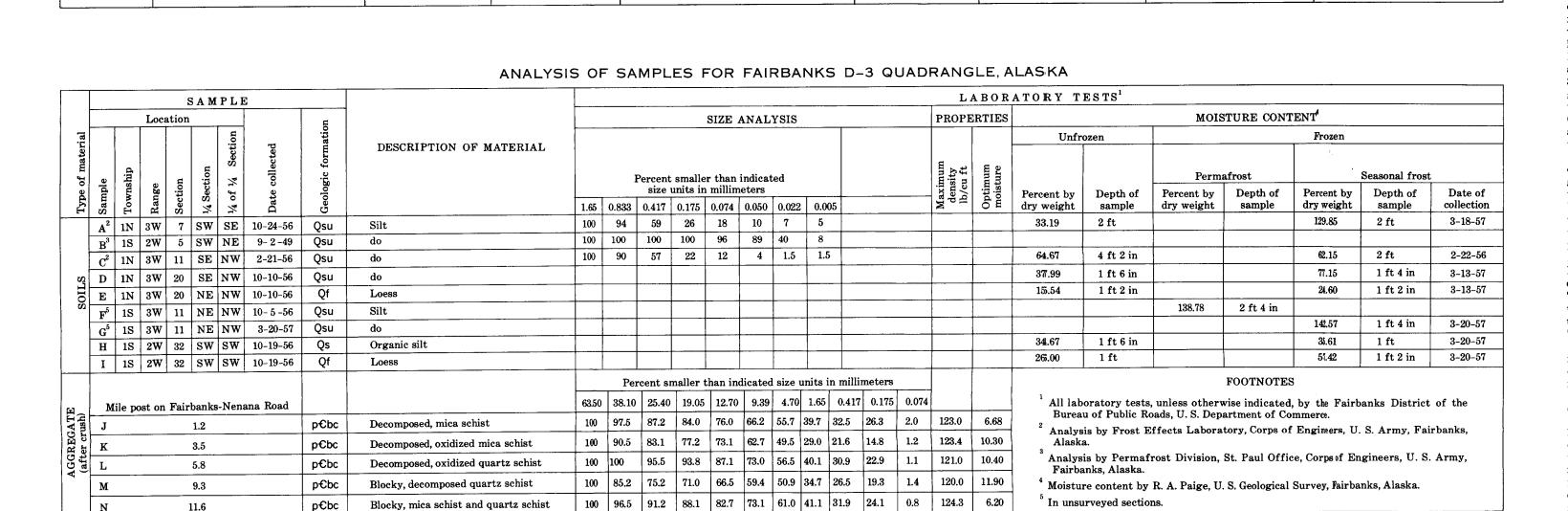


EXCAVATION BEARING STRENGTH SUSCEPTIBILITY DISTRIBUTION TERRAIN DRAINAGE GEOLOGIC PERMAFROSI SLOPE STABILITY COMPACTION NATURAL SLOPES PERMEABILITY THICKNESS UNIT Prainage excellent and | Depth to permafrost 2-4 feet in older parts | Silt: moderate to in-High bearing strength when Easily excavated with power Good foundation for structures; Small deposits in southeast quarter of Flat plain with mean-Flood plain quadrangle. Sec. 32, T. 1 S., R. 2 W.; of flood plain and more than 4 feet on inside frozen; sand and gravel high equipment except where perupper silt layer should be remove dering streams and permeability high extense; sand and Secs. 5, 6, 7, 8, T. 2 S., R. 2 W.; Sec. 12, when thawed, silt moderate to ennially frozen. Difficult to if structure is unheated. Gravel meander curves near river. Depth to perhigh when thawed and well compact. Very little or no good for subgrade, base course T. 2 S., R. 3 W. Surface layer of silt 1 shallow swales. mafrost 25-40 feet in some cleared areas. drained; low when poorly subsidence of ground upon and if crushed and screened, for to 15 feet thick. Total thickness of Permafrost absent in many areas, especially drained. Slopes may stand at thawing of permafrost. proves with land beneath lakes, rivers, and creeks. Active road metal, concrete aggregate alluvium adjacent to bedrock hills 1:1 to 2/3:1 except in unfrozen clearing and lowering and railroad-engine sand. Source layer 2-8 feet thick. Permafrost 5-265 feet of tremendous quantities of of permafrost table. thick. Permafrost discontinuous; unfrozen ground water. Surface silt fair to Subject to flooding. good for agricultural soil if fertilized. 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. High bearing strength when Very difficult to excavate Poor for construction foundation or Small deposits in southeast quarter of | Elongate, sinuous, Impermeable substra-In broad basin-like areas depth to permafrost | Intense quadrangle. Sec. 32, T. 1 S., R. 2 W.; unless thawed. When thawed flat-floored meander tum of permafrost 1½-2 feet. Active layer 1½-2 feet thick; frozen; very low when fill. Should be removed, if possiswale and thawed. Slopes subject to viscous sediment slides into ble, prior to construction. Pos-Secs. 5, 6, 7, T. 2 S., R. 2 W. Forms and slough scars and and organic silt in permafrost 5-30 feet thick and continuous slough desloughing and landsliding excavation. Difficult to comsible source clayey silt. complex drainage network on flood wide shallow basinbroad basin-like de-High ground-ice content of small segregaposits pact. Moderate subsidence tions. May be in contact with underlying upon thawing until well or plain. Thickness generally less than 15 pressions creates poor of ground upon thawing of feet; maximum probably 30 feet. permafrost of Oal. In sinuous linear scars drainage; marshy and moderately drained. permafrost. depth of permafrost 2-4 feet or absent undrained