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Surficial geologic map of the
Anchorage B-7 SE quadrangle, Alaska

By

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INTRODUCTION

The Anchorage B-7 SE quadrangle is located in south-central Alaska within the Municipality of Anchorage, about 30 km northeast of downtown (fig. 1). The quadrangle is one of a group in the Knik Arm and Anchorage regions for which surficial geologic maps have been completed at 1:25,000 scale (Daniels, 1981a,b; Reger, 1981a,b,c,d; Yehle and Schmoll, 1987a,b).

The map area is part of the Kenai-Chugach Mountains physiographic province (Wahrhaftig, 1965; fig. 1). The westernmost part of the Chugach Mountains can be subdivided into two parts: (1) a central core of very steep mountains with peaks in excess of 2,000 m, here called the Bashful region, after its highest mountain, Bashful Peak (2,440 m), and (2), a lower surrounding region where peaks and ridges are generally 500-1,000 m less in altitude. Except for its southeastern corner, the map area is entirely within this lower region. The Chugach Mountains are bounded to the west of the map area by a steep front that descends abruptly to the Anchorage lowland.

The Chugach Mountains are composed of structurally complex and variably metamorphosed sedimentary and igneous rocks (Clark and Bartsch, 1971; R.G. Updike and C.A. Ulery, Alaska Division of Geological and Geophysical Surveys, written communs., 1986, 1987; G.R. Winkler, written commun., 1986); in this quadrangle the rocks are entirely within the Chugach terrane (Coney and Jones, 1985; Jones and others, 1987). The highest mountain peak within the map area is in the southeastern part and rises to an altitude of 1,663 m. Mount Magnificent, 1,302 m, the only peak named on the topographic base map, is located in the central-western part of the area. Two major subparallel valleys, those of the Eagle River and of Peters Creek, transect the mountains in a generally southeast to northwest direction, as do the smaller valleys of Meadow Creek and an unnamed stream in the northwest part of the map area and the valley of Four Mile Creek in the northeast extremity of the map area. Other small tributary valleys to both the Eagle River and Peters Creek trend mostly in a north-northeasterly direction. All of the valleys are cut deeply below the level of the mountain crests. Maximum relief is about 1550 m.

The Eagle River and Peters Creek, the principal streams within the map area, both drain from glaciers to the southeast. Peters Creek and its tributaries to the east of the map area emerge from small glaciers that terminate at an altitude of about 800 m in the Bashful region (fig. 1). Within the map area, Peters Creek has a gradient of about 20 m/km. It is deeply entrenched to the north of the map area where it descends the Chugach Mountain front. The Eagle River on the other hand emerges from a lake at an altitude of 267 m that formed in historical time at the foot of the receding Eagle Glacier which is part of an interconnected complex of glaciers that dominates the mountains south of the Bashful region. Just east of the map area the Eagle River crosses the Bashful region in a short, narrow canyon; within the map area, the valley broadens and the river has a gradient of only 2.4 m/km. The valley is entrenched only moderately west of the map area where it emerges from the mountains and enters the Anchorage lowland.
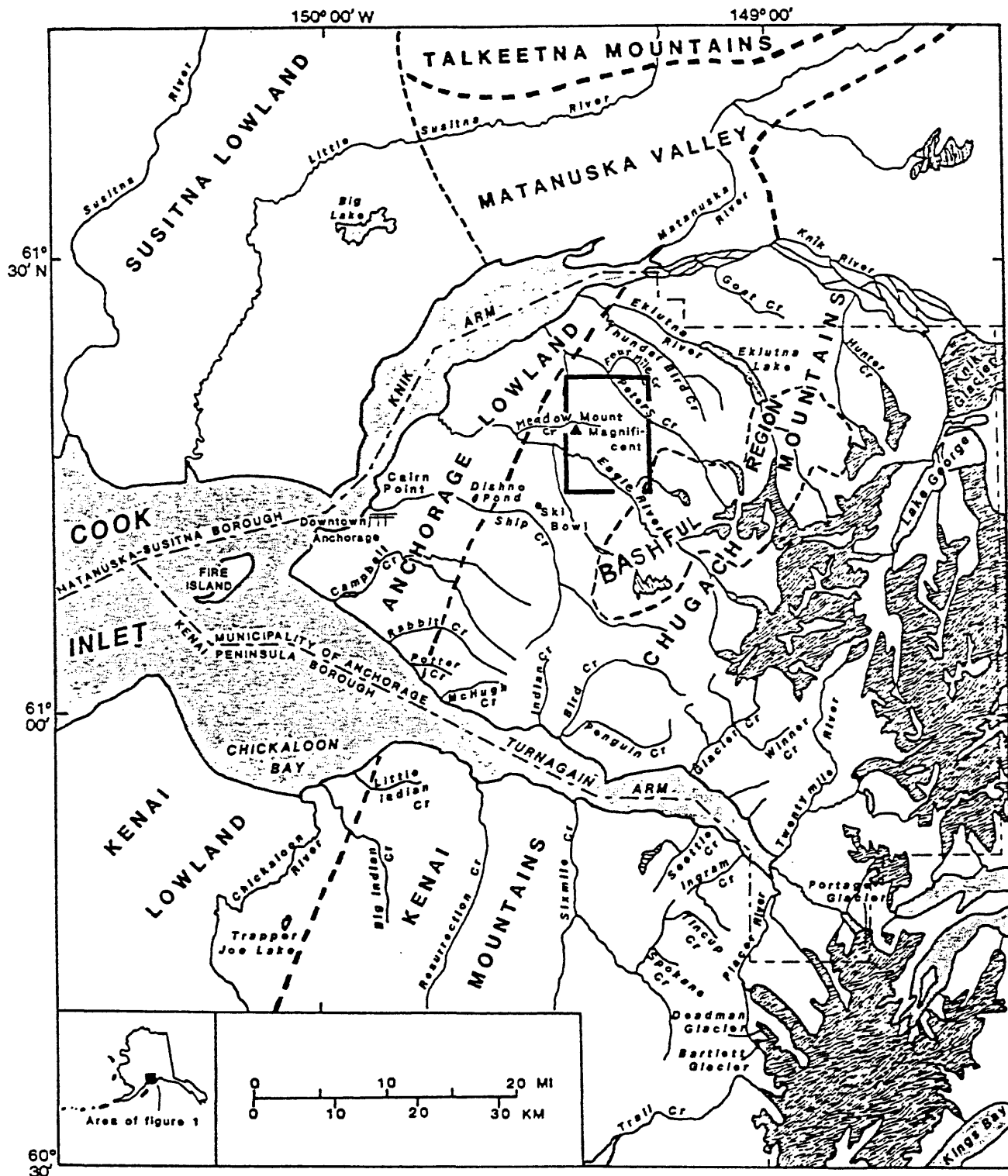
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Figure 1.--Location of Anchorage B-7 SE quadrangle and major geographic
features. Double-weight dashed line indicates boundary between major
physiographic provinces of Wahrhaftig (1965); single-weight dashed line and
water bodies separate physiographic subprovinces of informal usage.
Heavy pattern indicates glaciers.

