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GEOLOGICAL SURVEY

GEOLOGY OF THE DEVIL CANYON DAM SITE, ALASKA

by

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This report is preliminary
and has not been edited or
reviewed for conformity with
Geological Survey standards

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INTRODUCTION

A geological examination of the proposed Devil Canyon dam site area, Alaska, was made during the summer of 1957 by the U.S. Geological Survey at the request of and in cooperation with the Bureau of Reclamation. This report, which describes the engineering geology of the site, is based on field work studies made during the periods of July 5 to July 27, August 14 to August 17, and August 26 to August 29, 1957. The report transmitted in 1958 to the Bureau of Reclamation was originally made for use of the Bureau in evaluating the proposed dam site and is now being released to the public as an open-file report because of the recent renewed interest in the Devil Canyon dam site by governmental agencies and private companies. This report is essentially the same as that transmitted in 1958 except that the Seismic Activity discussion was rewritten to include seismic data to the end of 1970.

Mapping by the Geological Survey party consisted of traverses during which geological information was gathered and plotted on a base map of 1:1,200 scale. Additional information was obtained from trenches dug by a bulldozer and from diamond drill holes.

Previous investigations

Previous geologic work in the area consists only of reconnaissance mapping by Capps (1940), who described the geology of the Alaska Railroad Region of which Devil Canyon dam site is a part.

Acknowledgments

Field work and logistic support were greatly facilitated by the cooperation of numerous Bureau of Reclamation employees. Of particular value was the cooperation of Les H. Abernathy, Drilling Supervisor, in charge of the Bureau of Reclamation operation at the dam site. The base map used in this report is a reduction of a 1:1,200-scale topographic map prepared by Bureau of Reclamation engineers.

Petrographic examinations of specimens were made by the Bureau of Reclamation Division of Engineering Laboratories in Denver, Colorado.

GEOGRAPHY

Location

The Devil Canyon dam site is on the Susitna River in the Talkeetna Mountains, approximately 125 mi north of Anchorage, Alaska, and about 175 mi south of Fairbanks, Alaska (fig. 1). The site lies entirely in the Talkeetna Mountains D-5 quadrangle and is bounded on the south by lat 62°48'40", on the north by lat 62°49'20", on the east by long 149°17'25", and on the west by long 149°19'20". The site is about 18 mi east of the Gold Creek station on The Alaska Railroad.

Accessibility

The dam site is not accessible by railroad or water. The nearest point on the railroad to the site is at Gold Creek station. Boat travel up the Susitna River is safe to within 3-1/2 to 4 mi of the dam site.

The Bureau of Reclamation has built a pioneer road into the area from Gold Creek station. In the summer of 1957 only four-wheel-drive vehicles, such as power-wagons and jeeps, could pass over the road.

Topography

The topography of the area is a relatively smooth upland containing numerous lakes and rounded hillocks 100 to 300 ft high and reflects modification of the original surface by a glacier that overrode the area during the late Pleistocene.

The principal streams in the map area are the Susitna River and its main tributary, Cheechako Creek. The Susitna River has cut a steep-walled canyon into the upland approximately 580 to 600 ft. At the proposed dam site (pl. 1) the canyon walls rise to an approximate altitude of 1,470 ft at Triangulation Station Roy on the south rim of the canyon wall and an altitude of about 1,500 ft on the north rim. Terraces have been cut by the Susitna River and Cheechako Creek in the eastern part of the mapped area.

In the southern part of the area, a southwest-trending depression, containing the two lakes, was developed by stream action during glaciation of the area. This depression will be referred to as the spillway area hereafter in this report.

Vegetation

Vegetation in the Devil Canyon dam site area includes spruce, birch, alder, and mountain ash trees. Carpeting the ground beneath the trees are blueberry, cranberry, huckleberry, laborador tea, fireweed, fern, sedge, grass, and moss. The largest trees are birch which are up to 14 in. in diameter. The spruce are up to 12 in. in diameter, and the mountain ash and alder trees are up to 4 in. in diameter.

