the riverbed is the river terrace deposit spread out toward the right bank side. When the thickness of the deposit at the present riverbed is estimated to be around 2 m, it may be estimated that the river terrace deposit averages approximately 5m. The terrace deposit on the whole has a large percentage of sand, while the surface of the terrace is being utilized as cultivated land.

Right Abutment: The abutment forms a gentle slope which continues upward from the terrace. Since the entire abutment is covered by slope wash estimated to be 1 to 3 m in thickness, there are no exposed rocks to be seen. However, judged by the surrounding geology, it is thought the basement rock is granite. Judging from geological data, the granite underlying the slope wash is feared to be considerably weathered. The crest of the abutment has numerous small scale ridges, while outcrops of the basement rock cannot be seen.

(4) Geology of Saddle Site

The two sites described previously are comprised of granite. The saddle lower than the high water level is being considered for the spillway and powerhouse. Although the scales of these structures have not yet been determined, adequately good foundation rock can be obtained by excavating the surface portion weathered granite to an extent not exceeding several meters.

(5) Material

The proposed dam is a fill-type dam. As materials, rock material, filter material and impervious core material will be required.

As raw rock material, the granitic gneiss distributed at the left bank in the vicinity of the damstite is of good lithological character quite satisfactory for use. However, since there is a broad river terrace deposit in this reservoir area it will be necessary to study the use of this deposit as rock material.

For impervious core material, it will be necessary to investigate the slope wash at the right bank approximately 1.5 km upstream from the damsite and in the vicinity of Pyeongchong. The mother rock of the slope wash near Chungbangton and at the right bank about 1.5 km downstream from the damsite is schist, and therefore, the material is fine grained with a high mica content.

(6) Comments

A) There is no problem with the foundation rock as the foundation for a fill-type dam.

B) The river terrace deposit distributed at the right bank side is high in sand content at the surface portion and not much gravel can be seen. It will be necessary to perform gradation tests of this terrace deposit to determined if it will be permissible to leave the deposit as the foundation of the rock fill zone.

C) Since it will be necessary for excavation of the impervious core zone, drill holes must be provided to confirm the thickness of the terrace deposit.

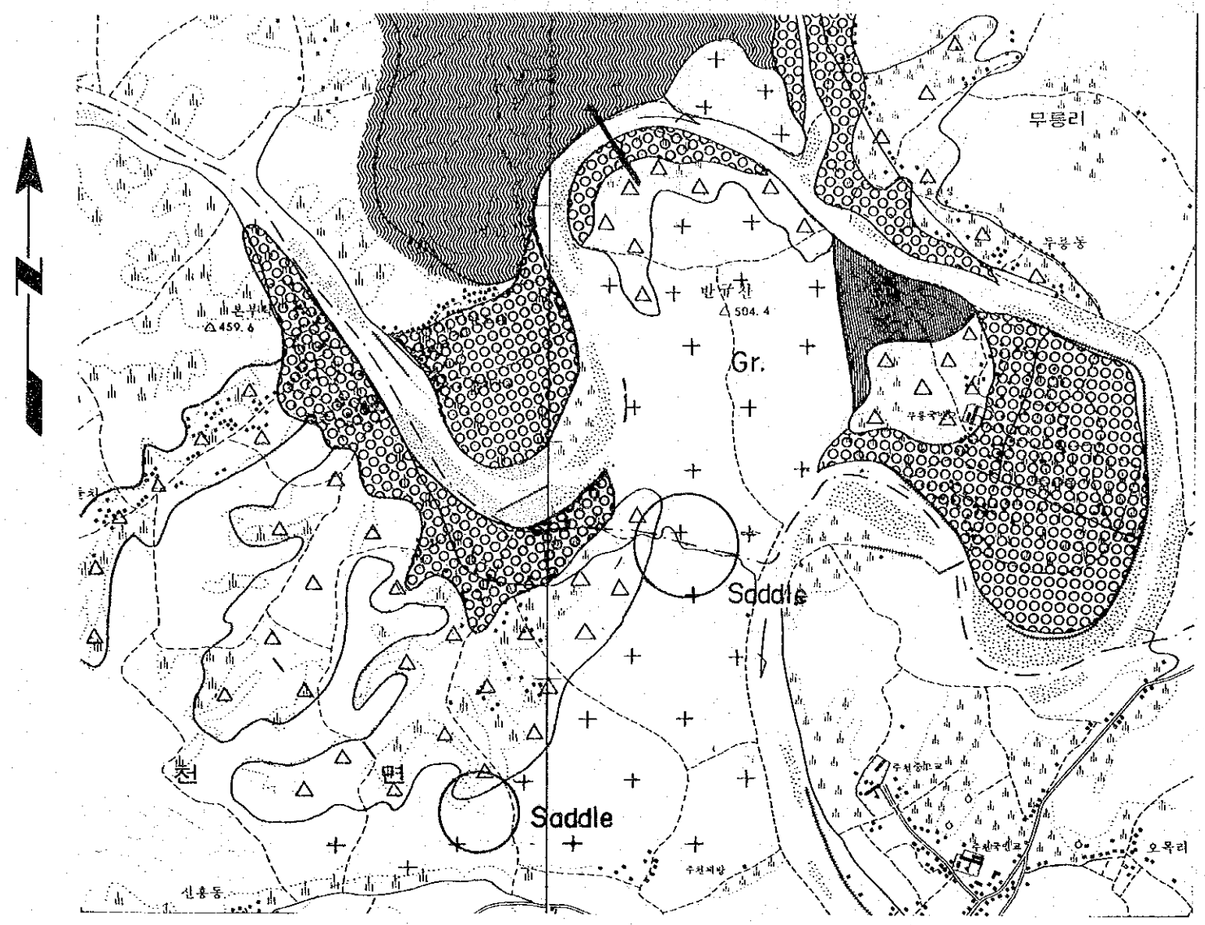
D) It will be necessary for drill holes to be made to investigate the thickness of the slope wash at the right abutment and the underlying foundation.

E) As it is necessary for the investigation of D) above, the vicinity of the crest of the right abutment should be subjected to topographical surveying over a wide area as practicable.

F) The vicinity of the saddle below high water level should be surveyed over a wide area, and on confirming the actual topographies of the saddle, plan should be established for drill holes to investigate permeability of the basement rock.

G) Soil investigations and gradation tests of the river terrace deposit should be carried out with the dam and reservoir area as the objectives.

H) According to a 1/25,000 geological map there is limestone distributed in the reservoir area and it will be necessary for surface investigations to be carried out based on a 1/10,000 to 1/25,000 topographical map.



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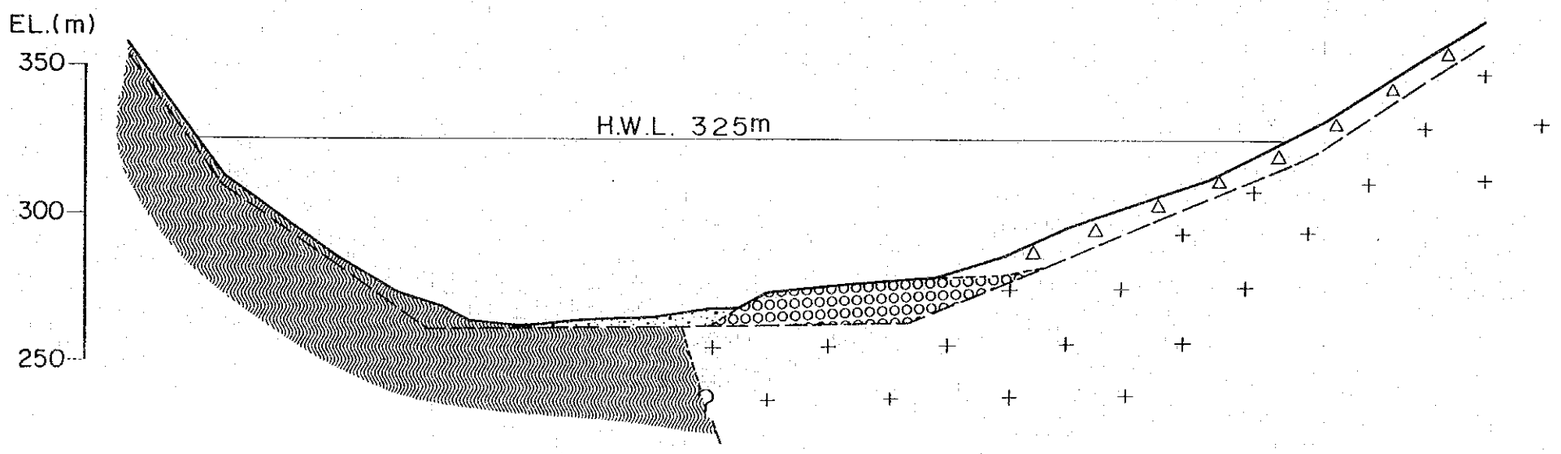


PROFILE

LEGEND

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

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY

10-12. DOGOG (道谷)

Feb. 20. 1978 | Fig. - 14

3-11 Dalcheon

(1) Outline of Project

Dam type	: Concrete gravity
Dam height	: 71 m
H.W.L.	: EL. 130 m
Power station	: Attached to the dam

(2) Topography and Geology of Reservoir Area

The topography within the reservoir area is mature to old age on the whole. The riverbed is entirely covered with thick sand-gravel and prominent river terrace deposits are found at the banks of the Dalcheon river and its various tributaries, and these have been developed on a large scale as cultivated land.

It was not possible to study the entire reservoir area in this reconnaissance. According to a 1/50,000 geological map (Geological and Mineral Institute of Korea), the geology of the reservoir area consists mainly of metamorphic rocks (gneiss, schist, phyllite, etc.) and granite, with locally a distribution of Hyangsanni dolomitic limestone extending in the NEE direction at the river bank of Um Song Chun (mainstream left bank). Since this formation is surrounded by non-calcareous rock bodies, it is judged for the presnet that there will be no fear of leakage of the reservoir. However, detailed geological investigations of the surrounding area should be carried out in the future.

The rivers and streams in the catchment area are stable on the whole while riverbed gradients are gentle, so that it is not thought sedimentation after completion of the reservoir will be very marked.

(3) Topography and Geology of Damsite

Topography

The river which bends from the southeast to the northeast direction at around 700 m upstream of the damsite flows down in the northeast direction in the vicinity of the damsite.

The left abutment is a steep cliff at a slope of approximately 60° and height of about 50 m from the riverbed which rises directly from the river. The top of the cliff is a ridge having a gentle slope. The width of the riverbed is approximately 120 m with a sand-gravel deposit about 70 m wide seen on the right bank side, while the left bank side is the water course of depth of approximately 2 m, but there are no outcrops of bed rock. Further, at the right bank upstream from the damsite a river terrace and a talus topography can be seen. The right bank is a smooth slope of approximately 30°.

Geology

Left Abutment: The entire abutment consists of fresh, hard granite. Irregular cracks and joints weathered to a brown color are conspicuous at the surface portion of the cliff. Weathering and development of cracks are even more extreme at the top of the abutment and the ridge, and the depth is estimated to be 3 to 5 m. Although soft sheared zones cannot be seen, there are a number of continuous fissures which have distinct slickensides and openings. The orientations of these are EW, 80°-90°N and N20°W, 20°NE.

Riverbed: The river bottom is entirely covered by sand and gravel, and the foundation rock is unknown, but it is probably granite. It is estimated that the thickness of the deposit is estimated to be around 10 m.

Right Abutment: The foundation rock is good granite similarly to the left bank. Although deposits of slope wash can be seen to cover the foundation rock upstream of the dam axis by the side of the road and above El. 100-110 m, the foundation rock is exposed at most of the area. Above El. 100-110 m, weathering of granite is prominent and a weathered zone of about 5 m is estimated at the outcrop approximately 20 m upstream from the dam axis.

The foundation rock granite of the left and right abutments is a rock body intruded into gneiss. Accordingly, the foundation rock changes to gneiss several hundred meters both upstream and downstream from the abutments.

(4) Geology of Appurtenant Structure Site

The location of the powerhouse has not yet been decided on. Geologically, neither the left nor the right bank will be a problem as a site. Topographically, the left-bank side is thought to be suitable.

(5) Material

Large quantities of good quality concrete aggregate will be available at the river in the surrounding area of the damsite.

