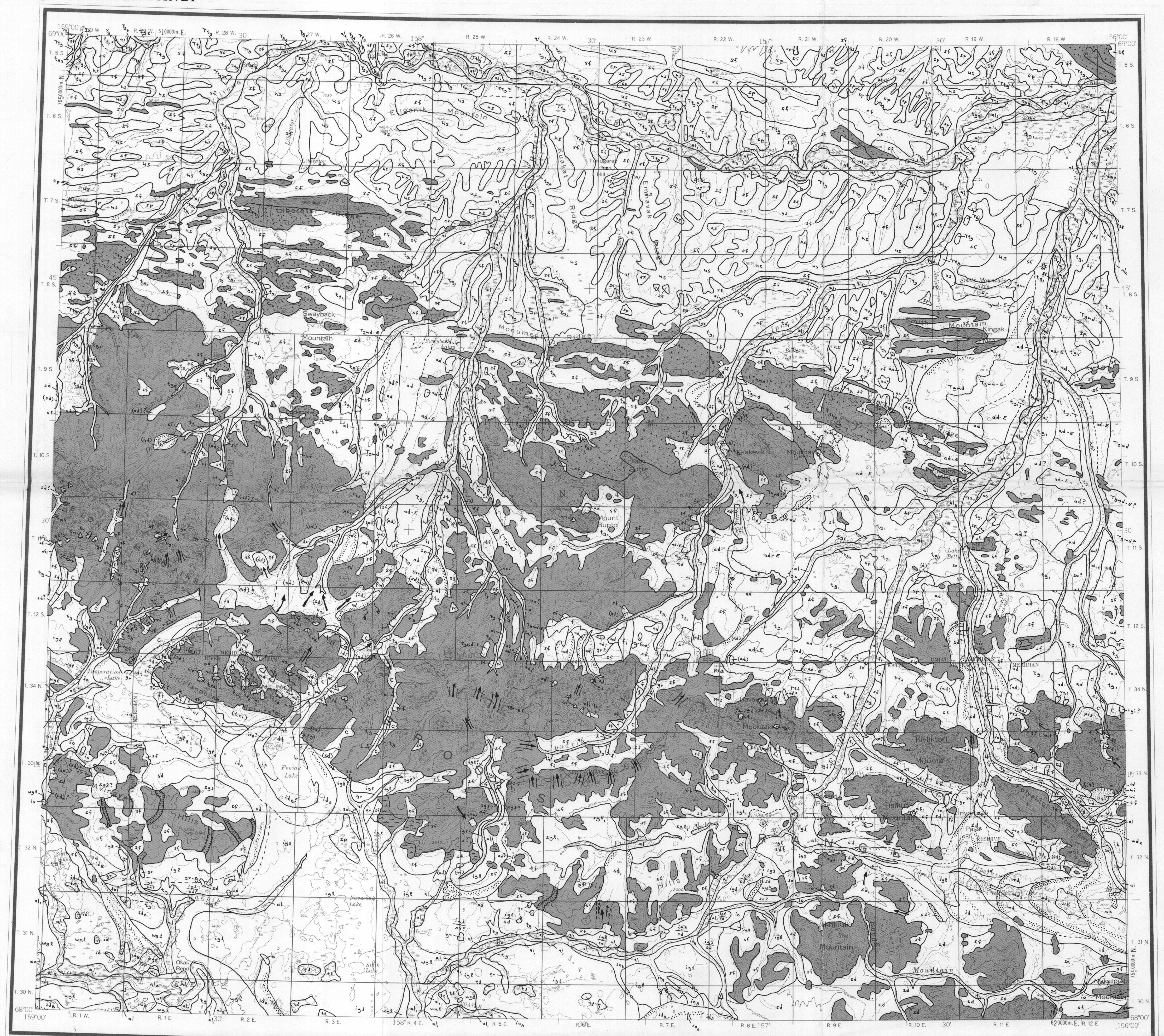
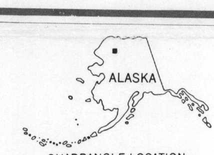