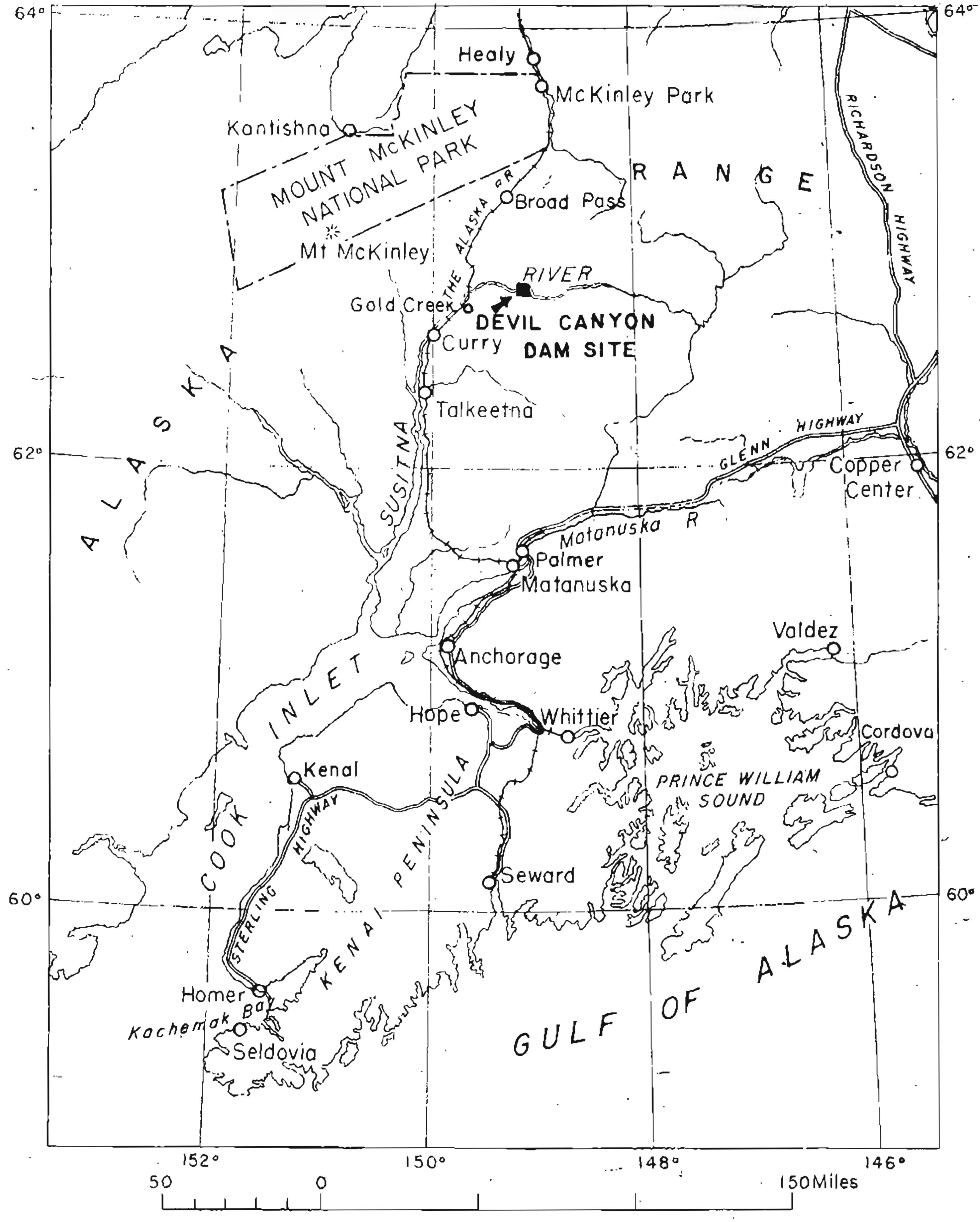

Figure 1. Index map showing location of Devil Canyon dam site, Alaska

Climate

Climatological data are not available for the Devil Canyon dam site area. Data are available, however, for the Talkeetna FAA airport, 45 mi southwest of Devil Canyon, and for the Summit FAA station, approximately 40 mi north of the proposed dam site (tables 1 and 2). Precipitation in the dam site area is comparable to or slightly higher than at the Talkeetna FAA airport. The temperatures, however, are more comparable to the Summit FAA station.

GEOLOGY

General

The general geology of the area is shown on plate 1. Bedrock consists of phyllite of probable Mesozoic age (Capps, 1940) in most part overlain by glacial and non-glacial deposits of Quaternary age. The glacial deposits consist of outwash (Qo) and moraines (Qmo). The non-glacial deposits underlie terraces formed by the Susitna River (Qtr) and Cheechako Creek (Qct); intermingled talus, frost-rived rubble and outwash (Qto); swamp deposits (Qs); and talus (Qta).

