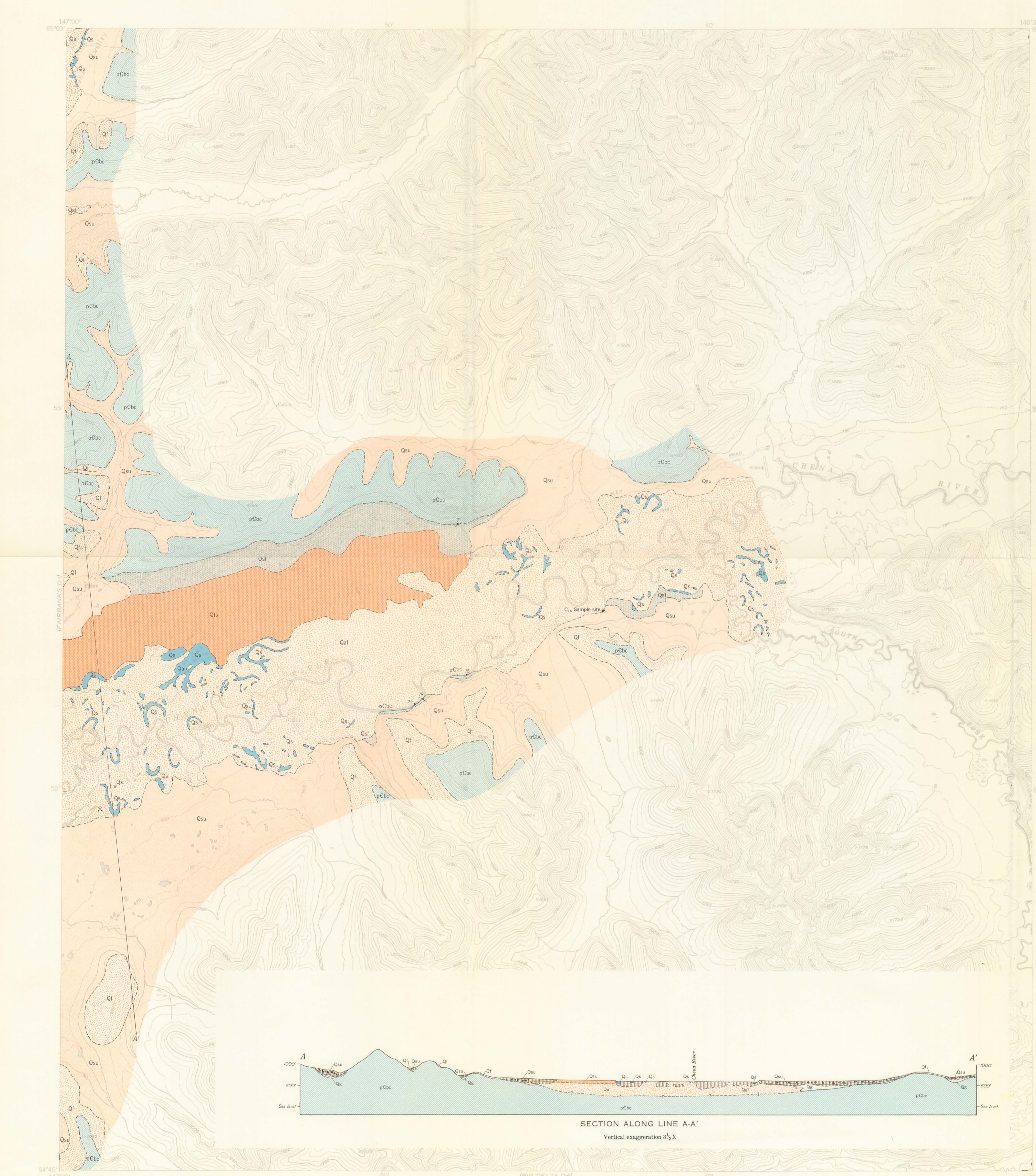
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-297



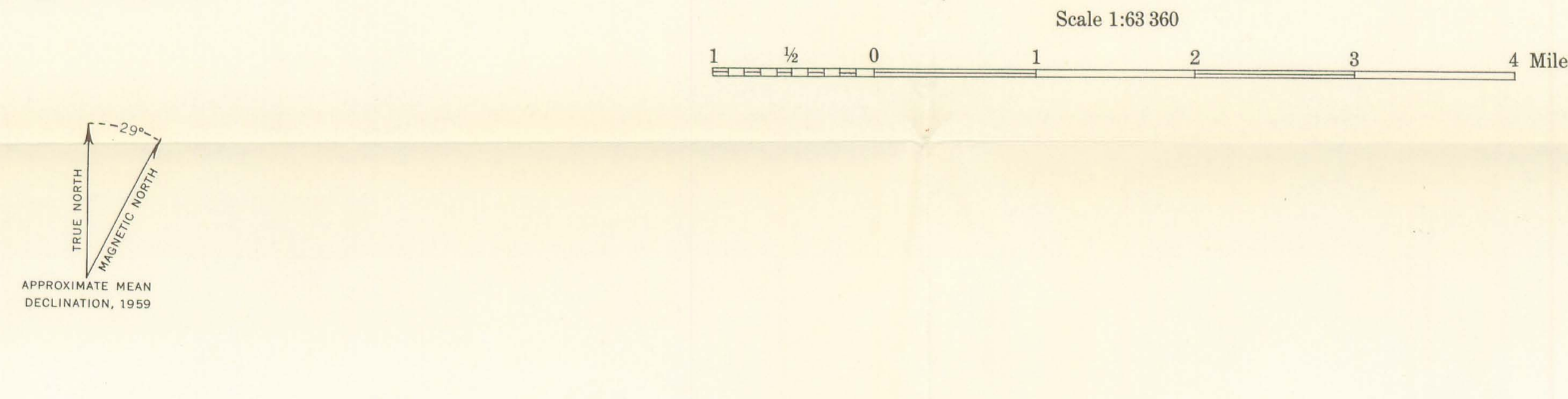
SECTION ALONG LINE A-A'