Base from U.S. Geological Survey, 1956

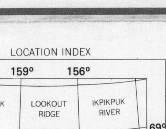


SCALE 1:250 000

5 0 5 10 15 20 MILES

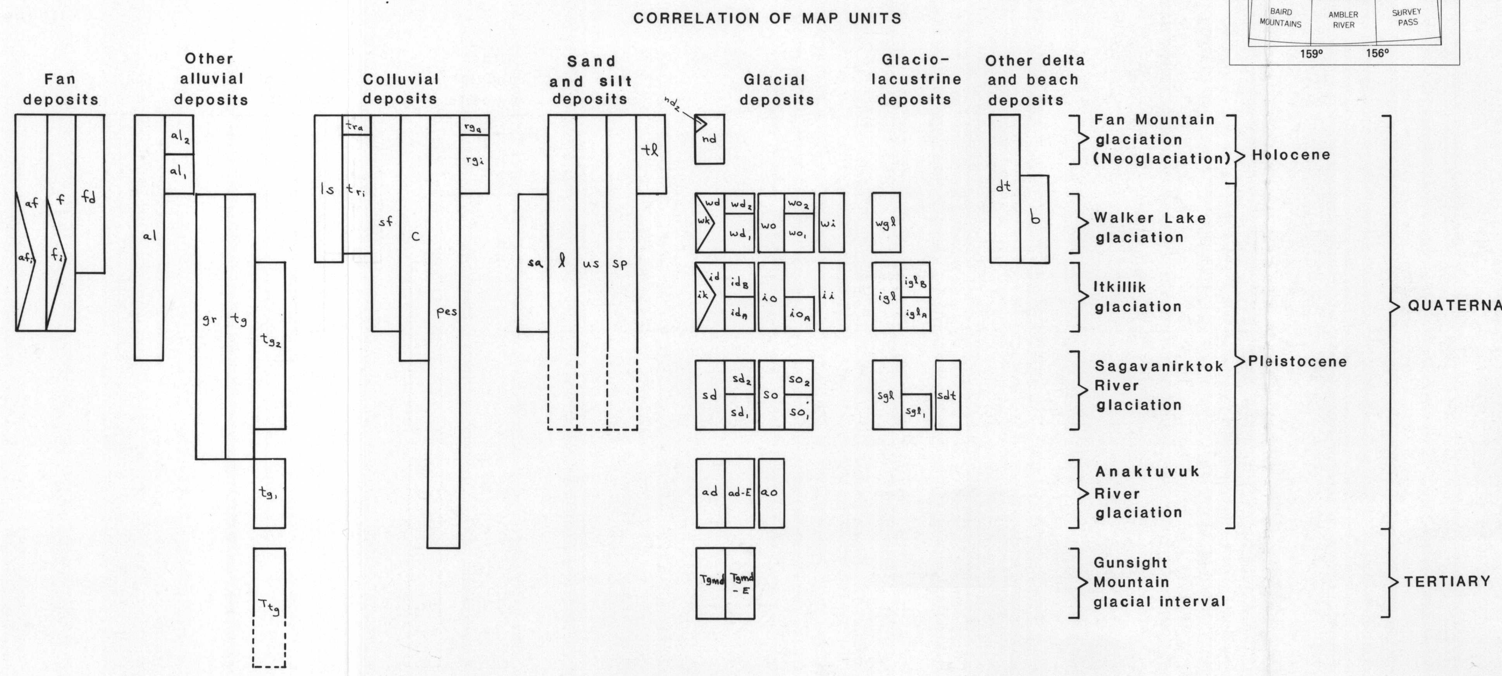
5 0 5 10 15 20 25 30 KILOMETERS

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL



Geology by R.M. Chapman, R.L. Detterman, and M.D. Mangus, 1949-1953; T.D. Hamilton, 1961, 1978-1982; and W.E. Yeend, 1982.

