OPEN-FILE REPORT
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	MATERIALS	DISTRIBUTION AND THICKNESS	TERRAIN AND NATURAL SLOPES	DRAINAGE AND WATER TABLE	PERMAFROST AND FROST SUSCEPTIBILITY	SUITABILITY FOR CONSTRUCTION
Cliffhead dune deposits (e)	Medium to fine sand, sandy silt, and silt interbedded with some peat and brush and forest vegetation.	Formed chiefly along leeward, generally north banks of major streams by wind deposition of material from exposed bluffs in a narrow band along the top of the bluff. Deposits extensive only in the Chitina area where strong winds from the Copper River canyon transport silt and silty sand well back from the bluffs. Thickness less than 10 m.	Normally forms narrow ridges having dune form at top of river bluffs with a back slope of 30 to 50 percent. Forms near vertical face at top of freshly undercut bluffs. Locally forms mantle on older deposits back from river bluffs.	Normally well drained and above water table. In a few places, where deposit is underlain by relatively impermeable materials, dune ridges block surface drainage and form wet swales. Not subject to flooding.	Generally not perennially frozen. Deposit contains abundant silty and sandy silt beds with some organic material that would be susceptible to frost action if water were available.	Even though a local source of sand, abundant silt and organic material make deposits generally unsuitable for most purposes. The well drained ridges along bluffs are poor foundations because of retreat of the bluffs under attack by rivers. Easy to excavate.
Floodplain alluvium (a)	Beds and lenses of coarse to fine sandy gravel, gravelly sand, coarse to fine sand, and silt; gravelly deposits generally coarser upstream, and include large boulders reworked from older glacial and glaciolacustrine deposits, talus, landslides, and bedrock. Gravelly deposits mantled by overbank flood deposits of sand and silt. Large particles angular to rounded. Silt content of coarser deposits ranges from less than 6 to as much as 20 percent.	Forms modern alluvial plain bordering glacial and nonglacial streams and outwash plains in front of existing glaciers. Thickness to about 50 feet.	Forms a succession of fluvial surfaces, marked by bar and swale topography and separated by low scarps, that are generally less than 7 m above the modern streams and have a downvalley slope approximately that of the modern stream; in front of glaciers, modern outwash plains are bare of vegetation and are channeled to a depth of generally less than 3 m.	Coarse, permeable alluvium has good soil drainage to a water table sloping gently toward river so that water table is generally only 1-3 m deep, and is as much as 6 m below land surface. Flood frequency varies with height above modern stream from annually flooded to flooded once in about 1,000 years; locally subject to winter ice floods, e.g. Copper River and tributaries such as Klutina River.	Permafrost generally absent beneath streams and adjacent low-lying parts of floodplain; may be as much as 10 m thick in alluvium of higher, older part of floodplain. Silt and certain sand and gravel deposits are frost susceptible, especially along glacial streams, and where large amounts of fine material are incorporated into deposits.	Other than flood and lateral erosion hazards, floodplain provides good, generally unfrozen granular material for foundations and borrow, except in local swales where silt mantle is more than a few meters thick. Excellent source of borrow with abundant water available for washing; pits generally intercept water table. Easy to excavate above water table where unfrozen.