SURFICIAL DEPOSITS

Surficial deposits within the map area consist of glacial drift that is entirely Pleistocene in age and alluvial, colluvial, rock-glacier, and peat deposits that are mainly Holocene in age. Glacial deposits occur mainly on the flanks of the major valleys, and at small, isolated areas higher on mountain ridges. Alluvial deposits occupy the floors of most valleys but are extensive only in the Eagle River valley where they overlie lacustrine deposits. Variably thick colluvial deposits cover bedrock on most mountain slopes throughout the area. Rock-glacier deposits occupy major areas within the several north-draining valleys tributary to Peters Creek. Peat and pond deposits locally overlie valley-bottom alluvium, mainly in the Eagle River valley. A ubiquitous mantle of organic and windblown materials, including minor amounts of tephra, covers all but the most recent or still actively accumulating deposits. This mantle has not been mapped separately.

GLACIAL DEPOSITS

Glacial deposits may be subdivided, in order of abundance within the map area, as follows: (1) deposits that occur in moraines and associated kame fans; (2) deposits of former glacial lakes and related deltas; and (3) outwash and channel deposits related to former glaciers. These deposits are the result of several glacial advances and retreats that have successively modified the terrain in the area (Miller and Dobrovolny, 1959; Karlstrom, 1964; Schmoll and Yehle, 1986). Here, as in most mountain regions where evidence for past glaciations is based largely on relict landforms, the oldest glacier advance for which there is evidence seemingly was the most extensive, and successively younger advances were successively less extensive; evidence for intervening advances of lesser extent than a following advance is lacking, although such ice advances probably occurred.

The most widespread glaciers to reach this area probably advanced from distant sources in mountains to the north and east and merged with ice of local source within the Chugach Mountains to fill the Cook Inlet-Susitna lowland with glacier ice. Only relict deposits at high altitude remain as evidence for these early events. When glaciers from the distant sources were less extensive, local glaciers in the Peters Creek and Eagle River valleys had separate identities. At these times they joined ice of distant source in the lowland and flowed southwestward toward and beyond Anchorage. At times of least extensive ice advance, local valley glaciers did not reach far enough downvalley to join with the lowland ice, and thus parts of the valleys within the map area were free of ice. When drainage in these valleys was still blocked by a glacier covering the lowland, however, lakes formed between the lowland glacier and the local glaciers. The latter either terminated directly in lake water or were separated from lake water by outwash plains that were deltaic to the lakes. (Similar relationships between major glaciers and glacier-free tributary valleys elsewhere are described by Sturm and Benson, 1985; Booth, 1986; and Saunders and others, 1987). Beginning about 12,000 yr ago, climatic warming resulted in the final stagnation and retreat of glacier ice that ended glacier domination of the map area. However, the presence of glaciers upvalley from the map area continues to influence stream discharge and alluvial deposition today.

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The glacial deposits are named according to the principal named lateral and end moraines with which they are correlated, as discussed by Schmoll and Yehle (1986). Correlations of the lateral moraines within the map area to named moraines along the mountain front to the west were made largely on the basis of graphically determined gradients of lateral moraines within each major valley and their concordance with moraines along the mountain front; likewise the glaciolacustrine and associated deposits are correlated on the basis of relative altitudes with mountain-front moraines of glaciers that most likely dammed the valleys.

Deposits that occur in moraines dominate the flanks of the Eagle River valley, and occur as scattered remnants in Peters Creek valley and in a few tributary valleys. The most continuous lateral moraines preserved along the flanks of the Eagle River valley descend northwestward in the map area from about 600 m to a probable but obscurely evidenced and unmapped end position at 100 m in altitude. These lateral moraines are correlated with the deposits of the Elmendorf Moraine near Anchorage (Miller and Dobrovolny, 1959) which are now regarded as having formed about 12,000 to 14,000 yr ago (Schmoll and others, 1972) and are the only morainal deposits that are dated closely by radiometric means. Older glacial deposits occur locally at higher altitudes bordering the Eagle River valley and are related with varying degrees of confidence to the successively older Dishno Pond and Fort Richardson moraines, which have informal type localities along the Chugach Mountain front southwest of the map area. (In a previous map of part of the area (Schmoll and others, 1980) deposits of the Dishno Pond moraines were not mapped separately from those of the Fort Richardson moraines). Deposits of the successively older Rabbit Creek and Ski Bowl moraines are tentatively identified at isolated localities within the map area on the basis of their position and altitude. A small area of drift on a topographic saddle at an altitude of about 950 m west of Mount Magnificent provides the highest conclusive evidence for this glaciation within the map area, and has been termed the Mount Magnificent ground moraine (Schmoll and Yehle, 1986) on the basis of this locality. These oldest glacial deposits are more extensive and better exposed to the west of the map area.

