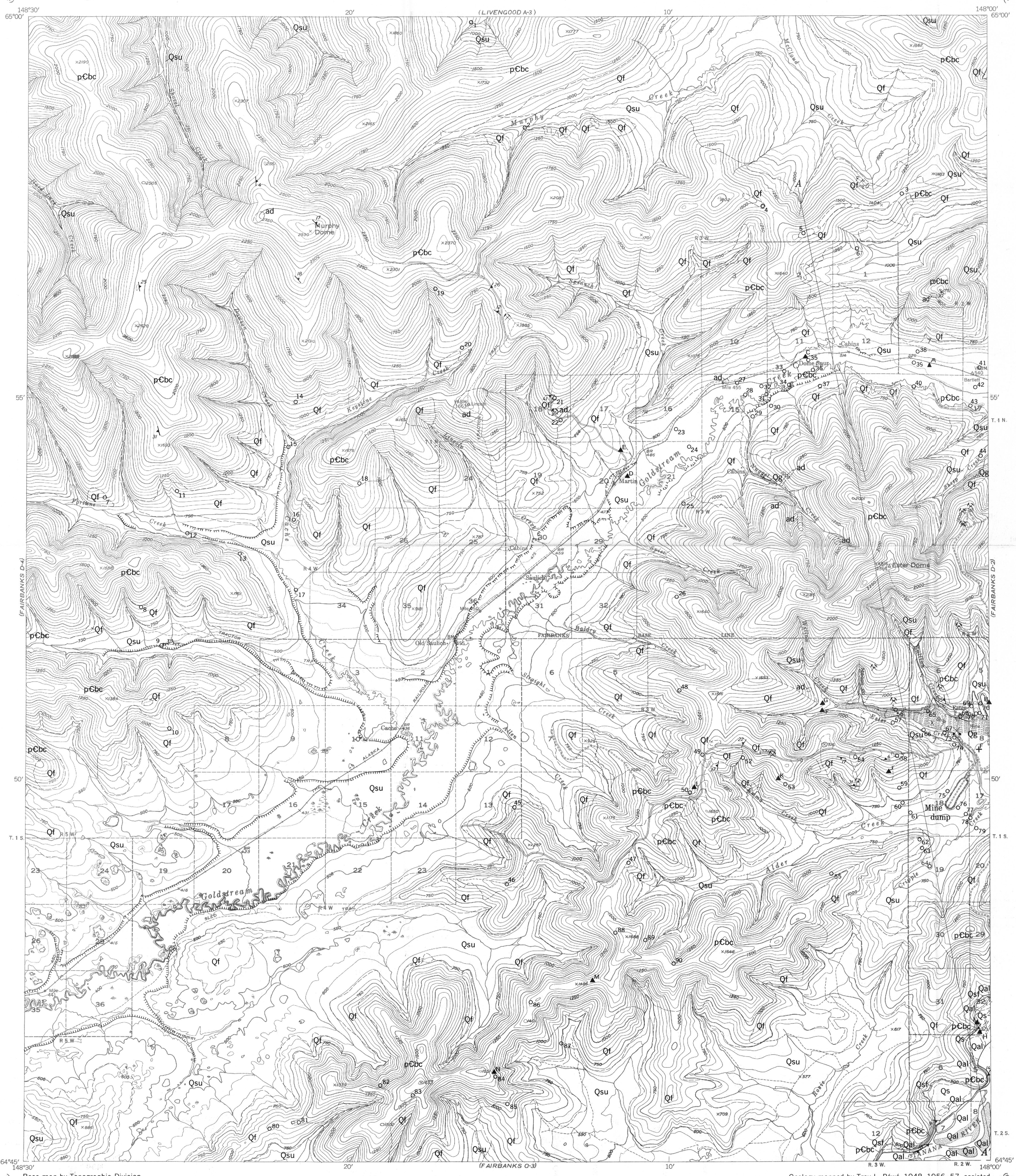
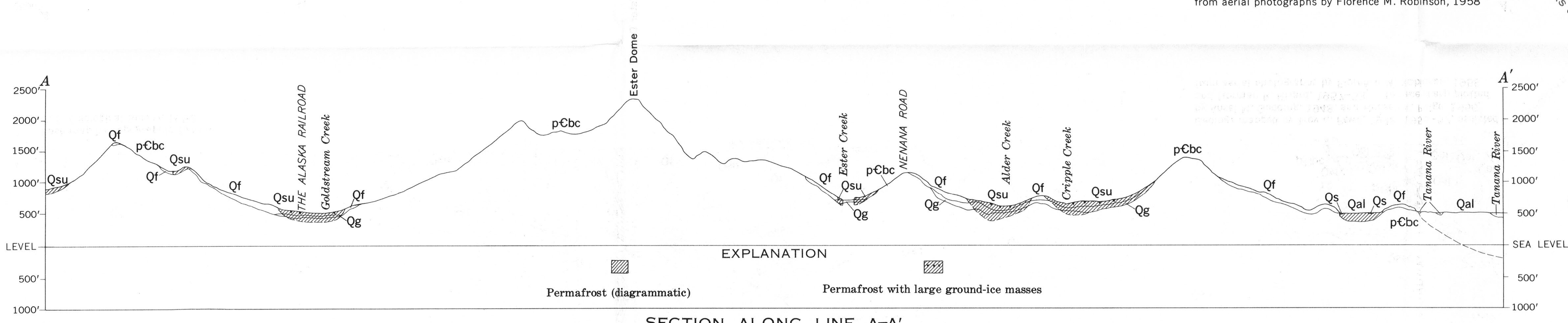


Base map by Topographic Division U. S. Geological Survey, 1952

Geology mapped by Troy L. Péwé, 1948, 1956–57, assisted by Ansel M. Gooding, 1948, and Russell A. Paige, 1956; and Norman R. Rivard, 1957–58. Terrace scarp plotted from aerial photographs by Florence M. Robinson, 1958