Terrace alluvium (t)	Beds and lenses of well-sorted coarse to fine sandy gravel, gravelly sand, coarse to fine sand, and silt; gravelly deposits generally coarser upstream and include large boulders reworked from older glacial and glaciolacustrine deposits, talus and landslide deposits, and bedrock. Gravelly deposits mantled by overbank flood deposits of sand and silt and, locally, by less than 1 m of eolian silt and sand. Large particles angular to rounded. Silt content of coarse deposits ranges from less than 6 to as much as 20 percent.	Forms terraces bordering floodplains of glacial and nonglacial streams; some terraces are outwash valley trains from glaciers at headwaters. Includes outwash deposits away from modern streams that were laid down by glacial streams during recession of last ice sheet. Normally, terrace deposits along major streams are less than 7 m thick, depending on the depth of scour of the stream forming the deposits.	Forms one or more terraces generally higher than 7 m above modern streams adjacent to modern glacial and nonglacial streams or deposits of abandoned glacial outwash channels away from modern drainage system, as for example, in front of moraines marking former positions of glaciers. Sedimentation in swales commonly smooths terrace top to a flat surface, sloping parallel to modern streams, and lacking in obvious bar and swale topography.	Coarse, permeable alluvium has good drainage where deposits are not perennially frozen, particularly along margin of unit adjoining river floodplains. Water table depends on topography; ranges from many meters deep where along floodplains to 1 or 2 m deep where perched on underlying fine-grained material or permafrost.	May be perennially frozen back from scarp bordering floodplain, but data on thickness of permafrost lacking. Silt is frost susceptible, and certain sand and gravel deposits are moderately frost susceptible, especially those formed by glacial streams.	Generally good granular material, although local high silt content makes material moderately frost susceptible; cover of silty or sandy overburden may be thicker than that of floodplain alluvium, particularly at base of scarps at inner edge of unit. Generally good foundations where silty overburden is thin or can be removed and backfilled. Generally easy to excavate or to rip where unfrozen; the difficulty in excavating or ripping frozen material depends on degree of cementation by ice.
Colluvium (c)	A generally unsorted mixture of rock fragments in the pebble-boulder size range, sand, and much silt to form a silty rubble or rubbly silt; deposited as creep or solifluction deposits on slopes or as deposits admixed with some water-worked material on and at the foot of stabilizing and stabilized river bluffs. Materials vary with local sources and range from clay and silt to bouldery silty rubble. Includes landslides too small to map along river bluffs and other slump features.	As mapped includes both creep and solifluction deposits of hillslopes and mountainsides and the slumped material on river bluffs and accumulations at the foot of the bluffs. Thickness generally less than 5 m.	Occurs on slopes of 10 to 30 percent and in and at the base of river bluffs that have slopes ranging from 20 percent to near vertical.	On slopes generally poorly drained, commonly with a perched water table which freezes in winter; true water table probably within bedrock or within or below permafrost several meters below surface. Generally well drained and dry in bluffs, except for local springs; water table within 3 m of surface in deposits along rivers, much deeper in deposits bordering terraces.	Permafrost probably common at shallow depth on north-facing slopes, north of the crest of the Chugach Mountains; possibly absent on some south-facing slopes. Permafrost may be absent in some south-facing river bluffs, but locally present in material at foot of bluffs. High silt content in most of the deposits makes material highly susceptible to frost action.	Generally thin and too silty for source of granular borrow, and too thin for economical excavation for use as impervious fill. May be locally suitable for subgrade, but in most areas is highly frost susceptible and too poorly drained for subgrade and foundations. Except for very bouldery and frozen deposits, generally easily excavated and ripped; very difficult to excavate or rip when frozen.
Talus and rubble (r)	Angular rock fragments of pebble to boulder size embedded in matrix of silt and sandy material, nonstratified and poorly sorted, except where locally reworked by running water.	Most commmonly occurs at the foot of and on lower mountain slopes in talus cones and in avalanche chutes, in scree slopes on upper mountainsides, and in cirques where the deposits may border glaciers or grade downvalley into rock glaciers. Thickness probably less than 15 m. Rubble deposits of flat hill summits and gentle slopes (felsenmeer) are frost split bedrock, mixed with finer material, that is as much as 5 m thick.	Talus cones at their apex are on slopes of about 100 percent, and at their lower ends, slopes are as low as 5 or 10 percent. Scree slopes probably are steeper than 100 percent at their upper limit and about 20 to 30 percent at the lower limit.	Rubble and talus are permeable and water from melting snow percolates freely through the deposits, removing the fines from the upper 0.5 to 1 m to present the typical blocky appearance. The ground water table probably lies in underlying bedrock at most locations.	Talus and rubble lie normally at higher elevations in the mountains where heavy snow cover may prevent formation of permafrost, although as much as 196 m of permafrost is known in the Bonanza Mine in the Wrangell Mountains east of the quadrangle (Bateman and McLaughlin, 1920). No other data are available. The silt content is generally high enough to make the deposits susceptible to frost action.	Parts of the talus and scree slopes are actively moving or are the locus of avalanches which make them unsuited for construction activity. The blocky material may locally be suitable for riprap, coarse fill, or in a few cases, dimension stone. However, excavation of these unstable deposits may cause slumping of the upper parts of the deposit into the pit. Excavation moderately difficult because of boulders and steep slopes.