Vertical exaggeration 3⅓X

Base map by Topographic Division
U. S. Geological Survey, 1952

Geology mapped in 1950

Scale 1:63 360



APPROXIMATE MEAN DECLINATION, 1959

EXPLANATION

A blanket of sediments of Quaternary age a few inches to more than 100 feet thick covers nearly all of the area. These sediments are not shown on the geologic map where they are less than 3 feet thick

SEDIMENTARY ROCKS

YUKON TANANA UPLAND

Qf

Fairbanks loess

Massive, homogeneous, unconsolidated eolian silt. May include some retransported silt on slopes; well-sorted; contains less than 10-percent clay. Angular grains of quartz, mica, and feldspar. Locally cemented by iron oxide; locally calcareous. Color buff to tan gray when dry, brown when wet. Locally mottled by thin carbonaceous layers and by iron oxide stains

Qsu Qsf

Perennially frozen silt

Silt, undifferentiated, Qsu, *consists of silt retransported from loess-covered hills to lower slopes and valley bottoms. Includes minor amounts of loess. Silt, massive, locally stratified, homogeneous, unconsolidated, well-sorted, less than 10-percent clay. Angular grains chiefly quartz, mica, and feldspar locally cemented and stained by iron oxide. Deposit, especially in valley bottoms, contains organic material in beds, lenses, and as finely disseminated flecks. Color buff to brown to gray, locally mottled by organic matter and iron oxide stain. Contains large masses of ground ice*

Silt composing coalescent alluvial fan deposits, Qsf, *which mantle alluvial sand and gravel; locally, at base of rock bluffs, includes beds and lenses of water transported rock fragments and occasional blocks moved down slope by gravity. No large ground-ice masses*

UNCONFORMITY

Qg

Creek gravel

Not exposed at surface; exposed only in vertical river banks. Recorded in boreholes and exposed in placer mines in Fairbanks mining district to west of area. Well-stratified layers and lenses of poorly sorted, angular to subrounded, sandy creek gravel; cobbles and boulders up to 24 inches in diameter composed mostly of quartz and schist, but include minor amounts of gneiss and granitic rocks. Color buff to brown, with much iron oxide staining. Locally perennially frozen

LITTLE CHENA AND CHENA VALLEYS

Qs Qal Qts

Flood-plain and terrace alluvium

Flood-plain alluvium, Qal, *consisting of well-stratified layers and lenses of unconsolidated silt, sand, and gravel; gray to brown; particles ¼ inch to 9 inches in diameter are mostly granite, quartzite, vein quartz, gneiss, and schist. Locally perennially frozen and cemented by interstitial ice. No large ground-ice masses*

Flood-plain swale and slough deposits, Qs, *consisting of poorly stratified layers and lenses of well-sorted, stream-laid silt and sandy silt; includes local pond deposits; contains 10- to 30-percent clay-size particles; grains angular and subrounded, consisting mostly of quartz, mica, feldspar; contains organic material. Color brown to grayish blue, mottled with carbonaceous material and iron staining. Where perennially frozen has moderate to high ice content, chiefly as interstitial ice, veins, and stringers*

Terrace deposits, Qts, *consisting of massive to poorly stratified layers and lenses of well-sorted alluvial (possibly eolian in part) silty sand and sand; form 30- to 50-foot river terrace. Angular and subrounded grains of quartz, mica, and feldspar. Color tan to gray. Permafrost deep or absent in most of unit; probably no large ground-ice masses*

QUATERNARY

METAMORPHIC ROCKS

pЄbc

Birch Creek schist

Gray to brown quartzite, quartz-mica schist, quartzite-schist, and lesser amounts of carbonaceous and calcareous schist. Original bedding largely obliterated; seamed with numerous, small quartz stringers and veins