SECTION ALONG LINE A–A′

EXPLANATION

A blanket of sediments of Quaternary age a few inches to several hundred feet thick covers nearly all the quadrangle. These sediments are not shown on the map where less than 3 feet thick

SEDIMENTARY ROCKS

YUKON-TANANA UPLAND

Qf

Fairbanks loess

Massive, homogeneous, unconsolidated eolian silt on upper slopes and hilltops. Well sorted, less than 10 percent clay; grains angular, consists mostly of quartz, feldspar, and mica; locally cemented by iron oxide; locally calcareous. Color buff to tan-gray when dry, brown when wet. Locally mottled by iron staining and carbonaceous material. Contains three white volcanic ash beds ½ inch to 6 inches thick

Qsu Qsf

Perennially frozen silt

Qsu, *silt, undifferentiated, consists of eolian silt retransported from hills to lower slopes and valley bottoms. Includes minor amounts of loess. Massive, homogenous, unconsolidated; well sorted, less than 10 percent clay. Grains angular, consisting mostly of quartz, feldspar, and mica; locally cemented by iron oxide. Deposit contains organic material, especially in valley bottoms. Color buff to brown to gray; locally mottled by organic matter and iron staining. Contains large masses of ground-ice.*

Qsf, *silt composing alluvial fans over flood-plain alluvium, small organic content; no large masses of ground-ice*

UNCONFORMITY

Qg

Reworked creek gravel

As mapped, gravel is placer-mine dredge tailings. Undisturbed gravel, shown on accompanying cross section, is buried, except where exposed in walls of excavations. Undisturbed gravel consists of well-stratified layers and lenses of poorly sorted, angular to subrounded, auriferous, sandy creek gravel; color buff to brown with much iron staining; cobbles as much as 24 inches in diameter, composed mostly of quartz, gneiss, and schist. Locally perennially frozen

TANANA LOWLAND

Qal Qs

Flood-plain alluvium

Qal, *well-stratified layers and lenses of unconsolidated gray silt, sand, and rounded river gravel; gravel consists mostly of quartz and gneiss and ranges from ¼ inch to 3 inches in diameter. Locally perennially frozen with low ice content.*

Qs, *swale and slough deposits, consisting of poorly stratified lenses and layers of unconsolidated stream-laid silt and silty sand; fairly well-sorted with 10 to 30 percent clay; grains angular and subrounded, consisting mostly of quartz, mica, and feldspar; contains organic material. Color, brown to grayish blue, mottled with carbonaceous material and iron staining. Perennially frozen, with moderate to high ice content*

QUATERNARY

IGNEOUS AND METAMORPHIC ROCKS

ad

Altered dike rock

Gray to yellowish-brown, porphyritic, medium-grained granitic rock composed mainly of quartz and feldspar. Highly weathered

MESOZOIC

p€bc

Birch Creek schist

Gray to brown graphite, quartz-calcite, and quartz-mica schist, amphibolite, quartzite, slate, and gneiss, seamed with quartz stringers. Original bedding largely obliterated. Includes associated intrusive and extrusive igneous rocks. Locally weathered to depths of more than 50 feet

PRECAMBRIAN

Contact
Dashed where indefinite, gradational, or inferred

Strike and dip of major foliation

Rock quarry

Gravel pit

Placer mine

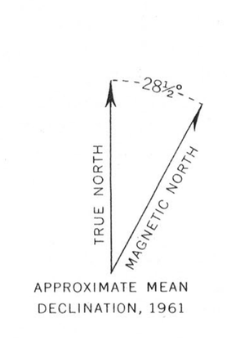
Lode mine (inactive)