(6) Comments

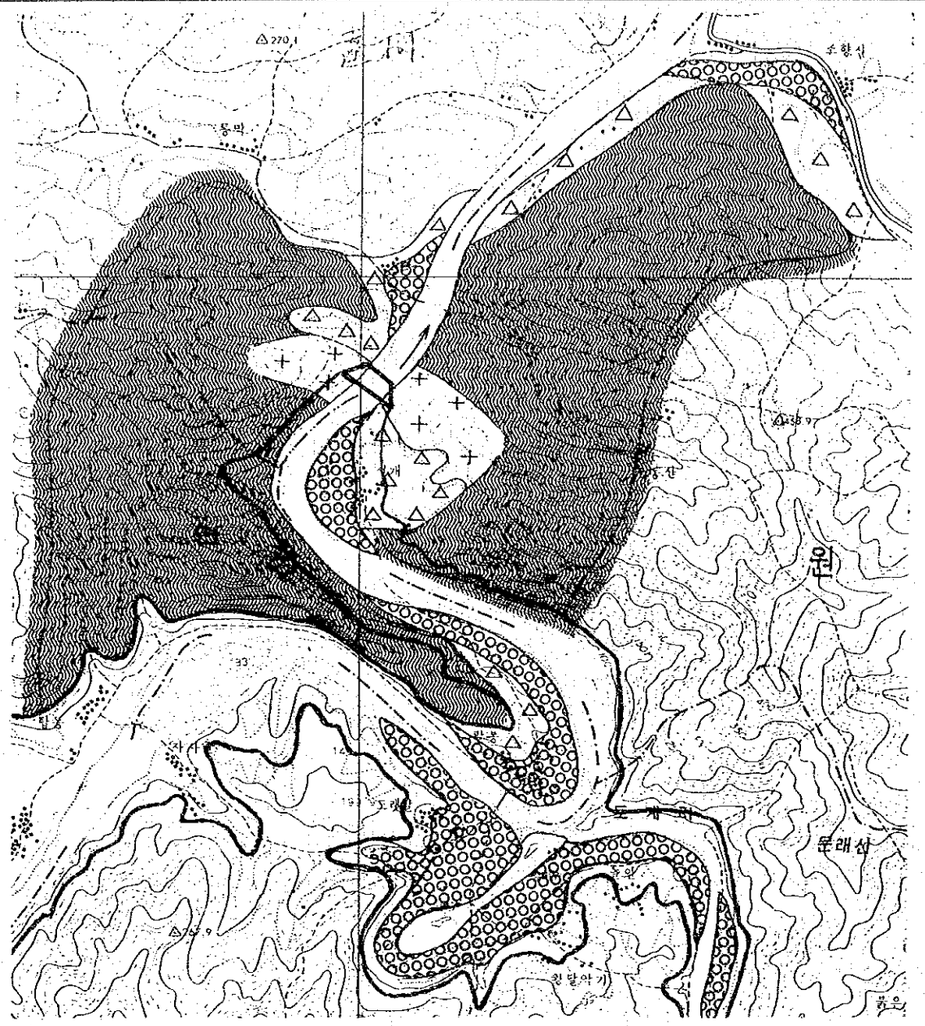
A) The granite distributed at the site is suitable as a foundation for the proposed dam. Since the dam axis is at a narrow ridge at the left bank it will need to be fixed there, while at the right bank, the present axis is located at a small gully. Hereafter, it will be necessary to consider shifting the axis at the right abutment from its present location within a range about 10 and several meters upstream and downstream.

B) Although there is no exposure at all of the foundation rock of the riverbed, judging from the geological conditions at the left and right banks, it is surmised that good bedrock will be available.

C) Open cracks and slickensides are conspicuous in the granite at the cliff of the left abutment. It will be necessary hereafter, along with detailed investigations, for the condition of deeper parts of the bedrock to be studied. In particular, thorough attention must be paid to the fissure located at the bottom of the cliff and inclined toward the downstream side in the N20°W, 20°NE direction. Weathering and development of crakcs become more extreme at the top, and the ridge as a whole is thin, and moreover cracky. It will be necessary for the permeability of the foundation rock to be confirmed by drill holes.

D) It is estimated that the depth of excavation for the dam foundation, assuming that the cracks and joints seen at the left abutment are treated by grouting, will be of a degree of removing unstable rocks at the steep part of the cliff, and about 3 to 5 m at the top. At the riverbed, it should be sufficient for excavation to be of about the extent of removing sand and gravel. As for the right bank, it is estimated to be around 1 m after removal of the slope wash.

E) Of the drill holes for confirming the thickness of the sand-gravel at the riverbed, it will be necessary for at least one to be an inclined hole to diagonally cross the riverbed.



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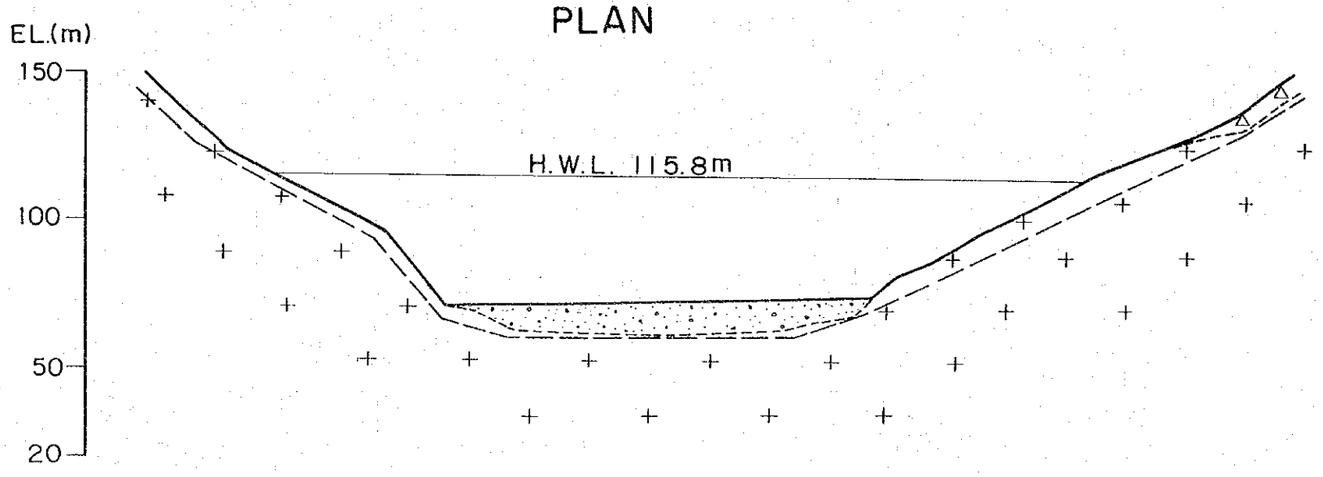


PROFILE

LEGEND

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

0 1000 m
PLAN

0 100 m
PROFILE

GEOLOGY

11-A1 DALCHON(達川)

Feb. 20. 1978 | Fig. - 15

3-12 Ganhyeon

(1) Outline of Project

Dam type : Concrete gravity
Dam height : 45.4 m
H.W.L. : EL. 111.4 m
Power station : Attached to the dam

(2) Topography and Geology of Reservoir Area

There are steep cliffs locally of heights to 30 to 50 m such as impingement slopes of the river, but as a whole, the topography is of old age where dissection has progressed. Consequently, the river deposits at the main river and major tributaries are marked and development of river terrace is prominent at both banks. All of the terraces have been developed as rice fields. Furthermore, many of the valleys are waste-filled valleys where also development of artificial ponds and rice fields are conspicuous.

There will be no fear of leakage since all of the reservoir area is located in a granite zone. Although deposition of sand-gravel is prominent at the rivers and streams in the reservoir area, it is thought sedimentation after construction of the dam will be small since river gradient is gentle and the mountain features are stable.

(3) Topography and Geology of Damsite

Topography

Both the left and right abutments indicate slopes of approximately 35°. The abutment at the right bank is a uniform slope as a whole from the riverbed, but the left abutment shows a step at the vicinity of around 40 m above the riverbed.

The width of the riverbed is 50 to 60 m, and although there is a deposit of width of 30 to 40 m seen at the left-bank side, foundation rock is exposed at the river bottom on the right-bank side.

Geology

The foundation rock is judged as being a large scale dyke of greenish and very dense, hard quartz porphyry intruded into granite. (It will be necessary for the rock name to be checked by microscope.)

Left Abutment: The foundation rock is a greenish, hard, cryptocrystalline quartz porphyry. As a whole, it is a good rock with few cracks. Although there is a possibility that the previously-mentioned step at the relative height of approximately 40 m from the riverbed is a fault, its outcrop could not be confirmed in this reconnaissance. Further, since the foundation rock of the valley located to the east side of the abutment and running roughly parallel to the river is granite, it is surmised that the contact on the east side between the granite and the quartz prophyry exists between the main river and the above-mentioned valley more or less parallel to the river.

Riverbed: Since hard quartz-porphyry thought to be outcropping of the foundation rock is seen here and there in the sand-gravel deposit at the left bank side also, it is supposed that the thickness of the deposit is not more than 2 m. The riverbed at the right bank side consists entirely of hard quartz-porphyry. The foundation rock of the riverbed may be judged to be of good quality.

Right Abutment: The abutment consists of good quartz-porphyry similarly to the riverbed and the left bank, but the valley immediately downstream the dam axis is comprised of granite. Consequently, there is a possibility that quartz-porphyry will be thin at the right abutment. The contact between the two rocks could not be confirmed in the present reconnaissance.

(4) Geology of Saddle Site

To the east side of the left abutment, at El. 111 m, there is a saddle of width of 150 to 200 m (according to a 1/25,000 topographical map). An artificial pond has been made at El. 90 m on the downstream side of this saddle and the area below this pond has been developed as a rice paddy. Consequently, the downstream side of the saddle on the

whole is decomposed granite or residual soil at higher elevations while the lower part is covered by clayey soil. On the other hand, the slope on the reservoir side is a steep cliff, and at El. 120 m and below a mass of hard granite is exposed.

(5) Geology of Appurtenant Structure Site

Although the powerhouse site has not yet been decided on, the geology will be of adequately good quality whichever bank is selected.

(6) Material

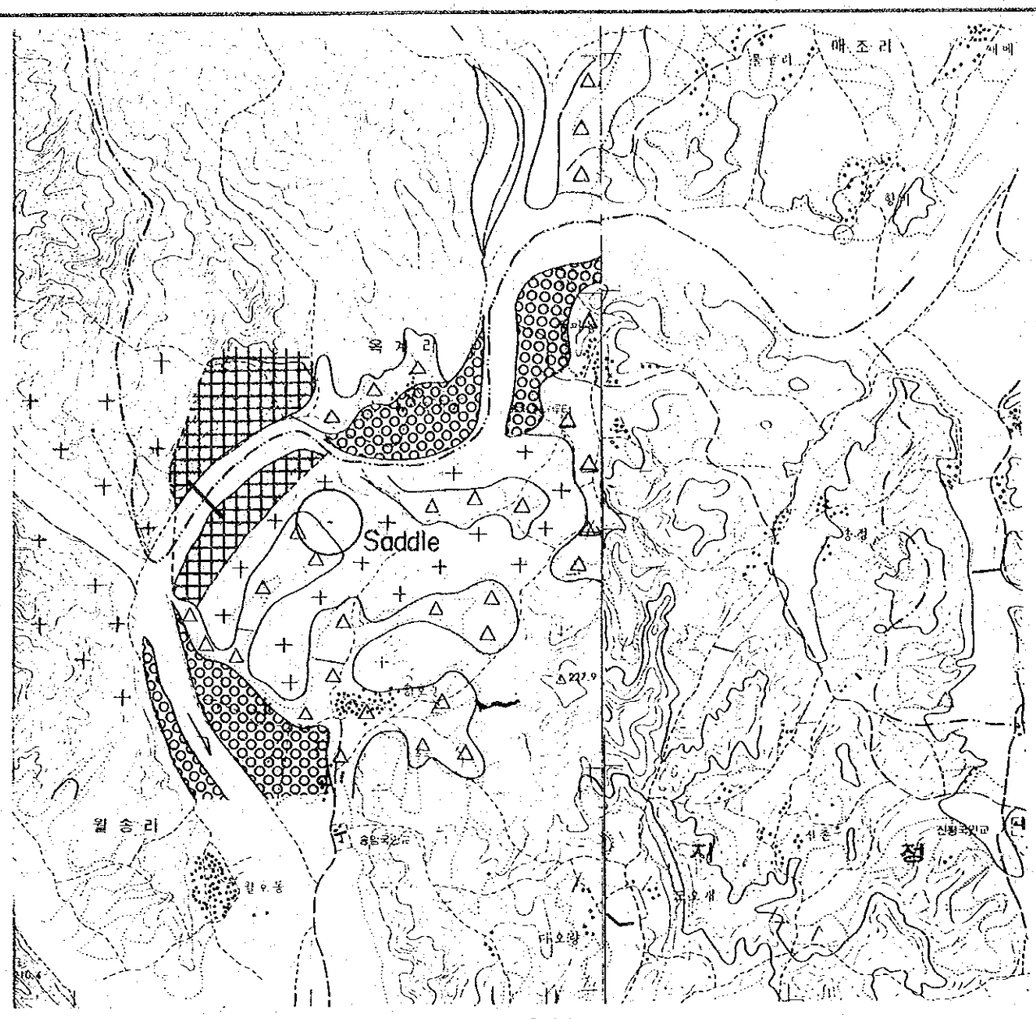
Good concrete aggregate will be abundantly available in the surrounding area of the damsite.

(7) Comments

A) The rock conditions of the site are very good for the foundation of the proposed dam.

B) Since it is thought possible from a topographical standpoint that the step seen at the left abutment may be a fault, it is advisable for an inclined drill hole combining permeability test to be provided. Further, with the purpose of confirming the contact between the quartz porphyry and granite at the right bank, it is desirable likewise for an inclined drill hole combining permeability test to be bored. The data from these holes can be utilized also for the foundation treatment plan.

C) It will be necessary for a topographical survey to be made of the saddle at the left bank to confirm the actual width below high water surface level.



