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

By

Lynn A. Yehle[1] and Henry R. Schmoll[1]

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INTRODUCTION

The Anchorage B-7 SW quadrangle is located in south-central Alaska within the Municipality of Anchorage and about 22 km northeast of downtown (fig. 1); the community of Eagle River is centered in the map area which is traversed north to south by the Glenn Highway and the Alaska Railroad (pl. 1A, in pocket). The quadrangle is one of a series in the Anchorage-Knik Arm region for which surficial geologic maps have been completed recently at a scale of 1:25,000 (Daniels, 1981a,b; Reger, 1981a,b,c,d; Yehle and Schmoll, 1987a,b; 1988; fig. 2).

The map area includes parts of two physiographic provinces, the Kenai-Chugach Mountains and the Cook Inlet-Susitna Lowland (Wahrhaftig, 1965), which are subdivided informally as shown on figure 1. The rugged Chugach Mountains dominate the area and consist of a central core of very steep mountains with peaks in excess of 2,000 m and a flanking region where peaks and ridges are generally 1,000-1,500 m in altitude. Only this lower region is present in the map area whose highest peak is Mount Gordon Lyon, 1,260 m, in the southeastern part. Near the western margin of the Chugach Mountains some of the mountaintops have smoothed, gentle to nearly flat slopes. The best developed of these surfaces, a few square kilometers in size, occur in the northeastern part of the map area. The western edge of the mountains is bounded by a steep front that descends abruptly to the Anchorage lowland. The steepness of this front suggests that it may be fault controlled, but in spite of assertions of the existence and recency of such faulting, especially farther to the northeast (Updike and Ulery, 1983; Updike and Schmoll, 1984), compelling evidence of Quaternary fault activity along the mountain front in this quadrangle has not yet been found.

The Chugach Mountains are composed of structurally complex and variably metamorphosed sedimentary and igneous rocks (Capps, 1940; R.G. Gastil, U.S. Army Corps of Engineers, written commun., 1956; Clark and Bartsch, 1971; Clark, 1972; R.G. Updike and C.A. Ulery, then Alaska Division of Geological and Geophysical Surveys, written communs., 1986, 1987; G.R. Winkler, written commun., 1986; oral commun., 1989; Madden and others, 1988; Updike and Ulery, 1988). The map area includes rocks of both the Peninsular and Chugach terranes (Coney and Jones, 1985; Jones and others, 1987). The Peninsular rocks are restricted to a narrow belt near the base of the mountain front and range from Permian to Jurassic in age. The Chugach terrane includes mainly (1) the McHugh Complex (Clark, 1973), Cretaceous in age but including protoliths as old as Late Triassic (Plafker and others, 1989); (2) the Valdez Group, Late Cretaceous in age, and (3) minor intrusive bodies of Tertiary age.

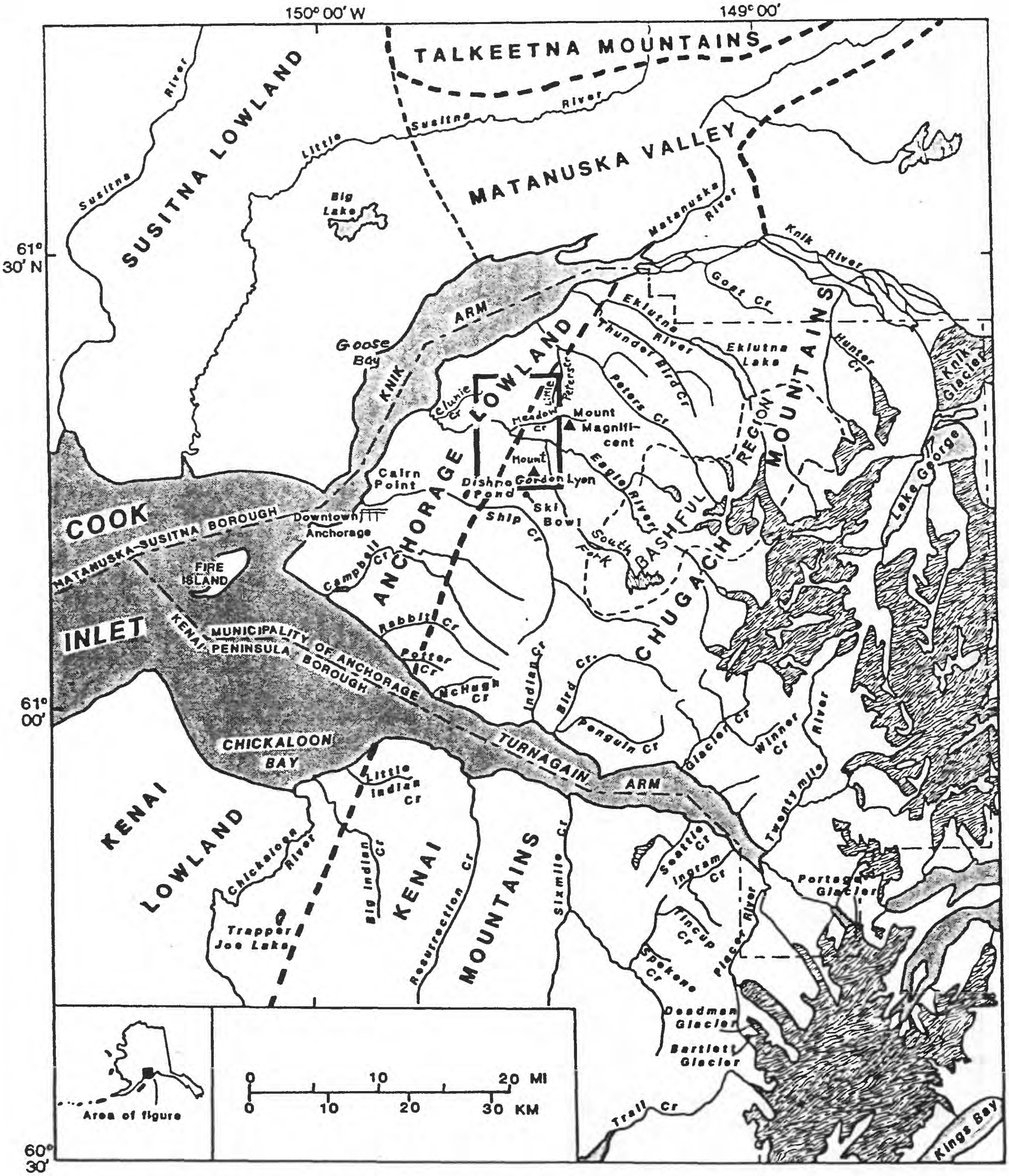


Figure 1.--Location of Anchorage B-7 SW quadrangle and major geographic features. Double-weight dashed line indicates boundary between major physiographic provinces of Wahrhaftig (1965); single-weight dashed line and water bodies separate physiographic subprovinces of informal usage. Heavy pattern indicates glaciers.