Sample site

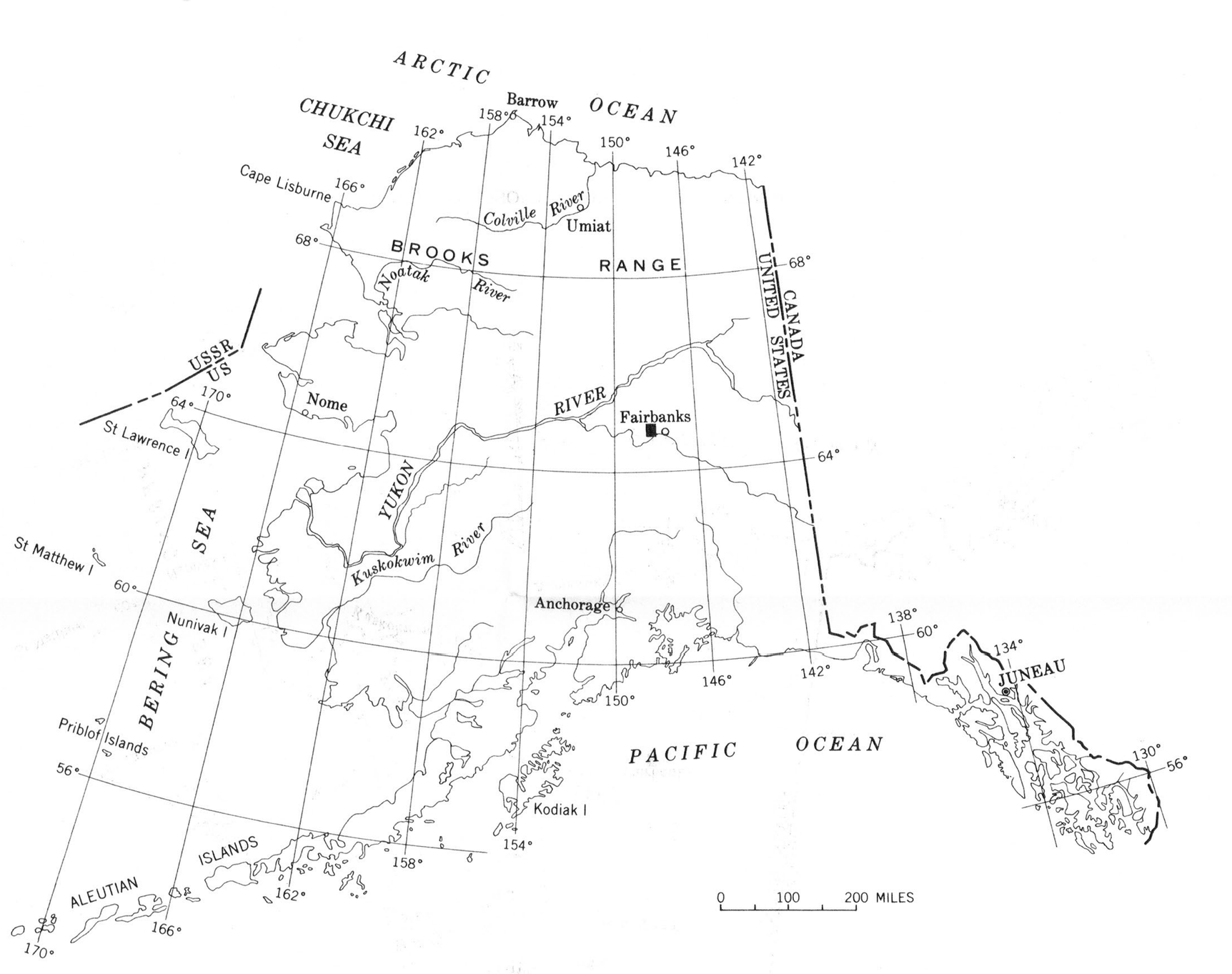
Site of subsurface data

Fossil locality
Quaternary vertebrates

Terrace scarp
Dashed where poorly preserved



APPROXIMATE MEAN DECLINATION, 1961



INDEX MAP SHOWING AREA OF THIS REPORT

DESCRIPTION OF GEOLOGIC UNITS

(See explanation for lithology of 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 USE
Flood plain alluvium (Qal)	Small deposits in southeast quarter of quadrangle. Sec. 32, T. 1 S., R. 2 W.; Secs. 5, 6, 7, 8, T. 2 S., R. 2 W.; Sec. 12, T. 2 S., R. 3 W. Surface layer of silt 1 to 15 feet thick. Total thickness of alluvium adjacent to bedrock hills 1-200 feet.	Flat plain with meandering streams and complex network of shallow swales.	Drainage excellent and permeability high except locally in silt or where perennially frozen. Drainage improves with land clearing and lowering of permafrost table. Subject to flooding.	Depth to permafrost 2-4 feet in older parts of flood plain and more than 4 feet on inside meander curves near river. Depth to permafrost 25-40 feet in some cleared areas. Permafrost absent in many areas, especially beneath lakes, rivers, and creeks. Active layer 2-8 feet thick. Permafrost 5-265 feet thick. Permafrost discontinuous; unfrozen lenses, layers and vertical zones. Low ground-ice content; mostly interstitial. Water table 10-15 feet where permafrost is absent or deep. Data based on information from Fairbanks D-2 quadrangle.	Silt: moderate to intense; sand and gravel: unsusceptible.	High bearing strength when frozen; sand and gravel high when thawed, silt moderate to high when thawed and well drained; low when poorly drained. Slopes may stand at 1:1 to 2/3:1 except in unfrozen sand.	Easily excavated with power equipment except where perennially frozen. Difficult to compact. Very little or no subsidence of ground upon thawing of permafrost.	Good foundation for structures; upper silt layer should be removed if structure is unheated. Gravel good for subgrade, base course, and if crushed and screened, for road metal, concrete aggregate, and railroad-engine sand. Source of tremendous quantities of ground water. Surface silt fair to good for agricultural soil if fertilized.
Flood plain swale and slough deposits (Qs)	Small deposits in southeast quarter of quadrangle. Sec. 32, T. 1 S., R. 2 W.; Secs. 5, 6, 7, T. 2 S., R. 2 W. Forms complex drainage network on flood plain. Thickness generally less than 15 feet; maximum probably 30 feet.	Elongate, sinuous, flat-floored meander and slough scars and wide shallow basin-like areas.	Impermeable substratum of permafrost and organic silt in broad basin-like depressions creates poor drainage; marshy and undrained in summer. Drainage slightly better in linear scars. Drainage in both type areas improves slightly to moderately with land clearing and lowering of the permafrost table. Subject to flooding.	In broad basin-like areas depth to permafrost 1½-2 feet. Active layer 1½-2 feet thick; permafrost 5-30 feet thick and continuous. High ground-ice content of small segregations. May be in contact with underlying permafrost of Qal. In sinuous linear scars depth of permafrost 2-4 feet or absent. Active layer 2-4 feet thick. Permafrost 5-30 feet thick with high ground-ice content of small segregations. Water table 10-15 feet where permafrost absent or deep. Data based on information from Fairbanks D-2 quadrangle.	Intense	High bearing strength when frozen; very low when thawed. Slopes subject to sloughing and landsliding upon thawing until well or moderately drained.	Very difficult to excavate unless thawed. When thawed viscous sediment slides into excavation. Difficult to compact. Moderate subsidence of ground upon thawing of permafrost.	Poor for construction foundation or fill. Should be removed, if possible, prior to construction. Possible source clayey silt.
Fairbanks loess (Qf)	Widespread on hillslopes in quadrangle. Thickness ranges from 3 feet on upper hillslopes to a maximum of perhaps 150 feet on middle slopes and low hill tops. Not mapped on most hill tops and upper slopes, where it exists as a veneer less than 3 feet thick.	Gently rolling hillslopes and low rounded hills. Old, slightly subdued parallel gullies and ridges at right angles to contours characteristic of most upper slopes.	Good surface drainage. Lateral permeability poor to fair; vertical permeability good.	No permafrost. Water table generally deep.	Mild to unsusceptible; locally intense if drainage poor.	High bearing strength when dry and in original position; very low when wet. Will stand in near vertical slopes. Extremely susceptible to gullying; freshly exposed surfaces susceptible to wind erosion.	Easily excavated with hand tools. Difficult to compact.	Source of fines, possible source of impervious fill. Good foundation for heated buildings if protection provided against gullying. Unsurfaced roads unstable-powdery when dry; plastic and sticky when wet. Good agricultural soil if fertilized.