Alluvial fan deposits (f)	Coarse to fine silty sandy gravel with occasional beds and lenses of silt and sand; generally poorly stratified. Fragments angular to subangular, but in some areas subrounded. Boulders incorporated from adjoining bedrock slopes and by erosion of till by streams. Near toe of fans and on fans remote from mountains deposits are better sorted and stratified, better rounded, and finer than those on mountainsides.	Deposited by permanent and intermittent streams at break in slope separating steep mountainsides from valley flats, and at breaks in slope, such as river-cut escarpments, within lowlands. Deposits equivalent in thickness to annual channel scour in upper reaches, to as much as 10 m thick near broad toe of fans in lowlands or mountain valleys.	Upper reaches of fans on slopes of 40 to 70 percent on mountainsides; lower reaches have slopes of 10 to 30 percent in valleys.	Fan deposits are granular and well drained, except locally on toes of slopes where fine-grained deposits, a mantle of silt, and frozen condition prevent percolation of water through the deposits. Water table is in underlying bedrock on upper parts of fan, but locally within 1 m of surface at lower limit near streams; more commonly, however, lower part of fan is truncated by modern axial stream to form terraces in which water table is as much as 10 m deep.	Permafrost probably absent or sporadic in upper parts of mountain fans, but present in finer grained valley bottom fan deposits north of the Chugach Range divide. Coarse and fine deposits generally contain more than 6 percent silt and are moderately frost susceptible.	Generally suitable for fill and, with some washing, suitable for aggregate, depending on local rock type. Locally subject to shifting channels and floods in spring, and, in a few places, to winter icings. Where deposit is unfrozen, generally easy to excavate; moderately difficult where fine-grained or bouldery deposits are frozen.
Mudflow cone deposits (mc)	Unstratified, unsorted, mixed boulders, cobbles, granules, sand, and much silt.	Deposits seem limited to east side of Chichokna River in the Wrangell Mountains. Thickness unknown but probably exceeds 10 m.	Mud flow cones deposited on 10 to 40 percent slopes. Paths of mud flows marked by levees as much as 3 m above adjoining flow channels.	Deposits poorly drained because of high silt content and probable permafrost. Depth to water table not known.	Permafrost probably widespread. Deposits highly frost susceptible because of high silt content.	Generally unsuited for fill and borrow because of high silt and boulder content. Difficult to excavate by rippers. Subject to periodic mudflow activity, which may pose a hazard to surface structures.
Landslide deposits (ls)	Disjointed, chaotic assemblage of finely broken rock fragments or large masses of bedrock that have been displaced by gravity. Landslides in unconsolidated deposits, mostly along river bluffs and generally too small to map, are included in colluvium (unit c).	Landslides localized in areas in which glacial action has oversteepened bedrock slopes and in which rock jointing and faulting provide planes of weakness for failure of slopes. Maximum thickness probably more than 100 m.	Landslide deposits are either a jumbled hummocky terrain with numerous boulder-sized rock masses at the surface or uneven slopes marked by successively lower dropped blocks of rock, each separated by an escarpment. Slopes range from about 20 percent to more than 100 percent.	Drainage is generally good through the coarse blocky landslide deposits in hard rock of the Chugach and Wrangell Mountains, but is poor in the viscous mud that forms from the shale of the Matanuska Formation in the northwestern corner of the quadrangle.	Deposits may be perennially frozen north of the crest of the Chugach Mountains. Highly fragmented materials containing more than 6 percent silt are frost susceptible; silde deposits derived from the Matanuska Formation are highly frost susceptible. Landslide deposits formed of large blocks of other types of bedrock generally not frost susceptible.	Generally landslides indicate slope instability, which requires specialized analysis. Removal of toe of slopes is undesirable because of inherent instability of deposit. Poor for aggregate, but locally may be used for fill or riprap if material has required qualities. Generally difficult to excavate without blasting, except local frost-split bedrock and soft rocks of the Matanuska Formation.
