DESCRIPTION OF MAP UNITS

Map units	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
Bedrock (I)	Exposed on hilltops and steep slopes where loess cover less than 3 ft thick. Upper weathered layer layer 1–3 ft thick on upper slopes; more than 75 ft thick on lower slopes	Rounded, gently rolling topography. Steep slopes adjacent to river flood plain	Surface drainage good to excellent. Joints, faults, fracture cleavage, and foliation result in poor to fair permeability. Upper weathered layer has low permeability	Locally perennially frozen under muck and tailings in creek valley bottoms and on north-facing slopes. Depth to permafrost on north-facing slopes 1–4 ft; locally 1–100 ft. Low ice content as interstitial ice in unweathered bedrock; low to moderate ice content as seams and interstitial ice in weathered bedrock. Water table generally deep	Moderately susceptible in weathered bedrock	High bearing strength in fresh bedrock; generally high in weathered bedrock if ice content low or absent. Highest bearing strength on horizontal or vertically slumping along joint, cleavage, and foliation planes, especially mica-laden planes	Weathered bedrock easily excavated with hand or power tools except where frozen. Unweathered schist generally is easily excavated with power tools with only little to moderate blasting; some varieties, especially the quartzite facies and vein quartz, may require additional blasting. Resistant where interbedded with schistose rocks. Difficult to moderately difficult to compact both weathered and unweathered bedrock	Schist varieties good for unclassified embankment fill; fair for selected use such as base course if processed; breaks down to silt with repeated traffic and frost action. Harder varieties, such as the quartzite facies and vein quartz, good for riprap and ballast, and coarse aggregate; if processed, good for base course and road metal; All varieties, especially marble facies, are good as decorative rocks
Tailings (II)	Placer-mine dredge tailings on Gold Hill, Ester Creek, and Cripple Creek. Thickness, 3 to more than 75 ft	Steep, imbricate, parabolic, symmetrical gravel piles forming rough terrain with some undrained depressions. Leveled in places	Material loose, porous, and slightly compacted. Excellent drainage and permeability except where locally perennially frozen	Locally perennially frozen; low ice content, primarily interstitial	Unsusceptible	High bearing strength. Slopes generally stable at 1:1	Easily excavated by power tools except where frozen. Relatively easily compacted	Good foundation for any structure if tailing piles leveled. Good for subgrade, ballast, riprap, pervious fill, and, if crushed and screened, for base course and aggregate. Possible sites for sanitary landfill
River gravel (III)	Covers most of southern half of the quadrangle. Surface layer of silt 1–15 ft thick. Total thickness of alluvium adjacent to bedrock hills 1–200 ft; thickness as much as 400 ft near Tanana River	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 ft in older parts of flood plain and more than 4 ft on inside of meander curves near river. Depth to permafrost 25–40 ft in some cleared areas. Permafrost absent or deep beneath lakes, rivers, and creeks. Seasonal frost layer 2–9 ft thick. Permafrost 2–275 ft thick. Permafrost discontinuous; unfrozen lenses, layers, and vertical zones. Low ground-ice content and mostly interstitial in sand and gravel; ice content low to moderate in top silt layer. Water table 10–15 ft where permafrost absent or deep	Silt, moderate to high; 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 frozen. Difficult to compact. Slight subsidence in silt when thawed; very little or no subsidence in sand and gravel when thawed	Good foundation for structures; upper silt layer should be removed to prevent frost heaving if structure is unheated. Gravel good for subgrade, base course, and if crushed and screened, for road metal and concrete aggregate. Source of tremendous quantities of ground water. Surface silt fair to good for agricultural soil if fertilized. Generally unsatisfactory for sanitary landfill site because of high water table
Loess (IV)	Widespread on middle and upper slopes and on lower hilltops. Thickness ranges from 3 ft on upper slopes to a maximum of more than 200 ft on middle slopes. Not mapped where less than 3 ft thick	Gently rolling terrain with 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	Generally permafrost free. Permafrost with little or no ice content may be present on north-facing slopes. Water table deep	Moderate to unsusceptible; locally high 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 except where frozen. Difficult to compact	Source of fine-grained sediment, possible source of impervious fill and unclassified embankment fill. Good foundation for heated structures if protection is provided against gullying. Unsurfaced roads unstable; powdery when dry, plastic and sticky when wet. Good agricultural soil if fertilized. Possible sites for sanitary landfill
Alluvial-fan silt (V)	Alluvial fan extending onto flood plain of Tanana and Chena Rivers. Thickness 1 to more than 50 ft	Gently sloping alluvial fan emanating from loess-covered hills	Surface and subsurface drainage generally fair to good, especially after land clearing and lowering of permafrost table. Permeability moderate	Depth to permafrost 3–25 ft. Active layer 3–4 ft. Permafrost 2–155 ft thick and in contact with underlying river sand and gravel. Discontinuous. Moderate to low ice content, primarily as pore ice, but may contain ice seams and lenses. No large ice masses. Water table 15–30 ft where permafrost absent or deep	Moderate to high	High bearing strength when frozen or dry; low when wet or thawed unless well drained. Subject to sloughing and 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 frozen. Difficult to compact. Little to moderate subsidence when thawed	Good foundation for heated buildings. Unfrozen silt possible source of unclassified embankment fill if moisture content low. Unsurfaced roads unstable; powdery when dry, plastic and sticky when wet. Good agricultural soil if fertilized. Unfrozen and well-drained areas are possible sanitary landfill sites