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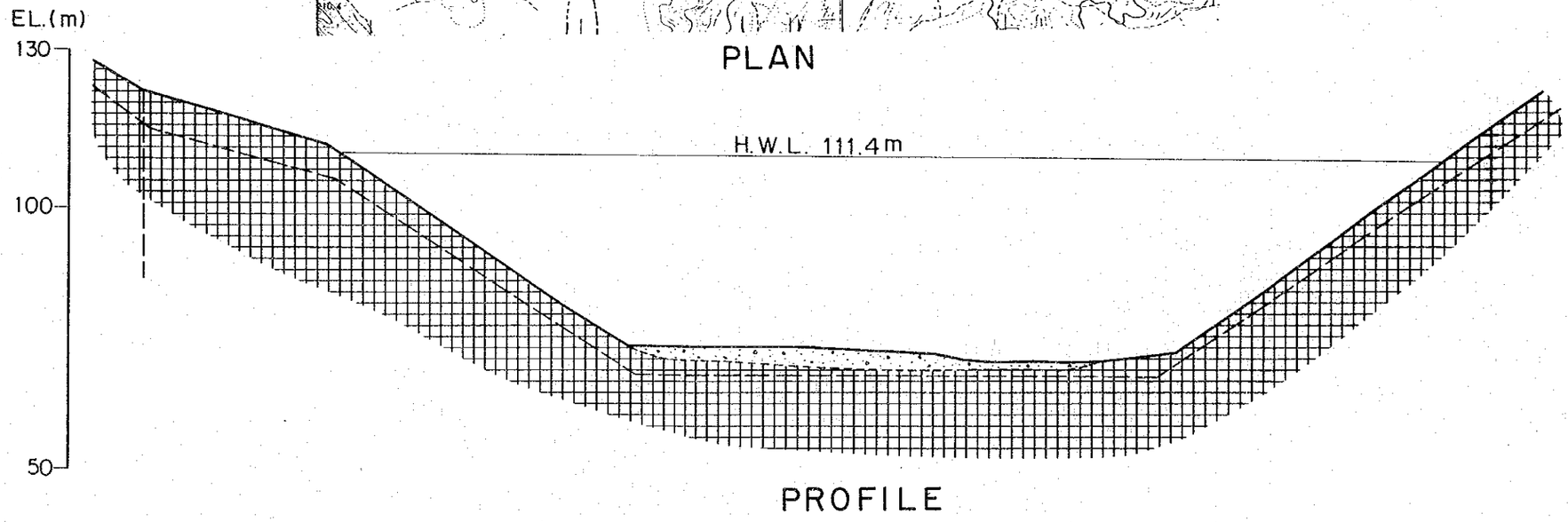


PROFILE

LEGEND

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

0 1000m
PLAN

0 50 m
PROFILE

GEOLOGY

12- A2. GANHYEON (艮峴)

Feb. 20. 1978 | Fig. - 16

3-13 Bonghwa

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 128.8 m
H.W.L.	: El. 303.8 m
Power station	: Attached to the Dam

(2) Topography and Geology of Reservoir Area

The reservoir area is generally composed of granite and gneiss, except cretaceous sedimentary rocks around the proposed damsite. Steep topography of mature stage prevails in the upstream basin. Granite area is well-dissected, showing later mature stage. Forestation is well-preserved in most part of the area, except in granite area where reforestation with pine tree has recently started. In these area, weathered and decomposed granite has been easily washed away, transported and deposited in the riverbed, forming raised bed rivers. Many examples are found around Yonju Town. Landslide hardly occurs in these granite and gneiss province. Riverbed gradient in the basin is 1/380 in average.

(3) Topography and Geology of Damsite

Some geological investigation had been carried out on this damsite, in the national survey of water resources potentials (1962).

Topography

A damsite is selected at very narrow channel of 60 m width in the course of south southeast flow of the Nakdongang. Right bank slope is very steep (48°) up to the height of 80 m and suddenly becomes gentle slope of 13° which is natural dip angle of the bedding plane. Left bank side is rocky cliff of 60° up to the height of 350 m. Riverbed is smooth-walled gorge.

Geology

The damsite comprises alternation of green sandstone, conglomerate and slate of Silla series of Cretaceous era. Bedding plane is N80°W, 20°S in the upstream of damsite, gradually changing its strike at the damsite and N55°E, 15°S in the downstream of damsite.

Alternation of Sandstone and Slate is exposed on the steep cliff (60°) on the left bank. Its dip angle is against cliff slope. Riverbed is covered with cobbles and boulders. Its thickness seems to be 1-2m, because Silla base rock is cropped out in the riverbed in up- and downstream reaches.

On the right bank, weathered and loosened alternation of conglomerate and sandstone is found between 1000 m upstream and 500 m downstream. The right bank slope is covered with blocky rock of sandstone and conglomerate separated at joint plane. It seems to be a fractured zone, but there is no decay characteristic in fractured zone. It may probably be severely weathered and loosened blocks along open joints. Fresh rock can be obtained after excavating these loosened rock for about 10 m inside. In these excavation, further loosening of cut face should be carefully controled during construction. Changes in the dips and strikes of the Silla series in up and downstream, suggests existence of fractured zone in the base rock at the right bank side.

(4) Geology of Appurtenant Structure Site

Spillway: Left bank cliff is too steep and high to layout spillway structure. It shall be laid on the right bank slope. Even on the right bank slope, deep excavation -- more than 10 m -- of rock is required for the layout.

Power station: Power station is also located on the right bank just downstream of the dam after removing loosened rock in the skirts of the slope.

(5) Material

Impervious core material: Source of impervious core material can be expected at low hill slope on the right bank, 2.5 km upstream of the damsite. A borrow area can be opened at weathered zone of Silla series and alternation of sandstone and slate of Naktong series, together with base rock of gneiss. Superficial 2-3 m thickness can be used for the purpose.

Filter material: Coarse sandy material is not available in and around the project area. These materials, together with concrete aggregates have to be prepared by milling quarried rock.

Rock material: Quarry site for rock material can be opened at rocky slope on the right bank, 1000 m upstream of the damsite, where abundant quantity of sandstone and conglomerate of Silla series is available.

Concrete aggregate: Sandstone and conglomerate of the Silla series may be less hard for concrete aggregates. Riverbed gravel at 8 km upstream reach can be exploited. If required quantity is not enough, coarse aggregate can be quarried at ganite rock on the right bank, nearby.

(6) Comments

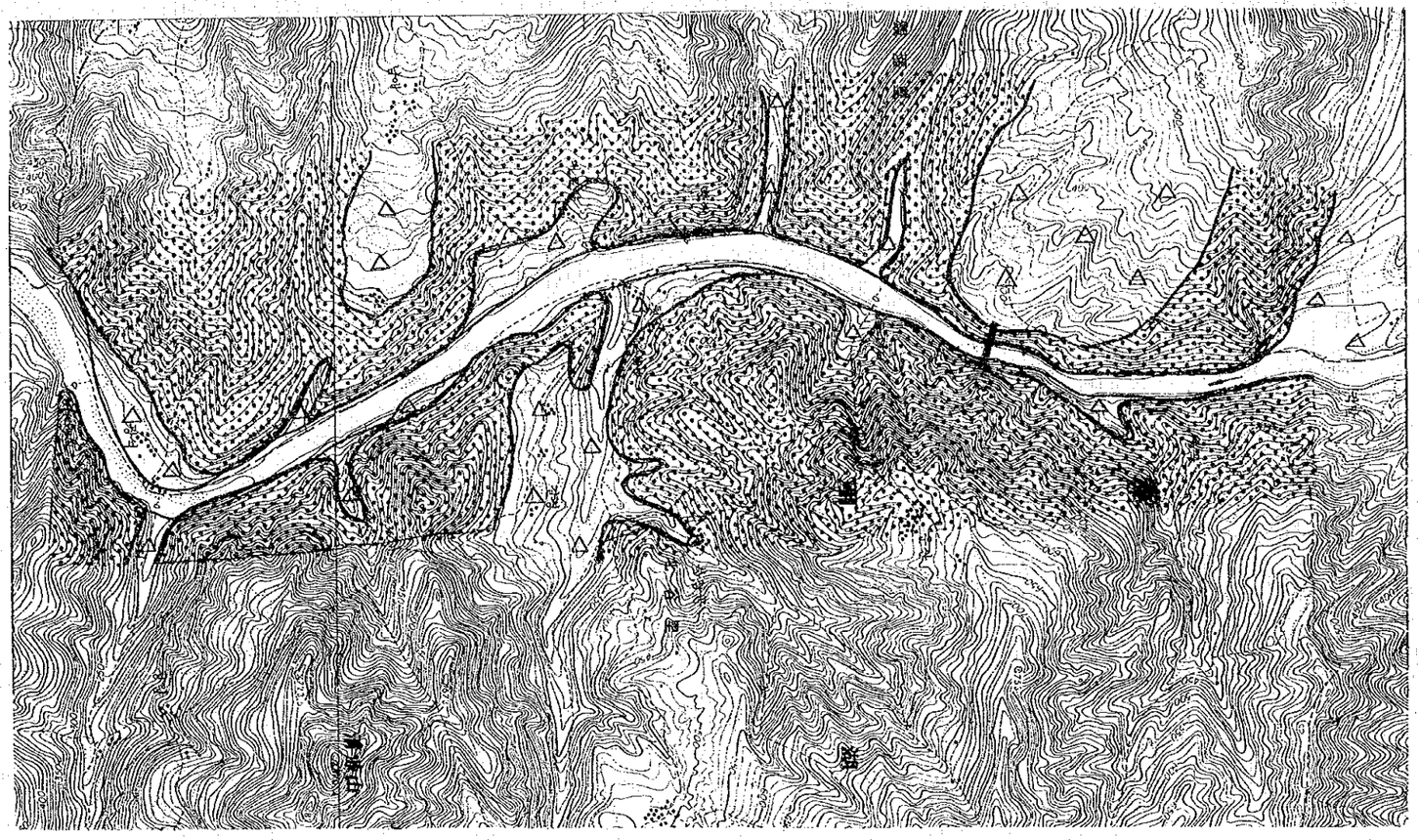
A) In case H.W.L. is taken at El. 303, dam crest will be placed on the gentle slope on the right bank side, where weathered and loose overburden is covering thick.

B) Major problem in this damsite is an extensive distribution of talus and crack zone on the right bank slope. Subsurface structure, especially of the right bank slope should throughly be investigated by means of seismic exploration, test boring, test adit and pitting, as well as permeability tests.

Past geological investigation in 1962 was very rough to appraise the foundation conditions.

C) Subsurface exploration of the right bank slope is also essential for layout of the spillway.

D) Borrow area for impervious material mentioned above should further be studied, especially for its soil mechanical properties.

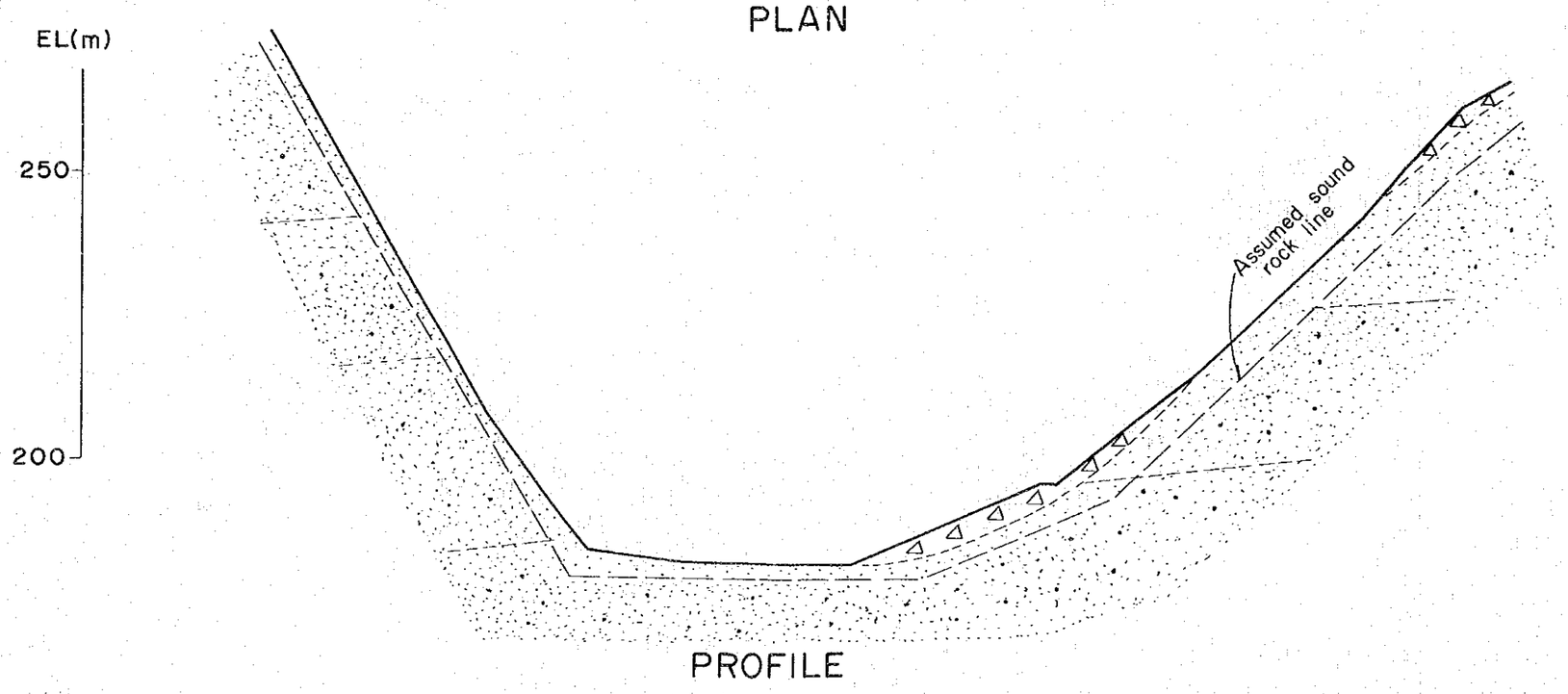


PLAN

LEGEND

- Talus
- Sand and Gravel
- Sandstone
- Strike and dip
- Damsite

N



PROFILE

0 1000m

PLAN

0 50m

PROFILE

GEOLOGY

13-35 BONGHWA(奉化)

Feb 27. 1978 | Fig.-17

3-14 Imha

(1) Outline of Project

Dam type : Rockfill
Dam height : 83 m
H.W.L. : El. 192 m
Power station : Attached to the Dam

(2) Topography and Geology of Reservoir Area

The reservoir area consists of granite, diorite, gneiss and sedimentary rocks of Paleozoic age. A limestone beds is known in the paleozoic formations but its distribution is limitted within a part of reservoir area and does not continue outside of reservoir or catchment area. Outside leakage of impounded water through limestone cannot occur. There is no possibility of landslide all over the reservoir area.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at a narrow gorge where river channel is running southwestward. Left bank slope is about 35° and has a small gully in its downstream side. Layout of dambody is limitted in narrow area. Riverbed gradient in the area is about 1/530. Base rock is exposed at riverbed. Right bank slope is 37° and sparsely wooded on the rocky ground. Left bank is also uniform slope, but is cut its upstream side by a gully. There are three thin ridges in the extension of right abutment ridge. Possible leakage of impounded water should be carefully studied.