Rock glacier deposits (rg)	Nonstratified, unsorted mixture of broken, angular rock fragments in silty, sandy matrix. Active rock glaciers, and possibly some farther downvalley that are now inactive, contain intergranular ice or ice that contains rock fragments in such a way that rock fragments are not in contact with each other.	Deposits are located within high mountain cirques or at the toe of talus cones in the Wrangell and Chugach Mountains. In some hanging valleys the rock glaciers cascade down the mountainside. Thickness unknown, but may be 5 to 50 m.	Form bulb-shaped masses on cirque floors and at the base of talus cones. Outer margin is a near-vertical slope, and surface is, in the case of actively moving rock glaciers, a series of 2- to 5-m-high ridges concentric with the front of the rock glacier. The active rock glaciers are normally those closest to the talus source in the cirque or on slopes, but those farther removed may also have ice. Movement of active rock glaciers is probably much less than 1 m per year downvalley.	Rock glaciers generally lie in areas of high snowfall, so that meltwater drains rapidly through the deposit and emerges in springs at the front, and forms streams at that point. Water table probably within 5 m of surface, except where deposit is frozen and ice cored or where deposit is on steep slope.	Active, and some inactive, rock glaciers contain ice either as intergranular ice or as discrete bodies incorporating rock fragments. Materials generally contain more than 6 percent silt and are frost susceptible.	Rock glaciers that are actively moving are an unstable foundation for construction. Those that have an ice content that exceeds the natural pore space of the rock material are subject to settlement upon thawing. Ice content must be determined to ascertain activity of the rock galcier. May provide material for fill or riprap, but pit walls are likely to be unstable. Moderately difficult to excavate or rip where unfrozen because of large boulders, but in frozen condition deposit very difficult to excavate or rip without blasting.
Lacustrine bottom deposits (lc)	Thick to thin lenses and beds of clayey silt, silt, fine to medium sand, clayey silt containing scattered pebbles and granules and local cobbles and boulders, and sandy gravel and gravelly sand. Sandy and silty units locally massive and nonstratified. Local beds of volcanic ash. Near Hudson Lake includes marl deposits of silty clay.	Generally restricted to altitudes less than 750 m in area north of Klutina River, 720 m in Nelchina River valley, 700 m south of Klutina River and north of Chitina, and 610 m in the Chitina and Chitina River areas. Upper limit marked by shoreline in local areas (see unit b). Thickness generally less than 18 m, as mantle over older glacial and fluvial deposits, and volcanic flows. Deposits of glacial lake (Lake Atna of Nichols, 1965a), but also includes higher level lacustrine deposits in ice-blocked valleys in Chugach Mountains.	Flat to gently sloping surfaces in Copper River basin and in some mountain valleys; relief generally less than 2 m, except in areas having relief of as much as 15 m reflecting topography of underlying deposits. Slopes generally less than 10 percent.	Water table variable, ranging from tens of meters deep near river bluffs to within a meter of the surface in unfrozen deposits near water courses or lakes; water table may be perched in permeable materials on top of impermeable beds or permafrost.	Permafrost 1 to more than 30 m thick and within 1 or 2 m of surface in fine-grained deposits and within 5 m of surface in coarse materials. Permafrost 8 to 10 m deep in areas repeatedly burned over. Silty and clayey deposits highly frost susceptible. Ice as lenses within frozen fine-grained deposits commonly exceeds natural voids of materials.	Frost susceptibility and high ice content of permafrost make deposits generally unsuited for foundations and subject to heaving and differential settlement on thawing of permafrost. Sources of granular borrow at surface generally absent or in very small quantities. Difficult to excavate and rip where frozen; relatively easy where unfrozen.