River silt (VI)	Widely distributed in a complex drainage network on flood plain in southern half of the quadrangle as broad basinlike areas and elongate, sinuous, meander scars. Thickness generally less than 15 ft, maximum probably more than 30 ft	Elongate, sinuous, flat-floored, meander and slough scars and wide shallow basinlike areas. Some intermittent streams present	Impermeable substratum of permafrost and organic silt in broad basinlike depressions creates poor drainage; marshy and undrained in summer. Drainage slightly better in linear scars. Drainage in both types improves slightly to moderately with land clearing and lowering of permafrost table. Subject to flooding	Depth to permafrost 1½–4 ft. Active layer 1½–4 ft. Permafrost 5–30 ft thick; continuous in broad basins; discontinuous in meander scars, generally absent in young sloughs. May be in contact with underlying permafrost of river sand and gravel. Moderate to high ice content as thin seams and lenses. Water table 10–15 ft where permafrost absent or deep	High	High bearing strength when frozen; very low when thawed. Slopes subject to sloughing and sliding upon thawing until well or moderately well drained	Very difficult to excavate unless thawed; when thawed, viscous sediment slides into excavation; difficult to compact. Moderate subsidence when thawed	Poor for construction foundation or fill; should be removed prior to construction. Possible source of clayey silt. Unsatisfactory for sanitary landfill sites because of high water table and permafrost
Muck VII	Widespread on lower slopes and valley bottoms. Thickness 3–30 ft	Very gently sloping alluvial fans and colluvial slopes; broad alluviated creek valley bottoms with 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 loess; produces quagmire in valley bottoms. Permeability low to moderate	Depth to permafrost 1½–3 ft on lower slopes and valley bottoms, 5–20 ft near the contact with the loess, 10–25 ft under cleared areas. Seasonal frost layer 1½–3 ft thick. Permafrost 3–30 ft; pinches out upslope; continuous except under lakes and near contact with the loess. Ice content high as seams and lenses in upper 3–30 ft, high in lower part (unit VIII) as seams, lenses, and large foliated ice masses arranged in polygonal pattern. Water table below permafrost. Permafrost temperature averages 31°–32°F. Pingos occur locally	High	High bearing strength when frozen or dry; very low when wet or thawed. May stand in near-vertical shallow cuts near contact with the loess. Subject to sloughing and sliding upon thawing; when drained, stable at 2/3:1. Very susceptible to gullying	Very difficult to excavate unless thawed; blasting moderately successful. When thawed, viscous sediment slides into excavation except near contact with loess or on low hills. Difficult to compact. Great differential subsidence when thawed	Poor foundation for construction. Upon thawing of permafrost, thermokarst mounds 10–50 ft in diameter and 1–10 ft high and pits 3–30 ft in diameter and 5–20 ft deep form on surface. Condition may improve near contact with the loess where permafrost table is lower and permafrost sporadic. Can serve as solid foundation if permafrost is prevented from thawing and structures are designed to absorb frost-heaving effects. Source of fine-grained sediment; possible source of impervious fill. Poor to fair for agriculture if fertilized. Unsatisfactory for sanitary landfill site unless permafrost is prevented from thawing or landfill is frozen
Peat muck VIII	Occurs in valley bottoms. Thickness 10 to more than 300 ft	Flat fans with small steep-sided cave-in lakes and a pattern of trenches 1–4 ft deep and 2–5 ft wide in polygonal network	Impermeable substratum of permafrost and organic material creates very poor drainage; marshy and undrained in summer. Land clearing produces summer quagmire. Permeability poor	Depth to permafrost 1½–3 ft. Seasonal frost layer 1½–3 ft. Permafrost 1½–140 ft thick; continuous except under lakes. Ground–ice content high as seams, lenses, and large foliated ice masses 1½–10 ft below the surface. Water table below permafrost. Pingos occur locally	High	High bearing strength when frozen; Very low when thawed. Slopes in cuts subject to sloughing and sliding upon thawing	Very difficult to excavate unless thawed; blasting only moderately successful. When thawed, viscous sediment slides into excavation. Difficult to compact. Great differential subsidence when thawed	Very poor foundation for construction of any sort. Thawing of permafrost results in formation of thermokarst mounds 1–10 ft high and 10–50 ft in diameter and pits 3–30 ft in diameter and 5–20 ft deep. Can serve as solid foundation only if permafrost is prevented from thawing and the structure is designed to absorb frost-heaving effects. Poor for agriculture. Poor for sanitary landfill sites. Good for mosquito studies
Peat (IX)	Occurs in broad, oval-shaped areas in valley bottoms. Thickness 3 to more than 20 ft	Flat peat-filled lake basins	Impermeable substratum of permafrost and organic silt creates very poor drainage; marshy and undrained in summer land clearing produces summer quagmire. Permeability poor	Depth to permafrost 1½–3 ft. Seasonal frost layer 1½–3 ft. Permafrost more than 20 ft thick; continuous except under lakes. Ice content high as seams and lenses; large foliated ice masses in underlying silt. Water table below permafrost	High	High bearing strength when frozen: very low when thawed. Slopes in cuts subject to sloughing and sliding upon thawing	Very difficult to excavate unless thawed; blasting only moderately successful. When thawed, viscous sediment slides into excavation. Difficult to compact. Great differential subsidence when thawed	Very poor foundation for construction of any sort. Good source of raw peat in thawed areas; excavation pits generally need dewatering for peat excavation. Poor for agriculture. Poor for sanitary landfill sites

