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ENGINEERING-GEOLOGIC MAP OF THE CHULITNA REGION, SOUTHCENTRAL ALASKA

by
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SHEET

[in envelope]

ENGINEERING-GEOLOGIC MAP OF THE CHULITNA MINING DISTRICT, SOUTHCENTRAL ALASKA

by
D.S. Pinney[1]

DISCUSSION

This map illustrates potential near-surface sources of various geologic materials that may be useful for construction. It was derived electronically from bedrock and surficial geologic mapping of the Chulitna region (Clautice and others, 2001), using ARC\INFO, a geographic information system (GIS). Field observations indicate that each geologic unit (for example, floodplain alluvium) has a definite composition or range of compositions wherever that unit is found. Therefore, the presence of materials is interpreted from the distribution of geologic units on the geologic map of this quadrangle. This map is generalized and is not intended to show exact locations of specific materials. The purpose is to indicate general areas where certain geologic materials may be present and to eliminate other general areas from consideration. Local variations are common, especially near unit boundaries.

Potential uses of map units are summarized in the tables below, which show potential availability of various construction materials in each geologic-materials unit. Economic evaluations of specific deposits as sources of construction materials will require detailed examination of each deposit, including areal extent, volume, grain-size variation, thickness of overburden, thermal state of the ground, and depth to water table as well as logistical factors, demand, and land ownership.

This map also identifies the principal geologic hazards that may be associated with various geologic-materials units. Many potential geologic hazards relate directly to map units because (1) the processes that formed the deposits are active and hazardous, and (2) conditions (like ground ice or massive bedrock failures) in the units present hazards if development occurs. The hazards presented on this map are intended only as a general guide to some hazards that might be present at given localities and do not preclude the presence of other unevaluated or site-specific hazards.

Numerous photolineaments suggest that faulting may be pervasive in the area, but evidence for faulting is less obvious in the lowlands, where there are fewer bedrock exposures. This map illustrates lineaments identified during photointerpretation. Faulting and related earthquakes may produce sudden displacements by shaking and impacts and may cause liquefaction and mass movements in both highlands and lowlands.

A major concern in the highlands is the significant potential for massive landslides because of sackung failures. Over 35 sackungen (plural of the German term sackung) are identified in bedrock areas, where the morphology of many bowl-shaped headwalls and steep sidewalls of glaciated valleys has been significantly modified by sackungen and related bedrock failures. These large features typically form in glaciated alpine terrains in rocks of variable composition (Beck, 1968; Tabor, 1971; Radbruch-Hall and others, 1976, 1977; Bovis, 1982). Driven by gravity, they slowly displace downslope the pervasively faulted and jointed bedrock by creep along ill-defined, shallow to deep zones of bedrock weakness and become progressively more unstable. Eventually, periods of extended rainfall or an earthquake may trigger massive rock failures, including catastrophic rock avalanches, from sackungen. During the period of slow, progressive creep, structures sited on sackungen may be subjected to destructive displacements.

More than 20 landslides were identified during photointerpretation and fieldwork. Landslides result from the downward and outward movement of slope-forming materials, wherein shear failure typically occurs along a specific surface or combination of surfaces (Schuster, 1978). Aside from the obvious hazards posed by a large mass of sliding material, even very small amounts of movement can cause substantial engineering or construction difficulties.

In the lowlands, the main hazard concerns are (1) loss or lack of bearing (shear) strength (for example, in saturated, fine-grained alluvium or swamp deposits) and (2) seasonal or outburst flooding. Loss of bearing strength due to liquefaction during earthquakes is likely on the unbraided, fine-grained reaches of the floodplains and low terraces of the Chulitna River. Thick accumulations of seasonal overflow ice (aufeis) should be anticipated in braided reaches of these surfaces and on floodplains of smaller streams as well as on slopes where bedrock is shallow and springs emerge (Sloan and others, 1976).