Bedrock

Lithology.--Phyllite (p) is exposed in the canyon walls of the Susitna River and in scattered outcrops throughout the area. It is hard, generally massive, medium- to dark-gray metamorphosed fine-grained sediment and contains numerous stringers and vugs of quartz. Locally the quartz stringers and vugs comprise as much as 50 percent of the rock. The Division of Engineering Laboratories of the Bureau of Reclamation has identified the bedrock as phyllite and determined that it is composed chiefly of fine-grained quartz and biotite with lesser amounts of amphibole and plagioclase. The fine-grained quartz occurs principally as angular microcrystalline grains and as thin crushed lenses. Two of the core specimens examined by the Bureau laboratories contained ".....angular silt-sized quartz, mica, and amphibole thinly laminated with quartz veins generally paralleling or cutting across at low angles to the foliation...." (Bureau of Reclamation Petrographic Memorandum No. 57-70, July 17, 1957). The Bureau laboratories also report calcite(?) in some of the specimens. Field examination of the rocks showed that incipient fractures, which are common in the phyllite, have been healed by calcite.

Although the phyllite is generally massive, it is locally thin-bedded. Beds 2 in. thick were noted in the vicinity of Triangulation Station Ann, on the left abutment, and beneath the foot bridge on the right abutment.

Table 1.--Climatological data for Talkeetna FAA airport[1/]

Month	Average temperature[2/] (F)	Average total precipitation[2/] (inches)
January	8.5	1.90
February	15.9	1.82
March	20.6	1.84
April	33.4	0.93
May	44.7	1.27
June	54.7	1.65
July	57.3	3.42
August	54.3	5.08
September	46.3	5.02
October	34.3	3.46
November	19.8	1.78
December	9.6	1.75
Annual average	33.3	29.92

1/ U.S. Weather Service, 1956 Climatological Data, Alaska Annual Summary, 1955, V. XLI, No. 13.

2/ Years of record: Precipitation 1928-1955
Temperature 1921-1955

Table 2.--Climatological data for Summit FAA station[1/]

Month	Average temperature[2/] (F)	Average total precipitation[2/] (inches)
January	2.6	1.01
February	7.5	1.33
March	11.2	1.32
April	23.3	0.54
May	37.1	0.98
June	48.9	2.13
July	52.4	3.38
August	48.7	3.37
September	40.4	3.35
October	25.1	1.89
November	9.6	1.43
December	3.2	1.52
Annual average	25.8	22.25

1/ U.S. Weather Bureau, 1956, Climatological Data, Alaskan Annual Summary, 1955, V. XLI, No. 13.

2/ Years of record: Precipitation 1941-1955
Temperature 1942-1955

Structure.—There are one well-developed and two poorly developed joint sets in the Devil Canyon dam site area. The strike of the well-developed or master joint set varies from N. 45° W. to N. 10° W. and averages N. 25° W. The dip of the joints ranges from vertical to 75° E. and averages 80° E. The average spacing of these joints is 4 to 5 ft. Locally, however, they are as close as 2 in. and far as 15 ft apart. The joints, with few exceptions, are tight. Many of these joints are filled with quartz containing finely disseminated pyrite.

The two poorly developed joint sets consist of a generally tight set striking parallel or subparallel to the bedding but generally dipping north instead of south, and an eastward-striking, nearly horizontal set. The first set has a spacing of 3 in. to 15 ft. It is locally well developed and its joints contain some quartz.

The second set has a spacing from 3 in. to 30 ft. With few exceptions, the joints in this set are tight. They dip from 15° N. to 15° S., but more commonly the dip is horizontal.

In the vicinity of Triangulation Station Shag, a well-developed joint set with a spacing of 3 to 15 ft occurs. The strike of the joints is N. 55° E., and the dip 80° N.

Well-developed shear zones, spaced from 50 to 800 ft apart, have been observed in the bedrock walls of Devil Canyon. The shear zones are not shown as concealed in areas of surficial deposits on plate 1 because it is assumed that the zones extend all the way across the mapped area.

Many of the larger shear zones contain gouge as much as 2 ft thick. The shear zones with gouge are much tighter than those without. Drill hole 10, an angle hole, placed about 90 ft south of the south rim of the canyon, intercepted one of these shear zones at a depth of 101 ft. The intercepted shear zone contains about 2 ft of gouge interbedded with highly fractured rocks 2 to 3 ft thick on each side. Two 5-minute water pressure tests, one at 50 $lb/in.^2$, and the other at 100 $lb/in.^2$, were made on the gouge and adjacent highly fractured rock. The tests indicated remarkably little water loss in the shear zone. In the 50-lb test only 0.8 gal of water were lost in 5 minutes; in the 100-lb test, 1.75 gal of water were lost in 5 minutes.

The shear zones appear to have developed parallel to or along the same trend as the master joint system, which is probably older than the shear zones. The strike of the shear zones is N. 25° W. and the dip is 80° E. This attitude is comparable to the average strike and dip of the master joint set discussed earlier in this report. The variation in the attitudes of the shear zones is of the same order of magnitude as the variation in attitudes of the master joint set.