ENVIRONMENTAL GEOLOGY AND FOUNDATION PROBLEMS

In the Fairbanks area, the effects of development on the geologic environment must be considered in determining proper land use. Persons concerned with the land, in particular, land planners, developers, public officials, engineers, architects, financial institutions, and educators, must be aware of recognizable geologic features that may prove hazardous; only then can proper and economical land usage be assured.

To provide a background for people concerned with the land, basic data from the geologic map of the Fairbanks D–2 SW quadrangle (Péwé and others, 1976), the map showing distribution of permafrost in the Fairbanks D–2 SW quadrangle (Péwé and Bell, 1974) and the map showing ground-water conditions in the Fairbanks D–2 SW quadrangle (Péwé and Bell, 1976a) have been recast into this foundation map. The description of units outlines in simple and basic terms the major problems and the various foundation conditions found in the quadrangle.

Not only do conventional foundation and constructional problems occur, but unique problems related to permafrost and seasonal frost action complicate otherwise normal land use. The bedrock is, in general, a solid foundation that presents no major problem. Most of the unconsolidated sediments would provide fair to good foundation in more temperate latitudes. In the Fairbanks area, however, the widespread blanket of silt is very susceptible to intense seasonal frost action, especially where poorly drained. Theoretical frost-heaving forces are given below. To prevent frost heaving, special precautions must be taken in the construction of roads, airfields, bridges, unheated buildings, and structures on piers or pilings. At some places, the silt can be removed; in others, drainage must be improved. It is also possible to anchor structures in the underlying permafrost to eliminate the effects of frost heaving.

Permafrost is critical in evaluating land use. Permafrost, or perennially frozen ground, is defined as soil or bedrock that remains at or below 32°F for 2 or more years. In this area, as well as in other parts of the North, many types of structures have been extensively damaged because the existence and nature of the frozen ground were little understood.