PRECAMBRIAN

▥

Permafrost, diagrammatic

Large ground-ice masses shown by solid symbol; on section only

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Contact

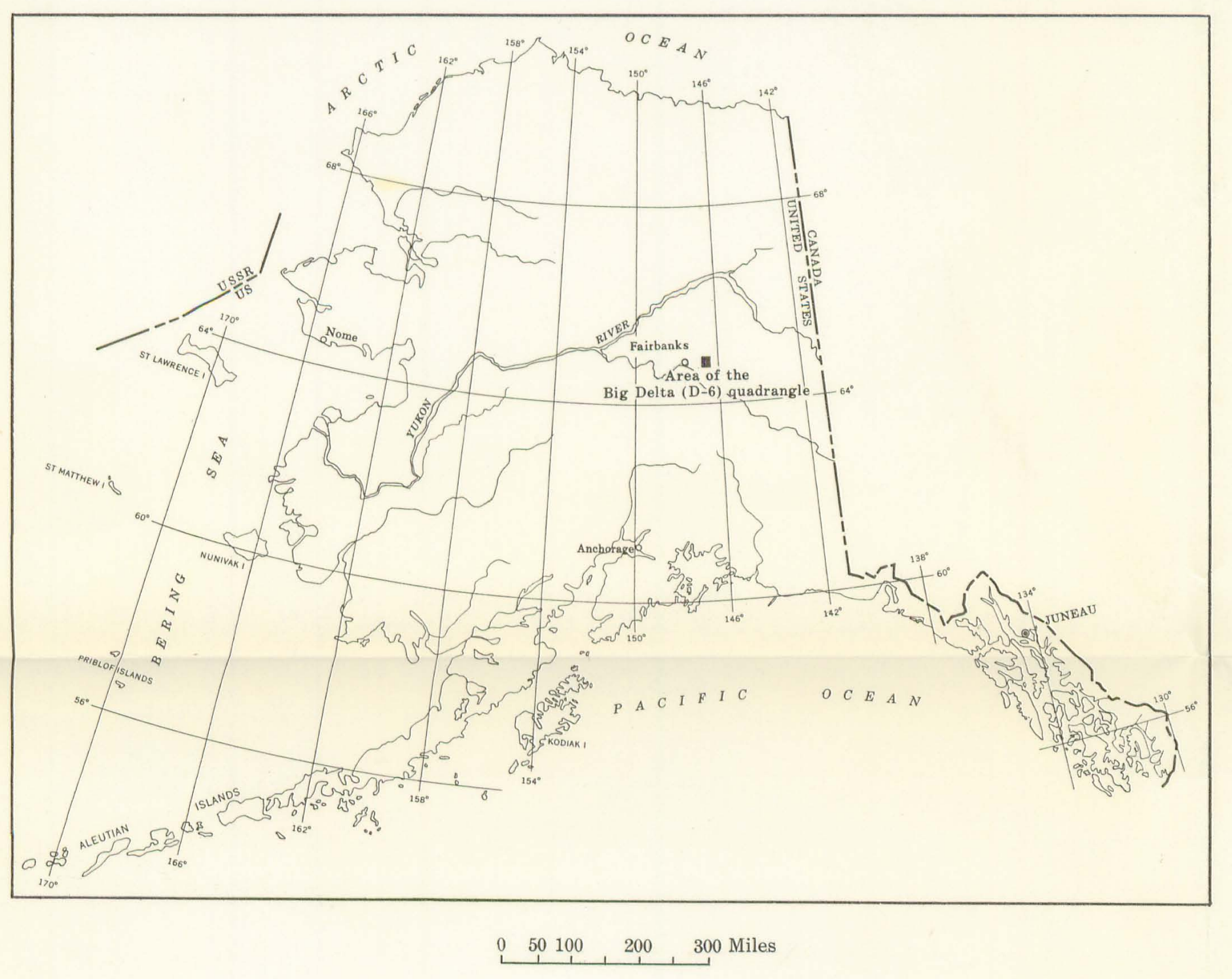
Dashed where gradational or approximately located, queried where doubtful

