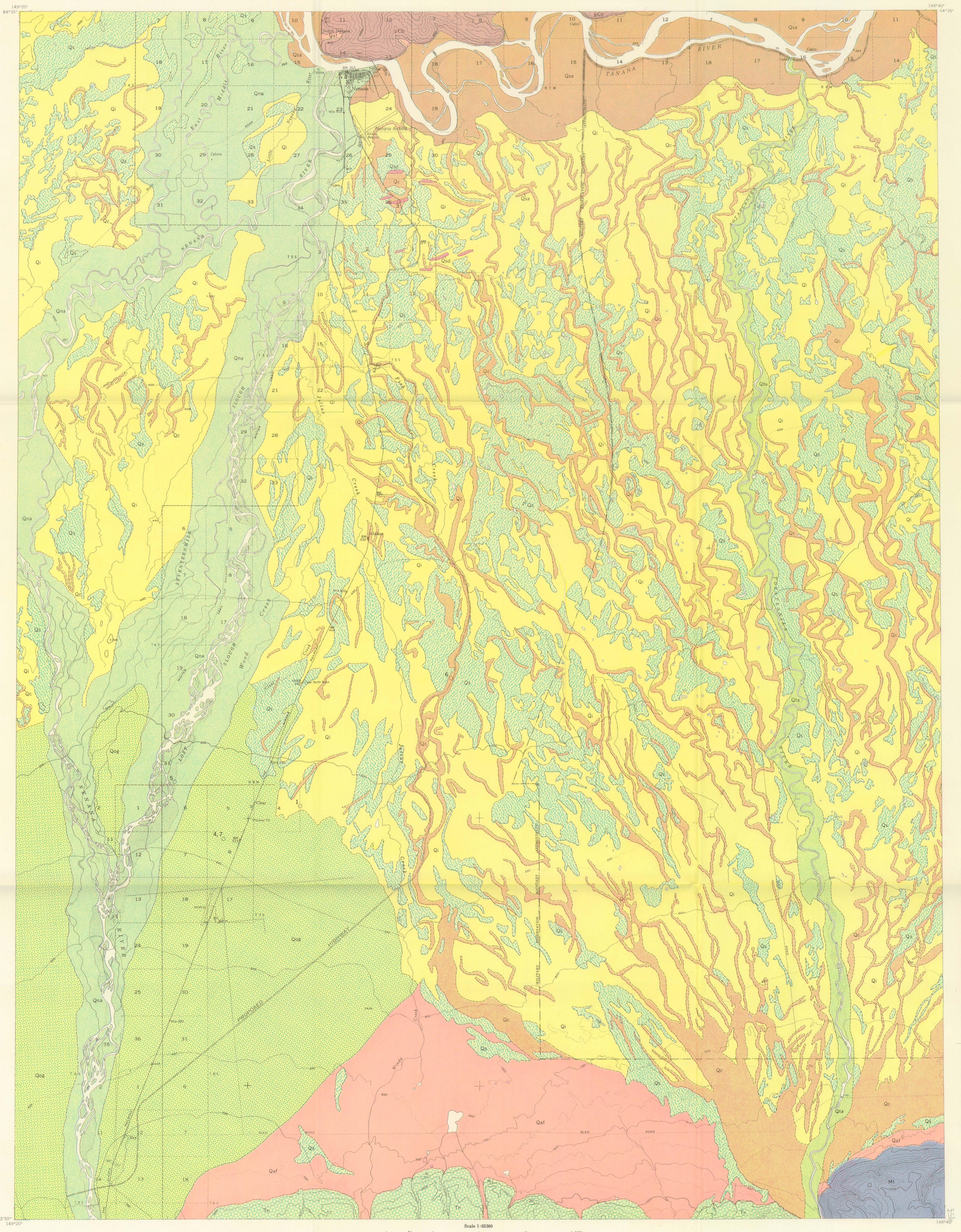
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-307



Base from U. S. Geological Survey topographic quadrangle maps

APPROXIMATE MEAN DECLINATION, 1959 (TRUE NORTH, MAGNETIC NORTH, 28°)

Scale 1:63360

1 ½ 0 1 2 3 Miles

Contour interval 50 feet
Datum is mean sea level

Geology mapped in 1954 by Reuben Kachadoorian assisted by Lloyd Plafker

EXPLANATION

UNCONSOLIDATED DEPOSITS

QUATERNARY

Recent

- Qna — Alluvium of the Nenana River
- Qsa — Alluvium of the Tanana River
- Qta — Alluvium of the Totatlanika River
- Qaf — Alluvial-fan deposits
- Qs — Swamp deposits

Pleistocene

- Qc — Channel sand
- Qi — Interchannel silt
- Qog — Outwash gravel
- Qsd — Sand-dune deposits

BEDROCK

- Tn — Nenana gravel (TERTIARY)
- Mt — Totatlanika schist (MISSISSIPPIAN(?))
- p€b — Birch Creek schist (PRECAMBRIAN)

Contact
Includes gradational contacts, inferred contacts, and indefinite boundaries of surficial deposits