Lacustrine bottom and near shore deposits (lc with dots)	Nonstratified pebbly, cobbly, and locally bouldery silt with some clay and sand; thin deposits of bedded silt, sand, and gravel in some areas. Pebbles, cobbles, and boulders anuglar to subrounded.	Occupies areas of Copper River basin and mountain valleys in which lacustrine deposits were thin, and pre-existing topography is reflected despite the mantle of lacustrine deposits; probably includes surficial deposits of till and lag deposits reworked by lake waters from till and gravel, and shallow-water sand deposits. Thickness generally less than 8 m.	Lies on lower mountain slopes having 10 to 30 percent slope, draped over drumlin-like ridges less than 10 m high, and in low rolling terrain with relief less than 10 m below elevation of 750 m. Locally cut by channels on mountain slopes, relief 1 to 4 m.	Drainage of fine-grained deposits generally poor on low slopes and where deposits are frozen at shallow depth. Water table generally below base of deposits, but locally perched on fine-grained materials or on permafrost.	Permafrost 1 to more than 30 m thick and within 1 to 3 m of surface in fine-grained deposits and within 5 m of surface in coarse materials. Silty and clayey materials that are perennially frozen generally have ice in excess of natural voids and are subject to differential settlement upon thawing. These fine-grained deposits are highly frost susceptible. Sand and coarser grained deposits moderately to highly frost susceptible.	High frost susceptibility and high ice content of permafrost make fine-grained deposits generally unsuited for foundations and subject to frost heaving and differential settlement on thawing of permafrost. Sources of granular material at surface generally difficult to locate or in small quantities. Easily excavated where unfrozen, but difficult to excavate or rip where frozen.
Deltaic deposits (d)	Well to poorly sorted medium to coarse sand and granule to cobble gravel, as topset and foreset beds of delta. Grades downward into fine sand or silt of bottomset beds. Locally mantled by eolian sand or lacustrine bottom sediments.	Forms deltas marginal to recessional levels of regional glacial lake adjacent to major stream courses, e.g. 410 to 425 m above sea level on Tonsina River, 490 to 565 m on Klutina River, 490 to 610 m on Nadina and Dadina Rivers, and at higher altitudes in local lakes within Chugach Mountains. Thickness 2 to 20 m.	Fan shaped areas having a slope slightly less than that of adjacent streams toward the center of the Copper River valley. Local channels provide relief of 2 to 8 m.	Drainage through permeable topset beds generally good. Water table in locations adjacent to incised streams generally deeper than 20 m, but higher away from canyons.	Permafrost having an ice content less than the void volume of the granular deposits lies more than 5 m below the surface in most of the unit. Frost susceptibility of granular materials is low.	Excellent grade and foundation materials. Suitable for base and surface course and as a source of granular borrow. Easily excavated; rippable where frozen.