⊥14

Dip and strike of foliation

×

Gravel pit



INDEX MAP OF ALASKA

DESCRIPTION OF GEOLOGIC UNITS

GEOLOGIC UNIT	DISTRIBUTION AND THICKNESS	TERRAIN AND NATURAL SLOPES	DRAINAGE AND PERMEABILITY	PERMAFROST	SUSCEPTIBILITY TO FROST ACTION	BEARING STRENGTH AND SLOPE STABILITY	EXCAVATION AND COMPACTION	POSSIBLE USES
Flood-plain alluvium (Qal)	Borders Chena River in central part of area and Little Chena River in northern part. Surficial alluvial silt 1-15 feet thick covers river sand and gravel. Thickness of alluvial deposits not known, but probably over 200 feet thick in Chena and Little Chena Valleys.	Flat plain broken by low terrace escarpments up to 10 feet high, a few ponds, meandering stream courses, and a complex network of shallow swales and sloughs (Qs) which mark former positions of braided and meandering river channels.	Drainage excellent and permeability high except locally in surficial silt or where granular deposits are frozen at shallow depth. Drainage is improved by the removal of vegetation mat which permits lowering of permafrost table. Subject to periodic river flooding. Water table 1-15 feet deep where permafrost is absent or deep.	Depth to permafrost 2-4 feet in older, higher parts of flood plain and on low terraces and more than 4 feet on inside of meander curves near rivers and in other especially well drained sites. Depth to permafrost 25-40 feet or absent in some artificial and natural clearings, and absent beneath some lakes and streams. Active layer 2-8 feet thick. Permafrost is 5 to more than 250 feet thick. It is discontinuous horizontally and vertically and has thawed layers, lenses, and vertical zones. Low ground-ice content, chiefly interstitial.	In silt: frost action moderate to intense. In sand and gravel: not susceptible to frost action.	Sand and gravel have high bearing strength at all seasons. Surficial silt has high strength when frozen or when thawed and well drained, but low bearing strength when poorly drained. Slopes stand at 1:1 to 2/3:1 except in sand.	Easily excavated with power equipment except where perennially frozen. Difficult to compact. Little or no subsidence of ground upon thawing of permafrost.	Good foundation for structures, except in marshy silt areas. Silt mantle should be removed before construction to eliminate frost-susceptible foundation material. Gravel good for subgrade, base course, and if crushed and screened, for road metal, concrete aggregate, and railroad engine sand. Source of moderate to large supplies of water from permafrost-free alluvium, or from below permafrost. Surface silt fair to good agricultural soil if fertilized.
Flood-plain swale and slough deposits (Qs)	Widely distributed in meander stream scars which mark former channels on the flood plain of the Chena and Little Chena Rivers. Thickness generally less than 10 feet, and only rarely between 10 and 25 feet.	Elongate, sinuous, branching, and flat-floored meander-channel scars and flat, wide, basinlike areas with indefinite boundaries. Some of channel scars occupied by ponds, creeks, and intermittent streams.	Organic-silt and silt deposits are poorly permeable when thawed, and impermeable when frozen. Impermeable soils cause marshy and boggy conditions throughout the summer. Drainage may be improved by stripping vegetation mat and lowering permafrost table where water table is low. Subject to local snow melt and river floods Water table ranges from surface to 15 feet deep.	In the broad basinlike swales grown over with stunted spruce, thick moss, and sedge tussocks, permafrost is at depth of 1.5 to 2 feet, and active layer is 1.5-2 feet thick; permafrost is 5-25 feet thick and laterally continuous. Contains high proportion of small ice segregations. Permafrost may extend into underlying alluvium (Qal). In filled meander scars, permafrost may be absent to within 2-4 feet of the surface; active layer is 2-4 feet thick.	Susceptible to intense frost action.	High bearing strength when frozen, but only moderate to very low bearing strength when thawed, depending on height of water table and vegetation cover. Slopes bordering sloughs and swales subject to slumping unless thawed and well drained.	Difficult to excavate when frozen. When thawed below water table, saturated silt flows back into excavation. Subsidence of ground upon thaw of permafrost is common, and degree of sinking depends on volume of ice in excess of void ratio of sediment and depth of thaw during and after construction.	Poor for construction foundation or fill. Should be removed if possible prior to construction. Possible source of clayey silt for use as binder, but source would be thin, small in volume, and probably contaminated with organic material.
Silt composing alluvial fans (Qsf)	Alluvial fan and colluvial deposits generally located at the base of river-cut escarpments. Deposits form a veneer up to 30 feet thick over river sand and gravel.	Steep colluvial slopes and alluvial fans of intermittent streams. Average slope of fans approximately 25 feet per mile; local relief 5 feet.	Surface drainage generally poor to fair on silt alluvial fans, but generally fair to good on steeper colluvial slopes. Drainage of silt generally improved by clearing of vegetation and lowering of permafrost table. Permeability low in frozen silt, but relatively high in thawed silt and mixed silt and rock fragments of the colluvial deposits.	Depth to permafrost 2 to 25 feet; active layer 2 to 4 feet thick. Permafrost ranges from 2 to 30 feet thick and may be in contact with permafrost of underlying sand and gravel (Qal). Discontinuous. Ground-ice content low, chiefly of interstitial grains rather than large ice masses.	Frost action moderate where well drained to intense where poorly drained.	When frozen or dry and well drained, silt and colluvial deposits have high bearing strength, but when wet and thawed the silt has low bearing capacity. Frozen silt is subject to slumping until thawed and drained and then is stable at 2/3:1 to 1:1. Very susceptible to gullying.	Silt easily excavated with hand or power tools except where frozen. Difficult to compact. Little to moderate ground subsidence upon thawing of permafrost. Mixed silt and bedrock fragments locally difficult to excavate where bedrock is resistant type of schist, but relatively easy to excavate where bedrock fragments are soft, weathered schist.	Fair foundations for structures. Unimproved roads on silt are dusty when dry, and soft and muddy when wet. Fair to good agricultural soil if fertilized.