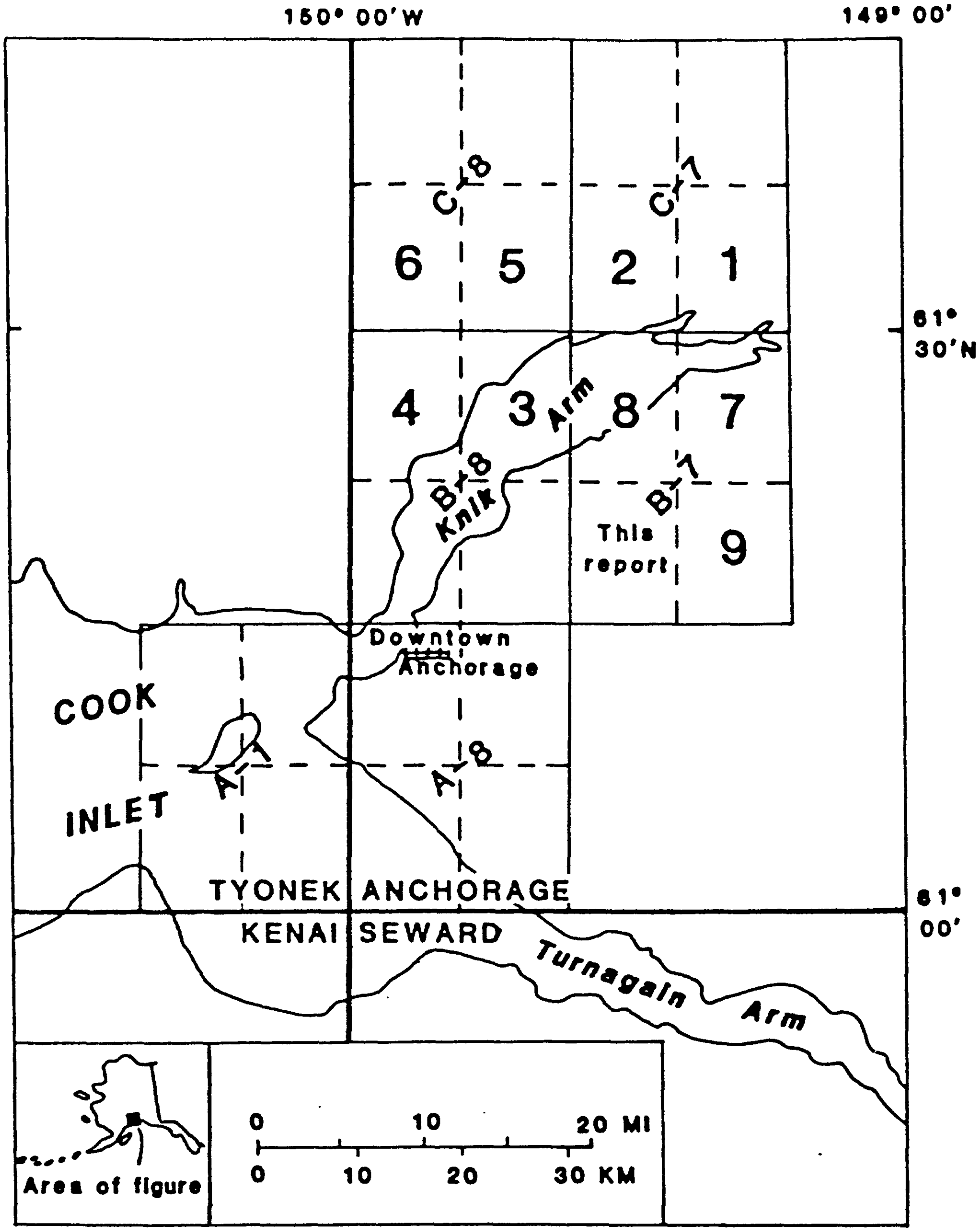


Figure 2.--Index map showing location of surficial geologic maps in the Anchorage-Knik Arm region at 1:25,000 scale (1, Daniels, 1981a; 2, Daniels, 1981b; 3, Reger, 1981a; 4, Reger, 1981b; 5, Reger, 1981c; 6, Reger, 1981d; 7, Yehle and Schmoll, 1987a; 8, Yehle and Schmoll, 1987b; 9, Yehle and Schmoll, 1988).

A pronounced structural grain is evidenced by the subparallelism of several topographic features that define two principal trends. The valleys of the Eagle River, Meadow Creek, and unnamed creeks in the southwestern part of the map area transect the mountains in a generally northwesterly direction. Although trending about due north within the map area, the valley of the South Fork Eagle River (hereinafter South Fork, as shown on most maps) also roughly parallels the other valleys over most of its course. In contrast, in the northern part of the map area, Little Peters Creek trends in a north-northeasterly direction that is roughly parallel to the mountain front and to other principal valleys within the mountains. These features are exhibited by the drainage lines shown on figure 1 and on the geologic map.

The Anchorage lowland (Schmoll and others, 1984), an informal physiographic subunit of the Cook Inlet-Susitna Lowland, lies southeast of Knik Arm and is characterized mainly by low- to moderate-relief hills of glacial drift having intervening meltwater channels many of which are surfaced by boggy ground. Some of the hills are cored by bedrock, especially so near the Chugach Mountains. Several of the hills and channels form bands subparallel to the mountain front. Metamorphic rocks of the Peninsular terrane probably underlie all of the lowland at depth. Except near the mountain front, however, these rocks are overlain by relatively soft, continental sandstone, siltstone, claystone, and minor coal of Tertiary age, probably Tyonek Formation as defined by Wolfe and others (1966), Calderwood and Fackler (1972), Wolfe and Tanai (1980), and Wolfe (1981). These sedimentary rocks crop out mainly along the Eagle River west of the Glenn Highway and at scattered localities north of the community of Eagle River. Rocks in the latter localities have not been examined in detail; some of them could prove to be Sterling Formation, as did rocks in a drill hole near downtown Anchorage (Stricker and others, 1988) as shown by examination of plant microfossils.

The Eagle River is the principal stream within the map area and flows across it in a west-northwesterly direction. A principal tributary, the South Fork, enters the map area in its southeastern part. Both rivers emerge from glaciers to the southeast, flowing through lakes close to their headwaters. The Eagle River drains from a lake at an altitude of 267 m that formed in historical time at the foot of the receding Eagle Glacier. Eagle Lake, at an altitude of 785 m near the head of the South Fork, is dammed by massive landslide debris. These streams flow in valleys that are deeply entrenched within the Chugach Mountains, the deeper being the Eagle River valley which is cut 300 m lower than the floor of the South Fork valley.

The Eagle River valley is about 2 km wide between the eastern edge of the map area and the Chugach Mountain front where it merges with the Anchorage lowland. The valley includes 3 principal components, (1) sloping margins that are underlain mainly by colluvial deposits, (2) a broad plateau-like region in the central part of the map area that is underlain by glacial deposits, and (3) an inner part that is flat-floored, is underlain by alluvial and lacustrine deposits, and has a gradient of about 2.5 m/km. The river meanders across the inner valley which narrows from about one kilometer in width at the eastern edge of the map area to about 50 m at a small canyon at the position of the Chugach Mountain front. The inner valley becomes increasingly entrenched until at the canyon it lies about 50 m below the floor of the main valley. Downstream from here, only the inner valley continues across the Anchorage lowland as a trench about 250 m wide and 50 m deep; here the river gradient is about 7 m/km.

Several small, elongate lakes occupy channels in the northwestern part of the map area. One of them, Lower Fire Lake, just east of the Glenn Highway, has been artificially enlarged by construction of a low dam at its southwestern end.

SURFICIAL DEPOSITS

Surficial deposits within the map area consist of glacial drift that is entirely Pleistocene in age, and alluvial, colluvial, pond, lacustrine, and other deposits that are mainly Holocene in age. Glacial deposits occur mainly on the Anchorage lowland, on the flanks of the Chugach Mountains, and in the Eagle River and South Fork valleys. In addition there are small areas of glacial till on some gently crested mountain tops which indicate that at times glacier ice filled the Cook Inlet-Susitna Lowland to a sufficient altitude to overtop and erode the adjacent mountain margins. Alluvial deposits occupy the floors of most valleys and are most extensive in the Eagle River valley. Variably thick colluvial deposits cover bedrock on most mountain slopes throughout the area. Deposits of massive landslides are present especially in the southwestern part of the map area as well as south of the Eagle River valley. Pond deposits occur mainly in the numerous glacial meltwater channels in the northwestern part of the map area and in the Eagle River valley. A ubiquitous mantle of organic and windblown materials, including minor amounts of tephra, covers all but the most recent deposits. This mantle has not been mapped separately. Mapped anthropogenic deposits include major areas of engineered fill and of extensively reworked ground.

GLACIAL DEPOSITS

Glacial deposits are subdivided into (1) those that form moraines and were deposited directly by glacier ice and (2) those that form associated kames, meltwater-channels, outwash plains, and glacial lakes and related deltas. Many of the moraines and associated landforms on the Anchorage lowland are aligned subparallel to the Chugach Mountain front in the direction of ice-flow southwestward roughly along the present position of Knik Arm.

In the map area there have been several glacial advances from and retreats to extensive mountainous regions to the north and east as well as the advance and retreat of local glaciers in major mountain valleys. Each of these glaciers successively modified the terrain in the map area (Dobrovolny and Miller, 1950; Miller and Dobrovolny, 1959; Karlstrom, 1964; Reger and Updike, 1983; Schmoll and Yehle, 1986). Here, as in most mountain regions, evidence for past glaciations is based largely on relict landforms, and only those landforms resulting from the last glacier to occupy a given area are preserved. Consequently, the oldest glacier advance for which there is evidence was the most extensive, and successively younger advances from which landforms still survive were successively less extensive. Evidence for intervening advances of lesser extent than following advances is lacking, although such ice advances probably occurred.

The most widespread glaciers to reach the map area probably advanced from distant sources in mountains to the north and east, and mostly overwhelmed local valley glaciers in the Chugach Mountains to fill the Cook Inlet-Susitna Lowland and adjacent mountains with ice. When glaciers from the distant sources were less extensive, glaciers in the Eagle River and South Fork valleys were able to develop more extensively. At these times, they still joined ice from distant sources in the lowland and the combined glacier flowed southwestward toward and beyond Anchorage. When glacier advances were even less extensive, local valley glaciers did not reach far enough downvalley to join with each other or with the lowland ice and the lower Eagle River and South Fork valleys were free of glacier ice. When drainage in local valleys was blocked by a lowland glacier or its lateral moraines, lakes formed between the lowland glacier and the local glaciers. The local glaciers either terminated directly in lake water, or were separated from lake water by tracts of outwash that formed deltas in the lakes. (Similar relations between major glaciers and glacier-free tributary valleys along other mountain margins are described by Sturm and Benson, 1985; Booth, 1986; and Saunders and others, 1987).