The till that constitutes the deposits found in most moraines is composed mainly of diamicton and poorly sorted silty to sandy gravel; gravel and sand, and lesser amounts of silt and clay, are present locally. Within the map area these deposits are exposed only in roadcuts in the Eagle River valley.

Deposits of glacier-dammed lakes are preserved mainly along the sides and on parts of the floors of the Eagle River and Peters Creek valleys. Beach berms are clearly defined, however, only along the southwest side of Peters Creek valley. The Eagle River valley may contain as much as 140 m of glaciolacustrine deposits (Deeter and George, 1982). Comparable deposits in smaller valleys formed in smaller lakes or accumulated subaerially against blockading glacier ice and are here called kame-fan deposits. Both glaciolacustrine and kame-fan deposits are varied in character, ranging from silt and clay to sand, gravel, and diamicton. Exposures of these deposits within the map area are very poor.

Glacioalluvial deposits occur only in small areas mainly in channels associated with lateral moraines, chiefly along the flanks of the Eagle River valley, and as outwash terraces in Peters Creek valley and the tributary to the Eagle River in the southeastern corner of the map area. These deposits consist chiefly of gravel and sand; however, most channels that carried glacial meltwater no longer contain even minor streams, and instead, may consist of organic deposits that grade laterally into, but may be substantially thicker than, the organic and eolian mantle.

COLLUVIAL DEPOSITS

Colluvial deposits, as that term is used here, are those deposits that occur on a slope and that have accumulated primarily through the action of gravity and secondarily through the aid of running water. They may be broadly subdivided into deposits that have accumulated particle by particle over a long period of time and deposits that have moved en masse (mass-wasting deposits), either rapidly (such as debris avalanches) or slowly (such as creep). The deposits that accumulated particle by particle commonly underlie relatively smooth, mostly concave-upward slopes, whereas mass-wasting deposits are generally characterized by sloping topography that is irregularly lumpy to hummocky. The smooth-surfaced deposits are mapped mainly as undivided colluvium (map unit c); however, several types of colluvium with special characteristics are mapped separately, including (1) prominent talus accumulations (ct), (2) colluvium admixed with alluvium (ca), (3) colluvium that partly conceals glacial deposits (cg), (4) colluvium derived mainly from morainal deposits (cm), and (5) colluvium that occurs on steep escarpments resulting mainly from stream erosion (cw). Hummocky colluvium is mapped as solifluction deposits (cs), landslide deposits undivided (cl), and those landslide deposits formed mainly by earthflows (cle). All of these deposits may include minor admixtures of soil and of windblown material, and, except as noted, can be derived either directly from bedrock, from other surficial deposits, or from a combination of these. Colluvium generally consists of poorly sorted material that ranges widely in grain size and is less compact than the poorly sorted material of moraines. Exposures of these deposits are uncommon, and descriptions are based largely on inference from similarity of landforms here to those better known elsewhere in the region.

Large areas of mountain slopes, commonly the middle part of the slope, are covered by colluvium derived mainly from bedrock and mapped as undivided colluvium. On slopes above and within lateral-moraine remnants, especially in the Eagle River valley, colluvium contains a significant component derived from glacial deposits, and conceals moraine deposits as well; some of these slopes are somewhat irregular in character. On slopes below the proximal side of some lateral moraines, colluvium is derived largely from the moraines and is in effect a type of ground moraine that has been subject to downslope movement. Talus deposits generally occur high on the slopes and along the upper courses of tributary valleys, usually beneath prominent bedrock outcrops. Solifluction deposits generally occupy smaller areas on broad slopes. Colluvium that is mixed with alluvium also occupies areas generally restricted in width, commonly in gullies and small ravines, a niche that these deposits share to some extent with earthflow deposits.

The steep walls of valleys that are incised into surficial deposits are particularly subject to instability and renewed stream erosion. These valley walls are commonly veneered by a downslope-thickening wedge of colluvium derived mainly from material into which the wall was cut during the last episode of erosion. Such erosion is likely to occur again at any place along the wall when the stream renews its attack, removes the colluvium, and additionally erodes the underlying material. Valley-wall colluvium is thickest and most extensive where major streams have cut into relatively soft, potentially unstable glaciolacustrine deposits; here, irregular, lumpy bluffs are common. Elsewhere, valley-wall colluvium forms long, narrow belts on terrace and channel escarpments; some of these bluffs are too narrow to map separately, but occur commonly where alluvial deposits of different ages are in contact.

Landslide deposits are the most important among the colluvial deposits in terms of their potential impact on human activity. They vary from individual earthflows and slumps in surficial deposits and (or) bedrock to huge retrogressive block failures in bedrock. Of the various types of landslides present, only earthflows larger than about 100 m in length are mapped separately; some of these occupy pre-existing gullies and ravines. In many places, landslides can be readily identified on the basis of surface morphology visible on airphotos. In other places, however, surface morphology is merely suggestive that landslide deposits might be present. The substantial number of such suspected deposits are queried on the map. Detailed investigation may suggest alternate interpretations for these features, and some of them, for which alternate origins can be confirmed, thus would be relegated to the category "pseudo-landslides" (Shlemon and Davis, 1986). The widespread occurrence of landsliding in the area is facilitated by (1) the structural complexity and highly fractured or sheared nature of the local bedrock; (2) steepness of slopes, caused in part by glacial erosion; and (3) slope orientation.