Perennially frozen undifferentiated silt (Qsu)	Widespread in creek valley bottoms throughout the quadrangle. Thickness 3 feet to at least 105 feet. Includes terrace remanents 10-15 feet high in lower and middle Goldstream Valley and tributaries.	Very gentle sloping alluvial fans and colluvial slopes; broad alluviated creek valley bottoms with small lakes. Includes low terrace with many small lakes.	Impermeable substratum of permafrost, especially in valley bottoms, creates poor drainage; marshy and undrained in summer. Land clearing and lowering of permafrost table improves drainage near contact with Fairbanks loess (Qf); produces quagmire in valley bottoms. Permeability low to moderate. Improved drainage along terrace front.	Depth to permafrost 1½-4 feet on lower slopes and creek valley bottoms; 5-20 feet near contact with Fairbanks loess (Qf). Active layer 1½-4 feet thick. Permafrost 3 to at least 170 feet thick; pinches out upslopes; continuous except under lakes and near contact with Fairbanks loess (Qf). Ground-ice abundant as horizontal sheets, vertical sheets, wedges, and saucer-shaped and irregular masses 1-50 feet diameter. Much ice arranged in polygonal network. Depth to ice masses 5-25 feet. Water table below permafrost. Temperature of permafrost averages 31-32°F.	Intense	High bearing strength when frozen or dry; very low when wet or thawed. May stand in near vertical shallow cuts near contact with Fairbanks loess (Qf). Subject to sloughing and landsliding upon thawing; when drained stable at 2/3:1 to 1:1. Very susceptible to gullying.	Very difficult to excavate unless thawed; blasting moderately successful. When thawed viscous sediment slides into excavation except near contact with Fairbanks loess (Qf) or on low hills. Difficult to compact. Great differential ground subsidence upon thawing of permafrost. Formation of thermokarst mounds 10-50 feet diameter and 1-10 feet high and thermokarst pits 3-30 feet diameter and 5-20 feet deep.	Poor foundation for construction; may improve slightly near contact with Fairbanks loess (Qf) with lowering of permafrost table. Source of fines; possible source of impervious fill. Poor to fair for agriculture if fertilized.
Silt composing fan over flood-plain alluvium (Qsf)	Small deposits in southeast quarter of quadrangle. Sec. 32, T. 1 S., R. 2 W.; Secs. 6, 7, T. 2 S., R. 2 W.; Sec. 12, T. 2 S., R. 3 W. Thickness: trace to probably 20 feet.	Gentle sloping alluvial fans from loess-covered hills and overlying floodplain alluvium.	Surface and subsurface drainage generally fair to good, especially after land clearing and lowering of permafrost table. Permeability moderate.	Depth to permafrost 3-25 feet. Active layer 3-4 feet thick. Permafrost 2-30 feet thick and in contact with underlying permafrost of Qal. Discontinuous. Ground-ice content low to moderate, mainly interstitial. Water table 15-30 feet where permafrost absent or deep.	Moderate to intense	High bearing strength when frozen or dry; low when wet or thawed unless well drained. Subject to sloughing and land sliding when thawed and undrained; when drained stable at 2/3:1 to 1:1. Susceptible to gullying.	Can be excavated with hand tools or light power equipment except where perennially frozen. Difficult to compact. Little to moderate ground subsidence upon thawing of permafrost.	Good foundation for heated structures. Unsurfaced roads unstable-powdery when dry; plastic and sticky when wet. Good agricultural soil if fertilized.
Creek gravel (Qg) (including tailings)	Exposed as placer mine dredge tailings on Nugget Creek, Sheep Creek, Willow Creek, Ester Creek, and Bullion Creek. Borings indicate buried gravel under Qsu in most drainage ways in southeastern one-half of quadrangle. Thickness 3-135 feet.	Steep imbricate parabolic symmetrical gravel piles forming rough terrain with some undrained depressions.	Material loose, porous, and slightly compacted. Excellent drainage and permeability except locally where perennially frozen.	Locally perennially frozen. Low ground-ice content.	Unsusceptible	High bearing strength. Slopes generally stable at 1:1.	Easily excavated by power tools. Relatively easily compacted.	Good foundation for any structure if tailing piles leveled. Good for subgrade, ballast, rip rap, pervious fill, and if crushed and screened, good for base course and aggregate.
Altered dike rock (ad)	Small isolated deposits between Murphy Dome and Ester Dome. At least 50 feet thick.	Gently rolling topography. Larger areas generally located on or near hill tops.	Good surface drainage. Low permeability.	Possible local permafrost.	Unsusceptible	High bearing strength. Steep stable slopes.	Weathered material easily excavated with power tools; non-weathered requires blasting. Difficult to compact.	Minor source for road base course material and road metal without crushing.
Birch Creek schist (p€bc)	Exposed on steep faces; also mapped on hill tops and steep slopes throughout the quadrangle where a veneer of less than 3 feet of loess is present. Probably underlies surficial deposits in nearly all the quadrangle. Thickness at least 2000 feet.	Rounded gently rolling topography. Steep slopes adjacent to Qal.	Surface drainage good to excellent. Joints, faults, fracture cleavage, and foliation result in poor to fair permeability. Upper weathered layer 1 to more than 50 feet thick has low permeability.	No permafrost except locally under Qsu and Qg in valley bottoms or on north-facing slopes. Low ground-ice content. Water table generally deep.	Locally moderately susceptible in weathered rock.	High bearing strength in gneissic facies; stands in vertical cuts. Schistose facies high bearing strength if horizontal or vertical; dipping beds moderate bearing strength. Susceptible to sliding and slumping along joint, cleavage, and foliation planes, especially sericite-laden planes.	Schistose facies easily excavated with power tools with only little to moderate blasting; gneissic facies requires additional blasting. Resistant layers more easily excavated where interbedded with schistose rock. Difficult to moderately difficult to compact.	Gneissic facies good for rip rap and ballast, and coarse aggregate; if crushed, good for base course, and road metal; only fair for concrete aggregate. Schistose facies fair for base course material without crushing; breaks down to silt by traffic and frost action.