Other lowland hazards include (1) permafrost, (2) seasonal frost, and (3) debris flows. There are indications of discontinuous permafrost at shallow depth, and during construction of the Alaska Railroad during 1915–1923 the Chulitna area was the railroad's first large-scale excavation in permafrost (Fuglestad, 1986). Differential

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subsidence due to thawing of ground ice may be a local problem in peats and associated organic soils. Seasonal frost action may be intense in poorly drained, fine-grained sediments. Rapid sedimentation and destructive impact by debris flows derived from fine-grained sediments (like colluvium and complexly interbedded glacial, glaciofluvial, and glaciolacustrine deposits) may be a problem in the upper reaches of small streams, lowland gullies, and on surfaces onto which debris flows debouch.

DESCRIPTION OF MAP UNITS

Unconsolidated Materials

(see table 1)

GM Poorly- to moderately well-sorted clay, silt, sand, gravel, and diamicton of colluvial, fluvial, and glacial origins. Includes angular, unsorted talus debris and chaotically deformed colluvium derived from landslides. Engineering applications vary widely due to large range of grain size and sorting properties. Commonly frozen. Estimated 20 to 80 percent coarse, granular deposits with considerable oversized material. Includes primarily GC and GM of the Unified Soil Classification (Wagner, 1957).

GS Fluvial and glaciofluvial gravel, sand, and silt. Chiefly (estimated >80 percent) clean sand and gravel. Grain size, sorting and degree of stratification are variable. Permafrost may be present, especially in older deposits. Older deposits may contain highly weathered clasts and thus may not be suitable as construction materials. Rare oversized materials. Includes primarily GP and GW of the Unified Soil Classification (Wagner, 1957).

OR Peat with interbedded organic silt and organic sand comprising undifferentiated swamp deposits. Chiefly organic-rich silt and peat in bogs and thaw lake basins. Commonly frozen and ice-rich due to the excellent insulating properties of peat. Generally poorly sorted and water-saturated. Estimated >50 percent peat, organic sand, or organic silt. Includes Pt, ML, MH, SM, SW, OC, and OL of the Unified Soil Classification (Wagner, 1957).

Bedrock Materials

(see table 2)

BC Medium-jointed, fine- to coarse-grained sedimentary carbonate rocks. Includes limestone, dolostone, and marble.

BG Coarse-jointed, coarse-grained igneous lithologies. Chiefly granitic rocks.

BM Medium-jointed, fine- to medium-grained quartzose sedimentary rocks. Includes quartzose sandstone and conglomerate, quartzite, chert, and hornfels.

BV Medium-jointed, fine-grained igneous rocks. Chiefly volcanic flow rock, dikes, and greenstone.

BO Rocks of mixed lithology and very fine-grained sedimentary lithologies that are generally poorly suited for use as construction materials. Includes shale, siltstone, graywacke and argillite.