CORRELATION OF MAP UNITS



SURFICIAL GEOLOGIC MAP OF THE HOWARD PASS QUADRANGLE, ALASKA

By
Thomas D. Hamilton
1984

INTRODUCTION

Surficial geologic mapping of the Howard Pass quadrangle was based on study of (1) morphology, composition, distribution, and interrelations of unconsolidated deposits; (2) sediments and soil profiles in auger borings and test pits; (3) exposures along lake shores and river bluffs; and (4) previously published geologic maps and reports (for example: Smith, 1913; Smith and Mertie, 1930; Chapman and others, 1964; Nelson and Nelson, 1982). The map units are defined on the basis of their character, age, and genesis; most are identical to units employed previously on other surficial geologic maps of the central Brooks Range (Hamilton, 1978a, 1978b, 1979a, 1979b, 1980, 1981, 1984).

The basic stratigraphic framework for the surficial units is provided by the central Brooks Range glacial sequence of Detterman and others (1958), with modifications by Porter (1964), Hamilton and Porter (1975), and Hamilton (1978c, 1979c, 1982). Drift of five successive glacial advances[1]--Gunsight Mountain, Anaktuvuk River, Sagavanirktok River, Itkillik, and Walker Lake--is recognized within the Howard Pass quadrangle. Drift and erratics of the Gunsight Mountain glacial interval represent one or more glaciations of probable late Tertiary age (Hamilton, 1979c). Extensive late Tertiary alluvial terraces (unit Ttg on the map) originate or are truncated near the northern limits of Gunsight Mountain drift and erratics. The drift and the terraces exhibit approximately the same amount of postdepositional stream incision, suggesting that they are of about equal age. The oldest Pleistocene terraces (unit tg_1), in contrast, are developed at lower levels and crosscut Gunsight Mountain drift; these terraces, therefore, postdate the glacial advances of Gunsight Mountain time.

The Anaktuvuk and Sagavanirktok glaciations of Detterman (1953) are currently termed the Anaktuvuk River and Sagavanirktok River glaciations to avoid confusion with previously named rock-stratigraphic units (Keroher and others, 1966, p. 91 and p. 3379). Drift sheets of Anaktuvuk River age have been modified by stream erosion, forming dissected surfaces that extend downvalley into alluvial terraces of early Pleistocene age (unit tg_1). The terraces stand at the same general level as outwash remnants of Anaktuvuk River age; therefore they may be in part contemporaneous with the Anaktuvuk River glaciation. Drift of the Sagavanirktok River glaciation was deposited on valley floors that were close to modern levels, indicating that glacial advances of Sagavanirktok River and Anaktuvuk River age must have been separated by a long-lasting interval of river downcutting. Deposits of Sagavanirktok River age were strongly modified by subsequent weathering, mass wastage, and stream erosion during a long interglacial interval that separated it from the succeeding Itkillik glaciation (Hamilton and Hopkins, 1982).

Usage of the term "Itkillik glaciation" differs from that of prior surficial geologic maps in the central Brooks Range series. Hamilton and Porter (1975) divided the Itkillik glaciation into phases termed "Itkillik I and II," and these were represented in the previous maps by units id_1 and id_2 and by related meltwater deposits. Field mapping during 1974 to 1982, however, showed that Itkillik I and II deposits are morphologically distinct in most valleys of the central Brooks Range and clearly were separated by a long-lasting interval of weathering, soil formation, mass wastage, and stream incision. Radiocarbon dates confirm the age separation. Itkillik I deposits largely predate 53,000 radiocarbon yr B.P. (before present), and Itkillik phase II glacial expansion clearly coincided in time with the span of late Wisconsin glaciation (24,000 to 10,000 yr B.P.) in the standard North American glacial sequence (Hamilton, 1982). The term "Itkillik" is retained for the older deposits that formerly were termed "phase I"; younger deposits formerly designated "phase II" are reassigned to the Walker Lake glaciation of Fernald (1964).

The complex surficial geology of the Howard Pass quadrangle is in part a consequence of the bifurcation of the western Brooks Range into two separate chains: the De Long Mountains to the north and Baird Mountains to the south. The two parallel mountain masses provided multiple source areas for glacier accumulation, and glaciers originating in the De Long Mountains repeatedly blocked the Noatak River, which flows westward between the two mountain chains. Glacial advances of Gunsight Mountain and Anaktuvuk River age may have originated in mountain ice caps that expanded to cover much of the Noatak Valley. Large outlet glaciers flowed north across the Howard Hills and the eastern De Long Mountains, and ice extended 35-45 km into the Arctic Foothills province along the Kuna, Etivluk, and Nigu rivers. Drift dating from these advances is heavily eroded and generally stands 50 m or more above modern valley floors.