Diamond drill holes 11, 11A, 11B, and 11C were placed on the left abutment, in the bottom of the canyon, to establish the profile of the Susitna River channel and the depth to bedrock beneath the river. The information obtained from these holes is not consistent. Table 3 summarizes the information which was obtained from logs furnished by the Bureau of Reclamation.

Table 3.--Logs of DH 11, DH 11A, DH 11B, and DH 11C

Hole	Coordinates	Ground Elevation	Angle from vertical	Bearing	Depth hole daylighted
DH 11	N10517.6 E9302.0	893.5'	48	N. 5° W.	30.5'
DH 11A	N10517.6 E9302.0	893.5'	45	N. 5° W.	29.1'
DH 11B	N10517.6 E9302.3	893.5'	39	N. 5° W.	33.9'
DH 11C	N10526.8 E9302.0	892.7'	33	N. 5° W.	52.0'

Drill hole 11C went back into bedrock at a depth of 53.1 ft.

If the above information is plotted on a cross section, DH 11C daylights or intercepts the river profile between DH 11 and DH 11A at an approximate depth of 23 ft instead of 52.0 ft as indicated on the logs. To resolve this discrepancy, an assumption is herein made that the north coordinate should be N 10516.8 instead of N 10526.8. If such is the case, the vertical depth of the Susitna River at a point where DH 11C intercepts the river is about 31 to 32 ft. This depth of 31 to 32 ft, however, is only a few feet offshore from the left bank of the river and probably does not indicate the maximum depth of the river or the depth to bedrock farther offshore.

Unconsolidated deposits

Moraines (Qmo).--Glacial moraine is the predominant surficial deposit in the Devil Canyon dam site area. It covers most of the area north of the Susitna River and much of the area south of the river. The moraine ranges in thickness from a few inches at Triangulation Station Roy to several feet in the vicinity of the Bureau of Reclamation campsite (house on pl. 1). The spillway area is covered by a thin veneer of morainal debris from 2 to 6 ft thick.

The moraine consists of angular to subangular unsorted pebbles, cobbles, and boulders in a matrix of sand and silt. In the spillway area, it has been slightly reworked and consists of subangular to subrounded gravel in a matrix of fine- to medium-grained sand. In the mapped area the moraine contains a low percentage of material greater than 4 in. in diameter; the largest boulder noted was 3 ft in diameter. South of the mapped area the moraine contains a high percentage of material greater than 4 in. in diameter and has boulders up to 8 ft in diameter.

The moraine was deposited by a glacier that extended over this area during Pleistocene time. Glacial striae observed in the vicinity of Triangulation Station Roy and an analysis of the topographic map and aerial photographs of the area indicate that the glacier moved westward across the Devil Canyon area.

Outwash (Qo).--Outwash crops out at the surface only in the westernmost part of the spillway area. Elsewhere in the spillway area the thin veneer of moraine is underlain by outwash as much as 86 ft thick (fig. 2). In the western part of the spillway area the outwash is approximately 35 ft thick.

Outwash consists of fine- to medium-grained sand containing subrounded to rounded pebbles, cobbles, and boulders up to 14 in. in diameter. A test pit 15 ft deep was dug between DH 4 and DH 5. The top 6 ft of the test pit contained sandy gravel and boulders up to 14 in. in diameter. The top 3 ft of this material is probably reworked moraine. From 6 ft to 10 ft the outwash consists of fine- to medium-grained sand containing scattered pebbles and cobbles. The bottom 5 ft of the pit contained silty to fine-grained very compact sand with an occasional subrounded to rounded pebble.

Two soil density tests were taken in the test pit, one at a depth of 7.9 ft to 8.4 ft, and the other from 10.7 ft to 11.2 ft. The in-place wet density of the material from 7.9 ft to 8.4 ft was 116.4 lb/ft^3; from 10.7 to 11.2 ft the density was 138.0 lb/ft^3.

Figure 2 shows that the original valley in which the outwash was deposited was V-shaped. This shape indicates that the valley was cut by water and not by ice, and that the outwash was deposited in front of an advancing glacier. After the deposition of the outwash, the advancing glacier overrode the debris and deposited the thin veneer of morainal material. The additional weight of the moraine and ice compacted the underlying outwash material.