Terrace sand (Qts)	Limited to 30- to 50-foot terrace bordering the Chena River flood plain on the north. Surficial sand deposits exceed 6 feet thick, but maximum thickness is unknown.	Flat terrace, slopes 6 feet per mile to the west. Local relief less than 5 feet. Bordered by gently sloping alluvial fans on north and by steep river-cut escarpment on south.	Drainage excellent in central and southern part, but poorer in northern part where silt mantle thickens at toe of alluvial fans and at sites of former ponds. Permeability of terrace sand generally high, but that of silt mantle in poorly drained areas is less.	Permafrost conditions not known. Permafrost probably deep or absent in well-drained southern edge of terrace, but may be present at shallow depths along northern border of unit. Large ice masses probably not present.	Sand not susceptible to frost action. Local silty sand deposits at surface and at depth slightly susceptible to frost action.	Bearing strength generally high at all seasons, but low in summer in the scattered swales or former ponds along north border of unit. Sand stands in slopes of about 2/3:1.	Easily excavated with hand and power tools. Possible permafrost at depth in northern part of unit would make excavation more difficult.	Possibly suitable for fill and subgrade in absence of coarser material. Offers good to fair foundations and provides sandy, well-drained agricultural soils that require fertilization.
Fairbanks loess (Qf)	Forms widespread silt mantle on hills of Yukon-Tanana Upland bordering Chena and Little Chena Rivers. Thickness ranges from a few inches on higher hilltops to over 25 feet on middle slopes. Mapped only where more than 3 feet thick.	Occurs on slopes and summits of gently rolling hills and on slopes of steep hills. Slopes are cut by subparallel gullies up to 40 feet deep.	Generally good surface drainage. Lateral permeability good to fair; vertical permeability good. Water table generally deep in the underlying bedrock.	No permafrost.	Mild to unsusceptible, except in poorly drained places, where frost action is severe.	High bearing strength when dry and undisturbed. Low bearing strength when wet. Will stand in near-vertical slopes. Very susceptible to gullying. Freshly exposed surfaces subject to wind erosion. Natural dry density less than 85 lbs/cu ft.	Easily excavated with hand and power tools. Difficult to compact.	Possible source of fines and a possible source for impervious fill. Good foundation for heated structures if protection is provided against gullying. Unsurfaced roads built on loess are dusty when dry and muddy when wet. Good agricultural soil if fertilized.
Undifferentiated perennially frozen silt (Qsu)	Widespread surface deposits of lower hill slopes and creek valleys of Yukon-Tanana Upland. Thickness 3 to more than 25 feet.	Gently sloping coalescent alluvial fans with average slope upward of 25 feet per mile and steeper lower hillslopes. Flat to gently sloping creek-valley bottoms. Locally dotted with lakes.	With few exceptions entire unit made impermeable by underlying permafrost at shallow depth. Drainage poor except near contact with Qf and pЄbc. Surface boggy and marshy in summer. Clearing near contact with Qf and pЄbc may improve drainage, but clearing in valley bottoms and on fans forms quagmire. Permeability low to moderate in unfrozen silt. Water table below permafrost.	Depth to permafrost 1.5-4 feet on lower slopes and creek-valley bottoms; 5-20 feet near contact with Qf and pЄbc and at well-drained knolls within unit. Active layer 1.5-4 feet thick. Permafrost 3 to at least 100 feet thick, pinches out upslope, and is laterally continuous except possibly under lakes and near contact with Qf and pЄbc. Ground ice abundant as horizontal sheets, vertical wedges, sheets, saucer-shaped and irregular masses 1 foot to 50 feet across. Ice commonly in polygonal pattern. Depth to ice 5 to 25 feet.	Mild to unsusceptible where dry near contact with Qf but generally poorly drained and susceptible to intense frost action elsewhere.	High bearing strength when frozen or dry; low when wet and thawed. Near contact with Qf may stand in vertical shallow cuts. Elsewhere subject to slumping until thawed and drained, then stable at 2/3:1 to 1:1. Very susceptible to gullying.	Very difficult to excavate unless thawed; blasting only moderately effective. When thawed viscous mud slides back into excavation except near contact with Qf or on low well drained knolls. Difficult to compact. Great differential settlement and ground subsidence upon thawing of permafrost forms mounds about 10-50 feet across and thermokarst pits 3-30 feet in diameter and 5-20 feet deep.	Poor foundation for construction; may improve slightly near contacts with Qf with lowering of permafrost. Possible source of fines and impervious fill. Soils poor to fair for agriculture if fertilized.
Creek gravel (Qg)	Exposed only in widely scattered vertical sections, and not mapped. Shown on cross section where known or inferred. Probable thickness 1 to over 50 feet.	Exposed only in vertical cuts; buried elsewhere.	Material porous and permeable except where perennially frozen.	Locally perennially frozen. Low ground-ice content.	Not susceptible to frost action.	High bearing strength. Slopes more gentle than 1:1 are generally stable.	Difficult to excavate with hand tools because of coarse texture, but easily excavated with power tools except when frozen. Difficult to compact	Good foundations for any sort of structure if exposed at surface. Good for subgrade, ballast, rip rap, pervious fill, and if crushed and screened, good for base course and aggregate.
Birch Creek schist (pЄbc)	Unweathered schist exposed in steep, river-cut bluffs along the Chena River. Weathered schist occurs on upper slopes and summits. Mapped where covered with less than 3 feet of Qf. Thickness unknown, probably several thousand feet.	Rounded hills and narrow valleys. Steep bluffs cut by rivers at edge of upland.	Surface drainage good to excellent. Well-developed jointing, fracture cleavage and foliation planes offer fair permeability compared to poor permeability in other directions. Upper weathered layer 1 foot to more than 50 feet thick and has low permeability. Water table generally deep.	No permafrost, except in schist buried locally beneath Qsu or Qg in creek valley bottoms or on north-facing hill slopes. Low ground-ice content.	Weathered rock is moderately susceptible to frost action, and where weathered to silty clay is susceptible to intense frost action. Exposed micaceous schist varieties disintegrate rapidly upon exposure to repeated cycles of freezing and thawing.	Bearing strength generally high in quartzitic, calcareous, and carbonaceous schists. Stands in vertical cuts. Micaceous schist types have high bearing strength if cleavage is horizontal or vertical. If cleavage or bedding is inclined, the schist has only moderate bearing strength. Susceptible to rock sliding and slumping along joint, cleavage, and foliation planes, especially those planes in sericite-rich schist.	Micaceous schist generally easily excavated with power tools with only little to moderate amount of blasting. Quartzitic, carbonaceous, and calcareous schists require considerable blasting. Resistant layers more easily excavated when interbedded with soft mica schist. Difficult to compact.	Quartzitic, calcareous and carbonaceous schist good for rip rap and ballast, and for coarse aggregate. If crushed, good for base course, and road metal; only fair to poorly suited for concrete aggregate. Mica schist fair for base course without crushing; breaks down to silt size material under traffic and frost action.