Strike and dip of beds

Location of sample shown in figure 2

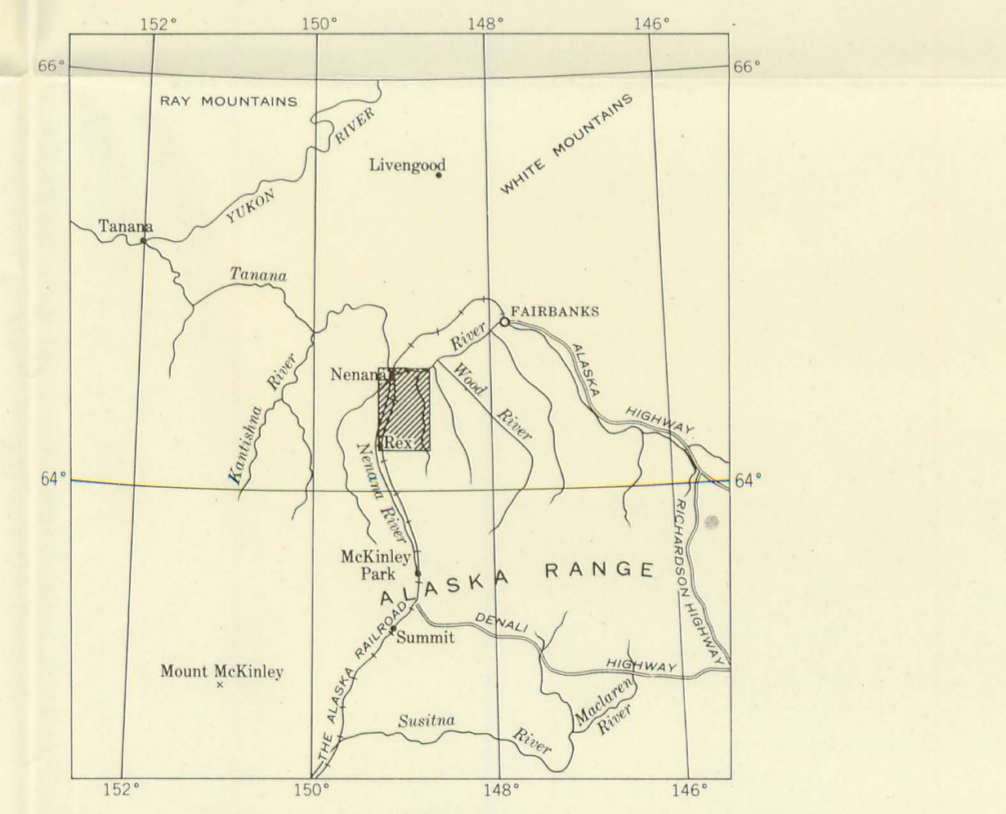


FIGURE 1. INDEX MAP SHOWING LOCATION OF NENANA-REX AREA, ALASKA

25 0 25 50 75 100 Miles

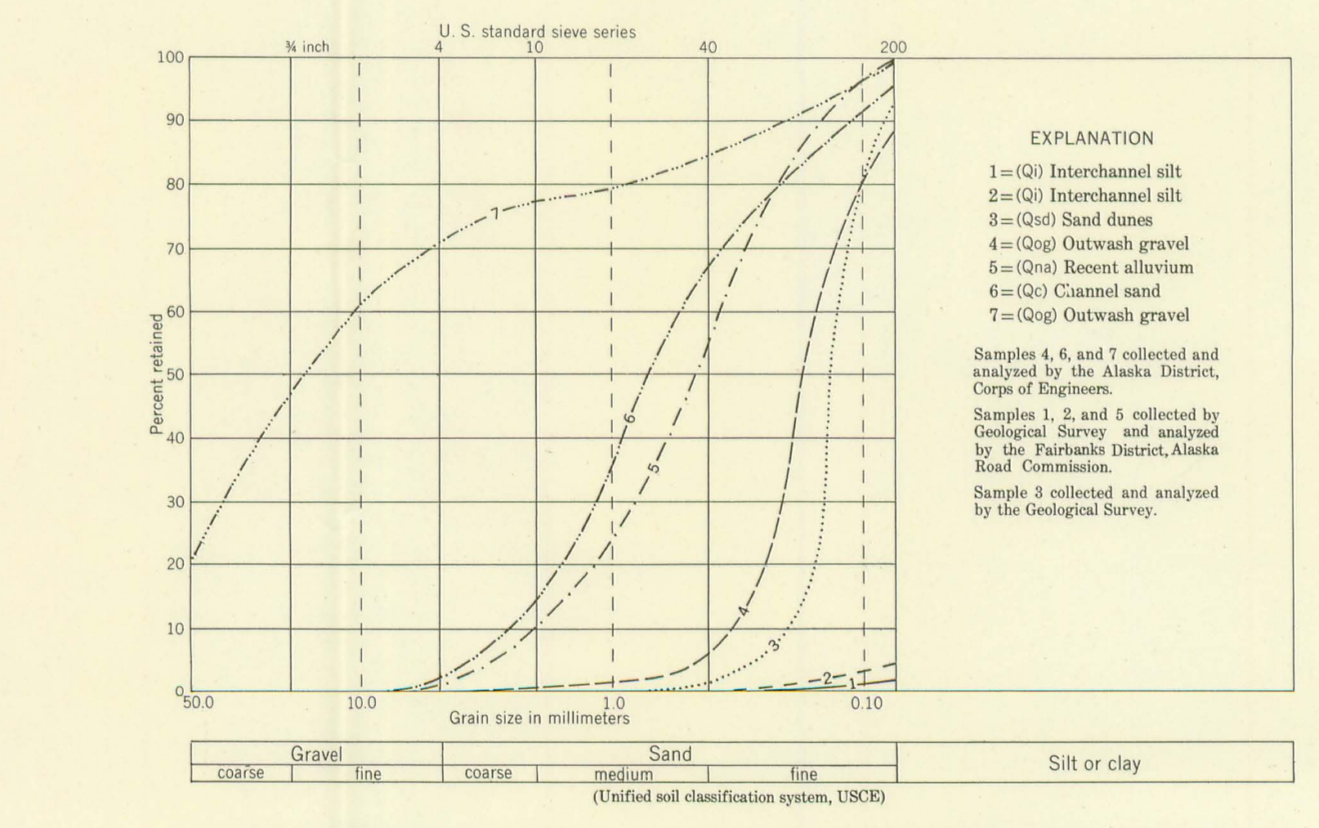


FIGURE 2. CUMULATIVE SIZE-FREQUENCY CURVES OF SEDIMENTS IN THE NENANA-REX AREA, ALASKA

DESCRIPTION OF GEOLOGIC UNITS

MAP UNIT	GENERAL DESCRIPTION	DISTRIBUTION	TERRAIN AND NATURAL SLOPE	DRAINAGE AND PERMEABILITY	FROST ACTION AND PERMAFROST	ECONOMIC CONSIDERATIONS
Recent alluvium (Qna, Qsa, Qta)	Alluvium of the Nenana and Totatlanika Rivers consists of interfingering lenses of gravel, sand, and silt. Varies from boulders near mountains to fine gravel, sand, and silt at the confluence with Tanana River. Alluvium of the Tanana River consists of sand and silt.	Underlies floodplains of Tanana River, Nenana River, and Totatlanika River.	Terrain: Flat surfaces, crossed by numerous recently abandoned channels, winding sloughs and minor streams and channels occupied only during floods. Slope: Gentle dips to the north.	Drainage: Generally good, locally poor, subject to occasional flooding. Permeability: High, locally low to moderate.	Frost action: Generally none in gravel areas; mild in sand and silt areas. Permafrost: May be present locally, on slip-off side of meanders and silty areas in Tanana River flood plain.	Generally satisfactory for road location. Local flooding should be anticipated. Good source of fill material if selective borrowing conducted. Good source of ground water; quality variable, however.
Alluvial-fan deposits (Qaf)	Interfingering lenses of cobbles, coarse and fine gravels, and minor amount of silt and sand. Surface commonly mantled with flood-plain and windblown sand and silt.	Base of foothills in the southern part of area.	Terrain: The relief of the surface of individual fans is 2 to 3 feet above stream channels; however, where fans adjoin one another, relief of 6 to 8 feet is common. Slope: Gentle dips at toe of fan to 10°-15° at head of fan.	Drainage: Generally good; locally poor in swampy areas. Permeability: Generally high, locally moderate.	Frost action: None. Permafrost: None observed; may occur at depths greater than 15 feet below the surface.	Generally good foundations for highways. Occasional radical changes of channels during or following floods may occur. Good source for fill material in select areas. Depth of pits will be controlled by depth to the water table. Poor to fair source of ground water.
Swamp deposits (Qs)	In areas of impeded drainage in which soils are saturated throughout the year, swamp deposits consist of peat and silt more than 2 feet thick. Maximum thickness unknown. May be 15 feet thick.	Throughout area, especially abundant north of Clear.	Terrain: Marshy areas in lowlands. Slope: Generally flat.	Drainage: Poor. Permeability: Low.	Frost action: Moderate to intense. Permafrost: At depths of 2 to 3 feet below surface. Lenses and stringers of clear ice as much as 2 inches thick are common.	Unfavorable as road foundation. Poor source for fill material.
Interchannel silt (Qi)	Consists of approximately 95 percent silt and 5 percent sand. Deposit mantled by windblown sand and silt. Interchannel silt areas are flood plains of relict stream channels.	Predominant unit in area; abundant throughout area except in southwestern part.	Terrain: Low-lying surfaces interrupted by swamps and abandoned stream channels. Slope: Flat to gentle.	Drainage: Poor. Permeability: Low.	Frost action: Intense. Permafrost: Throughout interchannel areas at 3 to 4 feet below the surface. Locally immediately underlies the vegetation cover.	Unfavorable for road foundations. Poor source for fill material.