ANALYSIS OF SAMPLES FOR FAIRBANKS D–3 QUADRANGLE, ALASKA

SOILS (LABORATORY TESTS[1]; SIZE ANALYSIS: Percent smaller than indicated size units in millimeters; MOISTURE CONTENT[4])

Type of material	Sample	Township	Range	Section	¼ Section	¼ of ¼ Section	Date collected	Geologic formation	DESCRIPTION OF MATERIAL	1.65	0.833	0.417	0.175	0.074	0.050	0.022	0.005	Maximum density lb/cu ft	Optimum moisture	Unfrozen: Percent by dry weight	Unfrozen: Depth of sample	Frozen, Permafrost: Percent by dry weight	Frozen, Permafrost: Depth of sample	Frozen, Seasonal frost: Percent by dry weight	Frozen, Seasonal frost: Depth of sample	Frozen, Seasonal frost: Date of collection
SOILS	A[2]	1N	3W	7	SW	SE	10-24-56	Qsu	Silt	100	94	59	26	18	10	7	5			33.19	2 ft			129.85	2 ft	3-18-57
	B[3]	1S	2W	5	SW	NE	9-2-49	Qsu	do	100	100	100	100	96	89	40	8									
	C[2]	1N	3W	11	SE	NW	2-21-56	Qsu	do	100	90	57	22	12	4	1.5	1.5			64.67	4 ft 2 in			62.15	2 ft	2-22-56
	D	1N	3W	20	SE	NW	10-10-56	Qsu	do											37.99	1 ft 6 in			77.15	1 ft 4 in	3-13-57
	E	1N	3W	20	NE	NW	10-10-56	Qf	Loess											15.54	1 ft 2 in			24.60	1 ft 2 in	3-13-57
	F[5]	1S	3W	11	NE	NW	10-5-56	Qsu	Silt													138.78	2 ft 4 in			
	G[5]	1S	3W	11	NE	NW	3-20-57	Qsu	do															142.57	1 ft 4 in	3-20-57
	H	1S	2W	32	SW	SW	10-19-56	Qs	Organic silt											34.67	1 ft 6 in			35.61	1 ft	3-20-57
	I	1S	2W	32	SW	SW	10-19-56	Qf	Loess											26.00	1 ft			57.42	1 ft 2 in	3-20-57

AGGREGATE (after crush)

Sample	Mile post on Fairbanks-Nenana Road	Geologic formation	DESCRIPTION OF MATERIAL	63.50	38.10	25.40	19.05	12.70	9.39	4.70	1.65	0.417	0.175	0.074	Maximum density lb/cu ft	Optimum moisture
J	1.2	p€bc	Decomposed, mica schist	100	97.5	87.2	84.0	76.0	66.2	55.7	39.7	32.5	26.3	2.0	123.0	6.68
K	3.5	p€bc	Decomposed, oxidized mica schist	100	90.5	83.1	77.2	73.1	62.7	49.5	29.0	21.6	14.8	1.2	123.4	10.30
L	5.8	p€bc	Decomposed, oxidized quartz schist	100	100	95.5	93.8	87.1	73.0	56.5	40.1	30.9	22.9	1.1	121.0	10.40
M	9.3	p€bc	Blocky, decomposed quartz schist	100	85.2	75.2	71.0	66.5	59.4	50.9	34.7	26.5	19.3	1.4	120.0	11.90
N	11.6	p€bc	Blocky, mica schist and quartz schist	100	96.5	91.2	88.1	82.7	73.1	61.0	41.1	31.9	24.1	0.8	124.3	6.20

FOOTNOTES

1 All laboratory tests, unless otherwise indicated, by the Fairbanks District of the Bureau of Public Roads, U. S. Department of Commerce.
2 Analysis by Frost Effects Laboratory, Corps of Engineers, U. S. Army, Fairbanks, Alaska.
3 Analysis by Permafrost Division, St. Paul Office, Corps of Engineers, U. S. Army, Fairbanks, Alaska.
4 Moisture content by R. A. Paige, U. S. Geological Survey, Fairbanks, Alaska.
5 In unsurveyed sections.

INTRODUCTION

The Fairbanks D-3 quadrangle, an area of about 250 square miles, is in central Alaska approximately 100 miles south of the Arctic Circle. The eastern boundary of the quadrangle is approximately 10 miles west of Fairbanks, the second largest city in the State. Fairbanks, with a metropolitan area population of 60,000 (1958), is the principal trade center in interior Alaska because of its strategic location with respect to the air, highway, and railroad net of the State. Ester, a small mining community in the D-3 quadrangle, is 11 miles west of Fairbanks.

Placer gold was discovered in 1902 about 12 miles north of Fairbanks and, within a few years, the region became one of the greatest gold-producing regions in Alaska. Early placer mining was by underground methods and by the early 1920's most of the richer deposits were exhausted. In the middle twenties a revival of mining in the Fairbanks gold region occurred that was stimulated by the initiation of large-scale operations with huge gold dredges and hydraulic stripping of the frozen overburden. In 1959 six gold dredges were being operated in the Fairbanks region by the United States Smelting, Refining, and Mining Company. Between 1928 and 1948 more than $100,000,000 worth of gold (at $35 per fine oz.) was mined in the region by this company. In addition to the large-scale operations there were several small-scale operations in the region.