The first step in preparing the land for construction or farming is usually the stripping of the vegetative cover, an operation that disturbs the natural thermal equilibrium and causes thawing of nearby permafrost. As the ground thaws, the ground surface and anything on it settle differentially, sometimes producing severe damage. The type and extent of permafrost vary, and the consequences of building on ice-rich ground vary as well.

The foundation map presents as much data as possible on engineering problems that would be found in any particular area. Information is presented on frost heaving and permafrost and on general ground stability and soil properties.

Nine foundation units are defined: I, bedrock; II, tailings; III, river gravel; IV, loess; V, alluvial-fan silt; VI, river silt; VII, muck; VIII, peat muck; IX, peat. Each unit poses different foundation problems, depending upon the presence and type of permafrost, the mechanical properties of the material, whether or not it is consolidated, and its characteristics upon thawing. The conditions within a unit are generalized and may vary locally, especially near contacts.

The most critical foundation problem is the existence of large, massive ground-ice masses in the reworked valley-bottom silts (units VII, VIII, and IX). Small ice wedges occur locally in some broad river-silt deposits (unit VI) of the flood plain.

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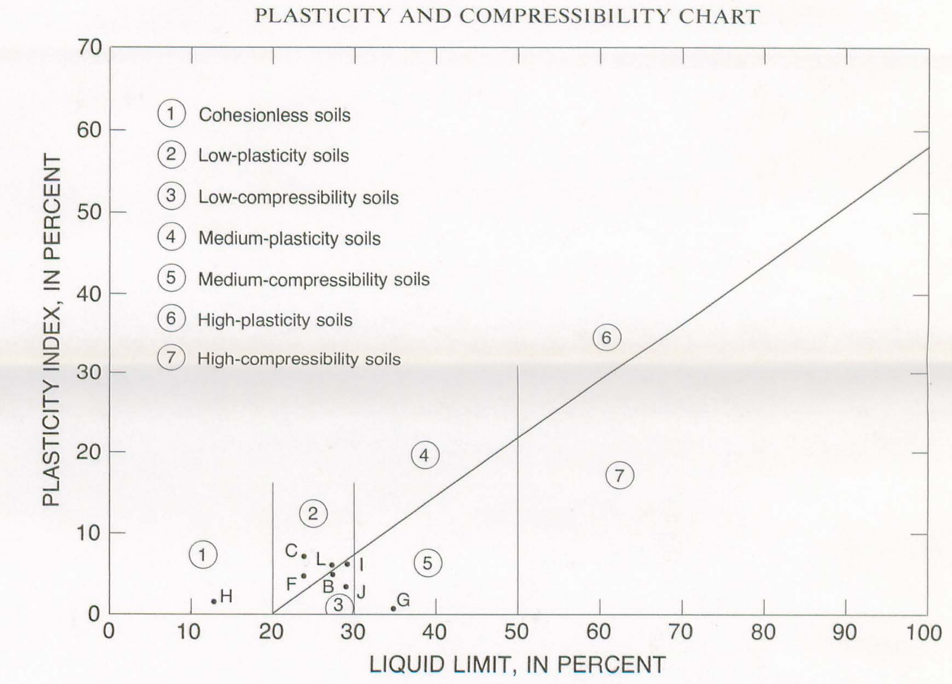
POSSIBLE EFFECTS OF FROST HEAVING

Date	Depth of frost penetration, in feet	Maximum force pushing upward, in pounds
November 1	1	21,600
December 1	1½	32,400
January 1	2	43,200
February 1	3	64,800
March 1	4	86,400
April 1	4½	97,200

Hypothetical example of seasonal frost penetration into silt in central Alaska and possible upward push on 40-inch-perimeter pile (ground temperature constant). (Péwé and Paige, 1963, table 6.)