Channel sand (Qc)	Consists chiefly of washed, medium- to fine-grained sand, with minor amounts of subrounded to rounded gravel. Fine windblown sand and silt 6 to 18 inches thick, locally mantles deposit.	Throughout the area with exception of southwestern part.	Terrain: Narrow, meandering discontinuous abandoned stream channels. Slope: Flat to gentle.	Drainage: Surface good; subsurface generally fair, but locally poor. Permeability: High.	Frost action: None to mild; may be anticipated where water table lies within 2 feet of surface. Permafrost: Not observed in test pits 6 feet deep. May exist at depths greater than 10 feet below the surface.	Excellent for road foundation. Local problem may arise where water table is close to surface. Good source for fill material. Locally may contain insufficient fine-grained material.
Sand-dune deposits (Qsd)	Consists chiefly of fine-grained sand with minor amounts of medium-grained sand and silt.	Restricted to a 2-square mile area 2 miles east of the Nenana River and 3 miles south of the town of Nenana.	Terrain: Elongate hills, 600 to 1,200 feet long, 100-200 feet wide, and as much as 50 feet high. Slope: Moderate.	Drainage: Good. Permeability: High.	Frost action: None. Permafrost: None observed; may exist locally at depths of 8 to 10 feet.	Good foundation for highway. Good source for fine-grained fill material.
Outwash gravel (Qog)	Interbedded sand and sandy gravel. Gravel angular to well rounded and averages 1 inch in diameter. Locally contains cobbles as much as 6 inches in diameter. Top 2 to 3 feet of unit has been enriched with windblown sand and silt.	Southwestern part of area.	Terrain: Broad, fan-shaped plain with little relief. Slope: Gentle dips to the north.	Drainage: Good. Permeability: Moderate to high.	Frost action: None. Permafrost: Sporadic, locally at 20 feet below surface.	Excellent source for road foundation. Good source for fill material and ballast. Locally lack of fines may make material poor as fill. Best source of ground water in Nenana-Rex area.
Nenana gravel (Tn)	Mostly interbedded medium- to fine-grained sandstone, shale, siltstone, claystone, and conglomerate with some thin lenses of coarse-grained sandstone and local lignite beds. Surface mantled by as much as 5 feet of windblown sand and silt.	Foothills in southern part of the area.	Terrain: Smooth rounded hills. Locally forms cuestas. Slope: Gentle to moderate.	Drainage: Good. Permeability: Moderate.	Frost action: None. Permafrost: None observed.	Generally good road foundation. Good source of fill material. Poor source of gravel, however, because of the abundance of fines and decomposed pebbles.
Totatlanika schist (Mt)	Quartz-feldspar schist and gneiss. Characteristic schist contains porphyroblasts of quartz and white feldspar in a groundmass of fine-grained mica and quartz. Surface mantled by 4 to 5 feet of windblown sand and silt.	Extreme southeastern part of the area.	Terrain: Irregular rounded hills. Slope: Generally moderate.	Drainage: Good. Permeability: Moderate.	Frost action: None observed; however, may be mild. Permafrost: None observed but may occur locally.	Generally good road foundation. Poor source for fill material.
Birch Creek schist (p€b)	Consists chiefly of quartz, mica, calcareous schists, and minor amounts of greenstone. Commonest phase is quartz-sericite schist. Surface mantled by as much as 5 feet of windblown sand and silt.	In Yukon-Tanana Uplands north of the Tanana River.	Terrain: Irregular rounded hills. Slope: Moderate.	Drainage: Good. Permeability: Low to moderate.	Frost action: None observed. Roads surfaced by Birch Creek schist will be subject to frost action because the schists will break down into clay and silt due to mechanical disintegration. Permafrost: None observed.	Generally good road foundation.