A special type of slope process that occurs on some steep mountain slopes but that does not give rise directly to colluvium is inferred from small, narrow, bedrock-flanked trenches interpreted as sackung features. The trenches occur along or just downslope from and subparallel to the crests of a few high mountain ridges. Sackung features are interpreted to have formed by gravitational spreading of a ridge by gradual displacement along a series of disconnected planes or by deep-seated plastic deformation of the rock mass without formation of a through-going slide plane (Radbruch-Hall, 1978; Savage and Varnes, 1987). Although the process is not fully understood, conditions especially conducive to sackung formation are thought to include oversteepened valley walls left unsupported after retreat of a glacier. Earthquake shaking and tectonic or glacio-isostatic uplift might enhance or accelerate development of the sackung features. All of these conditions obtain in the Chugach Mountains where we recognize sackung features. They are well exhibited locally in the eastern and northeastern parts of the map area. Similar, more extensively developed features have been noted on upper mountain slopes northeast of the map area (H.R. Schmoll and Ernest Dobrovolny, unpublished mapping, 1966-1973). Special lineations mapped there by Updike and Ulery (1983) may also be sackung features.

Active rock glaciers and the deposits of formerly active rock glaciers are transitional features that have characteristics of both true glaciers and mass-wasting deposits. Active rock glaciers constitute a body of sediment that is still in the transport mode, albeit moving very slowly and having the appearance of a deposit. An attempt has been made, following the criteria of Wahrhaftig and Cox (1959), to differentiate active rock glaciers from what they termed inactive rock glaciers, those probably no longer moving. The latter are here termed rock-glacier deposits, and they lack the active rock glacier's steep front from which clasts are actively falling as the glacier moves forward and which commonly exhibits a prominent moisture zone.

Rock-glacier deposits are subdivided here into a younger and an older group. The younger deposits are closely associated with active rock glaciers, and are difficult to distinguish from them in places, to some extent because the same mass of sediment alternately may move and stop several times over a period of years, and the characteristics visible on airphotos or even by inspection on the ground may not necessarily reflect the present state of movement. Active rock glaciers generally are free of vegetation, whereas the younger rock-glacier deposits commonly support at least some low plants. The older deposits are commonly somewhat dissected, in contrast to both active rock glaciers and the younger deposits, each individual occurrence of which occupies a single map-unit area. The older rock-glacier deposits in places might be regarded as ground moraine (the deposits of true glaciers), but generally the surface morphology is more massive and uniformly hummocky in appearance, with the well developed flow fronts that are characteristic of rock glaciers and younger rock-glacier deposits. The areas of the older deposits support a vegetative cover similar to that of similarly situated older lateral and ground moraines.

Within the map area active rock glaciers terminate at a mean altitude of about 1,200 m; rock-glacier deposits have a lower altitudinal limit of about 1,000 m, and older rock-glacier deposits, about 700 m. These altitudinal differences probably reflect different climatic regimes under which the deposits formed, as well as differences in rock type and valley orientation. The younger rock-glacier deposits are regarded as late Holocene in age on the basis of their association with and similarities to active rock glaciers. The older deposits may be of earlier Holocene or even of Pleistocene age, because their substantially greater extent and position within each valley are more compatable with a climatic regime more severe than that of the recent past. All three features occur in the map area mainly in north-facing valleys tributary to Peters Creek valley.

OTHER DEPOSITS

Other surficial deposits mapped include alluvial deposits and peat and pond deposits. Alluvium has been mapped mainly in the Eagle River and Peters Creek valleys as well as in many smaller valleys. Alluvium occurs also within small valleys in areas that are too narrow to map separately. The alluvial deposits are subdivided into stream alluvium and fan alluvium, the latter deposited where tributary valleys enter a larger valley. Large alluvial fans are especially well developed in the Eagle River valley. Both kinds of alluvium are also subdivided into younger and older deposits. In addition, alluvium that occupies the active flood plain of the Eagle River, and that is still at least intermittently in the transport mode, is mapped separately because the area of these materials is continually subject to reoccupation by the river. We presently do not have the data to relate this map-unit area, as well as adjacent areas of younger alluvial deposits, to any numerical frequency of flooding. The older alluvial deposits generally occur in terraces that are as much as several meters above the younger alluvium or in fans that have been incised by streams which then developed the younger fans. Because some older alluvial fans bordering Peters Creek appear to be altitudinally related to Pleistocene lake levels in that valley, the deposits of those fans are mapped separately and tentatively are correlated with the corresponding glaciolacustrine deposits. Alluvial deposits consist mostly of sand and gravel.

Peat and pond deposits are mapped mainly in the broad, nearly flat valley of the Eagle River and consist of varying proportions of silt, sand, and peat, the latter commonly dominant, that occupy present-day bogs. These deposits may in part be the last phase of glaciolacustrine deposition where those deposits are not yet completely covered by alluvium of the Eagle River.