INTRODUCTION

The western part of the Big Delta D-6 quadrangle occupies approximately 65 square miles of central Alaska, 21 miles east of Fairbanks and 6 miles north of Eielson Air Force Base. Except for a small military reservation, almost all of the land is unpopulated public domain. Although the Fairbanks mining district northwest and west of the area has produced large quantities of placer gold, and lesser quantities of lode gold and tungsten, important mineral discoveries have not yet been made in the western part of the Big Delta D-6 quadrangle. Sand and gravel are among the most important potential resources of the region. These deposits are near the surface and readily accessible in the flood plain of the Chena and Little Chena Rivers; sand is available from the 30- to 50-foot terrace north of the Chena flood plain. Elsewhere sand and gravel are absent or so deeply buried by perennially frozen silt that they cannot be economically developed.

The area lies at the margin of the Tanana Valley agricultural region, which ranks second in crop value among Alaskan farming regions. The principal commodities are dairy products, livestock, oats, barley, spring wheat, potatoes, and garden vegetables (Gasser, 1946). Spruce timber of saw quality is locally available along the Chena River and on some of the upper hillslopes.

The geologic map shows the areal distribution of rock units with emphasis on the widespread mantle of unconsolidated deposits. This mantle is important because it is the foundation for engineering structures, the source of construction materials, and the parent material for agricultural soils. The explanation briefly summarizes the lithologic character of the geologic units. The description of geologic units given in tabular form summarizes the distribution and thickness, terrain and natural slopes, drainage and permeability, permafrost, susceptibility to frost action, bearing strength and slope stability, ease of excavation and compaction, and possible uses of the materials in each unit. The only subsurface records are from a 105-foot water well drilled in river sand and gravel at the military installation south of the Chena River (near the western edge of the area) by the Alaska District, Corps of Engineers, U. S. Army, Nov. 9-29, 1951, and from the nearby pit, in which river sand and gravel were encountered to a depth of 28 feet. These records and data from comparable geologic units in the adjacent Fairbanks area are the basis for understanding the vertical distribution of the geologic units and of permafrost within these units in the absence of natural or artificial exposures. Generalizations on the engineering properties of the geologic units are based largely on field observation and sampling performed at engineering and agricultural projects in comparable units in the Fairbanks area, to the west. These generalizations may be useful in preparing preliminary plans and designs, but are not intended to supplant standard field and laboratory tests required for design of engineering structures.

PHYSICAL SETTING

PHYSIOGRAPHY

The western part of the Big Delta D-6 quadrangle lies within two major physiographic units: (1) the Yukon-Tanana Upland, and (2) the Tanana Lowland, which occupies a narrow re-entrant along the Chena River. These units are both part of the central Alaska uplands and valleys, which form arcuate belts between and parallel to the Brooks and Alaska Ranges. The Yukon-Tanana Upland between the Yukon and Tanana Rivers is a maturely dissected area of accordant rounded summits 2,000 to 3,000 feet in altitude, interrupted by scattered groups of mountains that project above the upland ridges to altitudes of 5,000 to 6,500 feet. South of the upland lies the Tanana Lowland, a broad, sediment-filled trough between the upland and the Alaska Range.

Within the mapped area, the Yukon-Tanana Upland consists of hills and valleys between 600 and 1,650 feet above sea level. Slopes are locally gullied and are covered with dense spruce-birch forest and second-growth birch, aspen, and willow brush. Steep rock bluffs occur where the Chena River has eroded the valley sides as it migrated back and forth across the valley bottom. Tributaries to the Chena and Little Chena Rivers occupy narrow steep-walled valleys in their upper courses, but in their lower courses the creek-valley bottoms widen into poorly drained, gently sloping alluvial fans, which merge with the valley floor of the larger rivers. Scattered small lakes occur on the silt fans and creek-valley bottoms.

The lowland part of the area, between 500 and 700 feet above sea level, consists of the woodland- and brush-covered flood plains and low terraces, Qal, Qts, of the Chena and Little Chena Rivers. Silt-filled sloughs and swales, Qs, and oxbow lakes mark the former positions of the rivers on the flood plains, Qal. Spring runoff and heavy summer rains cause periodic floods over part of the lowland. The Chena River is a tributary of the Tanana River and is a part of the Yukon drainage system.