Terrace deposits (Qtr and Qct).--Terrace deposits occur beneath terraces formed by the Susitna River (Qtr) and Cheechako Creek (Qct). Terraces cut by the Susitna River include the one upon which Triangulation Station Ho is located and the broad flat surface on the floor of Devil Canyon in the eastern part of the mapped area. The deposits that underlie these terraces consist of clean sand and subrounded to rounded gravel containing a few boulders up to 3 ft in diameter. The gravel is composed of granite, quartzite, diabase, dacite, and phyllite fragments with minor amounts of decomposed granite, schist, gneiss, and graywacke. It contains a few rare pebbles of quartz, chert, jasper, hornfels, muscovite schist, argillite, and pyroxenite. The chief constituents comprise about 85 percent of the gravel; the minor constituents about 13 percent of the gravel; and the rare pebbles less than 2 percent of the gravel.

The thickness of gravel deposits between the river level and the terrace on the canyon floor is approximately 65 ft; the thickness of gravel below the river level is unknown. Approximately 210 ft of gravel occurs above the river level underlying the terrace remnant upon which Triangulation Station Ho is located.

The gravel beneath the broad flat terrace on the floor of Devil Canyon is overlain by 3 to 5 ft of clean, washed coarse-grained sand. In places, seasonal frost forms in this coarse-grained sand.

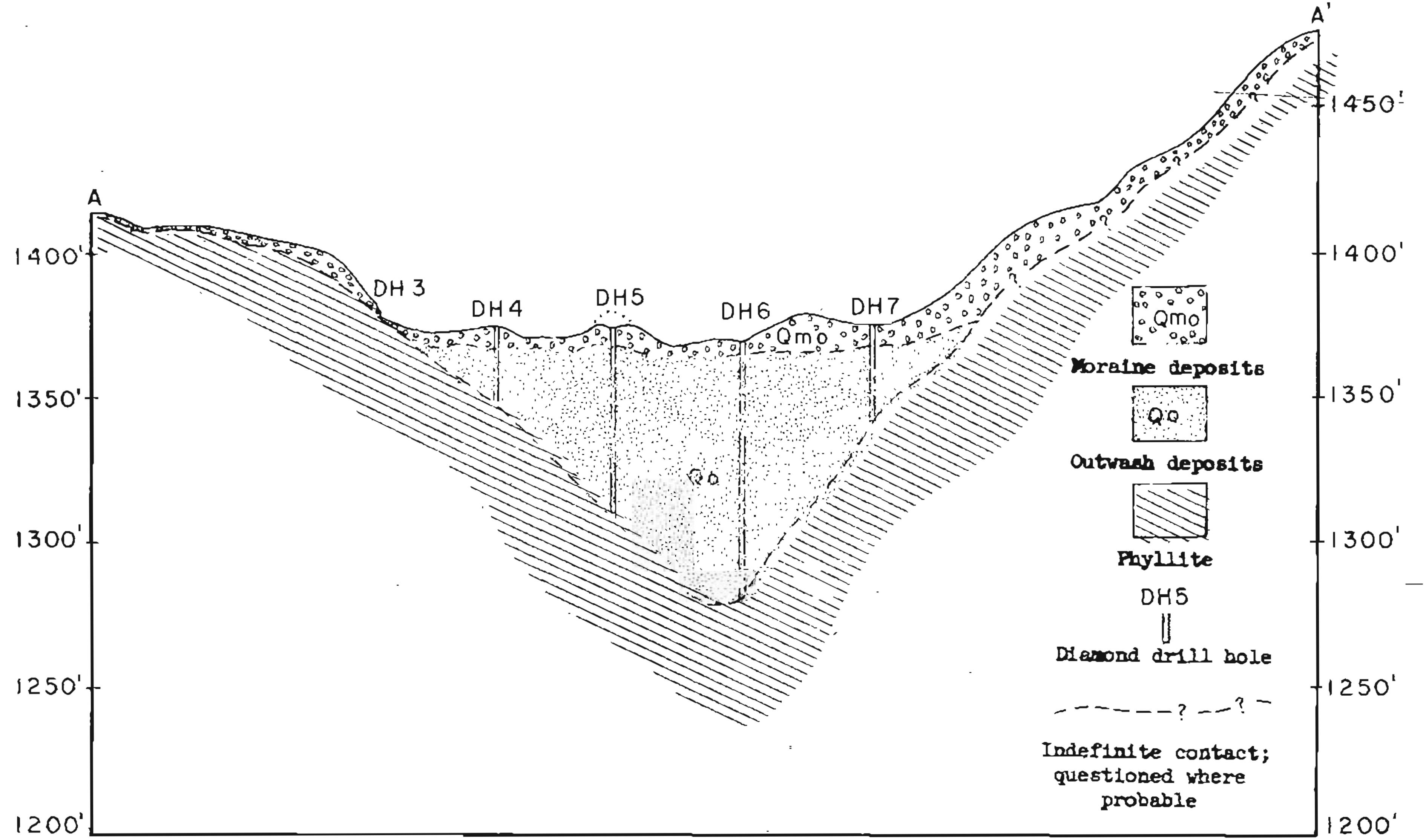

Figure 2. Profile through Section A-A'