Timing of any of the events described in a general way above is not well established, nor is it certain how many such events occurred within the Wisconsin glaciation (Bowen and others, 1986). All radiocarbon age determinations on samples from sites within the map area are listed in table 1. They fall into two groups, those that lie beyond the range of the radiocarbon-dating method, and those that are clearly Holocene in age. No radiocarbon dates provide evidence that well defined interstadial intervals separate any of the postulated glacial events. At Anchorage and along Knik Arm, the Bootlegger Cove Formation (Miller and Dobrovolny, 1959; Updike and others, 1982), the upper part of which is dated at about 14,000 yr B.P. (Schmoll and others, 1972), could be regarded as evidence for such an interval. Although a major glacier retreat has been postulated for this period of time in Turnagain Arm to the south (fig. 1; Bartsch-Winkler and Schmoll, 1984), a retreat of similar magnitude apparently did not extend into this map area. Beginning about 12,000 yr ago (Schmoll and others, 1972; Reger and Updike, 1983, 1989), final stagnation and retreat of glacier ice 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 in the mountain valleys.

The glacial deposits are subdivided and named after the informally named lateral and end moraines with which they are correlated, as discussed by Schmoll and Yehle (1986). In that paper we also discuss difficulties in using the glaciation terminology developed by Karlstrom (1964) in classifying glacial deposits in the Anchorage area. Karlstrom's type localities are located in both the Anchorage area and to the south on the Kenai Lowland (fig. 1), and there are uncertainties in temporal relationships among type deposits at his localities, especially those near the map area. Thus we do not use Karlstrom's terminology in our current work. Instead, we relate our deposits directly to the standard chronology now in use for the Pleistocene (Bowen and others, 1986). We apply this chronology without using queries, but recognize that there are many remaining uncertainties with regard to the temporal placement of our deposits; some of these uncertainties are discussed below.

Table 1.--List of radiocarbon dates in the Anchorage B-7 SW quadrangle, Alaska

Locality number[1] and name	Location on map	Lab number[2]	Radiocarbon age[4]	Date of collection	Reference
1. Birchwood Elementary School[5]	NW1/4 SW1/4 Sec.19, T. 15 N., R. 1 W.	W-2154	>45,000	July 21, 1967	Sullivan and others, 1970, p. 328
2. Lower Fire Lake	SW1/4 NE1/4 Sec. 36, T. 15 N., R. 2 W.	W-2913	>37,000	July 26, 1971	(first publication here)
3. Moose Point Lodge[6]	NW1/4 NW1/4 Sec. 13, T. 14 N., R. 2 W.	W-1806	>38,000	Aug. 24, 1965	Marsters and others, 1969, p. 221
4. Eagle River lake deposits	SE1/4 SW1/4 Sec. 18, T. 14 N., R. 1 W.	W-2153	3,900±250	July 2, 1967	Sullivan and others, 1970, p. 329

[1]Shown on map, plate 1A

[2]Data from Meyer Rubin, U.S. Geological Survey radiocarbon laboratory, Washington, D.C. (now Reston, Virginia)

[3]In years before present (1950)

[4]Collectors: Ernest Dobrovolny and H.R. Schmoll

[5]Excavation along north side of building

[6]Abandoned site

Correlations of the lateral moraines within the Eagle River and South Fork valleys to named moraines along the front of the Chugach Mountains were made largely on the basis of graphically determined gradients of these moraines and the relative positions of local valley moraines and lowland moraines where each valley intersects 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.

Moraine deposits (1) cover much of the Anchorage lowland in the northwest part of the map area; (2) dominate the flanks of the Eagle River and South Fork valleys, (3) are common along the Chugach Mountain front and on the high-level surface in the northeastern part of the map area, and (4) occur as scattered remnants elsewhere. The till that forms most moraines is composed mainly of diamicton and poorly sorted silty to sandy gravel; the latter material is common especially in some areas of ground moraine in the lowland. Some gravel and sand are present locally, as are lesser amounts of silt and clay.

The most continuous lateral moraines are preserved along the front of the Chugach Mountains and along the flanks of the Eagle River valley. These moraines descend southwestward and westward in the map area. The youngest of these lateral moraines are part of the Elmendorf Moraine (Miller and Dobrovolny, 1959). This prominent moraine complex, a formally defined geographic feature, extends from near downtown Anchorage northeastward for about 45 km on both sides of Knik Arm and occupies most of the Anchorage lowland within the map area. As established near downtown Anchorage (Schmoll and others, 1972), the deposits of the Elmendorf Moraine formed between about 14,000 and 12,000 yr ago and are the only moraine deposits directly correlatable with those in the map area that are dated closely by radiometric means, and are clearly late Wisconsin in age.

Older glacial deposits occur locally at higher altitudes along the Chugach Mountain front and bordering the Eagle River and South Fork valleys. These moraines are related with varying degrees of confidence to the successively older Dishno Pond and Fort Richardson moraines both of which have informal type localities along the Chugach Mountain front southwest of the map area (Schmoll and Yehle, 1986). Although not dated by any direct means, the deposits of these moraines are probably of Wisconsin age also. In previous maps of parts of the area (Schmoll and others, 1980; Schmoll and Emanuel, 1983) and in the surficial geologic map directly north (Yehle and Schmoll, 1987b) most deposits of the Dishno Pond moraines were not mapped separately from those of the older Fort Richardson moraines, whereas other Dishno Pond deposits, especially in the Eagle River valley, were regarded as more likely related to those of the Elmendorf Moraine.

The chronological interpretations shown on the present map and correlation of map units (plates 1A and 1B, in pocket) are based mainly on inferences from the relative positions of lateral moraines. From these interpretations we infer the following sequence of late Pleistocene events and relations between Anchorage lowland (distant source) and the Eagle River valley (local source) glaciers in the vicinity of the community of Eagle River:

1. Fort Richardson glaciers: Anchorage lowland ice was dominant over that from the Eagle River valley and extended a short distance up the Eagle River valley where the two glaciers merged.

2. Dishno Pond glaciers, early phase: lowland ice was relatively close to its end position and Eagle River valley ice was able to extend downvalley to the mountain front and join the lowland ice there.
3. Dishno Pond glaciers, middle phase: lowland ice apparently had retreated sufficiently, but probably not far north of the Eagle River, so that Eagle River valley ice could form an end moraine that looped out into the lowland a short distance.
4. Dishno Pond glaciers, late phase: lowland ice still probably had not retreated very far north, and Eagle River valley ice extended downvalley only to a position just west of the mouth of the South Fork valley.
5. Elmendorf glaciers: lowland ice extended almost to downtown Anchorage, but along a relatively narrower front than the preceding Dishno Pond lowland ice, and also was able to push up the Eagle River valley a way, possibly as far as the mouth of the South Fork; local ice extended down the Eagle River valley only to a position just east of the map area (Yehle and Schmoll, 1988). At this time a local lake formed between the two glaciers; as the lowland ice retreated, the lake extended farther and farther down the Eagle River valley, having levels that probably were graded to successively lower altitudes of the lowland ice.

Deposits of the successively older Rabbit Creek and Ski Bowl moraines are identified on the basis of their relative position and altitude at several localities within the map area. The informal type locality of the Ski Bowl moraines is a short distance south of the south edge of the map area and that of the Rabbit Creek moraines is near Rabbit Creek (fig. 1). The age of these deposits is uncertain, but we regard the Rabbit Creek as possibly pre-Wisconsin and the Ski Bowl as more certainly pre-Wisconsin, probably middle Pleistocene in age. The oldest moraine deposits we have named, the Mount Magnificent (Schmoll and Yehle, 1986), comprise a body of surface-exposed ground-moraine deposits averaging 975 m in altitude that constitute the informal reference locality. It is in the northeastern part of the map area in N1/2 sec. 4, T. 14 N., R. 1 W., and W1/2 sec. 33, T. 15 N., R. 1 W., about 4.8 km northwest of Mount Magnificent (fig. 1). Part of the informal type locality of these moraines is in NE1/4 SW1/4 sec. 10., T. 14 N., R. 1 W., the remainder lying in the adjacent map area to the east (Yehle and Schmoll, 1988). These deposits are probably middle or possibly early Pleistocene in age, but we have no direct evidence for either age assignment.