INTRODUCTION

A geologic examination of the Nenana-Rex area, Alaska, was made during August 1954 by the Geological Survey as part of its engineering geology program in Alaska. The area examined lies in parts of the Fairbanks A-4, A-5, B-4, B-5, C-4, and C-5 quadrangles. A preliminary highway route and The Alaska Railroad cross the area mapped. As a result of the 1954 field studies, the preliminary highway route shown on Pl. 1, which is a segment of a proposed road from Fairbanks to McKinley Park, was selected and surveyed by the *Alaska Road Commission* (now Bureau of Public Roads). An earlier report was written as a result of studies along the highway and railroad routes, and describes only those areas that are of immediate importance in planning and construction of the highway (Kachadoorian, 1956). It placed special emphasis upon geologic factors that would affect construction and maintenance of the new highway. The present report includes all the data contained in the 1956 report, as well as additional information dealing with the general geology of the area.

Field mapping by the Geological Survey consisted of a series of foot and tracked-vehicle traverses during which geologic information was gathered and plotted on vertical aerial photographs of 1:10,000 and 1:40,000 scales. The information was transferred later to a topographic map of 1:40,000 scale. Areas not visited on the ground were mapped by photointerpretation and reconnaissance from a light airplane. Areas west of Lost Slough and the Nenana River, and east of Totatlanika River were mapped by photointerpretation and aerial reconnaissance.

The field work was greatly facilitated by the cooperation of the Alaska Road Commission and The Alaska Railroad. Mechanical analyses of samples collected by the Survey were prepared by the Fairbanks District of the Alaska Road Commission and the Fairbanks laboratory of the Geological Survey. The Alaska District of the Corps of Engineers supplied subsurface information and mechanical analyses of material from the Clear area. The Anchorage Office of the Civil Aeronautics Administration furnished subsurface information in the Nenana area. Mr. I. P. Taylor of Seattle, Wash., supplied information concerning a major channel change of the Nenana River in 1917.

The Nenana-Rex area lies in the Tanana Lowland and is bounded on the north by the Yukon-Tanana Upland, on the south by the foothills of the Alaska Range, on the east by longitude 148°40′ W., and on the west by longitude 149°20′ W. The Tanana Lowland in this locality is approximately 26 miles wide, and slopes to the north 9 to 50 feet per mile.

The area is drained by several small creeks, one large creek, two large rivers, and one small river. The small creeks, Clear, Fish, Julius, and Windy, flow into the northward-flowing Nenana River, which in turn joins the westward-flowing Tanana River. Totatlanika River flows northward into the Tanana River. The confluence of the Nenana and Tanana Rivers is at the town of Nenana in the north-central part of the mapped area.

The climatological data of the Nenana CAA Station are summarized in table 1 (U. S. Weather Bureau, 1956). The station is approximately 2 miles south of Nenana, and its records are typical of conditions in the Nenana-Rex area.

Table 1.—Climatological data for Nenana CAA Station

Month	Average temperature (°F)[1]	Total precipitation (inches)[2]
January	-8.0	0.75
February	-1.3	0.44
March	8.9	0.45
April	27.7	0.27
May	46.4	0.63
June	58.0	1.25
July	60.5	1.80
August	55.6	2.44
September	44.2	1.26
October	27.4	0.67
November	6.4	0.50
December	-6.1	0.44
Annual average	26.6	10.90 inches

[1] Based on a 27-year record.
[2] Based on an 18-year record.

Vegetation in the Nenana-Rex area consists of sedges, grasses, mosses, lichens, shrubs, and trees. The shrubs are primarily Labrador tea, cranberry, blueberry, and dwarf birch. The trees consist of alder, willow, aspen, cottonwood, birch, black spruce, and white spruce. The type of vegetation on the various deposits in the Nenana-Rex area is controlled chiefly by drainage of the deposits, which in turn is mostly controlled by permafrost. In addition, forest fires have interrupted the normal succession of plant growth in many parts of the area.

Aspen, birch, and white spruce trees occupy areas of well-drained deposits such as glacial outwash, (Qog), and some well-drained areas of alluvial-fan deposits, (Qaf). Alder, willow, and cottonwood trees grow chiefly along the stream courses. Black spruce trees grow in isolated patches in poorly drained areas of fine sediments such as interchannel silt, (Qi).

Labrador tea, cranberry, blueberry, and dwarf birch with minor amounts of lichen, moss, and grass provide the underbrush in the well-drained deposits. Grasses, sedges, mosses, lichens, and an occasional patch of dwarf birch occupy areas of swamp deposits, (Qs).