The succeeding Sagavanirktok River, Itkillik, and Walker Lake glacial advances were much less extensive and originated in high-altitude source areas on Siniktanneyak Mountain, near the heads of the Noatak and Nigu valleys southeast of the Howard Pass quadrangle, and in the De Long Mountains west of the map area. Drift lies close to modern valley floors, and outwash terraces generally are within 15 m of modern stream levels except near moraine fronts. Glaciers from the De Long Mountains flowed southeast to block the Noatak River on at least three occasions, forming glacial Lake Noatak (Hamilton and Ashley, 1983). Extensive glaciers of Sagavanirktok River age confined the glacial lake on the south, east, and west sides, forcing it to discharge northward through Howard Pass. Much of the drift dating from this advance is obscured beneath younger glaciolacustrine deposits (for example, composite unit igl/sd on map). During the Itkillik glaciation, glacial Lake Noatak attained its greatest surface area (about 4,400 km^2) and depth (about 200 m); its isostatically-warped surface plane rises eastward from 425 m a.s.l. (above sea level) to 525 m a.s.l. The youngest and smallest lake, dating from the Walker Lake glaciation, was a long, narrow water body that extended along the valley center. Its surface stood at 340 m a.s.l. near its eastern end.

Glacier and rock-glacier activity assignable to the late Holocene Fan Mountain glaciation of Detterman and others (1958) was negligible except on Siniktanneyak Mountain. For distribution and chronology of the more extensive Fan Mountain deposits east of the map area see Hamilton (1981) and Ellis and Calkin (1984).

Permafrost is continuous throughout the Howard Pass quadrangle. Depth of its upper surface varies from 20-40 cm in poorly drained deposits beneath thick sod and peat cover to half a meter or more in permeable coarse-grained sediments and several tens of meters beneath the larger lakes and rivers. Although thicknesses are unknown, records (for example, Ferrians, 1965; Williams, 1970) suggest that the base of permafrost may lie at depths of 150-250 m in much of the map area.

FAN DEPOSITS

af DEPOSITS OF STEEP ALPINE FANS--Very poorly sorted, nonstratified to weakly stratified, subangular to subrounded, silty-sandy, coarse gravel at mouths of avalanche chutes and steep canyons near heads of mountain valleys. Upper segments generally channeled, with levees of angular to subangular coarse debris. Subject to snow avalanches during winter (Luckman, 1978), slushflows during spring snowmelt (Washburn, 1980, p. 193-195), and debris flows during summer (Rapp and Nyberg, 1981). Surface gradients generally 12°-25°, intermediate between those of alluvial fans and talus cones

Subunit af_i designates inactive alpine fan deposits, as described above, generally weathered and covered with sod and vegetation. Most are periglacial features that formed beyond limits of ice advances of Walker Lake or Itkillik age

f FAN DEPOSITS--Vary from very poorly sorted, weakly stratified, subangular, silty-sandy, coarse gravel at mouths of steep canyons to moderately sorted and stratified subrounded to rounded sandy gravel at mouths of large tributary valleys with relatively gentle gradients. Locally subject to icings during winter (Sloan and others, 1976)

Subunit f_i designates inactive fan deposits, as described above; generally weathered and covered with sod and vegetation

fd FAN-DELTA DEPOSITS--Alluvial-fan facies (poorly sorted, weakly stratified, subangular, sandy gravel) near valley walls, grading into deltaic and lacustrine facies (well-sorted and well-stratified silt, sand, and fine gravel) near valley centers. Occur only in moraine-dammed basin of Desperation Lake