Other glacial deposits in the map area include glacioalluvial and glaciolacustrine deposits that formed both within and marginal to the areas of moraine. Among such deposits are (1) deposits of kames and minor eskers that formed mainly by running water within the ice during the early stages of glacier stagnation when large amounts of glacier ice were still present; (2) glaciolacustrine, glaciodeltaic, and kame-fan deposits that formed marginal to the glacier in nonglacial valleys that were blocked by a glacier; (3) outwash-plain deposits that formed at the margin of the glacier by drainage from within it; and (4) meltwater-channel deposits that formed in channels developed either adjacent to the glaciers or within morainal areas during the waning stages of glacier stagnation or perhaps when ice was no longer present.

Kames are locally prominent landforms that include irregular hills and areas of hummocky terrain mainly within the Elmendorf Moraine on the Anchorage lowland. Near the lateral moraines the kames are aligned roughly parallel to the direction of glacier flow. Smaller areas of similar deposits occur at higher altitudes along the Chugach Mountain front and in the Eagle River valley. The kame deposits are subdivided in part on the basis of differences in amount of local relief. They consist mostly of gravel and sand, but also include varying amounts of diamicton and finer-grained deposits. In places within the map area these deposits have been utilized as major sources of sand and gravel; this process has altered drastically some of the original kame landforms.

Deposits of glacier-dammed lakes and related deltas are found locally along the sides and on parts of the floors of the Eagle River and South Fork valleys; smaller areas of such deposits occur in Meadow Creek valley. Several holes drilled for water-resources investigations in the Eagle River valley confirm the existence of a thick sequence of soft, fine-grained sediments beneath the floor of the inner valley. These deposits are 60 m thick near the mouth of the South Fork (Dearborn, 1977; Johnson, 1979) and 140 m thick about 3.5 km upvalley from the eastern edge of the map area (Deeter and George, 1982). The deposits are of undoubtedly lacustrine and probably mainly glaciolacustrine origin. Because of their considerable thickness, they may represent the deposits of older glacial lakes as well as lakes whose deposits are mapped at the surface and related only to the Elmendorf Moraine. Evidence for older lake deposits lying stratigraphically between glacial deposits is found in a carefully logged drill hole 98 m deep in the NE1/4 NE1/4 sec. 13, T. 14 N., R. 2 W. (Munter, 1984). It is also possible that the upper part of the subsurface lake deposits is equivalent to those mapped as younger deposits (map unit ly). Paleontogical evidence from the upper part of the upvalley subsurface deposits suggests an early Holocene age (T. A. Ager, written commun., 1984). Wood incorporated into lacustrine deposits exposed along the Eagle River in the center of the map area (locality 4, table 1) yielded a radiocarbon age thought to be spurious. However, it now appears at least possible that the age is correct and that the youngest lake in the Eagle River valley, one probably confined to the inner valley, may be as young as early or even middle Holocene, and formed in a lake blocked perhaps by the Elmendorf Moraine rather than by a glacier.

Delta deposits related to glacial and possibly postglacial lakes are prominent at the mouth of the South Fork. Here, a massive, multilevel delta subsequently developed into an alluvial fan that continues to prograde onto the floor of the Eagle River valley, forcing the stream northward. In smaller valleys, kame-fan deposits formed in smaller lakes or accumulated subaerially against blockading glacier ice.

The deposits of and related to glacial lakes range in texture from silt and clay to sand, gravel, and diamicton. Glaciolacustrine deposits are dominantly fine grained, whereas deltaic deposits are dominantly coarse grained; both types of deposits are relatively well sorted. Kame-fan deposits are typically coarse grained and somewhat poorly sorted, and commonly include diamicton. Glaciolacustrine and related deposits within the map area are poorly exposed except in a few places along the Eagle River.

Deposits of glacial outwash plains occur in one locality adjacent to the Elmendorf Moraine at the western edge of the map area. Although not exposed there, the deposits probably consist of gravel and sand, by analogy with exposures in more extensive occurrences to the southwest.

Glacioalluvium that is extensive in the map area includes deposits formed by meltwater from the downwasting glaciers as well as drainage from glacial lakes and in small nonglacial valleys influenced by the presence of nearby glaciers. These deposits occur in a complex series of channels and fans on the Anchorage lowland and in smaller channels associated with moraines on the flanks of the Eagle River valley. Especially prominent are two channels cut to a depth of about 40 m in the southwestern part of the map area. One channel was originally described in a 1948 study by Bateman (1980 [sic]), and we informally refer to it as the Bateman channel. It extends across parts of secs. 13, 23, and 24, T. 14 N., R. 2 W. The other channel, named for the grossly underfit and thus aptly named Fossil Creek, deepens southwestward through parts of secs. 15 and 22, T. 14 N., and R. 2 W., and extends beyond the west edge of the map area. Although many glacioalluvial deposits are identified here only by the named moraines with which they are associated, major deposits on the Anchorage lowland that represent the waning phases of glacier ice that deposited the Elmendorf Moraine are informally named separately. These include Fossil Creek and Clunie Creek glacioalluvial deposits that are named herein for the first time and that are more extensively developed west of the map area, and the Mountain View fan deposits (Bartsch-Winkler and Schmoll, 1984, p. 16) that extend to and form the major surface deposits at downtown Anchorage (Schmoll and Dobrovolny, 1972a, map unit an). These glacioalluvial deposits consist mainly of gravel and sand, but in some small channels peat may be common at the surface, and diamicton or bedrock may be present at shallow depths.

The following sequence of alluvial events is interpreted to have occurred in the west-central part of the map area and in adjoining areas to the north, northeast, and southwest. Most of these events are related to the stagnation stages of the lowland glacier that deposited the Elmendorf Moraine. This interpretation expands somewhat upon that of Miller and Dobrovolny, 1959, p. 64, 70, 86). These events probably took place within a relatively short period of time about and shortly after 12,000 yr ago and are thus late Wisconsin in age; the sequence might extend into early Holocene time.

1. When the glacier was still internally active but its front was no longer advancing, outwash was deposited directly at its front and nearby side margins. Water from the northern part of the map area and farther northeast was restricted largely to the margin of the ice.
2. As the ice began to stagnate, much of this meltwater drained through the glacier, forming the prominent kames near the community of Eagle River. Ancestral Eagle River drainage initially was impounded by the glacier, although some drainage did proceed through the ice to form small eskers.
3. As the glacier stagnated further, water from the Eagle River flowed around the ice forming the earlier phases of the Bateman channel and then escaped southwestward through remaining areas of stagnant ice to deposit the Mountain View alluvial fan, possibly in a series of water-outburst events.
4. Subsequently, the Eagle River was able to flow more to the west across an area then partly free of glacier ice to form the notable series of alluvial terraces in the Fossil Creek channel in response to a rapidly lowering base level that was controlled in part by relative lowering of sea level in ancestral Cook Inlet. At this time northern water probably also drained from within the ice and into the Fossil Creek channel.

5. A short time later, but perhaps in part contemporaneously, drainage from north of the Eagle River formed the broad channels in the northwestern part of the map area and deposited the Clunie Creek glacioalluvial deposits. Some remnants of glacier ice still may have been present at this time, and in places the alluvium formed what we here term kame-channel deposits. These deposits have a somewhat irregular surface that is of lower relief than kames but not as smooth as other channel deposits with which they locally merge. During the latter part of this time, the Eagle River may have occupied part of its present channel south of the community of Eagle River, but at levels higher than any of the terraces now present in this channel.
6. Subsequently, stream flow in the Bateman channel appears to have reversed its direction, the drainage flowing eastward into the Eagle River valley, possibly into a low-altitude lake. If such a lake is substantially younger than deposits of the Elmendorf Moraine, the source of meltwater for this event is enigmatic, but still may have come through the Elmendorf Moraine from a source to the north.
7. Finally, as base level approached present levels, the Eagle River established its present alignment. Streams in the northern part of the map area began to flow northward, draining through Fire Creek (pl. 1A), and much of the surface drainage that previously had flowed southwestward through the lowland part of the map area instead followed the present courses of Peters Creek and Eklutna River north of the map area (fig. 1).

COLLUVIAL DEPOSITS

The term colluvial deposits (colluvium), as used here, includes 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. Colluvium is broadly subdivided into deposits that have accumulated particle by particle over a long period of time (for example, talus) and deposits that have moved en masse (mass-wasting deposits), either rapidly, such as debris avalanches, or slowly, such as by solifluction. 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.

Most colluvial deposits contain minor admixtures of organic-rich soil and windblown material, and can be derived either directly from bedrock, unconsolidated surficial deposits, or a combination of these materials. Colluvium generally is poorly sorted, ranges widely in grain size, and is only somewhat compact. Exposures of colluvial deposits are uncommon, and our descriptions are based largely on inference from exposures in similar landforms elsewhere in the region.