The largest trees in the area are the birch and white spruce trees that occur on the glacial outwash gravels. These trees are in a thick growth and average 6 to 8 inches in diameter with an occasional spruce tree as much as 12 inches in diameter. Trees growing on the other deposits average 4 to 5 inches in diameter although a few trees may reach as much as 6 inches in diameter.

GEOLOGY

Bedrock in the Nenana-Rex area consists of Birch Creek schist of Precambrian age (Capps, 1940, p. 95) exposed in the Yukon-Tanana Upland north of the Tanana River; Totatlanika schist of Mississippian(?) age (Wahrhaftig, 1958) exposed in the extreme southeastern part of the area; and Nenana gravel of Tertiary (Miocene) age (Wahrhaftig, 1958) exposed in the southern part of the area. The Tanana Valley lowland is mantled by unconsolidated deposits of Quaternary age of glacial and nonglacial origin.

BEDROCK DEPOSITS

Birch Creek schist, (p€b).—The Birch Creek schist exposed in the Yukon-Tanana Upland consists chiefly of quartz, mica, and calcareous schists with minor amounts of greenstone; it is mantled by as much as 5 feet of windblown sand and silt. The schists are the result of mild to moderate metamorphism of shales, sandstones, and limestones. The associated greenstone represents metamorphosed igneous rocks. The commonest phase of the Birch Creek schist is quartz-sericite schist. This phase of the schist is incompetent and has been most strained during compression. Where this rock is fresh the mica is highly conspicuous on faces parallel to the foliation. The weathered rock is gray, brown, and reddish, and breaks into thin slabs and fragments along the lines of schistosity.

All the lithologic types in the Birch Creek schist are cut by quartz veins of various ages. Some of the older quartz veins have been deformed by folding, but the younger veins have not been deformed and were evidently emplaced after the schists were metamorphosed. This metamorphism destroyed the original structure of the rocks so that in most places bedding cannot be determined. The foliation of the schists has a generally east-northeast strike, paralleling the axis of the Alaska Range, with dips both to the north and to the south (Capps, 1940, p. 96).

The name Birch Creek schist was first applied to a group of rocks in the basin of Birch Creek, a tributary of the Yukon River, by Spurr (1898, p. 140-145). Brooks (1911, p. 55-60) and Capps (1919, p. 26-29) found rocks of similar lithology in the Kantishna region and correlated them with the rocks of the Birch Creek basin. Spurr, Brooks, and Capps did not find any direct evidence as to the age of these schists, but found only that they were older than the fossiliferous sedimentary rocks of Paleozoic age of the region. The schists were classified as pre-Ordovician. Mertie (1937, p. 55-59) showed that in the Yukon-Tanana region, limestones of Middle Cambrian age not only lie above the Birch Creek schist but are separated from it by the Tindir group, which he believed to be Precambrian and Early Cambrian in age; he classified the Birch Creek schist as early Precambrian.

Totatlanika schist, (Mt).—Totatlanika schist is exposed in the extreme southeastern part of the mapped area and consists largely of quartz-feldspar schist and gneiss of igneous origin. Locally interbedded with the igneous rocks, as discontinuous beds, are sedimentary rocks consisting of carbonaceous shale, schist, and quartz conglomerate. The characteristic phase of the Totatlanika schist contains porphyroblasts of quartz and white feldspar in a groundmass of fine-grained mica and quartz. The long axes of the quartz and feldspar grains are generally parallel to well-developed lines of schistosity in the schist. The schists, gneisses, and associated sedimentary rocks are complexly folded, faulted, and metamorphosed, so that it is difficult to determine the original structure of the rocks. Locally, Totatlanika schist is mantled by as much as 4 or 5 feet of windblown sand and silt.

The name Totatlanika schist was first applied by Capps (1912, p. 22) to a series of quartz-feldspar schists and gneisses which form much of the foothill ranges between the Nenana and Delta Rivers. He tentatively assigned the formation a Silurian or Early Devonian age. Capps (1940, p. 106-107) states that the rocks are probably Paleozoic and earlier than Middle Devonian. They were considered pre-Devonian until recently, when Wahrhaftig (1958), upon fossil evidence, assigned the Totatlanika schist a Mississippian(?) age.

Nenana gravel, (Tn).—The Nenana gravel is exposed in the foothills in the southern part of the mapped area. The Nenana gravel is brown and consists predominantly of beds of medium- to fine-grained sandstone, shale, minor amounts of siltstone and claystone, and conglomerate interbedded with thin lenses of coarse-grained sandstone. Locally, lignite beds occur in the Nenana gravel. At Mile 384.5 on The Alaska Railroad, the medium- to fine-grained sandstone, shale, siltstone, and claystone underlie the conglomerate beds and comprise about 60 percent of the exposed material, which is mantled by as much as 5 feet of windblown sand and silt.

The conglomerate is poorly sorted, well cemented, and consists of 50 percent gravel and 50 percent sand. The pebbles comprising the conglomerate are chiefly schist, quartzite, graywacke, and igneous rocks of several types (Wahrhaftig, Hickcox, and Freedman, 1951, p. 152), which are generally well rounded and range in diameter from 1 inch to 3 inches. Locally, the gravel contains cobbles as much as 6 inches in diameter. Many of the pebbles are weathered.

The Nenana gravel in the Nenana-Rex area is exposed on the north flank of an eastward-trending anticline. The beds dip to the north gently to moderately.

Capps (1912, p. 30-34) assigned the Nenana gravel an Eocene or later age. Wahrhaftig (1958), upon fossil evidence, states the gravel is of Tertiary (Miocene) age.