in summer. Drainage slightly Active layer 2-4 feet thick. Permafrost 5-30 feet thick with high ground-ice content better in linear scars. Drainage in both type of small segregations. Water table 10-15 areas improves slight feet where permafrost absent or deen. ly to moderately with Data based on information from Fairbanks land clearing and low-D-2 quadrangle. ering of the perma-frost table. Subject to flooding. Good surface drainage. No permafrost. Water table generally deep. Mild to unsusceptible; High bearing strength when Easily excavated with hand Source of fines, possible source of Fairbanks loess | Widespread on hillslopes in quadrangle. | Gently rolling hillimpervious fill. Good foundation locally intense if dry and in original position; tools. Difficult to compact. Thickness ranges from 3 feet on upper poor to fair; vertical for heated buildings if protection very low when wet. Will hillslopes to a maximum of perhaps provided against gullying. Unsurstand in near vertical slopes 150 feet on middle slopes and low hill slightly subdued parallel gullies and Extremely susceptible to gul tops. Not mapped on most hill tops when dry; plastic and sticky when ridges at right anlying; freshly exposed sur and upper slopes, where it exists as a wet. Good agricultural soil if faces susceptible to wind veneer less than 3 feet thick. gles to contours fertilized. characteristic of erosion. most upper slopes. Depth to permafrost 1½-4 feet on lower Intense Very difficult to excavate Poor foundation for construction High bearing strength when Widespread in creek valley bottoms | Very gentle sloping Impermeable substraslopes and creek valley bottoms; 5-20 feet unless thawed; blasting modmay improve slightly near contact frozen or dry; very low when throughout the quadrangle. Thickness alluvial fans and tum of permafrost, erately successful. When with Fairbanks loess (Qf) with near contact with Fairbanks loess (Qf). wet or thawed. May stand 3 feet to at least 105 feet. Includes colluvial slopes: especially in valley undifferentiate thawed viscous sediment lowering of permafrost table. Active layer 1½-4 feet thick. Permafrost in near vertical shallow cuts terrace remanents 10-15 feet high in broad alluviated bottoms, creates poor slides into excavation except Source of fines; possible source of 3 to at least 170 feet thick; pinches out near contact with Fairbanks lower and middle Goldstream Valley creek valley bottoms drainage: marshy and loess (Qf). Subject to sloughimpervious fill. Poor to fair for upslopes; continuous except under lakes near contact with Fairbanks with small lakes. and tributaries. undrained in summer. loess (Qf) or on low hills. agriculture if fertilized. ing and landsliding upor and near contact with Fairbanks loess (Qf). Land clearing and Includes low terrace Difficult to compact. Great Ground-ice abundant as horizontal sheets, thawing; when drained stable with many small lowering of permadifferential ground