HISTORY OF INVESTIGATIONS

The surficial geology initially was mapped at 1:63,360 scale by H.R. Schmoll and Ernest Dobrovolny between 1965 and 1971, by interpretation of 1:40,000-scale airphotos taken in 1957 and by field investigations. Additional field investigations were undertaken by H.R. Schmoll in 1973, 1975, and 1976. Mapping subsequently was enlarged to a scale of 1:25,000 by L.A. Yehle and H.R. Schmoll in 1986 and 1987; additional detail was derived from interpretation of 1:24,000-scale airphotos taken in 1972 and 1973 and augmented by field investigations in 1986 and 1987. Early versions of surficial geologic maps of the area were presented by Schmoll and others (1980) for the Eagle River valley; a narrow strip along the western edge of the map area was shown by Zenone and others (1974) as derived from Schmoll and others (1971). Contacts with bedrock are in part modified from Clark and Bartsch (1971), Schmoll and others (1971), Schmoll and others (1980), and R.G. Updike and C.A. Ulery, Alaska Division of Geological and Geophysical Surveys (written communs., 1986 and 1987).
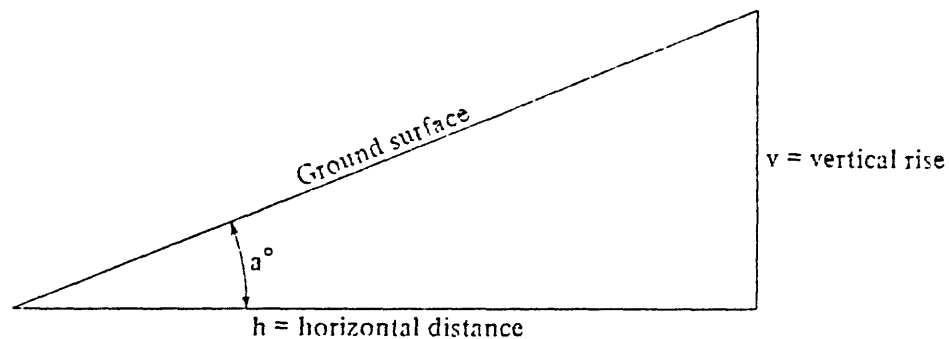
Diagrammatic representation of slope-measuring terms

Slope in percent = v/h X 100

Slope angle in degrees = a°

Slope ratio = h:v (h to v) where v is equal to 1 unit of measurement

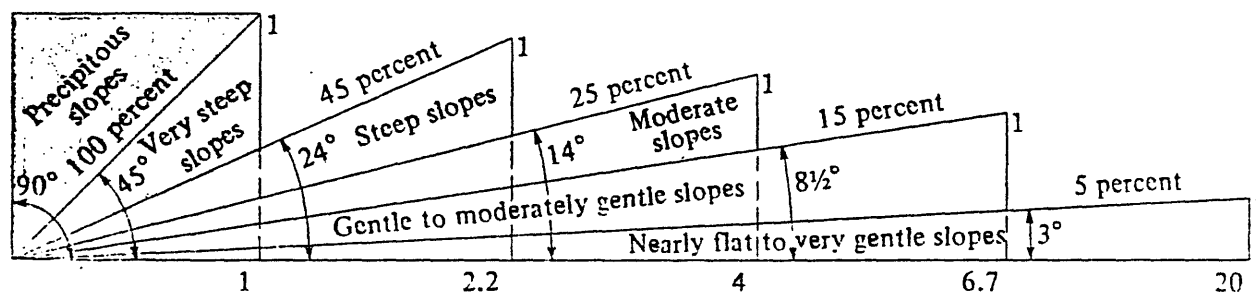Figure 2.--Diagram illustrating slope categories used on this map (after Schmoll and Dobrovolny, 1972).

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DESCRIPTION OF MAP UNITS

The surficial geologic map (plate 1A, in pocket) delineates deposits estimated to be 1 m or more in thickness. Estimates are based primarily on field observations. Grain sizes of unconsolidated particles follow the modified Wentworth grade scale (American Geological Institute, 1958). Slope categories, from Schmoll and Dobrovolny (1972), are illustrated in figure 2, and are generalized estimates derived mainly from the slope map in Zenone and others (1974, p. 2 and fig. 3). Standard age designations are omitted from map symbols because all units except bedrock are of Quaternary age. The correlation of map units is shown on plate 1B (in pocket).

SURFICIAL DEPOSITS

Moraine Deposits

Subdivided according to type of moraine, mainly lateral and ground moraines, and according to correlations with named lateral moraines that occur as remnants along the Chugach Mountain front west of the map area, as discussed above. The till that composes most moraine deposits is chiefly a diamicton consisting of massive, unsorted to poorly sorted mixtures of gravel, sand, silt, and relatively minor amounts of clay; includes scattered large boulders; it is generally moderately to well compacted.

Lateral-moraine deposits

eml   Deposits of the Elmendorf Moraine (late Pleistocene)--Thickness poorly known, but probably several to about ten meters; in places bedrock may occur at relatively shallow depth. Contacts with colluvium generally gradational, other contacts more sharply defined. Topography moderately irregular; slopes gentle to moderate on small areas on ridge tops, steep on ridge sides. Relatively more stable than other surficial deposits on mountain slopes; some instability likely on steepest slopes. Occur as remnants of narrow ridges on the flanks of Eagle River valley

dml   Deposits of the Dishno Pond moraines (Pleistocene)--Thickness poorly known, probably at least several meters. Contacts fairly well defined. Topography moderately irregular; slopes generally moderate. Occur extensively in valley tributary to Eagle River in the southeastern part of map area and as remnants of narrow ridges on flanks of Eagle River valley both upslope and downstream from occurrences of the Elmendorf moraines

fml   Deposits of the Fort Richardson moraines (Pleistocene)--Thickness poorly known, probably several meters. Contacts gradational. Topography moderately irregular; slopes moderate to steep. Some instability likely because of location on upper valley walls where colluvial processes dominate. Occur as isolated remnants relatively high along flanks of Eagle River valley, near the east edge of the map area in Peters Creek valley, and along a tributary valley of Peters Creek in the northwestern corner of the map area