UNCONSOLIDATED DEPOSITS

Approximately 95 percent of the mapped area is mantled by unconsolidated deposits consisting of about 15 percent glacial debris and 80 percent nonglacial debris. During early stages of Pleistocene glaciation in the high and rugged mountains of the Alaska Range to the south, the rivers and streams flowing outward from the glaciers carried great amounts of glacial outwash consisting of gravel, sand, and silt. The coarser fraction of the outwash was dropped along the southern part of the lowland. The finer material was carried farther northward into the Tanana Lowland. Shorter nonglacial streams flowing northward from the Alaska Range also contributed substantial amounts of debris to the Tanana Lowland. The coalescence of debris from the glacial and nonglacial streams built a large alluvial apron outward from the mountain front. This growing apron gradually forced the Tanana River to its present location along the north side of the Tanana Lowland.

The latest formed part of the outwash material of early Pleistocene age is represented in the southwestern part of the Nenana-Rex area by a broad, fan-shaped deposit of gravel, (Qog), that joins the Nenana River flood plain north of Clear. Elsewhere, the sediments of early Pleistocene age are covered by sediments of late Pleistocene to Recent age consisting of sand-dune deposits, (Qsd), channel sand, (Qc), interchannel silt, (Qi), swamp deposits, (Qs), alluvial-fan deposits, (Qaf), and alluvium, (Qna, Qsa, Qta), of the Nenana River, the Tanana River, and the Totatlanika River, respectively.

Channel sand, interchannel silt, and most swamp deposits in the Nenana-Rex area indicate relict drainage patterns of the Totatlanika River, the Nenana River, and minor streams flowing into the Nenana River.

Channel sand and interchannel silt east of Lost Slough were formed by the Totatlanika River at a time when the river flowed northwestward through the area. Channels that originally drained the outwash gravel, (Qog), have been covered by these deposits of the Totatlanika River. Thus, these deposits were formed after the deposition of the outwash gravel plain. West of Lost Slough, the channels and interchannel silt areas were also formed after the deposition of the outwash gravel, but were deposited by the Nenana River and by minor streams west of the slough that flow into the Nenana River.

Outwash gravel, (Qog).—The oldest exposed unconsolidated deposit in the mapped area is outwash gravel deposited by the Nenana River during late stages of Pleistocene glaciation. This deposit is expressed topographically as a broad, fan-shaped gravel plain mantled by a few inches to 5 feet of flood-plain and windblown fine sand and silt. The outwash plain has very little relief, and slopes gently to the north.

The outwash consists of interbedded sand and sandy gravel (Curve 7, fig. 2). The gravel pebbles are angular to well rounded and consist chiefly of greenstone, quartz, and granite with minor amounts of conglomerate, muscovite schist, argillite, and chert. The pebbles average 1 inch in diameter, but locally may be 6 inches in diameter. The sand in the interbedded sand and sandy gravel layers is clean and coarse grained.

Frost action and the infiltration of rain and snow melt have incorporated the mantle of flood-plain and windblown fine sand and silt into the underlying coarse sandy gravel. Comparative results of two samples collected from different depths of the same test pit analyzed by the Alaska District, Corps of Engineers, are shown on figure 2 (Curves 4 and 7). Sample 4 was collected at a depth of 2 feet, probably in the lowermost part of the flood-plain and windblown fine sand and silt. Sample 7 was collected at 4 feet, well into the underlying coarse sandy gravel. In this locality the fine sand and silt mantle is approximately 2 to 3 feet thick.

Areas underlain by outwash gravel are well drained. Consequently, no frost action is anticipated in the glacial outwash gravels.

Permafrost is sporadic and not found everywhere in the outwash plain. A 30-foot test pit dug at Mile 392 on The Alaska Railroad by the Alaska District of the Corps of Engineers did not reach permafrost. In the gravel pit at Clear, however, permafrost is found at 20 feet below the surface. Where permafrost was observed, it did not contain any ice lenses or wedges but was "dry."

Sand-dune deposits, (Qsd).—Sand-dune deposits occur in the north-central part of the Nenana-Rex area about 2 miles east of the Nenana River and 3 miles south of the town of Nenana. They are restricted to an area of approximately 2 square miles. The dunes are eastward-trending elongate ridges, 600 to 1,200 feet long, 100 to 200 feet wide, and a maximum of 50 feet high. They are transverse dunes formed by moderate winds from the south or south-southwest.

The sand-dune deposits consist chiefly of fine-grained sand with minor amounts of silt and medium-grained sand (Curve 3, fig. 2). The sand grains are angular to subangular and are mostly quartz.

The dunes are inactive and support a substantial growth of vegetation including white spruce trees as much as 6 inches in diameter; they have been terraced by the Totatlanika River at a time when the river was forming the interchannel-silt, (Qi), and channel-sand, (Qc), deposits. They are, therefore, older than the interchannel-silt and channel-sand deposits. Although the dunes are older than the interchannel-silt and channel-sand deposits, the actual age of the dunes was not determined. It is doubtful, however, that they are older than the outwash gravel, but more probably are contemporaneous with or slightly younger than the outwash.

Areas of sand-dune deposits are well drained and frost action is probably lacking. Permafrost is also probably lacking, or if it does occur, it is at great depths below the surface.

Channel sand, (Qc).—Channel-sand deposits are in flat, generally narrow, meandering abandoned-stream channels. The channels and areas upon which interchannel silt (Qi) sediments have been deposited, represent distinct environments within a large complex alluvial fan. In detail, the surface of this complex fan consists of sinuous elevated ridges, 1 foot to 3 feet high, flanked by gentle slopes and swales. The centers of the ridges contain slight depressions in which the streams flowed. Characteristic of streams on alluvial fans, these streams shifted frequently because of alluviation. The higher part of the ridges and the flanking gentle slopes are natural levees formed by overbank deposition during the spring floods. The natural-levee areas contain deposits of interchannel silt. The swales are areas that lie between the natural-levee deposits and have not received a substantial amount of overbank deposition. Most of these swales are occupied by swamps.