subsidat 2/3:1 to 1:1. Very suscepvertical sheets, wedges, and saucer-shaped tible to gullying. ence upon thawing of permaand irregular masses 1-50 feet diameter drainage near contact frost. Formation of thermowith Fairbanks loess Much ice arranged in polygonal network. karst mounds 10-50 feet (Qf); produces quag-Depth to ice masses 5-25 feet. Water table diameter and 1-10 feet high mire in valley bottoms. below permafrost. Temperature of permaand thermokarst pits 3-30 frost averages 31-32°F. Permeability low to feet diameter and 5-20 feet moderate. Improved drainage along ter-High bearing strength when Can be excavated with hand Good foundation for heated struc-Small deposits in southeast quarter of Gentle sloping alluvial Surface and subsurface | Depth to permafrost 3-25 feet. Active layer | Moderate to intense frozen or dry; low when wet tools or light power equip- tures. Unsurfaced roads unstablequadrangle. Sec. 32, T. 1 S., R. 2 W.; fans from loess-cov drainage generally 3-4 feet thick. Permafrost 2-30 feet thick ment except where perenor thawed unless well drained. powdery when dry; plastic and flood-plain Secs. 6, 7, T. 2 S., R. 2 W.; Sec. 12, ered hills and overfair to good, especially and in contact with underlying permafrost nially frozen. Difficult to Subject to sloughing and land after land clearing T. 2 S., R. 3 W. Thickness: trace to lying floodplain alluof Oal. Discontinuous. Ground-ice conalluvium sliding when thawed and compact. Little to moderate tural soil if fertilized. and lowering of pertent low to moderate, mainly interstitial. probably 20 feet. ground subsidence upor mafrost table. Per Water table 15-30 feet where permafrost stable at 2/3:1 to 1:1. Susthawing of permafrost. meability moderate. absent or deep. Exposed as placer mine dredge tailings | Steep imbricate para- | Material loose, porous, | Locally perennially frozen. Low ground-ice | Unsusceptible High bearing strength. Slopes | Easily excavated by power | Good foundation for any structure on Nugget Creek, Sheep Creek, Willow bolic symmetrical and slightly comgenerally stable at 1:1. tools. Relatively easily comif tailing piles leveled. Good for (Qg) (including subgrade, ballast, rip rap, pervious pacted. Excellent Creek, Ester Creek, and Bullion Creek. gravel piles forming fill, and if crushed and screened rough terrain with drainage and perme-Borings indicate buried gravel under good for base course and aggreability except locally some undrained de Osu in most drainage ways in southwhere perennially froeastern one-half of quadrangle. Thick-High bearing strength. Steep Weathered material easily ex- Minor source for road base course Good surface drainage. | Possible local permafrost. Small isolated deposits between Murphy | Gently rolling topog-Altered dike cavated with power tools; non-weathered requires blastmaterial and road metal without Dome and Ester Dome. At least 50 generally located on ing. Difficult to compact. or near hill tops.