Scale: Horizontal 1 inch = 100 feet
Vertical 1 inch = 50 feet

Two well-defined terraces (Qct) were formed by Cheechako Creek. Both of the terrace deposits beneath them are mapped as one unit on plate 1 because they contain the same type of gravel. The highest and oldest terrace is 260 ft wide and is approximately 22 ft below the Susitna River terrace (Qtr) on the floor of Devil Canyon. The second and youngest terrace is 27 ft below the first terrace and only 140 ft wide. Cheechako Creek is incised about 15 ft below this lower terrace.

The chief constituent of the gravel in both of the Cheechako Creek terrace deposits is granite with minor amounts of diabase, dacite, quartzite, phyllite, and pyroxenite. The proportions of the various constituents of the gravel were not determined. The gravel that comprises the Cheechako Creek terrace deposits is coarser than the gravel of the Susitna River terrace deposits. Granite boulders as much as 10 ft in diameter mantle the creek terrace surfaces.

The gravel beneath the terraces is reworked outwash material dumped by the Susitna River, and local debris (chiefly granite) brought down from the upland area south of the mapped area by Cheechako Creek. Field evidence indicates that the Susitna River occupied its present channel prior to the last glaciation that extended over the Devil Canyon area. When the ice retreated it filled Devil Canyon with glacial debris to an altitude of at least 1,150 ft. It is unlikely that glacial debris filled the canyon much above this altitude. This left the upper 250 to 300 ft of Devil Canyon exposed. Therefore, upon the retreat of the glacier, the Susitna River reoccupied its old channel through the Talkeetna Mountains. The river rapidly cut through the soft fill and in so doing formed the terrace upon which Triangulation Station Ho is located, and the terrace on the floor of the canyon in the eastern part of the mapped area. Cheechako Creek did not start cutting its terraces until the Susitna River had established itself in its present course around the canyon floor terrace. Once the master stream, the Susitna River, had established itself in its present course and continued to degrade, the Cheechako Creek terraces started to form.

Talus, frost-rived rubble, and outwash (Qto).--Intermingled talus, frost-rived rubble, and outwash occur in the southwestern part of the spillway area. This material consists chiefly of unsorted angular to subangular blocks as much as 2.5 ft in diameter intermingled with subrounded to rounded cobbles and boulders as much as 1.5 ft in diameter. Test holes were not placed in this material, and its thickness is unknown. It is unlikely, however, that the maximum thickness of this material is much greater than 10 ft.

Underlying the intermingled deposits is outwash which is at least 35 ft thick. Locally, it may be as much as 50 ft thick.

Swamp deposits (Qs).--Swamp deposits are in areas of impeded drainage in the southern part of the mapped area. They consist of shrubs, hedges, and grasses intermingled with fine sand and silt. The deposits in the spillway area are generally less than 3 ft thick and are underlain by moraine and outwash.

Talus (Qta).--Talus deposits are found chiefly on the canyon walls of the Susitna River. A large deposit occurs on the canyon wall above Cheechako Creek in the southeastern part of the mapped area.

Talus consists of angular, unsorted blocks up to 15 ft in diameter and the blocks are generally in unstable equilibrium. The larger talus deposits in the Susitna River Canyon are as much as 40 ft thick at their base. Most of the deposits are estimated to be about 20 ft thick.

CONCLUSIONS AND RECOMMENDATIONS

Dam site

Foundation.--Although physical tests have not yet been conducted on the phyllite, it is believed that the site is well suited for a masonry dam. The profile of the canyon and soundness of the foundation are such that an arch dam could be considered. The attitudes of the major joint set and shear zones insure that these zones of weakness will have a minimum effect upon the soundness of the foundation. Stripping will generally involve removal of less than 5 ft of material. Locally, the rock is weathered and crumbles easily, and stripping of 10 ft or more of material may be necessary. In addition, there are slump blocks as large as 100 ft long and 30 ft wide near and on the canyon rims, especially along the south rim. Triangulation Stations Ham, Walt, Roy, and Go on the south rim are located on such slump blocks. These blocks will present a hazard to workmen and structures below them if they are not removed.

Construction materials.--Approximately 2,500,000 yards of concrete aggregate may be obtained from the terraces (Qtr) formed by the Susitna River. An additional 300,000 yards may be obtained from the terraces (Qct) formed by Cheechako Creek, but gravel from Cheechako Creek will require crushing. Chemical and physical tests should be conducted to establish the amount and nature of deleterious constituents in the aggregate. The Susitna River terrace gravels contain dacite and chert and laboratory analysis of the aggregate should be conducted, especially of the normally deleterious dacite and chert.