OTHER ALLUVIAL DEPOSITS

al ALLUVIUM, UNDIVIDED--Varies from poorly sorted, moderately well stratified, subangular, coarse gravel near heads of mountain valleys to moderately well sorted, rounded, sandy, fine gravel along Colville River and its lower tributaries. May contain local beds and lenses of sand and sandy silt. Includes fan, flood-plain, and low terrace deposits that are too small to be designated separately

al_2 MODERN ALLUVIUM--Gravel and sandy gravel, as described above; generally unvegetated and commonly subject to icings within mountain valleys. Differentiated only along major streams

al_1 LOW ALLUVIAL TERRACE DEPOSITS--Gravel and sandy gravel, as described above; mantled with 0.3-1 m of silt, sand, or peat, typically vegetated, and forming terraces generally within 3-4 m of modern stream levels. Differentiated only along major streams

gr GRAVEL DEPOSITS, UNDIVIDED--Gravel and sandy gravel of diverse origins and composition within mountain valleys and Noatak valley. Occurrences within mountain valleys commonly are stream-eroded lag concentrates derived from erosion of older glacial or alluvial deposits. Occurrences within Noatak valley typically are wave-eroded lag concentrates formed from glacial deposits

tg LOWER TERRACE GRAVEL, UNDIVIDED--Gravel or sandy gravel of variable composition forming alluvial terraces within mountain valleys and along streams on floor of Noatak valley. Terraces commonly occupy levels below till and outwash surfaces but above Holocene flood plains and, therefore, represent intermediate stages in downcutting through drift deposits

tg_2 LOWER TERRACE GRAVEL, YOUNGER--Oxidized coarse gravel to sandy fine gravel of Pleistocene age, forming terraces about 5-15 m high that are inset within higher alluvial surfaces. Locally capped with ice-rich organic silt up to 5 m thick. Composed of nonglacial alluvium that in some valleys is mixed with distal outwash of Sagavanirktok River age

tg_1 LOWER TERRACE GRAVEL, OLDER--Rounded pebbles and small cobbles in oxidized sandy matrix; medium to large cobbles become more common southward toward Brooks Range. Forms terraces 8-20 m above Colville, Kiligwa, and Kuna Rivers and 10-30 m above Etivluk and Nigu Rivers. Gravel commonly overlies 5-15 m of exposed bedrock. Grades locally into broad erosion surfaces cut into drift of Anaktuvuk River and Gunsight Mountain age that rise toward valley sides. Generally contains residual erratic boulders in areas south of Gunsight Mountain drift limit. Generally capped with ice-rich silt up to 6.5 m thick. Composed of nonglacial alluvium that locally is mixed with outwash of Anaktuvuk River age

Ttg HIGHER TERRACE GRAVEL--Strongly oxidized gravel of Tertiary age, containing rounded to well-rounded stones to medium cobble size in sand matrix. Forms terrace-like erosion remnants 45-55 m above Colville River and lower courses of its principal tributaries. These surfaces rise southward up the Ipnavik, Etivluk, and Nigu Rivers to heights as great as 75 m, and gravel coarsens southward. Gravel, generally about 10 m thick, overlies bedrock with exposed thickness of 30-50 m. Capped by ice-rich silt and organic silt, as much as 10 m thick, that contains large coalescent marshy thaw basins (these are designated as unit sp on map). Terminates southward at Gunsight Mountain drift limit along Kuna and Ipnavik Rivers, where it includes large cobbles and small boulders probably residual from Gunsight Mountain outwash

COLLUVIAL DEPOSITS

ls LANDSLIDE DEPOSITS--Unsorted, nonstratified, coarse to fine, angular rubble, commonly with matrix of finer debris forming lobes below detachment scars and slide tracks on high, steep rock walls. Subject to episodes of rapid downslope motion and long periods of relative stability. A possible very large landslide occurs east of Nigu River near drift limit of Walker Lake age (hachures show headwall). Smaller landslide deposits (shown without hachures) are located at south flank of Avingyak Hills at west margin of map and within De Long Mountains near head of Wager Creek

tr_a TALUS RUBBLE, ACTIVE--Angular unsorted nonstratified rock debris forming cones and aprons more than 2 m thick and generally sloping 30°-33° along lower walls of mountain valleys and in cirques at valley heads. Also forms thinner and generally discontinuous sheets over many uplands mapped as bedrock. Generally unvegetated, unweathered to slightly weathered, with lichen cover sparse to absent. Subject to rockfalls from slopes above, especially during spring thaw (Porter and Orombelli, 1981)

tr_i TALUS RUBBLE, INACTIVE--Angular rock debris, as described above, generally weathered and lichen covered, with partial sod cover at some localities. Thin (less than 1.5 m) blankets of stabilized talus mixed with silt occur on some uplands mapped as bedrock in northern and central parts of map area