Beach deposits (b)	Clean, well-sorted, finely stratified to massive beds and lenses of medium to coarse sand, granule to cobble sandy gravel and gravelly sand. Granules, pebbles, and cobbles subangular to rounded. Little or no silt or clay.	Distributed locally along former shorelines of glacial lake (Lake Atna of Nichols, 1965a) at about 750 m above sea level and along lee shores bordering Tazlina, Klutina, and other lakes as series of beach ridges. Lesser shorelines, too small to map at 1:250,000, are shown in Nichols and Yehle (1969). Thickness generally less than 2 m at 750-m shoreline and less than 5 m along modern lake shores. Locally marked at 750-m shoreline by low scarp cut by waves and at its base by a lag concentrate of stones winnowed from underlying deposits.	Series of beach ridges generally less than 2 m high separated by wet or dry swales. Slopes of ridges less than 30 percent.	Beach deposits have excellent permeability and are well drained. Water table ranges from below base of unit in much of 750-m shoreline to within 1 m of surface in beach deposits bordering modern lakes. Includes modern beaches which, with youngest of raised beaches, are subject to flooding along Tazlina Lake during periodic dumping of water within Tazlina Glacier.	Permafrost probably absent. Materials, being low in silt and clay content, are not frost susceptible.	In a few localities beach deposits are suitable for foundations, but may require addition of binder material to provide adequate bearing capacity. Good local source for limited quantities of well washed granular material. Easily excavated.
Kame-esker deposits (k)	Well- to poorly-sorted irregular beds and lenses of sandy gravel, gravelly sand, fine to coarse sand, and minor silt; locally overlain by less than 2 m of silt (unit lc) below altitude 750 m. May contain local zones of round cobbles and boulders, but most of deposit is subrounded to subangular.	Formed by meltwater streams on, under, or beside stagnant glacial ice during retreat of the glaciers as local deposits throughout the map area; especially well developed in mountain valleys above the 750-m shoreline, below which deposits are masked by younger lake bottom deposits. Thickness generally 5 to 10 m, but locally as much as 30 m.	Includes steep-sided (30-60 percent), sharp-crested eskers and kames, gently sloping kame terraces, outwash broken by pits caused by melting masses of glacier ice, and subdued linear crevasse fillings. Relief generally 3 to 17 m.	Drainage through granular material in ridges and knobs is good, but in swales and in areas locally covered by lacustrine deposits drainage is poor to fair, depending on permeability, water table elevation, and permafrost. Water table variable; near surface in deposits along modern water courses and lakes, but deep or absent in deposits well above the rivers or where perennially frozen.	Deposits may be perennially frozen north of crest of Chugach Mountains, but top of frozen layer is at least 5 m deep. Generally not subject to differential settlement because of excess ice in perennially frozen granular materials, but may locally be subject to settlement in ice-rich fine-grained surficial lake sediments within unit. Granular material generally has more than 6 percent silt and is slightly frost susceptible; silt highly frost susceptible.	Granular ice-contact deposits are excellent foundations after being graded and levelled. Excellent as sources of granular borrow for fill and aggregate. Easily excavated and ripped, except for fine-grained deposits and local bouldery deposits.
Ground moraine (g)	Glacial till consisting of compact poorly sorted unstratified silty sandy gravel, gravelly silty sand, and gravelly sandy silt. Pebbles, cobbles, and boulders are angular to subrounded. Includes washed layers and lenses of sand, and silty sandy gravel, but otherwise massive. Larger clasts may be striated.	Widely distributed on lower slopes and bottoms of mountain valleys and in the Copper River basin above the 750-m shoreline; below that level generally masked by lacustrine deposits. South of Klutina River limiting altitudes decline fron 750 m to 700 m and 610 m; in middle Nelchina River valley limiting altitude is 720 m. Thickness 1 to 15 m, rarely greater than 15 m.	Gentle to moderate slopes (10 to 20 percent) of smooth to irregular ridges as much as 20 m above intervening broad swales.	Surface drainage fair to poor, depending on permeability and topographic position of deposit--normally higher in mountain valleys than in the Copper River basin. Water table variable, depending on topographic position and presence or absence of permafrost. In some swales may be at the surface, whether a perched water table on permafrost or a free water table.	Permafrost, common north of crest of Chugach Mountains, contains local zones of excess ice as lenses and small masses that may cause differential settlement upon thawing. Depth to permafrost table 2 to 5 m. Moderately (in sandy deposits) to highly (in silty deposits) frost susceptible.	Sandier deposits good for foundations and for borrow for fill; generally too much silt for aggregate; subject to moderate frost heave in foundations. Silty deposits less desirable for foundations and fill because of excess silt that makes the deposit highly frost susceptible, and excess ice that may locally cause differential settlement upon thawing beneath structures or roads. When wet may form mudflows that are difficult to control. Difficult to excavate and rip where frozen; moderately difficult where unfrozen because of boulders and compaction of material.