rml   Deposits of the Rabbit Creek moraines (Pleistocene)--Probably more
           compacted and oxidized than other lateral-moraine deposits.
           Thickness poorly known, probably several meters. Contacts
           gradational. Topography moderately irregular, slopes generally
           moderate. Identified only in the valley of Peters Creek
         Ground-moraine deposits
emg   Deposits of the Elmendorf Moraine (late Pleistocene)--Thickness
           several to a few tens of meters, commonly overlying older
           glacial deposits. Contacts generally well defined, gradational
           with lateral-moraine deposits. Topography smooth, slopes
           generally moderate. Occur in Eagle River valley generally lower
           on the slope than associated lateral moraines
dmg   Deposits of the Dishno Pond moraines (Pleistocene)--Thickness
           poorly known, probably several meters. Contacts generally well
           defined, gradational with colluvium. Topography smooth to
           somewhat irregular, slopes generally moderate. Occur mainly in
           Eagle River valley
fmg   Deposits of the Fort Richardson moraines (Pleistocene)--Thickness
           poorly known, probably a few meters. Contacts well defined,
           slopes generally moderate. Single occurrence on the north side
           of Eagle River valley
rmg   Deposits of the Rabbit Creek moraines (Pleistocene)--Thickness
           poorly known, probably only a few meters; small bedrock outcrops
           present locally; may be admixed with colluvium derived from
           bedrock. Contacts gradational. Topography smooth, slopes
           gentle to moderate. Tentatively identified only on the
           northeast side of Peters Creek valley
smg   Deposits of the Ski Bowl moraines (Pleistocene)-- Thickness poorly
           known, probably only a few meters; small bedrock outcrops
           present locally; may be admixed with colluvium from bedrock.
           Contacts gradational. Topography smooth, slopes moderate.
           Tentatively identified only on the northeast side of Peters
           Creek valley
smb   Deposits of the Ski Bowl moraines that thinly mantle bedrock
           (Pleistocene)--Thickness poorly known, probably a meter or less;
           small bedrock outcrops probably common; admixed with or
           consisting mostly of bedrock rubble. Contacts fairly well
           defined. Topography smooth, slopes gentle. Tentatively
           identified at only a few places upslope from both sides of Eagle
           River valley
mmg   Deposits of the Mount Magnificent moraine--Thickness poorly known,
           probably only a few meters; small bedrock outcrops present
           locally; probably admixed with bedrock rubble containing a
           matrix of sandy silt. Contacts fairly well defined. Topography
           smooth, slopes gentle. Occur only in a saddle at the central-
           west edge of the map area
mmb   Deposits of the Mount Magnificent moraine that include mainly
           bedrock rubble (Pleistocene)--Thickness poorly known, probably a
           meter or little more; only widely scattered erratics may be
           present; small bedrock outcrops common. Contacts gradational.
           Topography fairly smooth, slopes gentle. Occur only in a broad
           saddle at the head of a tributary to Peters Creek near the east
           edge of the map area

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Glacioalluvial and Glaciolacustrine Deposits

Subdivided into (1) outwash-terrace and meltwater-channel deposits that are glacioalluvial in origin and that consist dominantly of gravel and sand; (2) kame-fan and glacial-lake delta deposits that are transitional between glacioalluvial and glaciolacustrine in origin and that include a variety of coarse, fine, and mixed-size materials, and (3) glaciolacustrine deposits that are dominantly fine grained with variably admixed well to poorly sorted coarser materials.

Outwash-terrace deposits--Chiefly gravel and sand, well bedded and sorted. Thickness poorly known, probably one to several meters. Contacts well defined. Topography smooth, slopes nearly flat to very gentle

eo   Deposits of the Elmendorf Moraine (late Pleistocene)--Occur only along Peters Creek as terrace remnant

do   Deposits of the Dishno Pond moraines (Pleistocene)--Occur along Peters Creek where terrace extends downvalley from an end moraine west of the map area, and in valley tributary to Eagle River in the southeastern corner of map area

Meltwater-channel deposits--Chiefly gravel and sand, well bedded and sorted; at the surface may include some finer-grained material with thin organic accumulations. Thickness poorly known, probably one to a few meters. In places, channel deposits may be very thin or absent and ground-moraine deposits or bedrock may floor the channel or lie at shallow depth

ec   Deposits of the Elmendorf moraines (late Pleistocene)--Occur only in the southeastern corner of the map area

dc   Deposits of the Dishno Pond moraines (Pleistocene)--Occur only on the flanks of Eagle River valley

fc   Deposits of the Fort Richardson moraines (Pleistocene)--Single occurence on the southwest side of Eagle River valley

oc   Older deposits (Pleistocene)--Gravel and sand may be less well bedded and sorted, thinner, and probably more oxidized than other channel deposits; bedrock outcrops probably common. Tentatively identified in widely scattered occurrences at relatively high altitudes on mountain ridges

Kame-fan deposits--Probably mainly gravel and sand that is well to poorly bedded and sorted and that accumulated in alluvial fans or small lakes in small valleys blocked by glacier ice; may include beds of silt, fine sand, and some clay, as well as some diamicton. Thickness poorly known, possibly as much as a few tens of meters. Contacts gradational with colluvium. Topography generally smooth, slopes moderately gentle to moderate, locally steeper

ekf   Deposits related to the Elmendorf moraines (late Pleistocene)-- Occur along the northeast side of Eagle River valley

dkf   Deposits related to the Dishno Pond moraines (Pleistocene)--Occur only in north-side valleys tributary to Eagle River valley

fkf   Deposits related to the Fort Richardson moraines (Pleistocene)-- Well developed in hanging tributary valleys to Eagle River valley

rkf   Deposits related to the Rabbit Creek moraines (Pleistocene)--Occur in tributaries to Eagle River and Peters Creek valleys