Tunnel site

The Bureau of Reclamation engineers have indicated a possible tunnel site which is shown on plate 1. The intake portal will be approximately 500 to 600 ft upstream of the foot bridge; the outlet will be about 250 ft downstream of Triangulation Station Rich. The tunnel will fall from 25 to 30 ft in an approximate length of 2,200 ft.

The axis or center-line of the tunnel will intercept the strike of the bedding at approximately 35 to 40 degrees and will be about normal to the strike of the well-developed master joints and the shear zones. Because the axis of the tunnel is normal to the major zones of weakness, problems that may arise from them will be at a minimum.

The character of the rock indicates that a tunnel up to 25 ft in diameter may be driven through the phyllite generally without any support. Support may be necessary when passing through shear zones. It is believed, however, that this support will be at a minimum. Sloughing of rocks along the bedding planes should be expected. Although the phyllite is hard, it is brittle and breaks easily, especially along bedding planes. Therefore, overbreakage can and probably will occur during blasting of the tunnel face.

Powerhouse site

The steepness of the canyon walls and the narrowness of the Susitna River in the dam site area present problems in locating the powerhouse. A completely underground powerhouse, a partially underground powerhouse, and an angled powerhouse are herein considered.

An assumption is made that a completely underground power plant will require a chamber as large as 160 ft long, 40 to 50 ft wide, and from 30 to 35 ft high with an unsupported roof. With the information now available, it is not possible to determine the stability of an unsupported roof of such large dimensions. However, there is no information that would preclude the possibility of such a large chamber. Although it will require a difficult and dangerous drilling program, it is suggested that further geologic information be obtained from an adit placed in the powerhouse site area.

In a partially underground powerhouse the same problems may be encountered as in a completely underground chamber. Here again, more geologic information is required. In addition, some measures should be taken to prevent spalling rocks and debris from falling upon the power plant from the high steep cliffs above the plant.

There is sufficient room to place an angled powerhouse downstream from the dam. If this is done, however, the possibility of rocks and debris falling from above the plant should be considered.

Spillway site

The depression containing two lakes in the southern part of the mapped area may be used as the spillway for the dam. The foundation of the site consists of outwash and moraine that have been deposited in a pre-existing V-shaped valley. The maximum thickness of these deposits is at least 86 ft. Although the outwash has been compacted by overriding ice, it is doubtful that this compaction is sufficient to prevent a large water loss from percolation through the outwash. In addition, it is doubtful that the outwash and morainal deposits are sound enough to maintain structures such as a small dam. If maximum utilization of the Devil Canyon dam site area is considered, a dam is necessary in the spillway area. If such is the case, the glacial debris will have to be removed before construction of the spillway dam.

Along Section A-A', the maximum depth to sound rock is about 92 ft at an approximate altitude of 1,280 ft. Drill hole 15, located on Triangulation Station John, shows that bedrock is 52.7 ft below the surface at an approximate altitude of 1,276.4 ft.

The water table lies at a depth ranging from 11.5 ft in drill hole 7 to 17 ft in drill hole 6. The surface of the water table ranges from an approximate altitude of 1,353.0 ft to an approximate altitude of 1,365.0 ft.

Reservoir site

Time did not permit an examination of the reservoir site. However, if the nature of the bedrock upstream is similar to that of the dam site, water loss through ground-water leakage will be small.

Cofferdam sites

Foundation.--The foundation for the downstream cofferdam is sound and suitable, and no problems should arise at this site. Not so, however, the upstream cofferdam site, which the author understands will be placed in the immediate vicinity of the foot bridge. If such is the case, the right abutment will be in sound phyllite and the left abutment in terrace gravels. These gravels are porous and permeable, and leakage through them should be expected. Tests should be conducted to determine the amount of water loss and also to determine whether the terrace gravels are sound enough to anchor the left abutment. There is a good possibility that they are not, and special measures will have to be taken to strengthen the abutment or the dam will have to be moved downstream to where phyllite crops out on the left abutment.

Construction material.--The best known local source of construction material for the cofferdam is from a large knoll about half a mile south of the mapped area. This knoll trends westward and is about half a mile long, and is overlain by moraine deposits that have been slightly reworked in places. Although sieve analyses were not made on this material, it is doubtful that the deposits contain a sufficient percentage of minus no. 100 fraction for use in the core of the cofferdam. A cursory examination of the morainal till throughout the Devil Canyon region indicates that it contains a low percentage of minus no. 100 material. It is suggested that this factor be considered in the evaluation and design of the cofferdam.