Geology

Left bank slope is covered with surface soil of about 1 m thickness and weathered zone of 2-3 m thickness. Base rock of fresh granite is expected under these overburden. Granite is exposed at the foot of the slope. No indication of fault is recognisable in the slope ground. Boulders and cobbles are deposited in the up and downstream reaches. But little gravel deposits appears on the riverbed at the

damsite and hard granite is exposed all over the width. The granite floor has a small crack zone but no sizable fault. Firm and sound granite is exposed at lower parts of the right bank slope. The granite rock is covered with talus debris of about 1.0 m thickness in the middle and upper part of the slope. No big fault is found on the slope.

(4) Geology of Appurtenant Structure Site

Spillway: Spillway is recommended to be laid on the left bank slope, because firm foundation of granite can be expected after shallow excavation, compared with on the right bank slope.

Penstock and Power station: Base rock of granite is exposed on the right bank just downstream of the dam, providing sufficient space and firm foundation for building power station. Slope behind the station is rather gentle and stable. Penstock line on the right bank will be laid on a slope of granite with thin overburden - about 1.0 m thickness. Pipe line can be anchored on the firm granite.

(5) Material

Impervious core material: A borrow pit for impervious core materials can be opened at a gentle slope on the left bank, 2 km upstream of damsite. Residual soil of 2 m thickness is composed of clayey soil and clastics. Quality and quantity of the soil should be surveyed in detail. Another supplementary borrow pit can be expected in weathered granite in a gully on the right bank side, 600 m upstream of the damsite.

Filter material: River sand, suitable for filter materials is not available nearby. Economical comparison is necessary between production of sand by milling quarried granite and transportation of river sand at a distance.

Rock material: A quarry site can be opened at a big granite exposure on the right bank, 1,500 m upstream of damsite. It is hard and fresh granite with thin overburden.

Concrete aggregates: Abundant supply of coarse aggregates for concrete can be expected in the riverbed deposits at 200 m upstream of damsite.

(6) Comments

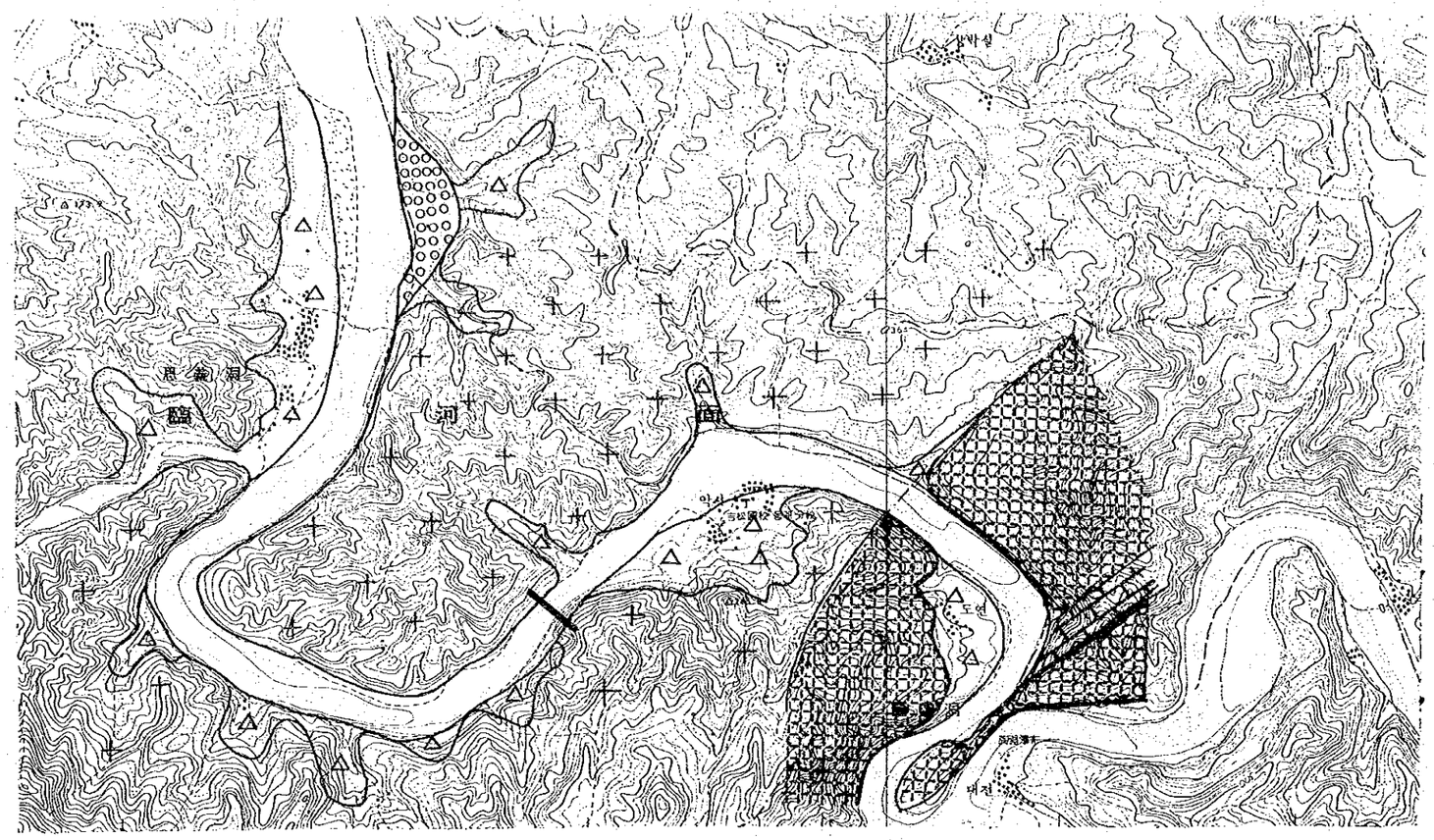
A) The proposed damsite is located in a gorge of hard and sound granite. Abutment slopes on both sides is covered with thin overburden. There is little sediments deposited in the riverbed. Site conditions are most favourable for dam construction.

B) Overburden seems to be rather thick in uppermost part of the dam abutment --- at elevation of dam crest. Further investigation should be concentrated to confirm the thickness of overburden and its permeability, by means of test boring.

C) Selection of borrow pit for impervious materials is not yet conclusive. Test pittings and soil tests should be performed in a few possible sites.

D) Either rockfill type or concrete gravity type can be adopted in this damsite from view point of geological conditions.

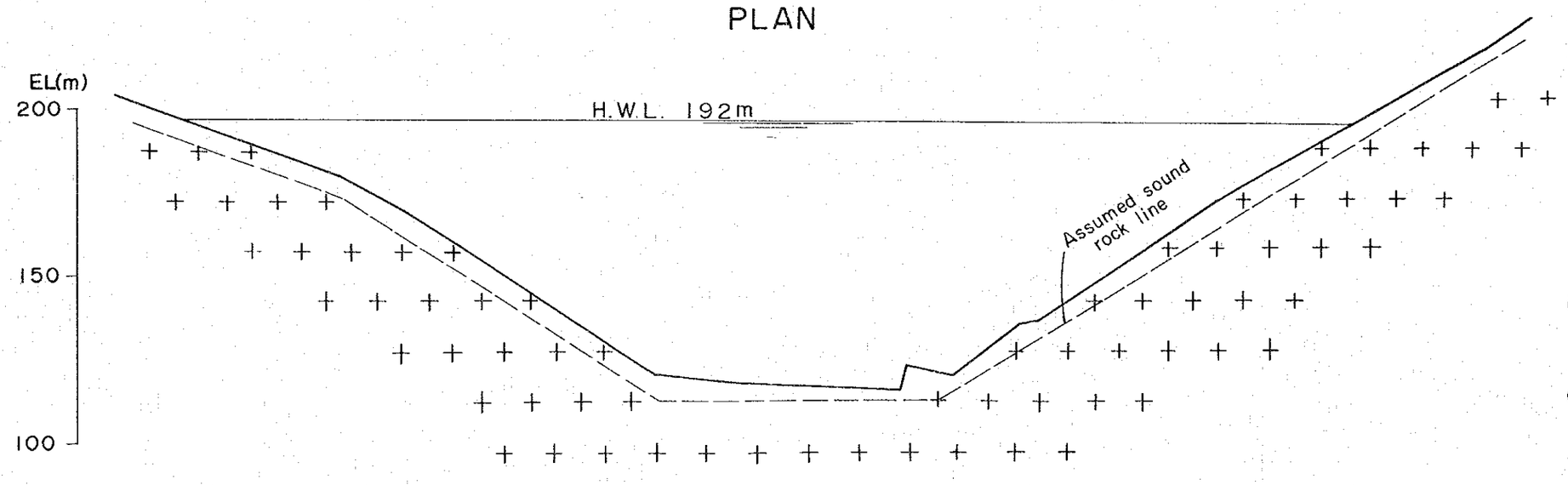
E) Further investigations for permeability and groundwater level are necessary at the saddle ridges on the right bank side.



PLAN

LEGEND

- Talus
- Sand and Gravel
- Terrace
- Diorite
- Granite
- Limestone
- Damsite



PROFILE

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
14-43 IMHA (臨河)

Feb. 27. 1978 | Fig.-18

3-15 Chibo

A new damsite has been selected at 5 km downstream from original site, after economical comparison of construction cost.

(1) Outline of Project

Dam type	: Concrete gravity
Dam height	: 45.7 m
H.W.L.	: El. 87.7 m
Power station	: Attached to the Dam

(2) Topography and Geology of Reservoir Area

Reservoir area comprises dissected hills and valley plains in an old stage of topography. It consists of granite gneiss, granite and alternation of sandstone, conglomerate and slate of Kyeongsang Series. There is no unstable slope that may cause landslide or landcreep. Several talc deposits are exploited in the area. There is no limestone that may cause groundwater leakage. Riverbed gradient in the area is as flat as 1/1,300 and sand and gravel deposits develop all along river channel.

(3) Topography and Geology of Damsite

Topography

A damsite has been selected at narrow channel between gentle sloped hills. On the left bank side, low round ridge with gentle slope of 30° stands on low river terrace as high as 25 m. Riverbed has a width of 480 m in which low river terrace of 4 m height is formed close to left bank. Right bank slope is 28° and base rock is partly exposed.

Geology

Left bank slope comprises heavily fractured granit gneiss and intruded diorite. Granite gneiss is too much fractured. Concrete dam should be abutted directly to sound diorite, after excavation of fractured gneiss.

Terrace and flood deposits on the riverbed are mostly sandy material. Thickness of these deposits is not known yet. It may be more than 10 m thickness. Granite gneiss can be expected underneath.

Right bank slope is also composed of granite gneiss and intruded diorite. But surface soil and weathered zone on this slope is rather thin. Firm and sound base rock can be expected underneath.

(4) Geology of Appurtenant Structure site

Power station: Power station should be built on the right bank side, attached to downstream of the dam, because base rock on the left bank is much fractured compared with that on the right bank.