Glacial-lake delta deposits (Pleistocene)--Chiefly gravel and sand, generally well bedded and sorted; may include thin beds of finer-grained material. Thickness poorly known, probably 10 m or less. Contacts generally well defined. Topography generally smooth, slopes gentle. Located in Peters Creek valley

dgd   Deposits related to the Dishno Pond moraines

fgd   Deposits related to the Fort Richardson moraines

Glacial-lake deposits--Interbedded clay, silt, sand, gravel, and diamicton in varying proportions; well to somewhat poorly sorted. Contacts relatively well defined. Topography generally smooth, slopes gentle. Moderately stable except near lower contact with colluvium (map unit cw) where susceptible to erosion, earthflowage, and other landsliding

egl   Glacial-lake deposits related to the Elmendorf Moraine (late Pleistocene)--Thickness about 5-10 m; may be much thicker beneath valley floor alluvial and peat deposits. Occur only on lowest slopes of Eagle River valley near valley floor

dgl   Glacial-lake deposits related to the Dishno Pond moraines (Pleistocene)--Thickness poorly known, possibly 5-10 m. Occur only on lower slopes of Peters Creek valley in northern part of map area

fgl   Glacial-lake deposits related to the Fort Richardson moraines (Pleistocene)--Thickness poorly known, probably 10 m or more. Occur on middle to lower slopes of Peters Creek valley, especially on southwest side where well-developed flights of numerous very narrow beach berms are preserved

Alluvial Deposits

Alluvium deposited by moderate and small streams. Generally well bedded and sorted, clasts commonly well rounded. Thickness variable, probably a few to several meters, and thickest in larger valleys. Contacts well-defined. Topography smooth, slopes nearly flat to very gentle

aa   **Alluvium in active flood plain of Eagle River (latest Holocene)**-- Sand and some gravel intermittently in the transport mode, deposited temporarily in bars which commonly change their position along braided and single channels. Vegetation cover generally absent or just beginning to develop in areas that have not been affected by the stream for a few years. Area subject to continuing erosion and flooding; in places activity may encroach upon adjacent map-unit areas

al   **Alluvial deposits along other modern streams and in lowest terraces (Holocene)**--Chiefly gravel and sand except in Eagle River valley where sand is common and locally overlies lacustrine silt and clay at depths of about 7 m. Generally at or no more than a few meters above stream level. Includes narrow active floodplains where too small to map separately

at   **Alluvial deposits in terraces (Holocene)**--Somewhat older alluvium, chiefly gravel and sand, generally several meters above stream level. Well developed along Peters Creek and Meadow Creek

Alluvial-fan deposits (Holocene)--Formed mainly in moderate to small fans where small tributaries enter larger streams of lower gradient. Graded to or just above modern stream levels. Materials commonly less well sorted than other alluvium. Slopes moderate to moderately gentle, steeper near heads of fans

af Coarse-grained deposits--Chiefly gravel and sand; may include some silt and thin diamicton beds resulting from minor mudflows

aff Fine-grained deposits--Chiefly silt and fine sand. Occur locally in Eagle River valley

afo **Older alluvial-fan deposits (Holocene and Pleistocene)**--Gravel and sand, possibly admixed with some finer-grained material. Deposits may be less well sorted and have steeper slopes than in other alluvial units. In part may include deltaic deposits of former glacial lakes. Occur as remnants commonly in association with younger alluvial fans, but graded to levels above modern streams; on the north side of Eagle River valley, older deposits form the larger part of fan complex

daf Alluvial-fan deposits related to Dishno Pond moraines (Pleistocene)--Similar to older alluvial-fan deposits but gradients suggest that in large part these deposits formed coevally with named outwash and glacial lake deposits. Occur only in Peters Creek valley

faf Alluvial-fan deposits related to Fort Richardson moraines (Pleistocene)--Similar to older alluvial-fan deposits but gradients suggest that in large part these deposits formed coevally with named glacial deltaic and lake deposits. Occur only in Peters Creek valley

Peat and Pond Deposits (Holocene and late Pleistocene)

p Chiefly mosses, sedges, and other organic material in various stages of decomposition; includes organic-rich silt, minor woody horizons, and a few thin interbeds of mainly ash-size tephra. At depth may include silt, clay, marl, or fine-grained sand. Developed mostly in small former lakes or stream channels now the site of bogs. Soft and moist. Thickness as much as 4 m; adjacent mapped deposits extend beneath these deposits. Contacts well defined. Surface smooth, slopes less than one percent. Poorly drained. Mostly on floor of Eagle River valley

Colluvial Deposits (Holocene and Pleistocene)

c **Colluvial deposits on mountain slopes, undivided**--Mainly apronlike deposits of loose sandy to rubbly diamicton derived directly from weathering of bedrock upslope; includes some sheetwash. Thickness poorly known, probably less than one to several meters, thicker on lower slopes. Contacts gradational. Topography smooth, surface gently concave upward, slopes generally steep to very steep, but usually not in excess of 70 percent. Commonly veneered by thin low vegetation; some instability likely