Seismic activity

The proposed Devil Canyon dam site lies in a zone of major seismic activity. To the end of 1970, 262 earthquake epicenters have been located within a radius of 150 mi of the dam site (Tarr and Martin, 1912; Gutenberg and Richter, 1954; U.S. Coast and Geodetic Survey, 1947 through 1970; National Oceanic and Atmospheric Admin., 1971 and 1972). Of these 262 earthquakes, 229 had a magnitude less than 5.3, 11 had a magnitude from 5.3 to 5.9, 10 from 6.0 to 6.9, 11 from 7.0 to 7.75, and 2 had a magnitude greater than 7.75. Of the two earthquakes with magnitudes greater than 7.75, one occurred in 1928 about 100 mi south of the dam site and the other was the Alaskan earthquake of 1964, whose epicenter was located approximately 130 mi southeast of the proposed Devil Canyon dam site. There were 42 earthquakes whose epicenters were within a radius of 50 mi of the dam site; 39 of the earthquakes had a magnitude less than 5.3, 2 from 5.3 to 5.9, and the remaining earthquakes had a magnitude from 6.0 to 6.9. Eleven earthquake epicenters have been located within a radius of 25 mi of the dam site. Nine of the earthquakes had magnitudes less than 5.3, one with a magnitude between 5.3 and 5.9, and on July 3, 1929 an earthquake with a magnitude of 6.25 occurred near the Talkeetna River approximately 25 mi southeast of the mapped area.

It is highly probable that an earthquake with the same order of magnitude as those described above will occur sufficiently close to the Devil Canyon dam site to affect a dam and other structures in the area. Therefore, an earthquake factor should be considered in the design of the dam and the various structures associated with the dam.

Townsite

The same knoll that was discussed as a source of construction material for the cofferdam will offer an excellent site for a town or construction camp. The knoll is well drained, insuring good drainage of rainwater and sewage. The knoll is sheltered from the south by high hills that rise to an altitude of 3,000 ft. The source of water for the town is discussed below.

Water supply

Cheechako Creek offers an ample supply of water for the town or construction camp and for making concrete. The creek is approximately 2,500 ft east of the proposed camp site. If water is obtained from the creek at its nearest point from the camp site, it will have to be pumped from an altitude of 1,400 ft to an altitude of 1,800 ft. However, water can be obtained from Cheechako Creek at an altitude of 1,800 ft, at a point about 1.1 to 1.3 mi from the townsite.

Water for use in making concrete can be obtained near the mouth of Cheechako Creek. Here the water is adjacent to the source of concrete aggregate. Additional water can be obtained from a creek that flows into the Susitna River approximately 1,200 ft upstream from the foot bridge.

Access roads

The geology of two access roads from Gold Creek station on The Alaska Railroad to the dam site is considered in this report. The first route discussed is the pioneer road constructed by the Bureau of Reclamation in 1957. The second route is along the south bank of the Susitna River.

From an engineering geology standpoint, the most feasible route is one parallel to the present pioneer road. This road originates at Gold Creek Station and lies on terrace deposits for about 2 mi. The terrace was formed by the Susitna River and Gold Creek and overlies deposits of subrounded to rounded gravel containing a high percentage of medium- to coarse-grained sand. The remainder of the road to the dam site, approximately 16 mi, generally follows a glacially scoured bench about 500 ft above the Susitna River. The unconsolidated material that underlies this bench consists of morainal debris similar in character to the morainal debris of the Devil Canyon dam site area, alluvial fan deposits, and local esker deposits of gravel. Locally, the road lies on bedrock. Most of the alluvial fans are concentrated in an area between 1 and 3 mi east of Jacklong Creek, which is approximately 10 mi east of Gold Creek station. Boulders as much as 8 ft in diameter were noted in the alluvial fans. The esker deposits are between the terrace deposits east of Gold Creek and Jacklong Creek. The eskers will provide an excellent source of construction material for the road but they contain only a small quantity of borrow material. The largest source of borrow material will be morainal deposits that mantle the bench. They will generally provide a good quality of borrow material but locally contain a high concentration of fines.

The route that follows the south bank of the Susitna River will be on terrace deposits for the first 5 or 6 mi from Gold Creek station with the exception of one half-mile stretch from 2-1/2 to 3 mi east of the station. Here the road will be on bedrock. The road will have to leave the river and climb up to the bench above the river about 6 mi from Gold Creek station. An examination of vertical aerial photographs indicates that the slope from the river onto the bench is sufficiently steep that the climb onto the bench will be very difficult. If the climb onto the bench is accomplished, the road will then have to follow the south rim of the canyon, bridge several deep gorges, and bypass numerous swamp and muskeg areas.

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