End and lateral moraine (m)	Generally consists of loose to slightly compacted glacial till, which is generally unsorted and unbedded silty sandy gravel but also includes many areas of stratified to nonstratified sandy gravel, sand, and silt. Pebbles, cobbles, and boulders are subrounded to subangular.	Form lateral moraines along mountain slopes and end moraines in mountain valley bottoms; generally not present at surface within the area covered by glacial lake. Thickness unknown, but probably less than 25 m.	Rough, ridged, and kettled topography with relief as much as 20 m between ridge tops and swales and channels. Slopes as great as 60 percent, more commonly 20 to 40 percent.	Drainage is good in relatively permeable till of ridges, but poor to fair in undrained depressions having a mantle of fine-grained pond deposits. On lateral moraines on mountainsides water table is deep, perhaps beneath unit, although locally perched on fine-grained material and permafrost. In valley bottoms end moraines adjacent to streams and lakes have water table ranging from 1 or 2 m in dry swales to more than 10 m deep in ridges.	Permafrost north of crest of Chugach Mountains is probably relatively free of excess ice, except in fine-grained deposits of depressions. Depth to permafrost ranges from 1 m in swales to at least 5 m in well drained ridges. Thickness of permafrost not known, but could be as much as 30 m; not present south of crest of Chugach Mountains. Material is slightly to moderately frost susceptible, except for fine-grained deposits of swales, which are highly frost susceptible.	Good foundation, but requires excess grading and levelling. Suitable for fill, but probably has too much silt for aggregate. Fine-grained deposits in depressions are poor foundations and not suitable for borrow, except possibly as source of binder material. Where well drained and unfrozen generally easy to excavate, except for boulder accumulations; where frozen difficult to excavate and moderately difficult to rip because of boulders.
Volcaniclastic debris flows (vd)	Typically chaotic assemblages of angular to rounded boulders in an unconsolidated to semiconsolidated matrix of finer volcanic debris, gravelly sand, sand, and some silt and ash. In places includes or appears to grade vertically or laterally into till, laminated silt and sand, or stratified gravel. Boulders, some from 20 to 90 m in diameter, include: unaltered dense black to gray andesite, friable red, brown, or gray andesite, or yellow, yellow-brown, or yellow-orange altered volcanic rocks. Smaller boulders (up to 1.0 m) include well-rounded, fresh-appearing granitic rocks; crumbly, severely weathered granitic, schistose, and volcanic rocks; and angular blocks of bedded silt, sand, and gravel. Matrix includes subrounded to subangular pebbles, locally predominantly nonvolcanic, but also including pumiceous fragments up to 1 cm.	Exposed in river bluffs on the southwest side of Mount Wrangell, including the Chetaslina, East Fork Chetaslina, and Kotsina Rivers; in road cuts and river bluffs in valleys of Tonsina, Chitina, and Copper Rivers, Horse, Kuslina, and Willow Creeks; and in cuts along the Edgerton Highway near Lower Tonsina and at Chitina Airport. Thickness as much as 50 m.	Mapped where unit comprises most of the bluff, although almost everywhere mantled by at least 3 m of ground moraine, lake deposits, volcanic flows, or fan gravel. Generally reflects topography developed on overlying deposits, notably on Edgerton Highway near Lower Tonsina.	Drainage fair to good. Water table generally below deposit in places where exposed.	Permafrost conditions generally unknown because most exposures are in river bluffs. Frost susceptibility generally low, but probably high in areas with high silt and clay content.	Good for foundations in most places and as a source of coarse fill where clayey parts of unit can be avoided. Locally may be acceptable for crushed rock. Easy to excavate or rip, except for occasional large firm boulders that have to be blasted and where deposit is indurated.