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ct **Talus deposits--Cone-shaped to apronlike deposits on valley walls within rugged mountains.** Mainly loose, coarse rubble and rubbly diamicton derived directly from weathering of bedrock upslope. Thickness variable, generally thickest in middle to lower parts of cones and aprons, probably several to a few tens of meters, thinning gradually upward toward apexes and more abruptly downward near toes. Contacts generally gradational, with bedrock at apex, and with other map units at toe; individual cones commonly have well-defined boundaries. Talus deposits too small to map separately occur within bedrock map unit. Topography smooth, slopes steep to very steep, as much as 100 percent near apex, rarely less than 35 percent near toe. Commonly free of even low vegetation and subject to continuing deposition from above, including rockfalls and debris-laden snow avalanches; generally unstable

ca **Colluvial and alluvial deposits, undivided--Areas of colluvium and alluvium too small to map separately.** Chiefly moderately loose sandy to rubbly diamicton, poorly sorted sand and gravel, and some organic debris. Thickness poorly known, probably a few meters. Contacts generally gradational. Topography irregularly gullied, slopes steep to very steep, generally ranging between 35 and 70 percent. Commonly covered by low vegetation, active deposition occuring only within some of the gullies. Some instability likely

cg **Mixed colluvial and glacial deposits--Diamicton consisting chiefly of gravelly to rubbly sand, silt, and clay; locally bouldery.** Derived from both bedrock and from glacial deposits, either of which are likely to occur at the surface in areas too small to map separately. Poorly bedded and sorted. Loosely to moderately compacted in most places. Thickness varies from a few to several meters. Contacts gradational. Slopes smooth to slightly irregular, steep to very steep

cm **Colluvial deposits derived from moraines or other glacial deposits--Diamicton similar to that of adjacent upslope moraines, but less compact;** includes minor amounts of better sorted sand, silt, and gravel that occur in irregular beds and that may have been derived from better-sorted glacial deposits and moved partly with the aid of running water. Commonly a few meters thick. Contacts generally gradational, especially upslope. Slopes generally moderate and moderately stable

cw **Colluvial deposits on walls of stream bluffs--Loose accumulations derived from adjacent, upslope deposits that form a veneer on bluffs following erosion.** Chiefly diamicton consisting of pebbly silt and sand with some clay, cobbles, boulders, and a variable amount of organic material. Poorly bedded and sorted. Generally a few meters thick, thinner at the upslope part; may be thicker downslope. Contacts generally well defined. Slopes steep to precipitous. Although stabilized locally by vegetative cover, subject to instability because of renewed gully or stream erosion and accompanying mass-wasting processes

cs   **Solifluction deposits**--Chiefly loose, organic-rich, sandy to rubbly diamicton, commonly lacking phenoclasts larger than pebbles; generally derived from weathering of easily frost-shattered bedrock directly upslope, moving very slowly down broad mountain slopes either with the aid of interstitial ice (solifluction in a rigorous sense) or of water derived largely from snowmelt. Thickness poorly known, probably one to a few meters. Contacts gradational to (1) very thinly covered bedrock, (2) other colluvium, and (3) thicker accumulations of material that have moved downslope by landsliding; includes some landslide deposits too small to map separately. Topography generally fairly smooth, but with many minor irregularities especially in the form of small lobes with flatter upper surfaces and steeper fronts. Slopes steep to moderately steep. Generally unstable

cl   **Landslide deposits, undivided**--Include a wide variety of materials, chiefly diamicton, gravelly silt and sand with relatively minor amounts of clay, and some organic material; may include boulders and some very large masses of bedrock. Includes some small earth-flow deposits too small to map. Nonbedded and nonsorted to poorly sorted. Relatively loose. Thickness poorly known, probably several meters to possibly hundreds of meters. Contacts moderately well to poorly defined. Topography irregular to slightly hummocky, slopes moderate to steep. Queried where identity uncertain; these deposits may be similar to those positively identified, but may instead consist of larger masses of unbroken bedrock. Occur on most mountain slopes throughout map area and locally in association with glaciolacustrine deposits

cle   **Landslide deposits resulting from earthflows**--Similar to other landslide deposits but interpreted on the basis of landform to have been emplaced in a more fluid medium and therefore may include a higher proportion of finer-grained material. Contacts generally well defined. Mainly in long narrow occurrences in gullies and small valleys

Rock Glaciers and Rock-Glacier Deposits

rg   **Rock glaciers (latest Holocene)**--Accumulations of mainly angular to some subrounded rock fragments still actively being transported, derived from upslope talus or landslide deposits; contain ice-rich matrix and move very slowly downslope; surface irregular and generally lacking vegetation. Upper surface dominated by angular to subangular cobble- and boulder-size fragments; at depth substantially more fine-grained material may be present to form coarse, rubbly, diamicton. Thickness several to a few tens of meters. Contacts generally well defined except gradational to talus deposits at upslope margin. Surface moderately hummocky and rough; slopes generally moderate, but steep to very steep along margins. Unstable because of continuing very slow movement and potential for melting of ice-rich matrix

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rd   **Younger rock-glacier deposits (late Holocene)**--Similar to active rock glaciers except that movement has probably ceased and some vegetation covers the somewhat smoother surface. Generally more stable than rock glaciers; some instability likely, especially if excavated, because of loose nature of material and possible presence of some interstitial ice. In places may still be active

rdo   **Older rock-glacier deposits (Holocene and Pleistocene)**--Similar to younger rock-glacier deposits but almost certainly not active; vegetation mat thicker and ground surface smoother than younger deposits

BEDROCK

b   **Undivided (Cretaceous and Jurassic)**--Includes rocks of the Chugach terrane, mainly variably metamorphosed graywacke, argillite, phyllite, and conglomeratic graywacke of the Valdez Group and, in the northwestern and southeasternmost parts of the map area, the McHugh Complex

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