Smooth-surfaced colluvium occupies large areas on mountain slopes, commonly in the middle part of the slope, and is derived mainly from bedrock and mapped as undivided colluvium (map unit c). Other types of colluvium that accumulated particle by particle have more specialized characteristics and are mapped separately. Talus deposits (map unit ct) generally occur high on the slopes and along the upper courses of tributary valleys, usually downslope from prominent bedrock outcrops. On slopes above and within mapped remnants of lateral-moraine deposits, especially in the Eagle River and South Fork valleys and along the Chugach Mountain front, colluvium (map unit cg) contains material derived from glacial deposits as well as from bedrock; some of these slopes have an irregular surface and only partly conceal in-place morainal deposits. On slopes below the proximal (toward-ice) side of some lateral moraines, colluvium (map unit cm) is derived largely from morainal deposits and is similar to ground moraine except that it has been subjected to downslope movement. Colluvium that is mixed with alluvium (map unit ca) occupies small areas generally restricted in width and commonly in gullies and small ravines.

The steep walls of valleys that are incised into surficial deposits are particularly subject to instability and renewed stream erosion. These valley walls commonly are veneered by a downslope-thickening wedge of colluvium (map unit cw) 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 lateral attack, removes at least part of the colluvium, and erodes anew 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 and are mapped separately (map unit cwf). 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.

Colluvial deposits that have formed en masse include mainly landslide deposits. These 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 developed entirely in bedrock, but are included mainly in an undivided map unit (cl). Only earthflows larger than about 100 m in length are mapped separately (map unit cle); most of these occupy pre-existing gullies and ravines. Solifluction deposits (map unit cs) accumulated more slowly than landslides, generally by creep, and occupy relatively small areas on broad slopes.

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 suspected landslide deposits are indicated by query on the map. Detailed investigation may suggest alternate interpretations for these features and some of them, for which alternate origins can be confirmed, 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) occurrence of fine-grained deposits, mainly silt and clay; (3) steepness of slopes, caused in part by glacial erosion, and (4) slope orientation.

A special type of slope process that occurs on some steep mountain slopes but which commonly does not give rise directly to colluvium, is inferred from small, narrow, bedrock-flanked trenches which we interpret 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 thought to have formed through 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 discrete 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, but are not regarded as the primary cause. All these conditions obtain in the Chugach Mountains where we recognize sackung features. A few sackung features are present in the southeastern part of the map area; others are well exhibited farther to the east and northeast in adjacent map areas (Updike and Ulery, 1983; Yehle and Schmoll, 1987b, 1988).

OTHER DEPOSITS

Other surficial deposits mapped include alluvial, peat and pond, lacustrine, interglacial, and anthropogenic deposits. Alluvium has been mapped mainly in the Eagle River and South Fork valleys as well as in many smaller valleys. Alluvium also occurs 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 or the Anchorage lowland. Large alluvial fans are especially well developed adjacent to the Chugach Mountain front and at the mouth of the South Fork valley.

In places significantly younger and older alluvial deposits are mapped separately. The youngest alluvium (map unit aa) occupies the active flood plain of the Eagle River, and is intermittently retransported. This area is continually subjected to inundation by the river, but we presently do not have sufficient data to relate this area to any numerical frequency of flooding. Older alluvial deposits generally occur in terraces that are as much as several meters above present stream levels, or in similarly high-level fans that have been incised by streams which subsequently developed fans near levels of present streams.

Alluvial deposits consist mostly of sand and gravel. Locally, alluvium is finer grained, mainly silt and fine sand; some of these occurrences are mapped separately (map units alf and aff).

Peat and pond deposits are mapped mainly in boggy areas of the broad, nearly flat inner valley of the Eagle River and on the Anchorage lowland within the many glacial-meltwater channels. Deposits consist of peat, varying amounts of silt and sand, and, locally, thin lenses of tephra. The deposits grade laterally into, but are thicker than, the unmapped mantle of organic and eolian deposits. On the inner floor of the Eagle River valley these deposits may have formed in the last phase of a major glacial and (or) postglacial lake rather than in individual ponds.

Interglacial deposits are exposed only poorly in a few places within the map area, notably along the Glenn Highway near Lower Fire Lake and along the Eagle River near the community of Eagle River. The deposits include mainly silt, clay, and organic debris with fresh-water gastropods prominent in a few thin beds. Organic material from both areas of outcrop have yielded ages beyond the range of the radiocarbon-dating method (table 1). We infer that these deposits are probably of Sangamon age, approximately 125,000 yr B.P. That they are at least this old is further suggested by the thermoluminescence (TL) date of 175,000 yr B.P. (Reger and Updike, 1989) from a peat bed at Goose Bay (fig. 1) that is in a comparable stratigraphic position. Although a reliable regional framework for TL dating has yet to be established, this single TL date tends to support the idea that buried organic horizons in the Anchorage region represent pre-Wisconsin interglacial or interstadial intervals rather than interstadial intervals within the Wisconsin glaciation. Reger and Updike (1989) discuss ages for possible interstadial events in the Anchorage region that have ages within the range of the radiocarbon-dating method; in our experience, however (Bartsch-Winkler and Schmoll, 1984, p 8; Schmoll and Yehle, 1986, p. 206), buried organic horizons that at first were determined by the radiocarbon method to have such ages were later determined to be older, beyond the range of the method.

Regardless of their true age, we have no firm evidence for relating the interglacial deposits to any of the mapped morainal deposits, beyond the acknowledgment that such deposits should lie between, rather than correlate with, any of the morainal deposits. The interglacial deposits are overlain by what appears to be a single drift sheet that is mapped at its surface as the deposits of the Elmendorf Moraine. A Sangamon or older age for these interglacial deposits thus is seemingly inconsistent with the 14,000 yr age for the upper part of the Bootlegger Cove Formation which underlies the deposits of the Elmendorf Moraine near Anchorage. The drift overlying the interglacial deposits appears to be a complex of diamicton and silty gravel beds, as shown by detailed examination of roadcuts along the Glenn Highway within one kilometer south of Eagle River (Schmoll and Dobrovolny, unpublished data). We infer that these deposits may well equate with older morainal deposits as well as with those of the Elmendorf Moraine. We have no evidence, however, to determine whether the interglacial deposits should be placed prior to the deposits of the Dishno Pond, Fort Richardson, or even older moraines.

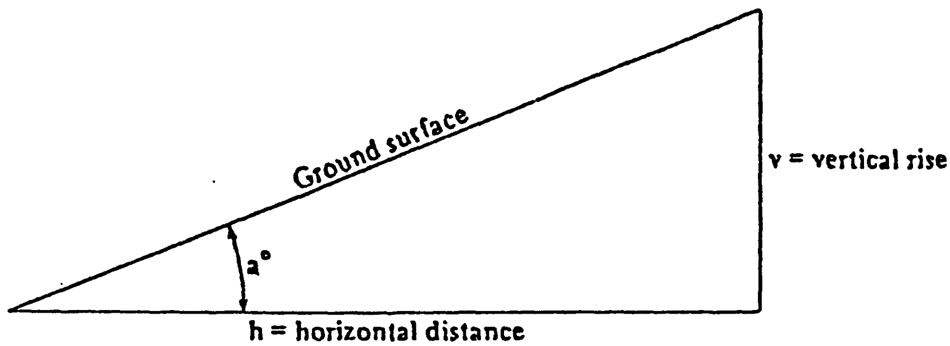
Anthropogenic deposits are those that have been emplaced or significantly disturbed by the activities of man. Engineered fill occurs mainly along the Glenn Highway and the Alaska Railroad. Areas in which naturally occurring materials have been extensively reworked include gravel pits, the Anchorage Regional Landfill, and a now-abandoned sanitary landfill on Hiland Road (secs. 22 and 23, T. 14 N, R. 2 W.), and parts of the community of Eagle River.

HISTORY OF INVESTIGATIONS

The surficial geology of this map area 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. This mapping subsequently was photographically enlarged to and further modified for a scale of 1:25,000 by L.A. Yehle and H.R. Schmoll in 1987 and 1988; considerable additional detail, especially in the mountainous parts of the map area, was derived from interpretation of 1:24,000-scale airphotos taken in 1972 and 1973 and augmented by field investigations in 1987 and 1988. Selected data from an earlier surficial geologic map of part of the area by Dobrovolny and Miller (1950) were also utilized. Other maps of parts of the area, derived mainly from the unpublished mapping of Schmoll and Dobrovolny, were presented by Zenone and others (1974) as derived from Schmoll and others (1971), by Schmoll and others (1980), by Burnett and Lee (1983), and by Schmoll and Emanuel (1983). Bedrock data are derived partly from Clark and Bartsch (1971), Schmoll and others (1971), and Schmoll and others (1980), as well as from the bedrock geologic investigations of Updike and Ulery (1988) as presented in the map area to the east.