| Surface drainage good | No permafrost except locally under Qsu and | Locally moderately

table generally deep.

slopes. Low ground-ice content. Water

EXPLANATION A blanket of sediments of Quaternary age a covers nearly all the quadrangle. These sediments are not shown on the map where less than 3 feet thick SEDIMENTARY ROCKS YUKON-TANANA UPLAND TANANA LOWLAND Fairbanks loes Perennially frozen silt Massive, homogeneous, unconsolidated eolian Qsu, silt, undifferentiated, consists of eolian silt retransported from hills to lower sloves silt on upper slopes and hilltops. Well and valley bottoms. Includes minor sorted, less than 10 percent clay; grains angular, consists mostly of quartz, feldspar, amounts of loess. Massive, homogenous, unconsolidated; well sorted, less than 10 and mica; locally cemented by iron oxide; locally calcareous. Color buff to tan-gray percent clay. Grains angular, consisting when dry, brown when wet. Locally motnostly of quartz, feldspar, and mica; locally tled by iron staining and carbonaceous cemented by iron oxide. Deposit contains material. Contains three white volcanic organic material, especially in valley botash beds 1/2 inch to 6 inches thick toms. Color buff to brown to gray; locally mottled by organic matter and iron staining. Contains large masses of ground-ice. Flood-plain alluvium Qsf, silt composing alluvial fans over flood-Qal, well-stratified layers and lenses of unconplain alluvium, small organic content; no large masses of ground-ice solidated 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 UNCONFORMITY with low ice content. Qs, swale and slough deposits, consisting of poorly stratified lenses and layers of unconsolidated stream-laid silt and silty sand; Reworked creek gravel fairly well-sorted with 10 to 30 percent clay; As mapped, gravel is placer-mine dredge angular to subrounded, auriferous, sandy grains angular and subrounded, consisting tailings. Undisturbed gravel, shown on creek gravel; color buff to brown with much mostly of quartz, mica, and feldspar; conaccompanying cross section, is buried, iron staining; cobbles as much as 24 inches tains organic material. Color, brown to grayish blue, mottled with carbonaceous except where exposed in walls of excava- in diameter, composed mostly of quartz, tions. Undisturbed gravel consists of well- gneiss, and schist. Locally perennially material and iron staining. Perennially frozen, with moderate to high ice content stratified layers and lenses of poorly sorted, frozen IGNEOUS AND METAMORPHIC ROCKS ad Altered dike rock Gray to yellowish-brown, porphyritic medium-grained granitic rock composed mainly of quartz and feldspar. Highly 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 Contact Dashed where indefinite, gradational, o Strike and dip of major foliation Gravel pi Placer mine Lode mine (inactive Sample site DECLINATION, 1961 Site of subsurface data Fossil locality Terrace scarp Dashed where poorly preserved

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 day 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 covered 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 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. Generaliza tions 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

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 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

PHYSICAL SETTING

Physiography — With the exception of a

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

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 posited on hills and valleys of the upland: organic silts accumulated in valley bottoms,

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.

became frozen, and large ground-ice masses

formed. Abundant mammal remains, includ-

ing partial carcasses, became entombed in

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 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

INDEX MAP SHOWING AREA OF THIS REPORT

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 prepara tion 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

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major earthquake shocks.

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tory of southern Alaska: a hypothesis:

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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 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. Bedck 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

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

*In permafrost at bottom of hole.

| High bearing strength in | Schistose facies easily excava- | Gneissic facies good for rip rap and

only little to moderate blast-

ing; gneissic facies requires

additional blasting. Resistant

layers more easily excavated

schistose rock. Difficult to

moderately difficult to com-

crushed, good for base course, and

aggregate. Schistose facies fair

traffic and frost action.

where interbedded with crushing; breaks down to silt by

for base course material without

to excellent. Joints, | Qg in valley bottoms or on north-facing | susceptible in weath- gneissic facies; stands in ver- ted with power tools with ballast, and coarse aggregate; if

tical cuts... Schistose facies

high bearing strength if hori-

zontal or vertical; dipping

strength. Susceptible to

beds moderate bearing

sliding and slumping along

joint, cleavage, and foliation

planes, especially sericite-

CONTOUR INTERVAL 50 FEET

Birch Creek

(p€bc)

Exposed on steep faces; also mapped on Rounded gently rolling

hill tops and steep slopes throughout

the quadrangle where a veneer of less

than 3 feet of loess is present. Prob-

ably underlies surficial deposits in

nearly all the quadrangle. Thickness

at least 2000 feet.

topography. Steep

slopes adjacent to

faults, fracture cleav-

age, and foliation re-

sult in poor to fair

permeability. Upper

weathered laver 1 to

more than 50 feet

thick has low perme-

ability.