Running water has been dominant in molding the landscape. It has eroded and carved mature stream valleys in the upland and has, by deposition, formed the flat alluvial surface of the Little Chena and Chena Valleys and that of some of the larger creek valleys of the Yukon-Tanana Upland. Although Pleistocene glaciers formerly extended northward from the Alaska Range and glaciers occurred locally in the mountainous sections of the Yukon-Tanana Upland (Mertie, 1937), the land within the mapped area was apparently not glaciated. However, much of the Pleistocene alluvial fill of the Tanana Lowland was deposited as huge alluvial fans by the heavily loaded, north-flowing tributaries of the Tanana River, which were fed by Alaska Range glaciers. Deposition of these fans forced the Tanana River to aggrade and flow along the northern edge of the lowland. Aggradation caused by overloaded glacial streams was doubtless superimposed on aggradation caused by Pleistocene uplift of the Alaska Range relative to the Tanana Lowland (Wahrhaftig, 1950). Aggradation of the Tanana River raised base level for rivers like the Chena and Little Chena which drained the Yukon-Tanana Upland and forced them to aggrade their valleys and to deposit at least 200 feet of silt, sand, and gravel. Loess blown from the braided river channels of the Tanana Valley to the upland ridges ranges in thickness from a few inches on the higher summits to more than 25 feet on middle slopes.

CLIMATE

The region has a continental climate, characterized by an extreme range of winter and summer temperatures. The minimum recorded temperature at nearby Fairbanks is −66°F., and the maximum is 99°F. (all weather data from U. S. Weather Bureau, 1943). Freezing temperatures occur on a mean of 233 days per year and in every month except July. Mean annual temperature is 26.1° F.

Interior Alaska has warmer summers and more hours of possible sunshine than any other established agricultural area in the State. The growing season averages 97 days for field crops on the flood plain at Fairbanks, but is 123 days on the sunny, southward-facing slopes of the upland.

Mean annual precipitation is 11.7 inches, of which 63 percent falls as rain from May through September. Mean annual snowfall is 66.6 inches. The period from September to May is generally calm but broken by occasional southwesterly storms, and the summer months from June through August are slightly more windy.

GEOLOGIC HISTORY

The only bedrock exposed in the western part of the Big Delta D-6 quadrangle is the Birch Creek schist, a complex group of metamorphosed sedimentary rocks of Precambrian age (Mertie, 1937). Except for metamorphism of the Precambrian sedimentary rocks in at least one episode of diastrophism, little is known of the geologic history of the area until Quaternary time. In the Fairbanks area, to the west, however, this interval is marked by intrusion of granitic rocks in Mesozoic time, deposition of Tertiary sediments and extrusive volcanic rocks, followed by erosion of the Tertiary cover as a result of orogenic movements (Péwé, 1958).

A complex group of Quaternary surficial deposits like those in the western part of the Big Delta D-6 quadrangle is exposed in the placer mining cuts in the Fairbanks D-2 quadrangle to the west. There the sediments record alternating deposition and erosion of silt, sand, and gravel; formation and thaw of permafrost; and climatic fluctuations ranging from a climate warmer than the present to one colder than the present (Péwé, 1952). Similarity of stratigraphic sections, surficial deposits, and landforms of the mapped area to those of the Fairbanks D-2 quadrangle (Péwé, 1958) and the Fairbanks D-1 quadrangle (Williams, Péwé, and Paige, 1959) lead to the belief that the Quaternary history of these areas is essentially the same. Therefore, in the absence of adequate subsurface data in the western part of the Big Delta D-6 quadrangle, much of the Quaternary stratigraphy and geologic history is based on observations made by Péwé in the Fairbanks D-2 quadrangle. See also Tuck (1940) and Taber (1943).

In early Quaternary time, sand and gravel, Qg, were deposited in the creek valleys of the Yukon-Tanana Upland, and also in the Chena and Little Chena Valleys as part of the alluvial fill beneath the present flood plain and terraces, Qal and Qts. Gravel deposition in the upland creek valleys was interrupted by at least two cycles of erosion, but evidence of similar trenching of the thick alluvium in the Chena and Little Chena Valleys is lacking. In the upland, where placer-mining excavations are available for study in the Fairbanks D-2 quadrangle, gold-placer deposits formed in stream channels were buried by a thick, coarse, angular gravel of local lithology during a period of aggradation. In the succeeding cycle of erosion, streams eroded most of the coarse gravel and reconcentrated much of the early placer gold into new placer deposits. During this cycle of erosion, many streams occupied different channels from those in which the placer gold was first deposited, and, therefore, some of the early placer deposits are still preserved as fragmentary bench placers, which are now largely buried by younger silt deposits. Aggradation following the first cycle of erosion was interrupted by a second episode of erosion. These cycles of erosion and aggradation are probably related to changes in base level of the Tanana River.