Channel-sand deposits generally consist of 95 percent medium- to coarse-grained sand and 5 percent subrounded to rounded fine gravel (Curve 6, fig. 2). Locally, the gravel content is as high as 30 percent. The gravel contains very few weathered fragments because the weathered portion of the gravel has been carried away by water. Windblown fine-grained sand and silt, 6 to 18 inches thick, mantles most of the channel-sand deposits.

Surface drainage in areas of channel-sand deposits is generally good. Subsurface drainage is fair, but where the water table lies within 1 foot to 2 feet of the surface the drainage is poor. The good surface drainage and generally fair subsurface drainage insure that frost action in the channel sands will be absent or mild. The mild frost action will be in areas where the water table lies within 1 foot to 2 feet of the surface and in areas that are mantled by a thick layer of windblown fine sand and silt.

Permafrost was not observed in channel-sand deposits although several test pits as deep as 6 feet were dug. It may exist locally at depths greater than 10 feet below the surface, probably in small isolated patches.

Interchannel silt, (Qi).—Interchannel silt is the predominant unconsolidated deposit in the Nenana-Rex area and occurs in gently sloping, low-lying surfaces interrupted by swamps and abandoned stream channels. Areas containing interchannel silt are natural levees associated with the relict stream system and were formed contemporaneously with the abandoned channels. During flood stage, areas underlain by glacial-outwash debris of early Pleistocene age were covered by silt-laden water from Totatlanika River and the minor streams flowing into the Nenana River. This deposition by flooding eventually mantled the glacial outwash by the interchannel-silt deposits, which range in thickness from 3 to 10 feet. Undoubtedly, these deposits were enriched slightly in silt and fine sand by windblown material; however, the amount of enrichment is indeterminable.

Where examined, interchannel-silt deposits consist of approximately 95 percent silt or clay and 5 percent fine sand (Curves 1 and 2, fig. 2). Because these deposits are so fine grained, areas of interchannel silt are poorly drained, and intense frost action takes place in these deposits. Telephone poles placed in interchannel-silt areas are heaved by frost action and have to be reburied periodically.

The top of the permafrost layer in this deposit is 3 to 4 feet below the surface. The perennially frozen ground is insulated by the vegetation on the surface. If the vegetative cover is destroyed or disrupted, the upper part of the permafrost will thaw, causing swampy areas to develop in the poorly drained interchannel silt deposits. Many of the smaller swampy areas adjacent to The Alaska Railroad developed as a result of tracked vehicles crossing over such areas. The vegetation cover adjacent to the railroad tracks was disrupted or destroyed by the tracked vehicles during the winter months of 1954; the following summer, swampy areas with as much as 1 foot of standing water were observed in this area.

Swamp deposits, (Qs).—Large areas of swamp deposits are scattered throughout the mapped area and are especially abundant north of Clear. Most of the swamp deposits are in the interchannel silt, but a few are on poorly drained alluvial fans. Swamp deposits are in large areas of impeded drainage in which soils are saturated throughout the year. Standing water a few inches deep covers much of the surface, but locally the water is 4 to 5 feet deep. Many areas mapped as swamp deposits do not generally contain any standing water but become marshy and contain water 2 to 3 inches deep after a few days of rain. Although deposits in some of these areas could be mapped as interchannel silt, they are considered and mapped as swamp deposits in this report.

The water in the swamps is underlain by peat and silt generally more than 2 feet thick. The maximum thickness is unknown, but it may be as much as 15 feet. Underlying the peat and silt is an unknown thickness of silt and fine-grained sand.

Because of the poor drainage in swamp areas, permafrost locally containing clear ice lenses as much as 2 inches thick commonly lies within 2 to 3 feet of the surface. Locally, it may lie within a foot of the surface.

Alluvial-fan deposits, (Qaf).—Alluvial fans much younger than the alluvial apron of early Pleistocene age that forced the Tanana River to the northern part of the Tanana Lowland are chiefly along the base of the foothills in the southern part of the mapped area. The large alluvial fan in the southern part of the mapped area was formed by the coalescence of numerous smaller fans of the creeks draining the foothills. In the southeastern part of the area, alluvial-fan deposits overlie channel-sand and interchannel-silt deposits. Individual fans have relatively little relief and stand 2 to 3 feet above the stream channels. Where the fans adjoin one another, however, relief of 6 to 8 feet is common.

Alluvial-fan deposits are of unknown thickness and consist of interfingering lenses of clean cobbles, coarse and fine gravel, and minor quantities of sand and silt. The average grain size of the material decreases with increasing distance from the foothills. The surfaces of the alluvial fans are commonly mantled by a few inches of flood-plain and windblown fine sand and silt. Rain and snow melt have incorporated slight amounts of this fine sand and silt into the underlying gravel, silt, and sand.

Alluvial-fan deposits are generally well drained and dry. However, swampy areas occur locally, especially where the smaller fans adjoin one another. Here, standing water as much as 6 inches deep covers the area after a few days of rain. Because alluvial-fan deposits are relatively coarse and well drained, permafrost either is lacking or occurs at depths greater than 15 feet below the surface. Permafrost was not found in several 4-foot test pits in the alluvial-fan deposits.

Recent alluvium, (Qna, Qsa, Qta).—Deposits of Recent alluvium underlie the Nenana River, the Tanana River, the Totatlanika River, and their flood plains. The flood plains underlain by these deposits are nearly flat surfaces crossed by numerous recently abandoned stream channels, a few winding sloughs and minor streams, and channels occupied only during flood stages of the Nenana and Tanana Rivers, and Totatlanika River.