The quadrangle includes a part of the Tanana Valley agricultural area, which ranks second in crop value among Alaskan farming districts. Farming dates from the early days of the local placer-mining camps and today provides dairy products, livestock, oats, barley, spring wheat, potatoes, garden vegetables, and other products.

The major portion of the quadrangle is accessible either by secondary roads or by railroad. The Alaska Railroad closely parallels Goldstream Creek through the sediment-filled Goldstream Valley. A major part of the southeastern portion of the quadrangle is readily accessible from the newly constructed Fairbanks-Nenana road.

Most of the quadrangle is covererd by a mantle of unconsolidated deposits that provide the parent material for agricultural soils and foundation and construction materials. A large proportion of the unconsolidated deposits and some of the bedrock is perennially frozen. The geologic map, therefore, emphasizes the unconsolidated deposits and distribution and extent of permafrost or perennially frozen ground.

Selected subsurface data summarized on the map were furnished by the United States Smelting, Refining, and Mining Company, U. S. Bureau of Public Roads, and local residents.

Data on the engineering properties of the material were obtained from field observations of their behavior in various engineering and agricultural uses and from laboratory tests made by Federal agencies. Generalizations presented on engineering properites of the unconsolidated and bedrock units may be useful in preparation of preliminary plans and designs, but they are not intended to replace standard field and laboratory investigations required for the design of specific structures.

PHYSICAL SETTING

Physiography—With the exception of a small area, the southeastern part of the quadrangle constituting the Tanana Valley flood plain, the entire quadrangle lies within the Yukon-Tanana upland, a west trending highland between the Yukon and Tanana Rivers. The upland is a maturely dissected area of accordant rounded ridges 2,000 to 3,000 feet high. Scattered discontinuous groups of higher mountains project above the upland ridges to an altitude of 5,000 to 6,000 feet. The upland is part of a larger area of rolling country in central Alaska between the Brooks and Alaska Ranges.

Central Alaska has not been glaciated except in small local mountain masses, but glaciers from the Brooks Range on the north, the Alaska Range on the south, and the Yukon Plateau on the east almost surrounded the interior of Alaska during times of glacial maxima. Glaciers from the Alaksa Range probably approached to within 50 miles of Fairbanks, and during glacial advances the heavily loaded rivers deposited several hundred feet of silt, sand, and gravel in the Tanana and Yukon valleys. Aggradation of the trunk valleys raised base level and caused tributaries from the unglaciated Yukon-Tanana upland to aggrade their lower valleys. More than 300 feet of sediment was deposited in creek valleys of the upland in the vicinity of Fairbanks. Loess, ranging in thickness from a few inches on summits to more than 100 feet on middle slopes, blankets the ridges of the upland.

Climate—The Fairbanks D-3 quadrangle has a continental climate characterized by an extreme range between summer and winter temperatures. The absolute minimum recorded at Fairbanks is −66°F; the absolute maximum is 99°F. The mean annual number of days with freezing temperature is 233, and freezing temperatures have been reported in every month except July. The mean annual temperature is 26.1°F. Interior Alaska has the warmest summers and more hours of possible summer sunshine than any other agricultural area in the State. The growing season on south-facing hill slopes is about 123 days for field crops.

The mean annual precipitation is 11.7 inches, and 63 percent of the annual precipitation falls from May through September. The mean annual snowfall is 66.6 inches. The wind regimen in central Alaska is, in general, composed of a long relatively calm winter period from September to May and a short, slightly windy summer period from June to August.

GEOLOGIC HISTORY

The oldest formation exposed in the Fairbanks D-3 quadrangle is the metasedimentary Birch Creek schist of Precambrian age, which underlies nearly all of the area. Associated intrusive and extrusive igneous rocks, also of Precambrian age, were included with the Birch Creek schist in mapping. The Birch Creek schist and associated igneous rocks were metamorphosed, probably in more than one period of diastrophism. Events subsequent to this period of metamorphism and prior to the intrusion of granitic rock in Mesozoic time are unknown. The gold mineralization in the area probably accompanied the period of igneous intrusion.

Although the Tertiary record in the interior of Alaska is only imperfectly known, it is believed that continental Tertiary sediments with local lava flows once covered much of the Yukon-Tanana upland. Perhaps a marine embayment in which marine or estuarine sediments were deposited extended into central Alaska as far as Fairbanks. Erosion, following orogenic movement, removed most of the Tertiary sediments from the upland during later Tertiary time.

A complex series of events took place in Quaternary time. Stratigraphic studies of the Quaternary deposits show a record of alternate deposition and erosion of silt and gravel, the formation and destruction of permafrost, and climatic fluctuations ranging from a climate warmer than that now to one colder than the present. In early Quaternary time gold placers were formed in creek valleys of the upland; later, much gravel alluviation took place in these valleys. This early period of gravel deposition was followed by erosion and removal of most of this course, angular, local gravel. Streams reconcentrated much of the gold in the earlier placers and deposited additional gold placers. Most of the stream channels of the second period of gold concentration are offset from the location of the earlier channels, and, therefore, some of the first placer accumulations still exist as fragmentary bench deposits. A second cycle of much gravel alluviation and subsequent erosion followed.

In later Quaternary time the hills were blanketed with loess derived from the flood plain of the Tanana River and glacial outwash plains south of the Fairbanks D-3 quadrangle. Much of this windblown silt was retransported to the valley bottoms, incorporated with much organic debris, including vertebrate remains, and became perennially frozen. Much of the loess and most of the valley bottom silt was removed during a later erosional period that immediately preceded Wisconsin events. Permafrost thawed and perhaps disappeared during this warm interval. It is thought that the fragmentary terraces on Goldstream and other creeks remain as physiographic evidence of this erosional period.