In later Quaternary time, the Yukon-Tanana Upland was blanketed with Fairbanks loess, Qf, (Péwé, 1955, 1958; Williams, Péwé, and Paige, 1959) blown northward from the flood plains of the Tanana River and its glacier-fed southern tributaries. Much of the upland loess was washed from the hills onto lower slopes and creek-valley bottoms where it became incorporated with much organic debris including vertebrate remains and became perennially frozen. In a subsequent erosional period, probably just before the Wisconsin glacial stage, much of the loess and most of the creek-valley silt deposits were removed, and permafrost was thawed, perhaps completely, by the accompanying mild climate. With the advent of the more severe climate of the Wisconsin glacial stage, deposition of the Fairbanks loess Qf, was again accelerated, and the Little Chena, Chena River, and the upland creeks once again aggraded their channels. As more loess was deposited, some of the younger and older loess was washed to the valleys where more creek-valley fill, Qsu, was formed of the retransported silt, organic material including both carcasses and plant remains, and loess deposited in the creek valleys. The creeks reworked some of this material, carried it downstream, and deposited it in coalescent alluvial fans built at the margins of the Little Chena and Chena Valleys. The creek-valley fill and alluvial-fan deposits were frozen under the prevailing severe climate. Large masses of ground ice were formed in the perennially frozen silt, Qsu, but not in the thin silt alluvial-fan deposits and colluvium, Qsf, which form a thin veneer over alluvial deposits of the Chena Valley and the valley margins. A sample (see map for location) taken from a peat bed separating two silt layers, Qsu, and about 6 feet below the surface was determined (Broecker, Kulp, and Tucek, 1956, p. 157) to be 8,450± 700 years old by the carbon-14 method. About 5,000 to 6,000 years ago a slight amelioration of climate caused thawing of the upper part of the perennially frozen sediments. Since that time, additional loess and creek valley deposits have been formed in the upland. A more severe climate permitted freezing of the newly formed deposits of creek valleys and associated valley-mouth alluvial fans and refreezing of the previously thawed deposits.

The later Quaternary history of the Little Chena and Chena Valleys is obscure. Tributary alluvial fans at the valley margins have covered any terrace deposits that may be present with the exception of the sand deposits of the 30- to 50-foot terrace north of the Chena River flood plain. The sand is probably alluvial, but may in part be eolian. This terrace represents the highest recognizable remnant of an old valley floor and is presumably related to aggradation accompanying the Wisconsin glaciation in the Alaska Range. After the close of the Wisconsin the Little Chena and Chena Rivers began trenching their valley bottom deposits. The record of alternating alluviation and trenching of the alluvial fill since Wisconsin time is complicated by the numerous low terraces (part of Qal) apparently caused by lateral migration of the Tanana, Chena, and Little Chena Rivers with respect to one another.

FOUNDATION PROBLEMS

In the western part of the Big Delta D-6 quadrangle the effect of permafrost and intense seasonal frost action must be considered in addition to the usual foundation problems of temperate climates (Williams, 1955). Foundation conditions are generally fair to good on Birch Creek schist, pЄbc. Most of the unconsolidated Quaternary sediments would provide fair to good foundations if in a mild climate, but in this area the widespread mantle of silt is subject to intense seasonal frost action, especially where poorly drained. Special precautions must therefore be taken in construction of roads, airfields, bridges, unheated buildings, and structures on piers and piling to prevent frost heaving. In addition to removing the fine-grained material to a depth beyond the effect of seasonal frost or improving the drainage, it is in some places possible to anchor the foundation in underlying permafrost to overcome the effect of frost action.

Permafrost, or perennially frozen ground, is defined (Muller, 1947, p. 3) as "thickness of soil, or other superficial deposit, or even of bedrock . . . . . in which a temperature below freezing has existed continually . . . . . for two to tens of thousands of years." It is "defined exclusively on the basis of temperature, irrespective of texture, degree of induration, water content, or lithologic character." Engineering structures in interior Alaska have been extensively damaged because the existence and physical properties of frozen ground were not known prior to construction. Stripping of the insulating vegetation mat over frozen ground in preparation for construction or farming (Péwé, 1954) disturbs the thermal regimen and causes thawing of permafrost. As the ground thaws, the foundation settles differentially causing damage to structures, especially those located on sites underlain by perennially frozen fine-grained sediments that contain large ground ice masses. If the temperature and extent of permafrost are known, it is possible to evaluate potential foundation problems and to decide whether to attempt to thaw perennially frozen ground before construction or to stabilize it for use as a foundation.

Permafrost in the western part of the Big Delta (D-6) quadrangle is similar to that in comparable parts of the Fairbanks (D-2) quadrangle (Péwé, 1958) where two types are recognized: (1) continuous perennially frozen silt with large ice masses, and (2) discontinuous permafrost in silt, sand, gravel, and bedrock with relatively low ice content and no large ice masses. The perennially frozen silt deposits of the flood-plain swales and sloughs, Qs, and of the lower slopes and creek valley bottoms of the Yukon-Tanana Upland, Qsu, are rich in ice veins and stringers and large irregular masses of ice, commonly arranged in polygonal patterns. These frozen silt deposits have an ice content ranging from a few percent by weight to nearly pure ice. They are therefore subject to severe differential settling on thawing and are generally unsatisfactory as foundations unless the permafrost can be kept frozen during and after construction. On the other hand the permafrost in silt, sand, gravel, and bedrock, Qsf, Qal, Qts, and pЄbc, is not subject to differential settling and provides satisfactory foundations.

The area lies within a region that in 1937 and 1947 was shaken by severe earthquakes. In 1937 the epicenter was about 20 miles south of the area (Bramhall, 1938), and in 1947 it was at Clear, approximately 70 miles southwest of the area (St. Amand, 1948). Intensity of the 1947 earthquake at Clear was 8+ (Mercalli scale); at Fairbanks it was intensity 7 with after shocks estimated at intensity 5. Buildings and other structures should be designed to resist strong earth movements.

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MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-297

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By
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1959

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