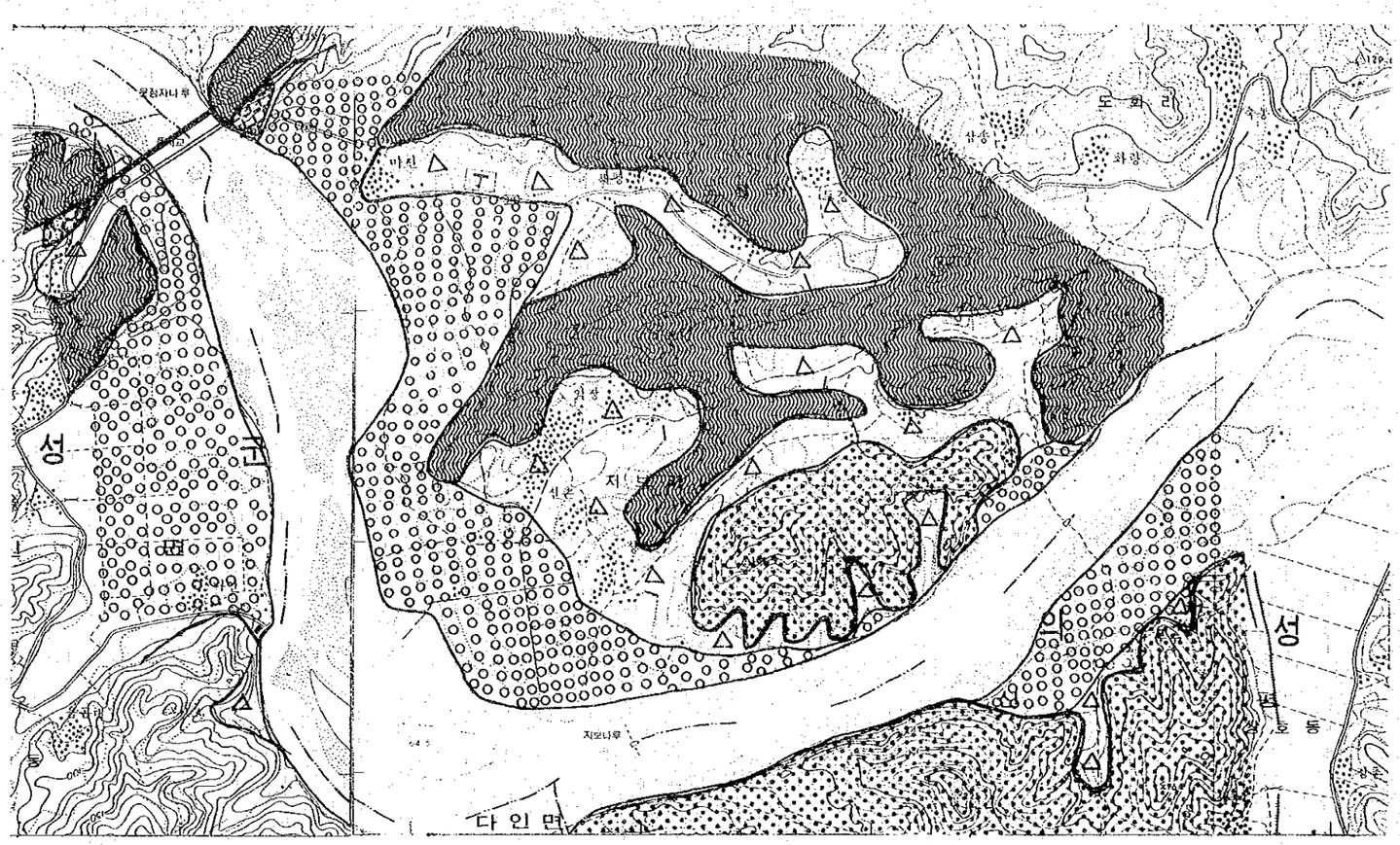
(5) Material

Concrete aggregates can be exploited in the sand and gravel deposits around Andong City, far upstream of damsite. Supplementary source for coarse aggregates can be supplied from granite hills scattered on the right bank side of upstream reach.

(6) Comments

A) Concrete gravity type is preferable for this wide-channel damsite. But riverbed condition is not clear because thick sandy deposits are covering all over the riverbed. Seismic exploration together with a series of test borings will be required to confirm the thickness of sandy deposits as well as base rock conditions.

B) Left bank abutment is so much fractured that detailed investigations of the fracture condition should be investigated by means of test adits and test borings.

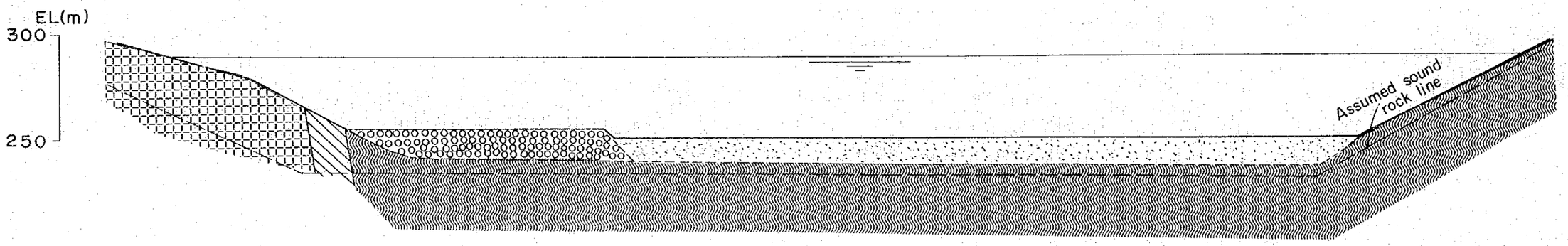


PLAN

LEGEND

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

0 1000m
PLAN
0 100m
PROFILE



PROFILE

GEOLOGY
15-36 CHIBO (知保)
Feb. 20 1978 | Fig.-19

3-16 Hamyang

Present damsite was selected at 5.5 km upstream of the originally planned damsite, after economical comparison.

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 95.5 m
H.W.L.	: El. 380.5 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, having wide valley plains in its upstream area. The damsite and its upstream area is composed of diorite, while far upstream reach is of granite gneiss. Hillside slopes in the area are generally gentle and talus deposits are also developed at many places in the area. No landslide topography prevails in the basin. Base rock is generally firm and sound and no leakage to outside area happens. Riverbed gradient is far gentle compered with that in the downstream reaches from damsite.

(3) Topography and Geology of Damsite

Topography

A damsite is selected at narrow gorge, just downstream of wide open valley. Left bank slope is very steep of 40° to 25 m height and suddenly changes to 25° slope. Riverbed is 50 m in width with rocky floor. Right bank is single slope of 32°. Many big rock blocks scattered on the slope. Tumbling down of these blocks during construction excavation should be carefully protected. Base rock itself, however, is firm and stable, never cause sliding.

Geology

On the left bank slope, diorite rock crops out at water's edge and road cut at the middle of the slope. Under surface soil of 1-2 m thickness and weathered zone of 3-4 m thickness, hard and fresh diorite can be expected.

Fresh diorite is exposed on the riverbed, accompanying no major fault or fracture. On the right bank, base rock of diorite is also expected underneath scattered blocky rocks and weathered and cracky zone of 2-3 m thickness.

Sound diorite occupies whole damsite, providing firm foundation for dam building.

(4) Geology of Appurtenant structure site

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

Tunnel: Tunnel of 8.4 km length will be opened on the left bank. The tunnel route will pass through diorite and granite gneiss. Boundary between the two rocks is fractured. There may be many minor faults expected in the granite gneiss. These minor faults near the outlet portion will be loosened due to shallow covering. Tunnel driving in these portion should be carefully controlled against cave in and groundwater spouting.

Penstock and Power station: Penstock line will be laid on the ridge line of sound granite gneiss. Power station can be built on the base rock after excavation of talus deposits.

(5) Material

Impervious material: Impervious core material can be expected in residual soil of weathered diorite on the gentle slope on the left bank, 1000 m upstream of the damsite. It seems to be rather clayey. Detailed soil tests will be necessary before opening a borrow pit.

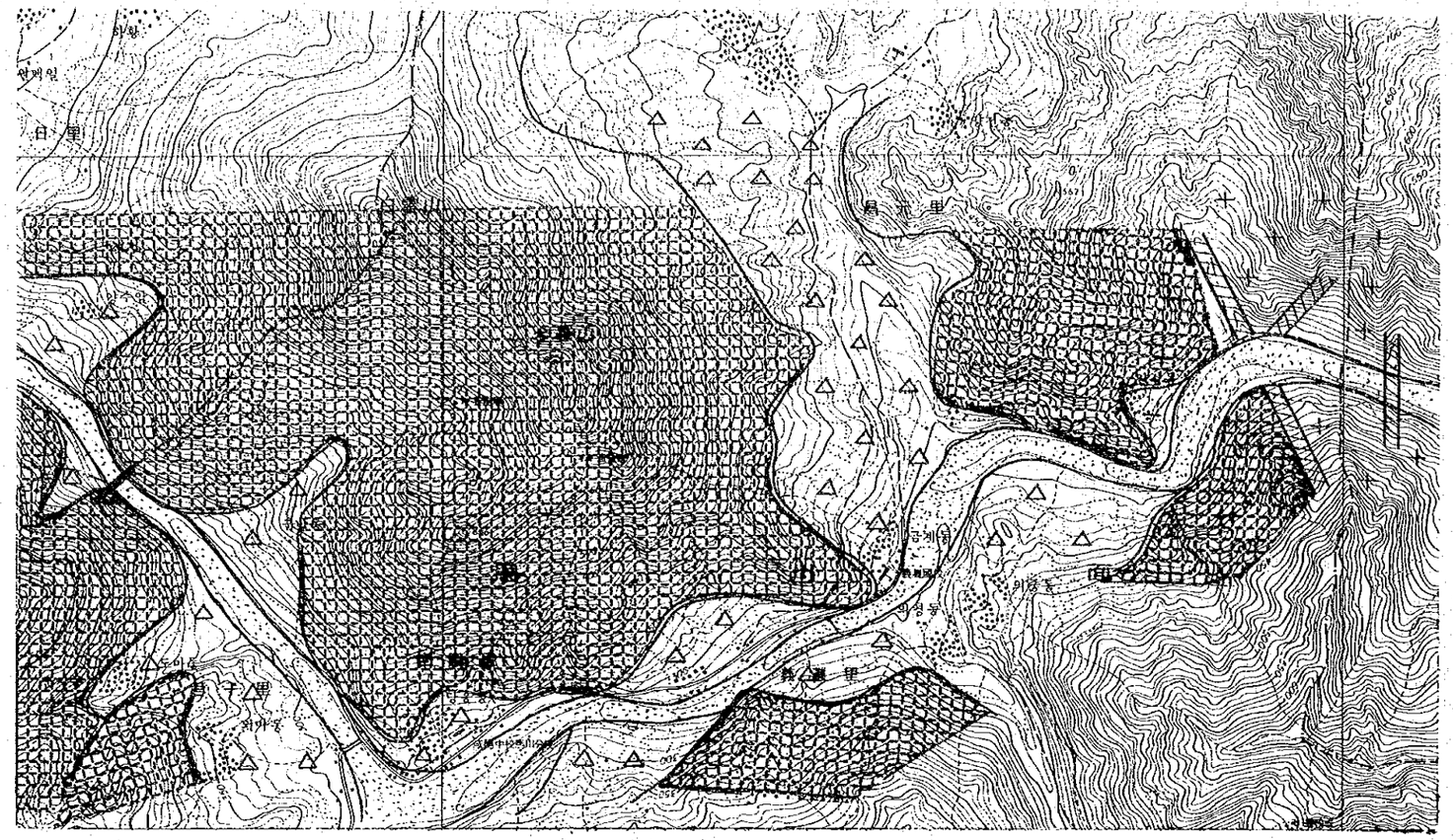
Filter material: Sandy material for filter zone embankment is not available nearby. It will be required to be transported from distant sources in downstream reaches.

Rock material: A quarry site can be opened at a big diorite outcrop on the right bank, 500 m upstream from the damsite. Abundant rockfill materials can be obtained at the quarry.

(6) Comments

A) The proposed damsite is a most favourable site from a viewpoint of topographical and geological conditions.

B) Location of fractured zones along the tunnel route should be thoroughly investigated before final layout of the tunnel course.

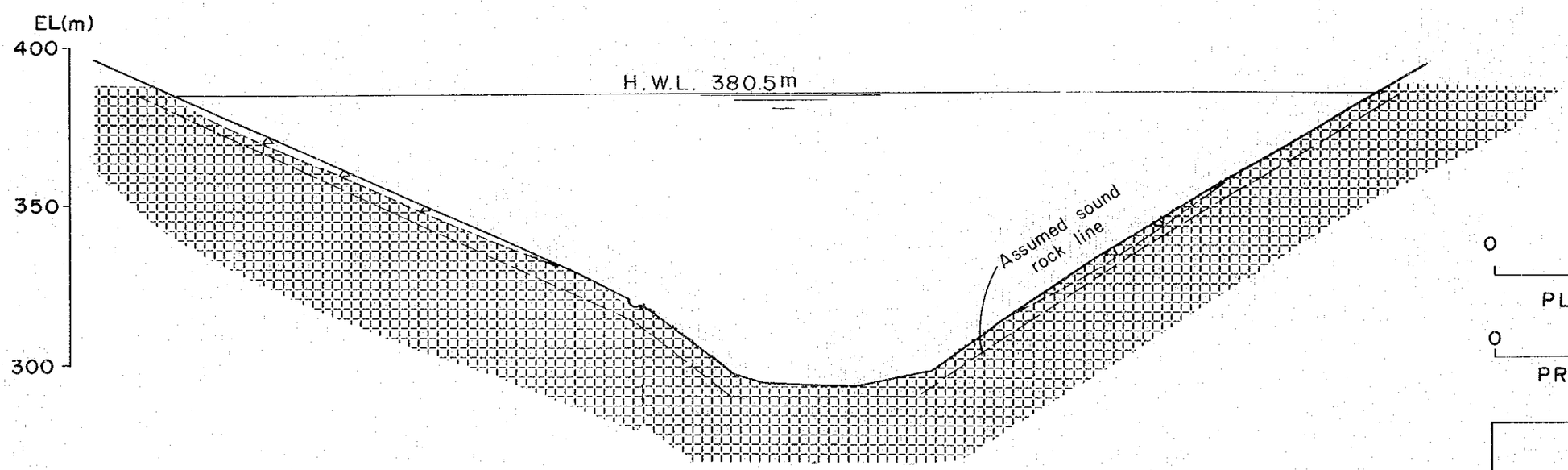


N

LEGEND

- Tarrace
- Sand and Gravel
- Granite
- Diorite
- Sheared zone
- Damsite

PLAN



PROFILE

0 1000m

PLAN

0 100m

PROFILE

GEOLOGY

16-51 HAMYANG (咸陽)
(SININWOL) (新引月)

Feb. 27. 1978 | Fig.- 20

3-17 Dogsan

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 77.4 m
H.W.L.	: 158.4 m
Power station	: Dam and Tunnel

(2) Topography and Geology of Reservoir Area

The reservoir basin comprises of granitic gneiss showing topography of mature stage. Talus slopes are developed in some parts of the foot of hills. There is neither geological structure nor rock facies which may cause landslide or sliding, in the basin area. Alluvial plain develops along river channel. The channel is filled with boulder and cobble deposits.