Table 1. *Engineering properties of unconsolidated units*

Map unit	Drainage	Permafrost	Frost susceptibility	Slope stability	Bearing strength	Potential primary products	Potential engineering considerations	Component geologic units[a]
GM	Variable, depending on proportion of silt- and clay-sized material and stage of permafrost development. Deposits on or at the base of steep slopes may be subject to snow avalanches and torrential flooding during periods of snowmelt or heavy precipitation.	Common on north-facing slopes, especially in older deposits. Segregated-ice content may be high where silt and organic materials are prevalent.	High in deposits that contain large proportions of silt or organic silt and in deposits with poor drainage. Fans are frost stable, except for silt and organic zones on old fan surfaces, especially where shallow permafrost inhibits drainage.	Thaw unstable where perennially frozen or where deposit contains excess ice. Deposits of predominantly silty material are susceptible to creep, especially where saturated by near-surface ground water, such as springs along faults. Steep colluvial deposits, such as talus aprons at or near the angle of repose, are generally unstable and may be subject to snow avalanches, debris flows, and rock falls. Fans are generally stable, except where overburden is susceptible to frost heaving.	Variable but generally fair to poor.	Unclassified fills, although some local pods or lenses may be a source of small quantities of moderately sorted, gravel-rich fluvial sand.	Fan surfaces may be subject to snow avalanches, debris flows, subsidence, and local liquefaction. Therefore, caution should be exercised during excavation and construction activities. Saturated or over-steepened deposits may be subject to slope failure, and local thaw subsidence may occur in areas of permafrost.	Qaf, Qc, Qcf, Qcl, Qcl?, Qct, Qd, Qd1?, Qrg, Qt1, Qt1?, Qt2, Qt2?
GS	Good in recently deposited alluvium above stream level, fair to poor in older alluvium where permafrost has developed and where covered by silty colluvium and peat. Good in younger permafrost-free terrace deposits without significant cover of organic silt. Drainage may be inhibited on older, inactive surfaces mantled by appreciable thicknesses of silt and organic materials.	Absent in younger alluvial deposits; locally present in older deposits mantled by silt and peat. May be present discontinuously in older terrace deposits; may be ice rich in organic silt or where silt has infiltrated into gravels by percolating ground water. Sporadic where accumulations of peat and organic silt promote development of segregated ice. Ice is typically limited to fine-grained overburden. May be present on older, inactive surfaces mantled by appreciable thicknesses of silt and organic materials.	Minimal in well-drained modern alluvium; may be moderate to intense in active layer silt and peat. Terrace gravels generally not susceptible to heave; heave may occur in organic silt that caps older alluvium.	Generally stable, except for ice-rich permafrost-bearing deposits subject to thaw instability and areas adjacent to cutbanks or free faces, where sudden, rapid collapse may occur due to stream erosion or surface loading. Fill terraces may be subject to slumping and rapid erosion.	Variable, but generally good to fair, especially below peat and silt overburden.	Crushed aggregates and miscellaneous clean fill.	Older deposits that contain permafrost and have significant cover of eolian, organic, or colluvial sediments are generally undesirable as materials sources. Very short, steep tributaries may have high potential for debris flows or snow avalanches. Cutbanks along active streams may fail, thus may not be suitable for structure sites. High flooding potential along margins of streams.	Qa, Qac, Qao, Qao?, Qat, Qfp, Qh, Ts
OR	Very poor, often with standing water.	Generally frozen except near stream cuts.	Very high. Thaw unstable following surface disturbance.	Thaw unstable; subject to failure due to saturation.	Generally poor, especially where thawed.	May be suitable for horticultural or energy applications.	Surface subject to inundation, extreme frost heaving, and thaw subsidence in saturated soils. Generally unsuitable as structure sites unless structures are pile supported.	Qs

[a]Source of geologic units: Clautice and others (2001)

Table 2. *Engineering properties of bedrock units*

Map unit	Principal rock characteristics	Potential primary products	Component geologic units[a]
BC	Medium-jointed, fine- to coarse-grained sedimentary carbonate rocks	•Dimension stone •Ornamental stone •Crushed rock •Cement	Dl, lTRl, Pl, uTRl
BG	Coarse-jointed, coarse-grained igneous rocks	•Dimension and ornamental stone •Riprap, armor, gabion and drain rock •Crushed rock and grüs	Kg, Km, Tg
BM	Medium-jointed, fine- to medium-grained quartzose sedimentary rocks	•Riprap and drain rock •Crushed rock •Unclassified fills	Dc, KJc, KJs, KJsa, TRrb, TRs
BV	Medium-jointed, fine-grained igneous rocks	•Riprap and drain rock •Crushed rock •Unclassified fills	Dv, Tb, TRb, TRJb, uPzt
BO	Other lithologies	•Unclassified fills •Serpentinite may be suitable •as an ornamental stone	Jac, Js, KJas, PPs, sp, sp*, TRvs, uPzs, uPzst

[a]Source of geologic units: Clautice and others (2001)

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