DESCRIPTION OF MAP UNITS

The surficial geologic map (plate 1A) delineates deposits estimated to be one meter or more in thickness, based primarily on field observations. Grain sizes of unconsolidated particles follow the modified Wentworth grade scale (American Geological Institute, 1982). Slope data are generalized estimates derived mainly from the slope map in Zenone and others (1974, p. 2 and fig. 3). and use the categories of Schmoll and Dobrovolny (1972b) that are illustrated in figure 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.



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

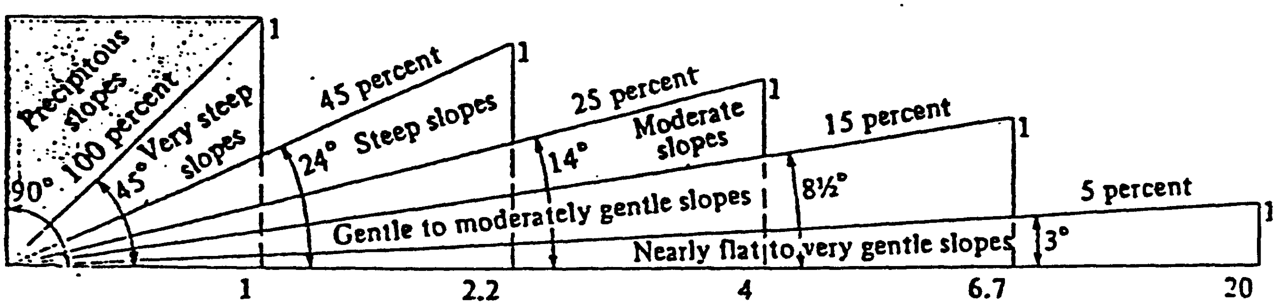


Figure 3.--Diagram illustrating slope categories used on this map (after Schmoll and Dobrovolny, 1972b).

SURFICIAL DEPOSITS

Moraine Deposits

Subdivided according to type of moraine (end, lateral, and several types of ground moraine) and according to correlations with named end and lateral moraines along the Chugach Mountain front within and southwest of the map area. 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; locally mainly poorly sorted silty sandy gravel; includes scattered large boulders; generally moderately to well compacted.

End-moraine deposits (late Pleistocene)--Thickness probably about 10 m or more. Contacts sharply defined. Topography highly irregular; slopes gentle to moderate on small areas on some ridge tops, steep on ridge sides

eme — Deposits of the Elmendorf Moraine--Occur in the Eagle River valley and in west-central part of map area where they mark limit of glaciers during this advance of ice. Along with high-relief kame deposits in the latter area, form an extensive complex of glacier-ice wastage landforms that extend southwestward, and are part of the formally-named geographic feature known as the Elmendorf Moraine

dme — Deposits of the Dishno Pond moraines--Occur in the Eagle River valley and in southwestern part of map area where they mark limits of minor readvances during recession of glaciers from upvalley sources

Lateral-moraine deposits

eml — Deposits of the Elmendorf Moraine (late Pleistocene)--Thickness poorly known, but probably several to about 10 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 some 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 Chugach Mountains

dml — Deposits of the Dishno Pond moraines (late Pleistocene)--Thickness poorly known, probably at least several meters. Contacts fairly well defined. Topography moderately irregular; slopes generally moderate. Occur along the flank of the Chugach Mountains and extensively in the Eagle River valley and southwestward where locally are well-formed narrow ridges, especially in sec. 23, T. 14 N., R. 2 W.; a large body of moraine blocks the South Fork valley

fml — Deposits of the Fort Richardson moraines (late Pleistocene)--Thickness poorly known, probably several meters. Contacts gradational. Topography varying from uniformly ridged to moderately irregular; slopes moderate to steep. Occur as isolated remnants along flanks of the South Fork valley, along the lower part of the Eagle River valley, and along the Chugach Mountain front, especially south of the Eagle River valley rml Deposits of the Rabbit Creek moraines (late or middle Pleistocene)--Probably slightly more compacted and oxidized than younger lateral-moraine deposits. Thickness poorly known, probably several meters. Contacts gradational. Topography moderately irregular, slopes generally moderate. Identified at scattered locations along the Chugach Mountain front, notably near Carol Creek and south of the Eagle River valley in sec. 25, T. 14 N., R. 1 W.

sml Deposits of the Ski Bowl moraines (middle Pleistocene)--Probably more compacted and oxidized than other lateral-moraine deposits. Probably several meters thick; contacts mostly gradational. Topography includes remnant ridges and irregular ground; slopes generally moderate to steep. Occur in several locations near and south of south edge of map area

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-, end-moraine, and some kame-moraine deposits. Topography smooth to gently hummocky, slopes generally gentle to moderate. Occur in the lower Eagle River valley and extensively on the Anchorage lowland

emf Deposits of the Elmendorf Moraine in fluted terrain (late Pleistocene)--Similar to other ground moraine but occur in elongated low ridges a few meters high that parallel direction of ice flow. Occur only in northwestern part of map area

emd Deposits of the Elmendorf Moraine in well-developed drumlin forms (late Pleistocene)--Thickness several to perhaps ten meters. Occur in elongate hills with moderately steep slopes on their sides that merge laterally to low-relief terrain usually of ground moraine. Present extensively in northwestern part of map area

emb Deposits of the Elmendorf Moraine that thinly mantle bedrock (late Pleistocene)--Thickness not well known but may be as much as a few meters. Small bedrock outcrops locally present. Contacts well defined except gradational with lateral-moraine deposits. Topography smooth, slopes gentle to moderate on hill tops, steeper on sides. Occur mainly bordering front of the Chugach Mountains

emk Deposits of the Elmendorf Moraine that include some kame deposits (late Pleistocene)--Similar to ground-moraine deposits but may include gravel and sand in large part or locally in areas too small to map separately. Located in northwest part of map area

emm Deposits of the Elmendorf Moraine modified by glacial lake water (late Pleistocene)--Mostly similar to other ground moraine but surface of deposits may be winnowed and include better-sorted silt, sand, and gravel. Occur only in the Eagle River valley in center of map area

dmg Deposits of the Dishno Pond moraines (late 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 the Eagle River valley dmf Deposits of the Dishno Pond moraines in fluted terrain (late Pleistocene)--Similar to other ground-moraine deposits but occur in the Eagle River valley in well-developed, long, relatively narrow ridges several meters high, parallel to direction of ice flow, and separated by channel-like depressions

dmo Deposits of the Dishno Pond moraines overridden by later glacier ice (late Pleistocene)--Probably similar to other ground moraine but occur in very subdued ridges. Present only in the Eagle River valley in center of map area

dmb Deposits of the Dishno Pond moraines that thinly mantle bedrock (late Pleistocene)--Thickness not well known but may be as much as a few meters. Bedrock outcrops present locally; includes some admixed bedrock rubble. Contacts relatively well defined. Topography smooth, slopes gentle. Present at one locality east of the South Fork in SW1/4 sec. 21. and NW1/4 sec. 28, T. 14 N., R. 1 W.

dmk Deposits of the Dishno Pond moraines that include some kame deposits (late Pleistocene)--Similar to ground-moraine deposits but may include gravel and sand in large part or locally in areas too small to map separately. Present only along base of Chugach Mountain front in southwestern part of map area

dmm Deposits of the Dishno Pond moraines modified by glacial lake water (late Pleistocene)--Thickness possibly a few meters in an irregular mantle of somewhat better sorted more gravelly diamicton, which forms a variable lag accumulation originating by the winnowing action of glacial lake waters. Probably gradational at depth to mostly glacial diamicton of Dishno Pond moraines. Occur at several places along north side of present Eagle River

fmg Deposits of the Fort Richardson moraines (late Pleistocene)--Thickness poorly known, probably a few meters. Contacts well defined, slopes generally moderate. Occur in the South Fork valley and at scattered localities along the Chugach Mountain front

fmb Deposits of the Fort Richardson moraines that thinly mantle bedrock (late Pleistocene)--Thickness not well known but may be as much as a few meters. Bedrock outcrops present locally; may include some admixed bedrock rubble. Contacts relatively well-defined. Topography smooth, slopes gentle. Present at a few scattered localities along the Chugach Mountain front

rmg Deposits of the Rabbit Creek moraines (late or middle 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. Single occurrence north of Carol Creek in NW1/4 SW1/4 sec. 32, T. 15 N., R. 1 W.