In late Quaternary time more loess was deposited on hills and valleys of the upland; organic silts accumulated in valley bottoms, became frozen, and large ground-ice masses formed. Abundant mammal remains, including partial carcasses, became entombed in this frozen, organic silt. About 5,000 to 6,000 years ago a slight warming of the climate caused a small amount of the permafrost to thaw. Since then additional loess and organic material have been deposited and cooling of the climate has caused the organic silt in valley bottoms to become perennially frozen. All the upland loess of Quaternary age in the Fairbanks area was named the Fairbanks loess for exposures near the city of Fairbanks. Excellent exposures occur in the placer excavations in the Fairbanks D-3 quadrangle in the center of Sec. 8, T. 1 S., R. 2 W.

During Quaternary time the sedimentary fill of the Tanana Valley probably was also modified by alternating periods of erosion and deposition and the formation and destruction of permafrost; however, information is not available to permit reconstruction of a detailed history.

GENERAL FOUNDATION CONDITIONS

In addition to considering conventional foundation problems, engineers in this area must also consider problems caused by permafrost and intense seasonal frost action. Foundation conditions are good in areas where igneous rocks are exposed and fair to good on Birch Creek schist. Most of the sediments would provide fair to good foundation if they were in the temperate latitudes; however, in this area the widespread blanket of silt is subject to intense seasonal frost action, especially where poorly drained, and special precautions must be taken for the construction of roads, airfields, bridges, unheated buildings, and structures on piers or piling to prevent frost heaving. In addition to removing the fine-grained material or improving the drainage, it is locally possible to anchor a foundation in the underlying permafrost to overcome the effect of seasonal frost action.

Permafrost is one of the most important factors to consider when evaluating foundation conditions in this area. Permafrost, or perennially frozen ground, is defined as soil or bedrock in which a temperature below freezing has existed continuously for a long time; it is thus defined exclusively on the basis of temperature, irrespective of texture, degree of induration, water content, or lithologic character. The destructive action of thawing of permafrost has materially impeded the development of the far northern part of the continent. Engineering structures have been extensively damaged because the existence and condition of the frozen ground was not known prior to construction and the behavior of frozen ground was little understood. Stripping of the insulating vegetation cover from the frozen ground in preparation for construction or farming disturbs the thermal regimen and causes thawing of the permafrost. As the ground thaws, foundations settle differentially causing great damage to structures. If the type and extent of permafrost are known, it is possible to evaluate the problem and determine whether to thaw the ground prior to construction or to use a more passive method and attempt to leave the permafrost undisturbed and frozen so that it will form a firm foundation.

Permafrost in the Fairbanks D-3 quadrangle is of two types: (1) continuous perennially frozen silt with large ice masses, and (2) discontinuous permafrost in silt, sand, and gravel with relatively low ice content and no large ice masses. The perennially frozen fine-grained sediments (Qs and Qsu) present many foundation problems, but the frozen coarse-grained sediments cause relatively little trouble.

The Fairbanks D-3 quadrangle lies in a major earthquake zone. In 1937 and again in 1947 severe earthquakes shook the area. The epicenter of the 1937 earthquake was at Salcha about 25 miles southeast of Fairbanks, and in 1947 it was near Clear about 55 miles southwest of Fairbanks. The intensity of the 1947 quake at the epicenter was 8+ on the Mercalli scale; at Fairbanks it was estimated to be 7. Aftershocks were large, reaching intensity of 5 at Fairbanks. In addition to historic records, post-Wisconsin fault scarps 75 miles away on the south side of the Tanana Valley indicate major seismic activity in the last few thousand years. Knowledge of past seismic activity in the area indicates that buildings should be designed to withstand major earthquake shocks.

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SELECTED SUBSURFACE DATA

(Number of item below refers to number by small circle on map.)

1. 0-1.2 ft loess. Schist at 1.2 ft
2. 0-6 ft organic silt. Poorly rounded creek gravel at 6 ft
3. 0-4.0 ft loess. No bedrock encountered
4. 0-4.0 ft loess. Schist at 4.0 ft
5. 0-3.0 ft loess. No bedrock encountered
6. 0-2.5 ft loess. Schist at 2.5 ft
7. 0-3.0 ft loess. No bedrock encountered
8. 0-3.0 ft loess. No bedrock encountered
9. 0-6 ft organic silt. Poorly rounded creek gravel at 6 ft
10. 0-3.0 ft loess. No bedrock encountered
11. 0-3.0 ft loess. Schist at 3.0 ft
12. 0-8 ft organic silt. Poorly rounded creek gravel at 8 ft
13. 0-1.2 ft loess. Schist at 1.2 ft
14. 0-1.5 ft loess. Schist at 1.5 ft
15. 0-4 ft organic silt. Poorly rounded creek gravel at 4 ft
16. 0-1.0 ft loess. Schist at 1.0 ft
17. 0-8 ft organic silt. Poorly rounded creek gravel at 8 ft
18. 0-2.0 ft loess. Schist at 2.0 ft
19. 0-1.0 ft loess. Schist at 1.0 ft
20. 0-2.0 ft loess. Schist at 2.0 ft
21. 0-3.1 ft loess. Schist at 3.1 ft
22. 0-2.4 ft loess. Schist at 2.4 ft