(3) Topography and Geology of Damsite

Topography

The proposed dam axis is located on biotite gneise and toe of dam on anorthosite, the anorthosite is understood as an intrusion in the gneiss, but their boundary cannot be found due to poor exposure of these rocks. The damsite is selected at relatively narrow channel which suddenly expand wider in its upstream reach. A big-scale shallow sliding is observed in the downstream reach on its right bank slope with thick debris found or its skirts. Selection of damsite is limited in present location.

Left abutment slope of 25° is covered with surface soil. Riverbed width is about 100 m. An existing small gravel weir for local irrigation is leading the flow line toward right bank side.

Right abutment slope shows 30°. Base rock is exposed at water's edge but slope wash of cobble size and covering mostpart of the slope. Both side slops are extending higher than the designed high water level. It must be carefully taken into consideration in the layout of design that the toe embankment of the dam body on the left bank side will extend in fan-shape, because convex shore line of the left bank.

Geology

The left bank slope comprises of granitic gneiss with dioritic rock in its skirt, which may be an intrusive body in the gneiss. Surface soil of average thickness of about 1 m. in covering the whole area and followed underneath by weathered zone of base rock of 3 - 4 m thickness. These overburden is gradually thinner in the skirt portion and thicker in upperparts of the slope. No remarkable fault or fracture is observed in topography. Fresh base rock is sound and firm enough for dam foundation.

The riverbed is covered by cobble and boulder of gneissose rock, having no exposure of bedrock. But an outcrop of anorthosite rock is found at about 300 m downstream of the dam axis. Thickness of cobble and boulder deposits at the dam center is, therefore, supposed to be 2-3 m at the center and about 5 m at left bank side. Under these gravel deposits, there may be a fresh and hard biotite gneiss or anotherthosite which affords favourable foundation for the dam building.

(4) Geology of Appurtenant structure site

Spillway: A spillway structure can be laid out on either side of the river. Location of Intake tunnel for the turbine is favourable selected on the right bank side, and the spillway shall be laid on the gneiss slope on the left bank.

Tunnel and Penstock: Headrace tunnel will be excavated to east southeast for the distance of 3.2 km, mostly through hard anorthosite rock. The tunnel route will cross a boundary of anorthosite and hornblende gneiss at 2.5 km and another boundary of hornblende gneiss and banded gneiss at 3.5 km distance from the intake. There is no informations about the structure of the former boundary. The tunnel route will cross the latter boundary at rather shallow underground, where fractured and weathered condition would be encountered tunnel excavation at the crossing should be carefully performed.

Penstock line will be laid on the banded gneise slope, where the gneiss exposed on the upper parts of the slope. Foundation condition for layout of penstock is firm and sound enough.

Power station: Power station site is selected on the alluvial flat on the right bank, downstream reach of the Dogsan gang, 3.3 km east southeast of the damsite. There is no possibility of landslide on the stable slope behind the power station. Base rock of banded gneiss will be expected at about 5 m underneath the alluvial gravel bed. Turbine and generation can be firmly placed directly on the base rock.

(5) Material

Impervious core material can be supplied from a weathered zone of gneiss on a gentle hill, left bank side of the river, 2 km upstream from the damsite. Impervious core materials over an area 700 m x 250 m with 2 m thickness can provide embankment quantity of 350,000 m^3.

Another weathered material can be expected on the right bank side of the river at further 3 km upstream.

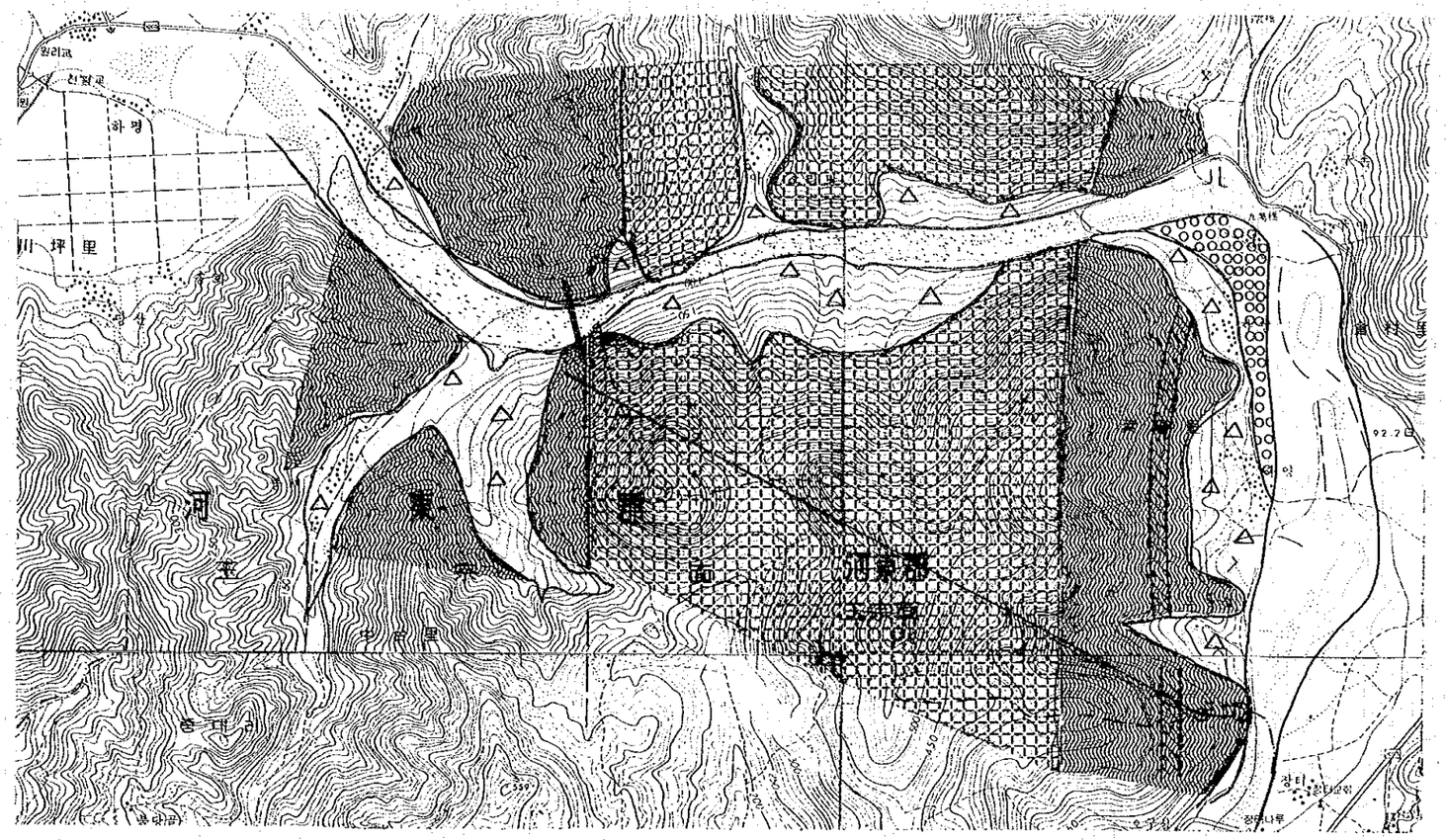
Filter material: Coarser material can be supplied from riverbed gravel in the Dogsan River. Finer material is not available in nearby area. It shall be supplied by crushing the coarser one. Rock material can be quarried from the left bank slope of a small tributary. Hard biotite gneiss which thin soil cover can provide rock material.

(6) Comments

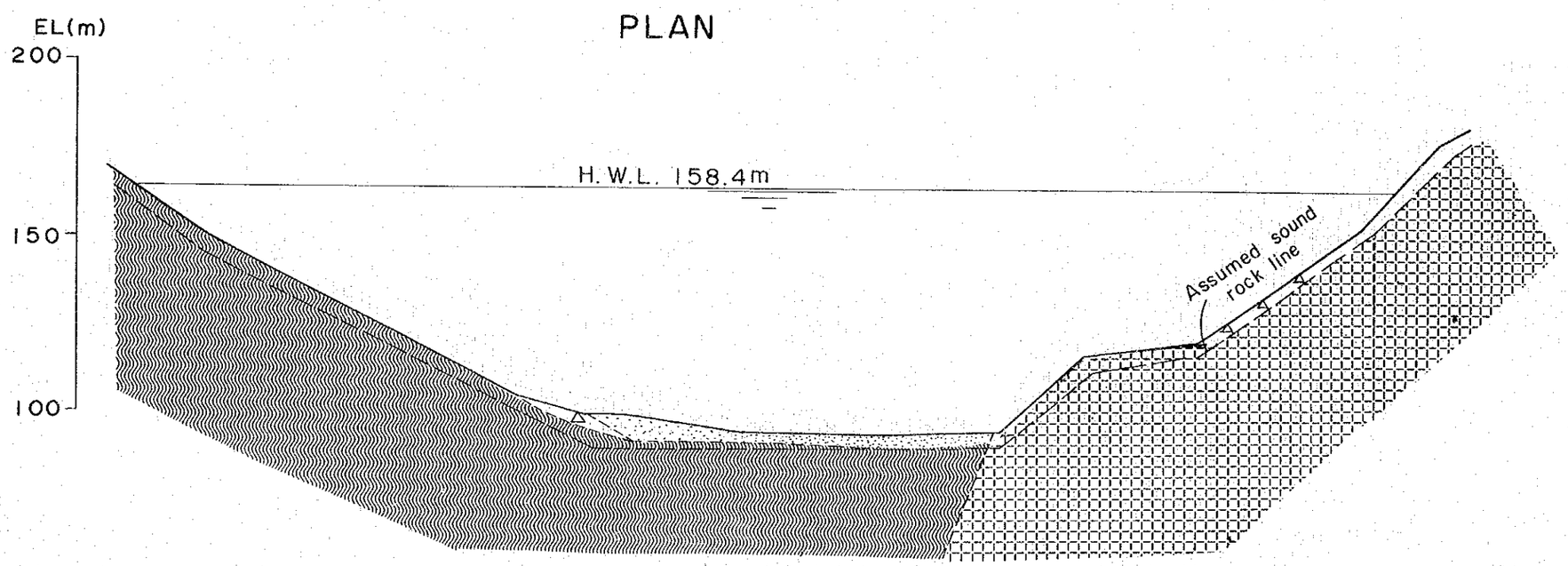
A) Present damsite is a most favourable site in the Dogsan river. Firm and sound base rock conditions allow to build dam of either rockfill or concrete gravity type.

B) In case of rockfill type, upstream skirt of dam body will extend to wider riverbed and embankment volume will be much increased corresponding to the height of dam.

C) Development of fractured zones, especially at the boundary between gneiss and intrusive anorthosite cannot be confirmed due to poor exposure of base rock. Geophysical exploration for areal discontinuity of base rock and test borings for detailed geological study are necessary for further investigation.



PLAN



PROFILE

LEGEND

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

0 1000m
PLAN

0 100m
PROFILE

GEOLOGY
17-53 DOGSAN(徳山)

Feb. 27. 1978 | Fig.- 21

3-18 Yongdam

There are two damsites under consideration for the Yongdam Project Site, the one at the time of preparation of the report on basic planning and designing of Yongdam Dam* in May 1967 and the one which was the objective of this water resources reconnaissance (1977). In this Report the former damsite will be called the alternative site and the latter the original site.

* Hereafter referred to as "1967 Report".

(1) Outline of Project

		Alternative site	Original site
Dam type	:	Rockfill	Rockfill
Dam height	:	79.7 m	
H.W.L.	:	269.7 m	
Power station	:	Attached to the dam	Attached to the dam

(2) Topography and Geology of Reservoir Area

Since this damsite is located at the end of the backwater of Sutong Reservoir planned downstream, the topography of the reservoir area is similar to that in the Sutong reservoir area. Accordingly, a mature river topography where the river flows down a rugged mountain area is indicated at its straight part, while at meandering parts and in the vicinities of conjunctions with large tributaries, an old-age topography of large river width is indicated. The gradient of the mainstream is gentle as a whole (1/500-1/800, 1967 Report), and at the meandering parts and the vicinties of conjunctions with major tributaries, there are developed large-scale river terraces, and above them, talus topographies.