Volcanic rocks (v)	Predominantly porphyritic andesite with phenocrysts of plagioclase, clinopyroxene, and rare hypersthene in fine-grained to glassy matrix; phenocrysts up to 2 mm long. Also includes well to partially indurated pyroclastic flows, tuffs, and small areas of other volcanic rocks. Color ranges from light gray to dark gray or mottled gray and red. Flows locally have excellent columnar jointing or closely spaced subhorizontal joints. Strong flow lines locally shown by orientation of phenocrysts. Part of Wrangell Lava (Mendenhall, 1905, p. 54-62).	Forms most of Mount Wrangell, an active stratovolcano; flows from Mount Wrangell are interbedded with glacial and glaciolacustrine deposits on lower flanks of the mountain. Thickness of individual flows where interbedded with glacial and glaciolacustrine deposits varies from 10 to 50 meters. Pyroclastic flows (ash flows of Miller and Smith, 1976) are exposed (but not mapped at this scale) in the Kotsina, Chetaslina, and East Fork Chetaslina Rivers, and in two unnamed Copper River tributaries northwest of the Chetaslina River. Thickness as much as 20 m (Miller and Smith, 1976).	Forms 4,137-m high Mount Wrangell and is exposed in vertical cliffs along Dadina, Chetaslina, and East Fork Chetaslina Rivers, in steep slopes along Horse Creek, and in extensive cliffs parallel to and east of Copper River. Local relief as much as 1,000 m on Mount Wrangell and 50 m where lavas are exposed in adjacent lowland near Copper River.	Good drainage in areas where columnar joints are closely spaced. Water table generally considerably below unit in lowlands near Copper River.	Data lacking on extent of permafrost.	Except for pyroclastic flows, unit is a good source of crushed rock, coarse fill, and, locally, riprap and dimension stone. Also good for road and building foundations. Requires blasting for excavation.
Bedrock, undifferentiated pre-middle Tertiary	Unmetamorphosed sandstone, siltstone, and shale at northern margin of quadrangle, locally passing under Wrangell Lavas (unit v); in the north-central belt metamorphosed sedimentary and volcanic rocks interspersed with small to medium bodies of igneous rocks ranging in composition from granite to dunite; in the southern two-thirds of the quadrangle phyllite and graywacke with minor lenses of greenstone. Details of rock types and ages provided in companion report in the Valdez folio (Winkler and others, 1980). Locally mantled by frost-shattered rubble and till.	Present throughout the quadrangle, but concealed beneath unconsolidated deposits and volcanic rocks (unit v), as mapped. Thickness of individual units variable; see companion reports in Valdez folio (Winkler and others, 1980).	Forms ridges and hills and crops out locally in river bluffs. Generally exposed on slopes greater than 40 percent, on summits in Chugach Mountains, and in local areas on the flanks of Mount Wrangell. Locally forms cliffs in river canyons cut through overlying unconsolidated deposits and volcanic rocks and forms low, glacially scoured knobs or bosses in some mountain valleys.	Position on steep slopes and mountaintops provides rapid drainage of surface water; in general water table lies deep within bedrock.	Probably perennially frozen to as much as 200 m below ground surface north of crest of Chugach Mountains, but specific data not available for analysis. Permafrost probably generally absent south of the crest of the Chugach Mountains. Bedrock subject to frost splitting to produce overlying rubble, but once quarried and used as fill generally not frost susceptible, except for shale and siltstone which rapidly break down to frost-susceptible materials.	Suitability for construction depends on rock type, degree of weathering, and fracture system; may range from good to poor for riprap, generally good for source of crushed rock and fill, and generally good for foundations. Exceptions are soft siltstone, shale, and phyllite.

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

DESCRIPTION OF MAP UNITS