*23. 0-48 ft silt, 48-95 ft creek gravel, 95-100 ft bedrock. Permafrost 2-100 ft
*24. 0-43 ft silt, 43-94 ft creek gravel, 94-99 ft bedrock. Permafrost 2-99 ft
25. 0-2.0 ft loess. Schist at 2.0 ft
26. 0-1.5 ft loess. Schist at 1.5 ft
27. 0-38 ft silt, 38-71 ft creek gravel
28. 0-25 ft silt, 25-90 ft creek gravel
*29. 0-28 ft silt. 28-114 ft creek gravel. Permafrost 2-114 ft
*30. 0-30 ft silt, 30-80 ft creek gravel, 80-85 ft bedrock. Permafrost 2-85 ft
*31. 0-30 ft silt, 30-87 ft creek gravel, 87-93 ft bedrock. Permafrost 2-93 ft
*32. 0-92 ft silt, 92-118 ft creek gravel, 118-124 ft bedrock. Permafrost 2-124 ft
*33. 0-40 ft silt, 40-54 ft creek gravel. Permafrost 2-54 ft
34. 0-26 ft silt, 26-66 ft creek gravel
*35. 0-36 ft silt, 34-46 ft creek gravel, 46-50 ft bedrock. Permafrost 2-50 ft
*36. 0-23 ft silt, 23-43 ft creek gravel, 43-47 ft bedrock. Permafrost 2-47 ft
*37. 0-94 ft silt, 94-105 ft creek gravel, 105-112 ft bedrock. Permafrost 2-112 ft
*38. 0-63 ft silt, 63-77 ft creek gravel, 77-91 ft bedrock. Permafrost 2-91 ft
*39. 0-28 ft silt, 28-42 ft creek gravel, 42-48 ft bedrock. Permafrost 2-48 ft
*40. 0-9 ft silt, 9-33 ft creek gravel, 33-37 ft bedrock. Permafrost 2-37 ft
*41. 0-39 ft silt, 39-79 ft creek gravel, 79-84 ft bedrock. Permafrost 2-84 ft
*42. 0-25 ft silt, 25-77 ft creek gravel, 77-82 ft bedrock. Permafrost 2-82 ft
*43. 0-16 ft silt, 16-27 ft creek gravel, 27-33 ft bedrock. Permafrost 2-33 ft
*44. 0-76 ft silt, 76-103 ft creek gravel. Permafrost 2-103 ft
45. 0-6.5 ft loess. Schist at 6.5 ft
46. 0-2.0 ft loess. Schist at 2.0 ft
47. 0-2.0 ft loess, 2-4.5 ft schist
48. 0-2.5 ft loess. Schist at 2.5 ft
49. 0-2.0 ft loess. Schist at 2.0 ft
50. 0-2.0 ft loess, 2-4 ft schist
51. 0-2.8 ft loess. Schist at 2.8 ft
52. 0-1.0 ft loess, 1-5 ft schist
53. 0-2.0 ft loess, 2-6 ft schist
54. 0-3.2 ft loess. Schist at 3.2 ft
55. 0-2.0 ft silt. Schist at 2.0 ft
56. 0-4.5 ft silt, 4.5-27.5 ft creek gravel
57. 0-31.5 ft silt, 31.5-37.5 ft creek gravel
58. 0-3.5 ft loess. Schist at 3.5 ft
59. 0-72 ft silt, 72-175 ft creek gravel. No permafrost
60. 0-43 ft silt, 43-169 ft creek gravel. No permafrost
61. 0-82 ft silt, 82-182 ft creek gravel. Permafrost 2-170 ft
62. 0-54 ft loess, 54-86 ft creek gravel
63. 0-96 ft loess, 96-152 ft creek gravel. No permafrost
64. 0-75 ft silt, 75-140 ft creek gravel. Permafrost 2-105 ft
65. 0-49 ft silt, 49-62 ft creek gravel. Bedrock at 62 ft. Permafrost 11-34 ft
*66. 0-77 ft silt, 77-92 ft creek gravel. Permafrost 2-92 ft
67. 0-96 ft silt, 96-114 ft creek gravel. Bedrock at 114 ft. Permafrost 2-96 ft
68. 0-19.5 ft silt, 19.5-46 ft creek gravel
*69. 0-63 ft silt, 63-91 creek gravel. Permafrost 2-91 ft
*70. 0-100 ft silt, 100-112 ft creek gravel. Permafrost 2-112 ft
*71. 0-89 ft silt, 89-102 ft creek gravel. Permafrost 2-102 ft
*72. 0-80 ft silt, 80-84 ft creek gravel. Permafrost 2-84 ft
*73. 0-66 ft silt, 66-77.5 ft creek gravel, 77.5-79 ft bedrock. Permafrost 2-79 ft
74. 0-102.5 ft silt, 102.5-120 ft creek gravel. Bedrock at 120 ft. No permafrost
75. 0-105 ft silt, 105-188 ft creek gravel. Permafrost 2-46 ft
76. 0-101 ft silt, 101-190 ft creek gravel. Permafrost 2-115 ft
*77. 0-100 ft silt, 100-150 ft creek gravel. Permafrost 2-150 ft
78. 0-78 ft silt, 78-213 ft creek gravel. Permafrost 2-137 ft
79. 0-99 ft silt, 99-115 ft creek gravel. Permafrost 2-113 ft
80. 0-9.5 ft loess. No bedrock encountered
81. 0-2.5 ft loess. Schist at 2.5 ft
82. 0-1.0 ft loess, 1-5 ft schist
83. 0-4.0 ft loess. Schist at 4.0 ft
84. 0-1.5 ft loess, 1.5-5 ft schist
85. 0-3.3 ft loess. Schist at 3.3 ft
86. 0-1.0 ft loess, 1-4 ft schist
87. 0-3.0 ft loess. Schist at 3.0 ft
88. 0-1.0 ft loess, 1-4 ft schist
89. 0-1.5 ft loess. Schist at 1.5 ft
90. 0-1.0 ft loess. Schist at 1.0 ft

*In permafrost at bottom of hole.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—61025

GEOLOGIC MAP AND SECTION OF THE FAIRBANKS D–3 QUADRANGLE, ALASKA

By
Troy L. Péwé and Norman R. Rivard

SCALE 1:63360

CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

1961

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-340

For sale by U. S. Geological Survey, price 50 cents