The mountainsides of the reservoir area are stable and there are few places where collapses have occurred. However, sings of sand and rock flows are seen at streams of comparatively steep river gradients, and many places were seen here and there in this investigation where river improvement works are in progress. In general, judging from the stable mountain features, gentle river gradients and the progress of

improvement works being executed on steep-gradient tributaries, it is inconceivable that sedimentation will be prominent. In the 1967 Report, sedimentation of 90 m^3/km^2/year is adopted.

Adequate geological investigations could not be carried out on the reservoir area in this present reconnaissance. However, according to the present reconnaissance and a 1/250,000 geological map, since the greater part of the reservoir area consists of metamorphic rocks such as gneiss and schist, it is thought there will be no leakage problems which would affect water impoundment. According to the 1967 Report, it is reported there are small-scale distributions of limestone, but being localized, there would be no fear of leakage, and in consideration of the geological distribution of the area as a whole, it may be judged that this report is correct.

There are no landslide topographies recognized in the reservoir area, while since the large-scale talus deposits developed at various places in the reservoir area present a gentle-sloped, stable topography, it is inconceivable that sliding will occur due to storage of water.

(3) Topography and Geology of Alternative Damsite

Topography

The damsite is located approximately 700 m downstream from Ancheon Bridge which connects Wajon Village and Kyonderi Village, and there is a large outcrop of foundation rock at the river bank of the left abutment. The height of approximately 15 m from this outcrop to the road comprises a steep cliff of about 70°. The slope beyond this height is gentle at about 30°. The right abutment comprises a ridge as a whole. Since the skirt of this ridge is covered by a thick talus deposit up to about 40 m relative height from the riverbed, a gentle slope is formed as a whole. From the end of this talus deposit to the top of the ridge is a cliff of about 50°. The top of the ridge forms a thin saddle. The river channel runs in a straight line roughly south to north. The width of the river at the dam axis is approximately 90 m, and toward the right bank there is a river terrace of height from the riverbed of about 3 to 6 m at a width of 40 m on the dam axis, which widens out further upstream of the dam. It is above this river terrace where the previously-mentioned talus topography is developed.

Geology

Left Abutment: The left bank as a whole is comprised of hard and dense granitic gneiss, and other than the upper part of the abutment being covered by talus deposit, the greater part is a direct exposure of foundation rock. Moreover, according to the 1967 Report, weathering of the foundation rock is shallow, and velocities obtained from seismic prospecting are indicated to be between 3.1 and 3.3 km/sec. It is further reported that the strike and dip of gneissocity are N47° - 55°E and 50° - 60°SE.

Riverbed: The entire riverbed is covered by deposits of the present river or terrace deposit. According to the 1967 Report, the sand-gravel of the present river is thin being several meters, while the thicknesses of terrace deposits are between 3 to 6 meters. The foundation rock under both the river and terrace deposit is granitic gneiss, and although hard rock has been confirmed for the foundation rock under the present river deposit, except for weak zones, it has been found that the granitic gneiss under the terrace deposit has a weathered belt from several meters to not more than 10 meters. A number of drill holes at the riverbed have confirmed a sheared zone, but there is a possibility of a number of weak zones other than these still existing at the riverbed.

Right Abutment and Saddle Site: According to the 1967 Report, the thickness of the talus deposit covering the foot of the right abutment is not more than 5 m. The underlying foundation rock is granitic gneiss and a weathered rock of 5 to 15 m depth existing under the talus has been confirmed by drill holes. The bedrock not covered by the talus deposit and exposed at the cliff is hard. However, in the area from the top of the ridge to the saddle, there is weathering to a depth of 8 to 40 m. It is reported that the seismic velocity of this part is 1 to 2 km/sec.

(4) Geology of Appurtenant Structure Site

Regarding the geology of the powerhouse site, the granitic gneiss will be adequate regardless of whether the left or right bank is selected. Therefore, the location should be selected from the standpoints of topography and civil works.

(5) Material

The following will be the materials required for the proposed dam according to the 1967 Report.

Rock	882,100 m^3
Sand and gravel	436,200 m^3
Impervious core material	201,900 m^3
Total	1,520,200 m^3

Of the above, the volume of the rockfill zone including filter material will be a total of approximately 1,318,300 m^3. Meanwhile, as materials already investigated, the reserves of granitic gneiss at quarries within a radius of 1 km from the damsite are said to be approximately 30 x 10^6 m^3, while a total of about 730 x 10^3 m^3 of river deposits is available for collection within 5 km from the damsite. As for impervious core material, it is reported that approximately 200,000 m^3 can be borrowed from Wajon Village on the left bank about 1 km upstream from the damsite and a total of about 320,000 m^3 from the area downstream to about 6 km.

(6) Comments

A) Although there are a few points remaining to be confirmed through some amount of additional geological investigation to be made further regarding the foundation rock at the damsite, construction of the proposed dam will be possible as of the present.

B) Based on a topographical judgment, there is a possibility that the line from the valley where Songpun Ri is located which passes the damsite riverbed and reaches to Sannan Ri is a fault valley. It will be necessary to investigate the underlying parts of the riverbed and terrace deposit on the dam axis through inclined drill holes for the purpose of confirming this fault.

C) It is not stated in the 1967 Report whether the weathered granitic gneiss at the left-bank saddle can be available as the foundation for the spillway structure, and it will be necessary for drill holes to be bored to ascertain this point and the permeability of the saddle needed for foundation treatment planning.

D) In the same way, it will be necessary for drill holes combining permeability test for ascertaining whether the weathered rock underlying terrace and talus deposit can be available as the foundation for the impervious core zone.

E) On studying test results on the Wajon and Hoeryong sites proposed as sources for impervious core material given in the 1967 Report and on examination of the materials in the field, there was a tendency seen for the materials to be excessively fine-grained. Plotting the results of gradation analyses for the two sites on the gradation curve range of a dam constructed by the USBR, the gradation curve at Wajeong site is in out-side of the range and the curve at Hoeryong is situated near the upper limit of the fineness. It will be necessary to make further investigations for suitable material in the vicinity of the damsite.

F) However, judging from the mother rock (metamorphic rock) in the surrounding area of the damsite, it may be difficult to obtain better material. As one way of making up for this drawback, investigation should be made whether there are weathered zones in the base rock underlying the tested materials at the two proposed sites, and if there are weathered zones, a method of collection making possible mixing together the overlying silt-clay material and the weathered material should be considered.

G) The rock at the proposed site indicated in the 1967 Report is suitable as rock material. However, as stated in the report, natural river deposit of approximately 730,000 m^3 are available within a radius of 5 km from the damsite. It is thought that reconsideration should be given to greater utilization of these natural deposit.

(7) Topography and Geology of Original Damsite

This damsite is located approximately 3 km downstream from the alternative site. Accordingly, the topography in the reservoir area may be considered to be similar to that of the alternative site. However, in case of this site there is a large valley surmised to be a fault valley where Songpun Ri is located which merges with the mainstream at the left bank approximately 2 km upstream from the damsite.

Topography

The Geum River mainstream meanders widely at a point about 1 km downstream from the alternative site and then again flows down in a straight line from south to north. The damsite is located at roughly the far end of this straight-line portion, and the river again meanders downstream of the damsite.

The left and right banks of the site are more or less symmetrical and indicate steep slopes of approximately 40°. The width of the riverbed is about 200 m, and there is a small-scale river terrace formed at the right bank.

Geology

Both the left and right banks consist of hard granitic gneiss. Slope washe is thin on the whole. Although exposed bedrock shows some amount of weathering and irregular open cracks at the surface portion, it is adequately serviceable as the foundation for the proposed dam. Although the thickness of the sand-gravel at the riverbed has not yet been investigated, since the river has a gentle gradient, it is thought to be more or less the same as at the upstream alternative site (2-3 m). The riverbed base rock also has not yet been investigated,

but similarly to the alternative site, the site is not one topographically where a weak zone can be assumed.

(8) Geology of Appurtenant Structure Site

The appurtenant structures of the dam are a spillway and a powerhouse. Although the spillway site is undecided as yet, the foundation rock is hard at both left and right banks. The powerhouse site is also undecided, but topographically, the right bank side is suitable for the location.

(9) Material

As in the case of the alternative site, a rockfill dam is planned for this site also. The various materials have been discussed in Paragraphs 5 and 6.

(10) Comments

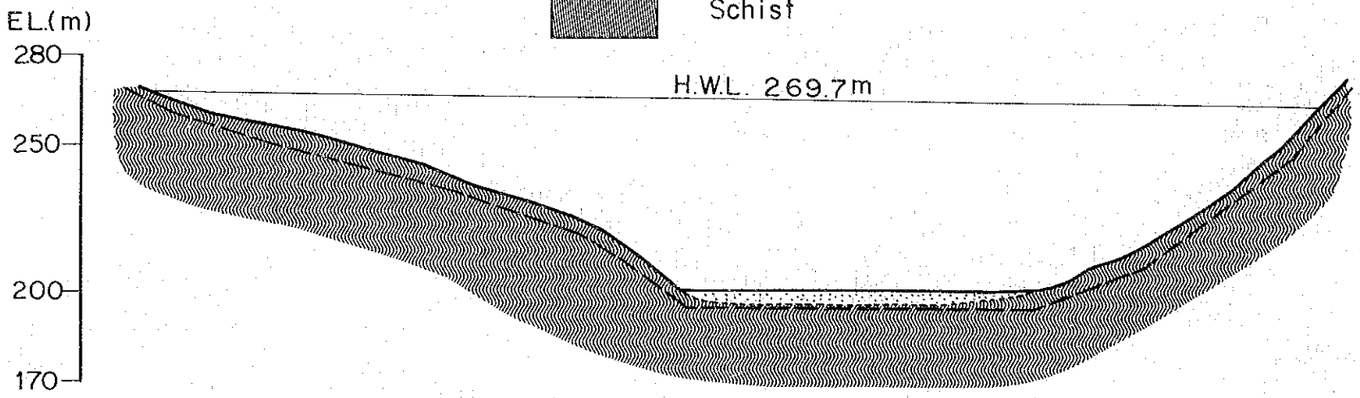
A) The geology of the site is of adequate nature for the foundation of the proposed dam.

B) Although a comparison is difficult to make at the present stage since the extent of the investigation is different from that on the alternative site, one question about the alternative site is whether a weak zone exists underlying the riverbed or the river terrace, while another question is whether the weathered granitic gneiss distributed under the talus deposits and at the saddle can serve as the foundation for the dam and the spillway, depending upon which the volume of excavation can vary considerably.

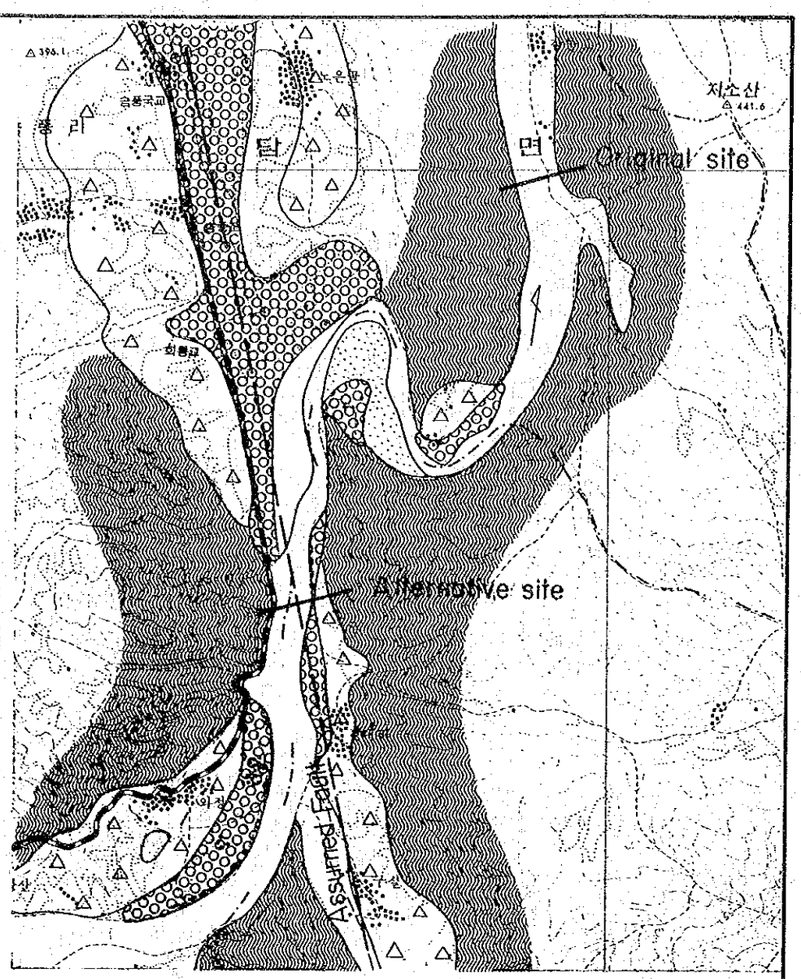
C) Further detailed investigations will be required for both sites with regard to impervious core materials.