rmb Deposits of the Rabbit Creek moraines that thinly mantle bedrock (late or middle Pleistocene)--Thickness poorly known but may be as much as a few meters. Bedrock outcrops present; includes admixed bedrock rubble. Contacts relatively well defined. Topography smooth, slopes gentle. Identified at scattered places along the Chugach Mountain front smg Deposits of the Ski Bowl moraines (middle 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. Occur in the northeastern part of the map area; tentatively identified near the head of Little Peters Creek and south of Meadow Creek

smb Deposits of the Ski Bowl moraines that thinly mantle bedrock (middle 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 southwest of upper Meadow Creek and south of the Eagle River valley at NW1/4, sec. 25, T. 14 N., R. 1 W.

mmg Deposits of the Mount Magnificent moraine (middle or early Pleistocene)--Thickness poorly known, probably as much as several 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 over a broad area averaging 975 m in altitude in northeastern part of map area (informal reference locality; see text) and also in sec. 10, T. 14 N., R. 1 W. (part of informal type locality, see text)

mmb Deposits of the Mount Magnificent moraine including mainly bedrock rubble (middle or early 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 as many scattered remnants

g **Older glacial deposits (Pleistocene)**--Occur only in stratigraphic exposure and not directly related to surface moraines. Diamicton consisting of poorly sorted mixture of gravel, sand, silt, and clay; material is somewhat oxidized and is more fine grained and compact than deposits of ground moraine at the surface. Thickness several meters; may overlie bedrock at shallow depth. Probably extensive in much of the Anchorage lowland underlying glacial deposits of the Elmendorf Moraine and, locally, interglacial deposits. Mapped only along Glenn Highway (where slightly exaggerated in extent to show at map scale) near center of SE1/4, sec. 25, T. 15 N., R. 2 W. Several other exposures occur a few kilometers to northeast in adjoining map area (Yehle and Schmoll, 1987a)

Glacioalluvial and Glaciolacustrine Deposits

Subdivided into (1) kame deposits; (2) meltwater-channel deposits that are glacioalluvial in origin and that consist dominantly of gravel and sand; (3) 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 (4) glaciolacustrine deposits that are dominantly fine grained and include variably admixed, well to poorly sorted coarser materials.

Kame deposits--Chiefly pebble and cobble gravel and sand, moderately to well bedded and sorted; some silt, and, especially in the cores of hills, diamicton; locally may include large boulders. Includes deposits of small eskers, some of which are shown by symbol. Moderately loose, but compact in cores of hills. Contacts generally well defined; merge with moraine deposits. Topography sharply hilly to hummocky with some local depressions; slopes moderate to steep, except gently to nearly flat in minor channels, on depression floors, and on some small areas on tops of hills

ek Kame deposits of the Elmendorf Moraine, undivided (late Pleistocene)--In landforms of high to low relief, includes some areas of pitted outwash. Thickness a few to several tens of meters. Extensive on Anchorage lowland and at mouth of the Eagle River valley

ekh Kame deposits of the Elmendorf Moraine that exhibit high relief (late Pleistocene)--In landforms of generally higher relief and locally broader size than most kames. Thickness probably several tens of meters. Located mainly south of the Eagle River and west of the Glenn Highway

ekb Kame deposits of the Elmendorf Moraine that thinly mantle older bedrock (late Pleistocene)--Similar to undivided kame deposits but thickness may be only one to a few meters overlying older bedrock which may be exposed locally. Located near Fire Lakes

ekby Kame deposits of the Elmendorf Moraine that thinly mantle younger bedrock (late Pleistocene)--Similar to undivided kame deposits but thickness may be only one to a few meters overlying younger bedrock which is exposed locally. Located near and north of community of Eagle River

ekc Kame-channel deposits of the Elmendorf Moraine (late Pleistocene)--In landforms of generally low relief that mainly lie at levels of major channels cut into moraine surface. Thickness poorly known but probably only a few meters. Include pitted outwash-plain or meltwater-channel deposits. Merge with meltwater-channel deposits and undivided kame deposits. Occur in moderately irregular topography with mostly gentle to some moderate slopes. Located extensively on Anchorage lowland

dk Kame deposits of the Dishno Pond moraines, undivided (late Pleistocene)--In landforms of high to low relief, include areas of pitted outwash. Thickness a few meters to several tens of meters. Many deposits in southwestern part of map area near Chugach Mountain front

dkh Kame deposits of the Dishno Pond moraines that exhibit high relief (late Pleistocene)--May in part include kame-terrace deposits. Thickness probably a few to several tens of meters. Located on north side of the Eagle River valley

dkb Kame deposits of the Dishno Pond moraines that thinly mantle bedrock (late Pleistocene)--Similar to kame deposits but thickness may be only one to a few meters overlying bedrock which may be exposed locally. Located in a few places in southwestern part of map area adjacent to meltwater channels and the Chugach Mountain front

rk Kame deposit of the Rabbit Creek moraines (late or middle Pleistocene)--Thickness poorly known, probably several meters. Single occurrence along the Chugach Mountain front north of Carol Creek in NW1/4 SW1/4 sec. 32, T. 15 N., R. 1 W.

Meltwater-channel and meltwater-fan 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, but in some large channels a few tens of 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

ecc Clunie Creek glacioalluvial deposits (late Pleistocene)--Occur in major channels cut typically about 20 m lower than the general surface of the Elmendorf Moraine and graded to a level below that of the moraine. Thickness may be a few tens of meters. Extend southwest to informal type locality along Clunie Creek

ecf Fossil Creek glacioalluvial deposits (late Pleistocene)--Occur in a series of terrace levels within the prominent, single channel of Fossil Creek which is cut as much as 50 m lower than the surface of the Elmendorf Moraine and Mountain View fan but graded to levels of some kame deposits within the moraine. This occurrence and its extension southwestward constitutes the informal type locality for these deposits

mvf Mountain View glacioalluvial fan deposits (late Pleistocene)--Occur in broad, large, low-gradient fan that heads from major meltwater channel near the center of sec. 23, T. 14 N., R. 2 W., in the southwestern part of the map area and widens southwestward toward and beyond the community of Mountain View (about 10.5 km southwest of the southwestern corner of the map area) to downtown Anchorage. The entire fan constitutes the informal type locality

ec Channel deposits of the Elmendorf Moraine (late Pleistocene)--Occur on the Anchorage lowland mainly near and along lower slopes of the Chugach Mountain front mostly north of the community of Eagle River. Merge locally with kame-channel deposits

eo Outwash-fan deposits of the Elmendorf Moraine (late Pleistocene)--Occur only at one place at western edge of map area north of Fossil Creek

dc Channel deposits of the Dishno Pond moraines (late Pleistocene)--Occur at numerous places along the front of the Chugach Mountains and along the south flank of the Eagle River valley

dcm Channel deposits of the Dishno Pond moraine overridden by later glacier ice (late Pleistocene)--May be relatively thin and (or) include mainly diamicton. Merge laterally with overridden moraine deposits (map unit dmo). Present only in the Eagle River valley near center of map area

fc Channel deposits of the Fort Richardson moraines (late Pleistocene)--Occur at several places along the Chugach Mountain front especially south of the Eagle River valley

rc Channel deposits of the Rabbit Creek moraines (late or middle Pleistocene)--Occur in a few places along the Chugach Mountain front

sc Channel deposits of the Ski Bowl moraines (middle Pleistocene)--Occur at scattered localities within the Chugach Mountains

mc Channel deposits of the Mount Magnificent moraine (middle or early Pleistocene)--Occur on a few prominent topographic saddles in the northeastern part of the map area oc Older channel deposits (middle or early Pleistocene)--Gravel and sand of these deposits may be less well bedded and sorted, thinner, and probably more oxidized than other channel deposits; bedrock outcrops probably common. Tentatively identified at scattered sites at relatively high altitudes on several mountain saddles in southern part of map area

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

ekf Deposits related to the Elmendorf Moraine (late Pleistocene)--Occur at one locality along the Chugach Mountain front adjacent to Carol Creek in SW1/4 SW1/4 sec. 31, T. 15 N., R. 1 W.

dkf Deposits related to the Dishno Pond moraines (late Pleistocene)--Occur at several prominent localities along the Chugach Mountain front north of the Eagle River valley and locally west of the mouth of the South Fork valley

fkf Deposits related to the Fort Richardson moraines (late Pleistocene)--Occur at many locations scattered along the Chugach Mountain front and along the flanks of the Eagle River and South Fork valleys and Little Peters Creek. Especially prominent north of Meadow Creek in sec. 6, T. 14 N., R. 1 W.

rkf Deposits related to the Rabbit Creek moraines (late or middle Pleistocene)--Occur at a few localities along the Chugach Mountain front, the most prominent in sec. 25, T. 14 N., R. 2 W. near the stream that descends from the northwest flank of Mount Gordon Lyon

skf Deposits related to the Ski Bowl moraines (middle Pleistocene)--Occur at a few localities near the central-south edge of the map area