PLASTICITY AND COMPRESSIBILITY CHART



Relation of plasticity and compressibility to plasticity index and liquid limit for samples (indicated by letters) in the Fairbanks D–2 SW quadrangle. Although none of the samples fall into groups 4, 6, or 7, it does not necessarily mean that these groups are absent from the area. After Legget (1967, fig. 5)

ANALYSES OF SAMPLES FROM FAIRBANKS D–2 SW QUADRANGLE

SAMPLE — DESCRIPTION OF MATERIAL — LABORATORY TESTS[1]

Soils (mechanical analyses: percentage of sample smaller than grain size listed; grain size in millimetres; U.S. Standard sieve size or inches given in parentheses)

Type of material	Sample letter	Township	Range	Section	¼ section	¼ of ¼ section	Map unit	Description of material	Grain size	0.833	0.417 (#40)	0.175	0.074 (#200)	0.050	0.022	0.005					A.A.S.H.O.[2] classification	Specific gravity	Maximum density (lb/ft^3)	Theoretical density (lb/ft^3)	Percent voids	Unit weight (lb/ft^3) loose	Unit weight (lb/ft^3) dry rodded	Adsorption (percent)	Los Angeles abrasion test (percent loss)	Liquid limit	Plastic limit	Plasticity index	Unfrozen: percent by dry weight	Unfrozen: depth of sample	Frozen, permafrost: percent by dry weight	Frozen, permafrost: depth of sample	Frozen, seasonal frost[3]: percent by dry weight	Frozen, seasonal frost: depth of sample	Date collected
SOILS	A	1S	1W	6	NW	SW	Loess	Windblown upland silt																															
	B	1S	2W	1	NE	SW	Loess	Windblown upland silt					93.2	82.0	44.5	19.0				[4]	A–4(8)	2.81	105.9	120.0	8.78					27.5	22.6	4.9	18.0	2 ft	No permafrost		17.29	1 ft	1–24–56
	C	1S	2W	16	NE	NW	Loess	Windblown upland silt					97.2		31						A–4(8)	2.77								24.0	16.7	7.3							
	D	1S	2W	33	NE	NW	Loess	Windblown upland silt			100		97.3		14						A–4(8)	2.70								ND	ND	ND							
	E	1S	2W	11	SE	SE	Alluv.-fan silt	Reworked silt over river gravel			99		97.4								A–4(8)	2.68								23.2	NP	NP							
	F	1S	2W	12	NE	NW	Alluv.-fan silt	Reworked silt over river gravel					98.46	91.5	48.0	12.0				[4]	A–4(8)	2.45	103.6	109.4	9.4					24.1	19.4	4.7	25.90	3 ft 6 in.	ND	ND	30.81	1 ft	1–24–56
	G	1S	2W	1	SW	SW	Alluv.-fan silt	Reworked silt over river gravel			100		97.0								A–4(8)	2.65								34.6	34.0	0.6							
	H	1S	2W	1	SE	NW	Alluv.-fan silt	Reworked silt over river gravel			100		95.6								A–4(8)	2.77								12.9	11.0	1.9							
	I	1N	1W	31	NE	NW	Muck	Reworked valley-bottom silt					95.30	92.0	56.0	22.5				[4]	A–4(8)	2.34	108.0							29.7	23.0	6.7	17.0	2 ft 6 in.	52.6[6] 38.6[6]	16 ft[6] 40 ft[6]	36.24	1 ft	1–24–56
	J	1N	2W	35	SE	NW	Muck	Reworked valley-bottom silt			99		96.1								A–4(8)									29.3	25.3	4.0							
	K	1S	2W	8	NW	NE	Muck	Reworked valley-bottom silt		100	100	100	90	72	38						A–4(8)									ND	ND	ND							
	L	1S	1W	7	SW	SW	River silt	River slough and top silt			100		98		75	20				[5]	A–4(8)	2.78				59	66			27.2	21.2	6.0			50.7	4 ft 5 in.			April 1969
	M	1S	1W	5	NE	SE	River silt	River slough and top silt					92.73								A–4(8)	2.50	89.8	101.2	8.87					25.6	NP	NP	ND	ND	ND	ND	ND	ND	
	N	1N	1W	32	SW	SE	Peat	Peat-rich valley bottom silt														ND	ND	ND						ND	ND	ND	641.00	1 ft 5 in.	82.60	2 ft 1 in.	1176.0	1 ft	1–24–56

Aggregates (after crush)