LEGEND

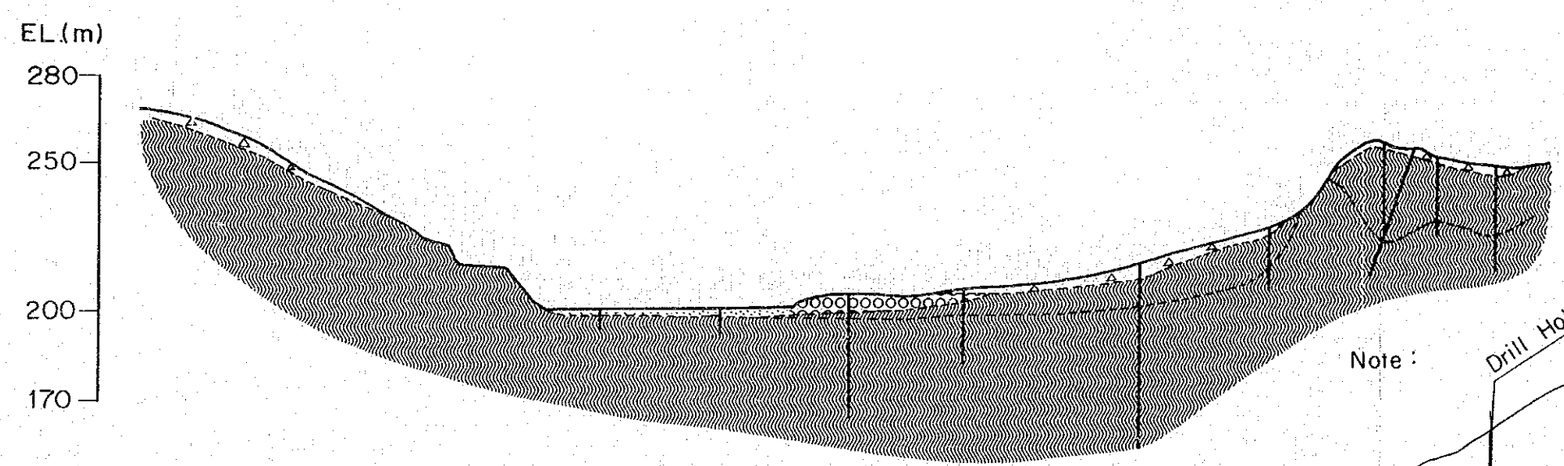
- Talus
- Sand and Gravel
- Terrace
- Quartzporphyry
- Granite
- Sandstone
- Limestone
- Gneiss
- Schist



PROFILE (Original site)



PLAN



PROFILE (Alternative site)

Note : Drill Hole

0 1000 m
PLAN

0 100 m
PROFILE

GEOLOGY
18-62. YONGDAM(竜潭)

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3-19 Sutong

(1) Outline of Project

Dam type	: Rockfill
Dam height	: 62 m
H.W.L.	: EL. 200 m
Power station	: Attached to the dam

(2) Topography and Geology of Reservoir Area

The topography in the reservoir area is a so-called mature topography with a rugged mountain terrain indicated as a whole. The gradient of the river is gentle (1/600 - 1/700) and meanderings are extreme. River channel is entirely covered by sand and gravel, and particularly, development of terraces is prominent at meandering parts. At the impingement slopes of meandering portions and at the straight line flows, cliffs of bare bedrock rise directly from the river, but at curved parts of rivers near conjunctions of gullies at the left and right banks with the mainstream, the development of river terrace and talus topography above them is prominent. Muju Village in the reservoir area is located on a large-scale talus topography.

The mountains of the reservoir area are stable as a whole, and the collapse areas scattered about have been provided with artificial protection at the initial stage of collapse. Considering that river gradients are gentle, the mountains are stable, and artificial protections are throughly provided, it is inconceivable that sedimentation after completion of the reservoir will be very great. Further, according to the basic investigation report on this site (Ministry of Land Development, February 1962, hereafter referred to as "1962 Report"), the sedimentation is estimated at 100 $m^3/km^2/year$.

Detailed geological investigations of the reservoir area were not made in the reconnaissance for the present Report. According to rough investigations and a 1/250,000 geological map published by the Geological and Mineral Institute of Korea, the principal rocks distributed in the reservoir area are Cretaceous porphyries, Precambrian gneiss, and partially, in the vicinity of upstream Muju, sedimentary

rocks. There will be no concern about leakage with respect to this reservoir.

(3) Topography and Geology of Damsite

Topography

The damsite is 1.0 to 1.5 km upstream of the village of Sutong Ri, and is located just upstream of a meander from where the river changes it course from southeast to west. This site is a narrowed portion where bedrock at the left and right banks is exposed, with the right bank sloped 30° to 40° (from horizontal), having small-scale gullies upstream and downstream from the proposed dam axis and covered by thin slope wash. At the left bank, a cliff of height approximately 60 m from the river having a slope of approximately 70° faces the river directly. This cliff changes at its top to a gentle slope of about 20° and comprises a ridge as a whole, at the upstream and downstream sides of which there are small-scale gullies covered by talus. The width of the riverbed is 120 m with the entire width the water course while sand-gravel bars and terrace topography are developed at the left bank downstream of the dam axis.

Geology

Left Abutment: The geology upstream and downstream of the dam axis, including abutment, consists of a reddish-pink rhyolite porphyry (1962 Report). The lithological character is fresh, dense and extremely hard. Other than the gently sloped part at the top of the abutment, the upstream and downstream gullies and the foot of the abutment being covered by a thin, small-scale slope wash (chiefly rock debris), bedrock is exposed over more or less the entire area.

Besides irregular cracks, development of joints is seen in the bedrock, and according to the 1962 Report, the orientations are 1) N30°E, 55°NW and N53°E, 60°SE for main joints, and 2) N40°W, 80°NE for subjoints.

Regarding weak zones such as faults, it was not possible to confirm them during the reconnaissance on this time. However, judging from the topography and the condition of development of gullies, it is

estimated that a weak zone exists from the end of the gently-sloped part of the top of the left abutment to the line along the gully downstream of the abutment.

Riverbed: The entire riverbed is covered by sand and gravel, and although exposure of base rock cannot be seen, according to the 1962 Report, the thickness of the river deposit is around 2 m, and there exist two trachyte dykes of width of several meters to 10 and several meters at the riverbed roughly parallel to the river.

River Abutment: Similarly to the left abutment, the geology of the abutment is comprised of good-quality rhyolite-porphyry. Base rock is exposed as a whole with only small-scale slope washe seen to be deposited at small gullies upstream and downstream of the dam axis. There are some irregular cracks and openings of joints seen at outcrops. The orientation of joints are the same as at the left abutment. Weak zones such as faults could not be distinctly recognized during the reconnaissance.

(4) Geology of Appurtenant Structure Site

The powerhouse site for this Project will be immediately downstream of the dam. From a topographical veiwpoint, there will be no problem whether the site is selected at the left or right bank. Consequently, the powerhouse site should be selected from the standpoints of topographical and approaches civil works.

(5) Material

A rockfill dam is planned for this site. Rockfill material will be expected from the river deposit around the damsite. Impervious core material shall be investigated at the weathered granite area of the downstream from the damsite.

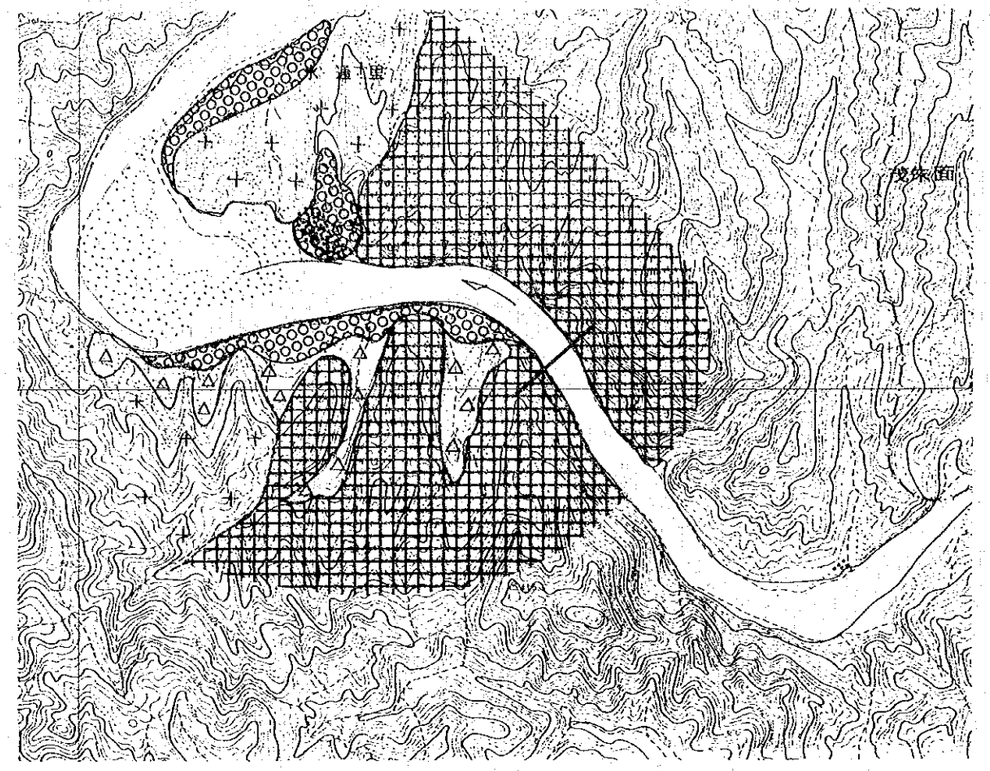
(6) Comments

A) The foundation rock at the damsite is sufficiently good as the foundation for the proposed dam.

B) It is considered that the depth of excavation for the dam foundation will be 1 to 2 m after removal of unstable rocks.

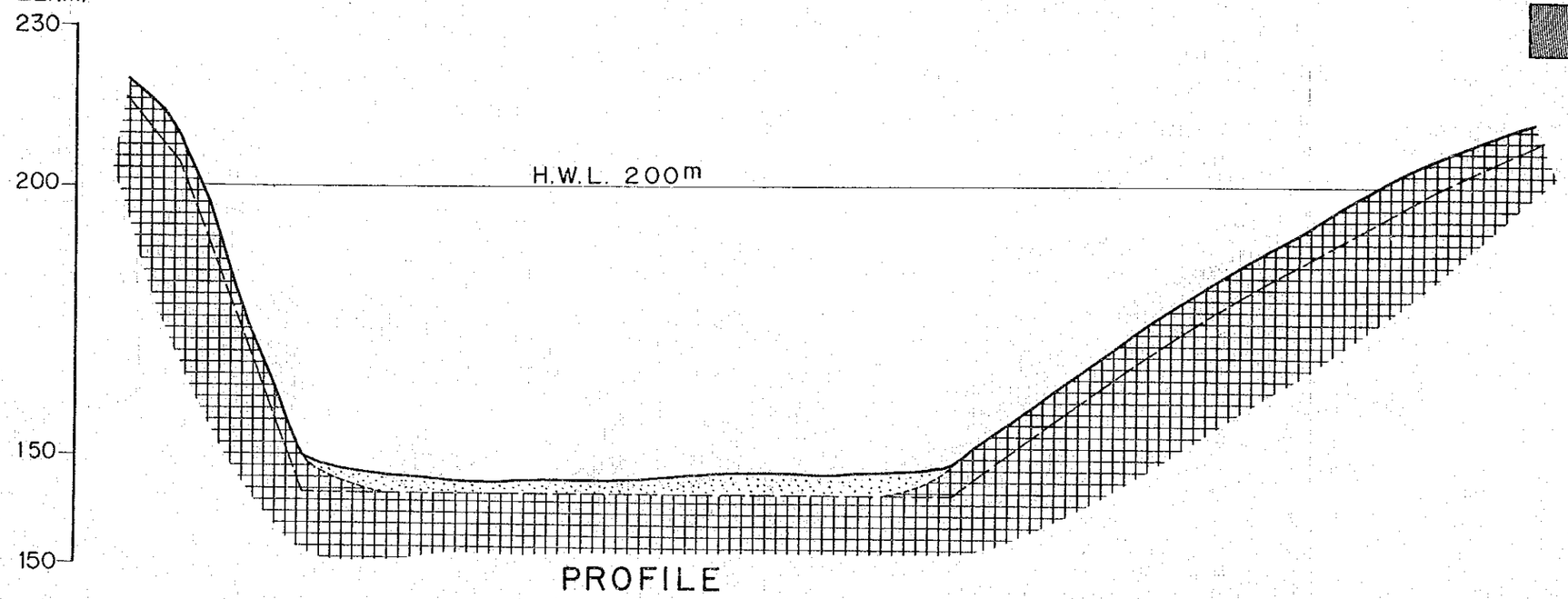
C) It will be necessary to further carry out permeability tests by drill holes and study the need for rim grouting at the ridge at the top of the left abutment. At the time of this reconnaissance, it will be necessary for investigations to be made also on the downstream-side gully.

D) Since permeability tests were not performed at the time of investigations for the 1962 Report, it will be necessary for several drill holes with permeability tests to be provided at the left and right abutments and the riverbed for data needed to prepare a foundation treatment plan. In such case the drill holes at the riverbed should be made inclined holes to confirm the contact between dyke and base rocks, and whether there are faults at the riverbed.



PLAN

EL.(m)



PROFILE

LEGEND

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

0 1.000m
PLAN

0 50m
PROFILE

GEOLOGY

19-63. SUTONG (水通)

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