Recent alluvium of the Nenana River and Totatlanika River consists of interfingering lenses of washed, clean gravel, sand, and silt. In the area mapped, the Recent alluvium of the Tanana River consists chiefly of sand and silt. The Nenana River flood-plain alluvium, however, varies greatly. The average size of the gravel contained in the Recent alluvium of the Nenana River decreases with increasing distance from the base of the mountains. Near Rex, the alluvium consists chiefly of coarse gravel with local accumulations of cobbles, and boulders as much as 3 feet in diameter. Near the town of Nenana, it is composed predominantly of sand and silt. A large part of the pebbles comprising the Recent alluvium of the Nenana River is reworked glacial debris, so that the pebbles are in large part lithologically similar to those found in outwash gravel, (Qog). The sand and silt of the Tanana River flood-plain alluvium consists chiefly of quartz grains. Alluvium of the Totatlanika River consists of fragments from the Totatlanika schist and the Nenana gravel.

The water table is generally less than 5 feet below the flood-plain surface and during high water the entire area of Recent alluvium is subject to occasional flooding. Sometimes a major change of the river channel will occur, such as happened in a reach of the Nenana River in 1917. I. P. Taylor (oral communication, 1957) reported that during high water in the late fall of 1917, a part of the Nenana River overflowed into Lost Slough, a minor stagnant slough approximately 60 feet wide. At the present time Lost Slough is the main channel of the Nenana River and is approximately 150 feet wide. This flood breeched The Alaska Railroad grade being constructed at the time so that realignment of the railroad grade was necessary. This abandoned railroad grade is referred to as "Winter trail (Old railroad grade)" on the map.

Heaving resulting from frost action in Recent alluvium is virtually absent in the gravel but is mild in the sand and silt areas. Permafrost has not been recognized in the alluvium but may be present locally, at depths greater than 6 feet, especially in the slip-off slopes of meanders and in silty areas of the Tanana River flood plain.

ECONOMIC AND ENGINEERING GEOLOGY

Most of the economic considerations and engineering characteristics of the various mapped units are discussed in the accompanying table. Therefore, the following discussion is restricted to water supply, icing, and seismic activity of the area.

WATER SUPPLY

Water may be obtained from the Tanana River, the Nenana River, the Totatlanika River, the numerous small creeks in the area, and from ground water. Two major factors should be considered in the development of surface water: (1) Typical of all glacial rivers and streams, the Nenana and Tanana Rivers contain a high percentage of silt-size particles; removal of the particles will require the construction of settling basins. (2) All the rivers and streams in the area freeze over in the winter, and if a settling basin is constructed it also will freeze over.

Ground water is the most reliable source of potable water in the area. Not all the mapped units, however, will yield sufficient water to warrant development. Only outwash gravel, Recent alluvium, and to a limited extent, alluvial-fan deposits can be developed as sources of ground water. Of these deposits, outwash gravel offers the largest quantity and highest quality water with the minimum development. The Alaska District of the Corps of Engineers (oral communication, 1954) report that 14 churn-drill holes (less than 100 feet deep) were drilled in the vicinity of the airstrip and abandoned Air Force Base to measure the fluctuation of the water table in the outwash gravel. Observations of these holes from July 24, 1948, to April 20, 1949, indicated that the water table fluctuated between altitudes of 511 feet and 520 feet. In 1955 one of these holes was reoccupied, and the water table was observed at 37 feet below the surface or at an approximate altitude of 530 feet. In the gravel pit about one-third of a mile south of Clear the water table was 15 feet below the surface or at an altitude of about 515 feet in 1955. The water table was 18 feet (altitude of 507 feet) below the surface at The Alaska Railroad section house at Clear.

The town of Nenana gets its water from shallow wells drilled in Recent alluvium. The residents of Nenana report (oral communication, 1955) that the water table was only 6 to 12 feet below the surface and that the quality of the water was highly variable. This variation of water quality may be in large part due to some of the shallow wells being placed in swampy water of old covered oxbows while other wells were placed in better drained deposits. It is doubtful that the water quality would vary if the wells were dug much deeper and were cased to the bottom of the hole.

The water table in alluvial-fan deposits varies from 15 feet below the surface at the head of the fans to 5 feet below the surface at the toe of the fans. The supply of water from these deposits is limited, however. The storage capacity of alluvial-fan deposits is not as large as that of outwash gravel and Recent alluvium. Furthermore, recharge in alluvial fans is chiefly from rainwater; but recharge in outwash gravel is from rainwater and the Nenana River; and recharge in Recent alluvium, from rainwater, the Nenana River, and the Tanana River.

ICING

Icing (aufeis) in the Nenana-Rex area occurs locally along the creeks. Local residents report icing has occurred along Julius Creek, and icing scars were observed on trees along the creek as high as 3 feet above the base of the trees. Icing scars were not observed along the Nenana and Tanana Rivers. Although overflow icing is commoner on the smaller creeks of the area, it is probable that the Nenana and Tanana Rivers may ice over into their flood plains. Icing should be considered in the design of structures crossing the creeks and the Nenana and Tanana Rivers.

SEISMIC ACTIVITY

The Nenana-Rex area lies in a seismic zone of major intensity. In 1937 and again in 1947 severe earthquakes shook this area. The epicenter of the 1947 earthquake was at Clear, within the Nenana-Rex area. St. Amand (1948, p. 622) has determined an intensity of 8+ on the Mercalli Scale for this earthquake at Clear. The epicenter of the 1937 earthquake was near Salcha (Bramhall, 1938, p. 71-75) approximately 55 miles east of Nenana, and this earthquake was slightly less intense than the 1947 earthquake. Recurrence of earthquakes of similar intensity in the Nenana-Rex area is probable. Therefore, manmade structures in the Nenana-Rex area should be made earthquake resistant.

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By
Reuben Kachadoorian
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MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-307

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