Type of material	Sample letter	Township	Range	Section	¼ section	¼ of ¼ section	Map unit	Description of material	Grain size	38.10 (1½")	25.40 (1")	19.05 (¾")	12.70 (½")	9.39 (⅜")	4.76 (#4)	2.0 (#10)	1.65	0.417 (#40)	0.175	0.074 (#200)	A.A.S.H.O.[2] classification	Specific gravity	Maximum density (lb/ft^3)	Theoretical density (lb/ft^3)	Percent voids	Unit weight loose	Unit weight dry rodded	Adsorption (percent)	Los Angeles abrasion test (percent loss)	Liquid limit
AGGREGATES (AFTER CRUSH)	O	1S	1W	5	NE	SE	River gravel	River gravel: quartz, 50 percent; gneiss, 25 percent; schist, 6 percent; chert, 6 percent; slate, 5 percent; diorite, 3 percent; other, 5 percent (before crush)		91.1	84.9	74.0	60.2	46.8	35.2		30.0	24.0	7.5	6.6	A–1–a	2.63	109.1	124.7	8.8	ND	ND	1.32		25.6
	P	1S	2W	13	NW	NW	River gravel	River sand and gravel (before crush)		97	87	77	63	54	33.2	24		20		5.1	A–1–a	2.70				120.8	132.8		28	NV
	Q	1S	2W	14	SW	SE	River gravel	River silty, sandy gravel (before crush)		99	97	90	73	60	42.8	38		34		7.7	A–1–b	2.65				118.4	131.2		28	NV
	R	1S	2W	23	SW	SW	River gravel	River sandy gravel (before crush)		100	98	96	77	65	41.5	32		24		0.6	A–1–a	2.63				123.6	128.8		ND	NV
	S	1S	2W	28	SW	NE	River gravel	River sandy gravel (before crush)		99	94	83	59	44	29.2	26		23		4.7	A–1–a	2.66				120.0	126.8		29	NV
	T	1S	2W	28	SE	SW	Bedrock	Weathered schist			99	97	93	88	71.8	55		35		18.9	A–2–4	2.76				ND	ND		ND	31.4
	U	1S	2W	33	NW	NW	Bedrock	Weathered schist		92	88	83	76	71	55.2	46		28		13.5	A–1–b	2.80				ND	ND		ND	NV
	V	1S	2W	29	NE	SW	Bedrock	Weathered schist		90	82	75	68	62	50.4	40		23		6.7	A–1–a	2.79				ND	ND		ND	NV
	W	1S	2W	20	NW	SE	Bedrock	Weathered schist			99	98	95	90	71.6	56		33		18.2	A–2–4	2.76				ND	ND		ND	21.6
	X	1S	2W	16	SW	NE	Bedrock	Weathered brown micaceous schist with 15–20 percent siliceous lenses				100	97	93	75.8	47		26		10.0	A–1–a	2.79				97.6	109.6		ND	NV
	Y	1S	2W	16	SW	NE	Bedrock	Hard siliceous and micaceous schist with weathered micaceous schist				100	98	96	85.0	65		40		23.3	A–2–4	2.70				91.6	100.0		ND	NV
	Z	1S	2W	11	SW	SW	Bedrock	Weathered schist			99	96	91	88	78.6	71		56		30.1	A–2–4	2.79				ND	ND		ND	NV

Heavy-mineral analysis of sample A[7]

Mineral	Numerical frequency, in percent
Opaque	37.0
Zoisite	10.3
Hornblende	10.1
Garnet	9.6
Epidote	7.2
Unknown fragments	6.0
Clinozoisite	3.8
Augite	3.1
Sphene	3.1
Tourmaline	2.8
Hypersthene	2.6
Zircon	1.9
Apatite	1.4
Rutile	0.7
Enstatite	0.2
Tremolite	0.2

Separation made with acetylene tetrabromide; permanent mount made in canada balsam; 415 grains counted. Opaque minerals approximately 70 percent magnetite and ilmenite. All isotropic grains listed as garnet

Footnotes

[1] All laboratory tests, except where noted, by Fairbanks District of the Alaska Road Commission Department of Interior, and its successor, the Alaska Department of Highways.
[2] American Association of State Highway Officials.
[3] Moisture content by R. A. Paige.
[4] Analysis by Frost Effects Laboratory, Corps of Engineers, U.S. Army, Fairbanks, Alaska.
[5] Analysis by Permafrost Division, St. Paul office.
[6] Moisture content by Dr. E. B. Rice, University of Alaska. Samples collected by Maurice Butler, Fairbanks, Alaska.
[7] Analysis by T. L. Péwé.