Glacial-lake delta deposits--Chiefly gravel and sand, generally well bedded and sorted; may include thin beds of finer-grained glacial-lake deposits. Thickness poorly known, probably 10 m or less. Contacts generally well defined. Topography generally smooth, slopes gentle

lyd Young deposits (early Holocene and late Pleistocene)--Occur only at mouth of the South Fork valley graded to low-level lake deposits in the inner Eagle River valley

egd Deposits related to the Elmendorf Moraine (late Pleistocene)--Occur in the Eagle River valley in a prominent landform at mouth of the South Fork and farther downstream on both sides of the Eagle River

dgd Deposits related to the Dishno Pond moraines (late Pleistocene)--Occur only in the South Fork valley near south edge of map area

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

ly Young deposits (early Holocene and late Pleistocene)--Occur only at low levels in the inner Eagle River valley; may underlie alluvium on valley floor egl Deposits related to the Elmendorf Moraine (late Pleistocene)--Thickness about 5-10 m; may be much thicker beneath alluvial and peat deposits that form the floor of the inner Eagle River valley. Occur only in the Eagle River valley

dgl Deposits related to the Dishno Pond moraines (late Pleistocene)--Thickness poorly known, possibly 5-10 m. Occur only on lowermost slopes of the South Fork valley in the southeastern part of map area

fgl Deposits related to the Fort Richardson moraines (late Pleistocene)--Thickness poorly known, probably 10 m or more. Occur only in Meadow Creek valley.

rgl Deposits related to the Rabbit Creek moraines (late or middle Pleistocene)--Thickness poorly known, probably about 10 m. Occur only in Meadow Creek valley near eastern part of map area. In adjacent map area (Yehle and Schmoll, 1988) merge upstream with alluvial-terrace deposits that may be, in part, deltaic

Alluvial Deposits

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

aa **Alluvium in active flood plain of the Eagle River (latest Holocene)**--Sand and some gravel that is transported intermittently and 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 directly by the stream for a few years. Area subject to continuing erosion and flooding; in places stream may encroach upon areas adjacent to this map unit

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

alf Fine-grained deposits along some minor streams (Holocene)--Chiefly silt and fine-grained sand; may include some peat deposits near surface. Occur along Fire Creek in northwestern part of map area and locally elsewhere

at **Alluvial deposits in terraces, undivided (Holocene)**--Somewhat older alluvium, chiefly gravel and sand, generally several meters above stream level. Developed along part of the Eagle River and locally elsewhere

ath Deposits in higher terraces (Holocene and Pleistocene)--Occur more than 10 m above stream level mainly along Little Peters Creek and upper Meadow Creek. May grade downstream to kame-fan deposits

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. Extensively distributed throughout map area

aff Fine-grained deposits--Chiefly silt and fine sand. Occur in a few scattered places in map area

afo **Older alluvial-fan deposits (Holocene and Pleistocene)**--Gravel and sand, possibly admixed with some finer-grained material and thin diamicton beds. Deposits typically less well sorted and have steeper slopes than those in other alluvial units. Occur as remnants commonly associated with younger alluvial fans, but graded to levels above modern streams; well exhibited at mouths of several large streams along Chugach Mountain front

Peat, Pond, and Lake Deposits

p **Peat and pond deposits (Holocene and late Pleistocene)**--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-sized tephra. At shallow depth may include silt, clay, marl, or fine-grained sand; at deeper levels may be mostly sandy gravel. Accumulated mainly in small former lakes or in former stream channels which are now 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. Distributed extensively in northwestern part of map area, especially near Lake Clunie and on floor of the Eagle River valley

pf **Deposits of a possible lake along Fire Creek valley (Holocene)**--Probably consist of silt, clay, and fine-grained sand; may include peat near surface. Deposits not exposed, character and genesis mainly inferential. Alternatively, deposits could (1) relate to a narrow inlet of Knik Arm and be of estuarine origin, or (2) be mainly fine-grained alluvium of Fire Creek. Thickness unknown, but probably several to a few tens of meters. Contacts gradational to fine-grained alluvium of present Fire Creek. Surface smooth to slightly irregular with low relief; general slope less than one percent. Poorly drained. Occur only in northwest part of map area

i **Interglacial pond deposits (Pleistocene)**--Chiefly silt and clay with some beds of fine sand; commonly includes intermixed and interbedded organic material. As much as a few meters thick, overlain and underlain by glacial deposits. Exposed in a roadcut on the west side of the Glenn Highway near Lower Fire Lake, and along the north side of the Eagle River near the site of the long-abandoned Moose Point Lodge east of the Glenn Highway. Radiocarbon analyses of organic material from both localities indicated ages for these deposits beyond the range of the radiocarbon method (table 1, localities 2 and 3)

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 deposits. Thickness poorly known, probably less than one to several meters, thicker on lower parts of slopes. Contacts gradational. Topography smooth, surface gently concave upward, slopes generally steep to very steep, but usually not in excess of 70 percent; some instability likely

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, to bedrock at apex, and to other map units at toe; individual cones commonly have well-defined boundaries. Talus deposits too small to map separately are included in bedrock map unit (bo). 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. Occur in a few high-altitude areas

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. Locally extensive in mountain areas

cg **Mixed colluvial and glacial deposits**--Diamicton consisting chiefly of gravelly to rubbly sand, silt, and clay; locally bouldery. Derived from both bedrock and glacial deposits, either of which may be present 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 mainly from moraines**--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. Non-bedded to poorly bedded; poorly sorted. Generally a few meters thick, thinner at the upslope part; usually 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

cwf Fine-grained colluvial deposits on walls of stream bluffs--Chiefly silt, clay, and fine-grained sand; non-bedded to poorly bedded; poorly sorted. Occur along north bank of the Eagle River in eastern part of map area mostly where lacustrine deposits are upslope. Thickness probably as much as a few meters. Slopes irregularly moderate to steep, and particularly susceptible to instability

cs **Solifluction deposits**--Chiefly loose, organic-rich, sandy to rubbly diamicton, commonly lacking clasts 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 strict 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 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. Located throughout mountain areas

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; include some very large masses of bedrock as in sec. 26, T. 14 N., R. 2 W., and earthflow deposits too small to map separately. 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 in many places on mountain slopes throughout map area and locally in association with glaciolacustrine and lacustrine deposits, where in part, merge to fine-grained bluff colluvium (map unit cwf)

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 state and therefore may include a higher proportion of finer-grained material. Contacts generally well defined. Mainly deposited in long, narrow gullies and small valleys

Anthropogenic Deposits (latest Holocene)

f **Engineered fill and land areas extensively modified by earthmoving equipment**--Chiefly compacted pebble gravel underlain by a more poorly sorted base course of sandy to silty gravel; in modified areas may include a more heterogeneous assemblage of material. Mapped mainly along the Glenn Highway and the Alaska Railroad, and in borrow pits and sanitary landfills. Thickness one to several meters, thicker where roads and railroads cross major valleys such as that of the Eagle River. Contacts well defined, width shown on map may be exaggerated to accommodate linear symbols for the highway and railroad

BEDROCK

by **Younger rocks (Tertiary)**--Continental rocks, mainly sandstone, siltstone, claystone, and minor coal; probably Tyonek Formation. Exposed locally along the lower course of the Eagle River where two fossil-plant localities have been examined by Schaff (1964) and by Wolfe and others (1966), and at scattered localities within about 2 km of the Chugach Mountain front northward from the Eagle River to the Fire Lakes area (Dobrovolny and Miller, 1950). Farther north, Tertiary continental bedrock is buried at depths of only 18 m near the north edge of the map area in SW1/4, sec. 19, T. 15 N., R. 1 W. (Johnson, 1979), and exposed in NE1/4 of the same section in the map area to the north (Yehle and Schmoll, 1987a). Because of minimal induration of most Tertiary bedrock, and thus possible confusion with some surficial deposits, several exposures are queried, especially where there is (1) glacial erosion of the rock and incorporation of large masses of it into the surficial deposits or (2) modification by construction activity

bo **Older rocks (Tertiary to Permian)**--Primarily rocks of the Chugach terrane, including variably metamorphosed graywacke, argillite, phyllite, and conglomeratic graywacke all of the McHugh Complex, and, in the southeastern part of the map area, graywacke of the Valdez Group. Secondarily, at scattered localities along and near the mountain front, rocks of the Peninsular terrane, including greenstone, greenschist, and gneiss, as well as metadiorite, metaquartzdiorite, chert, metaargillite, and some marble. Also includes felsic to intermediate hypabbysal intrusive rocks of Tertiary age in a few places principally in the southeastern part of the map area

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