NV = Not viscous
NP = Not plastic
ND = No data

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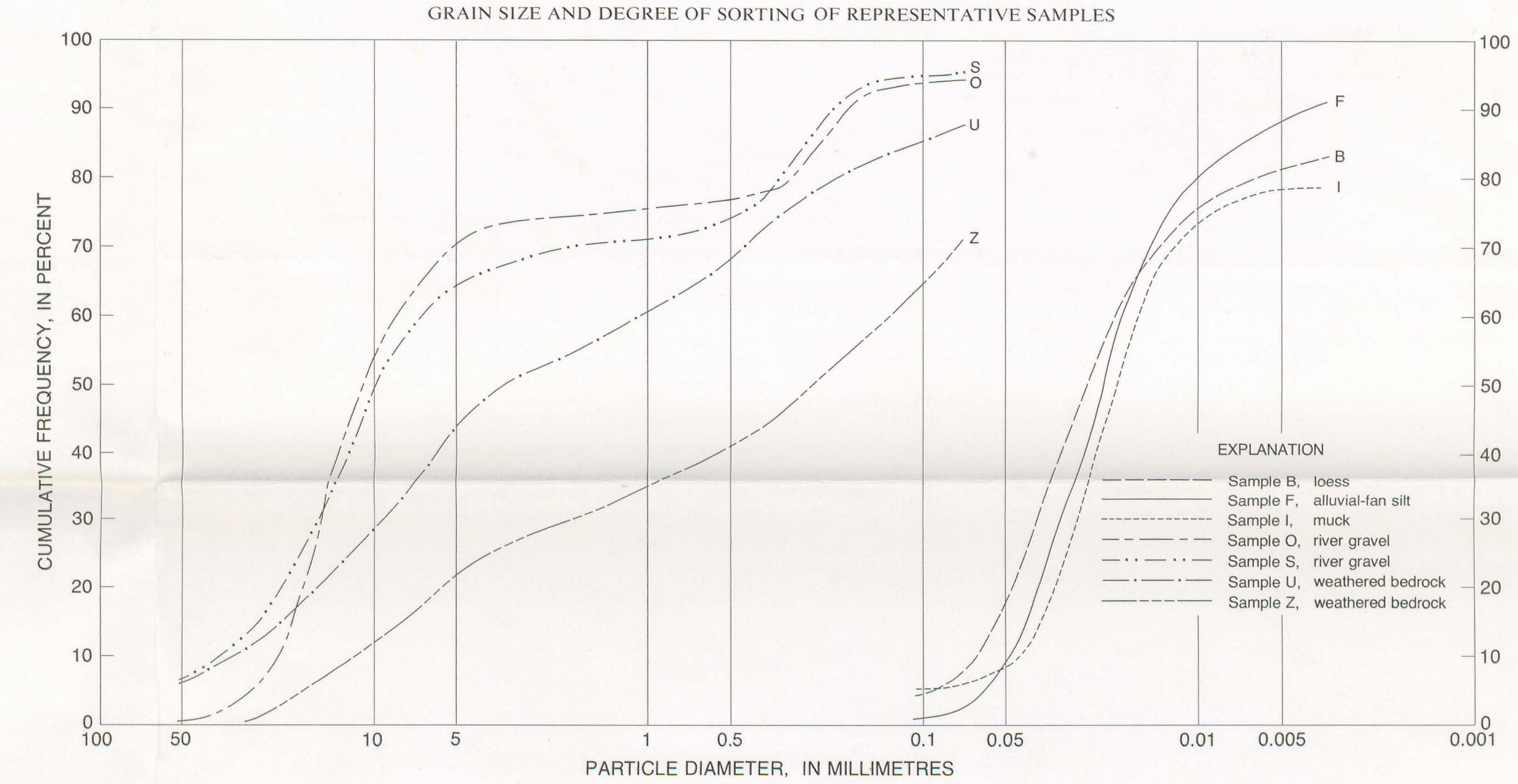
GRAIN SIZE AND DEGREE OF SORTING OF REPRESENTATIVE SAMPLES



The graph shows the frequency of occurrence of particles of various sizes in several types of foundation materials from the Fairbanks D–2 SW quadrangle. The slope of a curve indicates the degree of sorting of the materials; the steeper the slope, the higher the degree of sorting

DATA SHEET FOR MAP SHOWING FOUNDATION CONDITIONS IN THE FAIRBANKS D–2 SW QUADRANGLE, ALASKA

By
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1976