Subunit (tr_i) designates thin but continuous sheets of inactive talus rubble over bedrock along south flank of Siniktanneyak Mountain

sf SOLIFLUCTION DEPOSITS--Very poorly, sorted nonstratified to weakly stratified, stony silt and organic silt in sheets and aprons more than 1-2 m thick. Platy to elongate stones generally oriented parallel to slope. Forms widespread deposits on gentle to moderate slopes beyond limits of glacial advances north of Brooks Range; locally present farther south on older glacial deposits and on shale bedrock

c COLLUVIUM, UNDIVIDED--Mixed talus rubble and solifluction deposits, as described above, in sheets and aprons more than 1-2 m thick. Intermixed with alluvium across floors of some narrow valleys. Most common along walls of moutain valleys above and beyond limits of ice advances of Itkillik age

pes PIEDMONT EROSION-SURFACE DEPOSITS--Complex of solifluction deposits, debris flows, steep alpine fans, rock glaciers, and altiplanation-terrace rubble above near-surface bedrock. Occur along north flank of Brooks Range on erosion surfaces that evidently formed by backwastage of range front over long period of time. Modify landscapes glaciated during Anaktuvuk River time, but do not occur within glacial limits of Sagavanirktok River age

rg_a ROCK-GLACIER DEPOSITS, ACTIVE--Very poorly sorted, nonstratified, coarse, angular rock debris with matrix of silt and fine rubble; contains abundant interstitial ice. Upper surfaces generally unvegetated, unweathered to moderately weathered, with sparse lichen cover. Frontal slopes barren, steep (35°-38°), and highly unstable, meeting upper surfaces at abrupt angle. Subject to slow downslope motion. Occurs only as lobate variety (White, 1976) near north flank of Siniktanneyak Mountain

rg_i ROCK-GLACIER DEPOSITS, INACTIVE--Coarse angular rock debris, as described above, but without interstitial ice. Upper surfaces and frontal slopes weathered and lichen covered, commonly with partial cover of sod or vegetation. Frontal slopes grade into upper surfaces without abrupt angles. Most commonly present on Siniktanneyak Mountain and in adjoining parts of De Long Mountains

[1] Geologic-climate units (glaciations, interglaciations, stades, and interstades), defined in the previous stratigraphic code (American Commission on Stratigraphic Nomenclature, 1970, p. 31), have been abandoned by the North American Commission on Stratigraphic Nomenclature (1983, p. 849) and are now recognized as informal units. Inferences regarding climate are subjective and have proved to be too tenuous a basis for the definition of formal geologic units.

SAND AND SILT DEPOSITS

sa SAND DEPOSITS--Moderately sorted fine to medium sand, horizontally bedded to slightly crossbedded, commonly contains thin interbeds of sandy peat or organic silty fine sand. Forms terraces up to 25 m high along Nigu River behind moraine complex of Walker Lake age

l LACUSTRINE DEPOSITS--Poorly exposed fine-grained sediments in upper valley of Ipnavik River. Form level planar surfaces with poor internal drainage

us UPLAND SILT DEPOSITS--Poorly to moderately sorted generally unstratified silt, organic silt, and slightly clayey, sandy, or stony silt on uplands of low to moderate relief north of oldest drift limits. Formed from loess mixed by frost action with local organic matter and weathering products. Generally has tussock cover broken by frost boils. Grades laterally into solifluction deposits on slopes steeper than about 1°-2°

sp SILT AND PEAT DEPOSITS--Thick (3-8 m) accumulations of slit, silty peat, and peat in moist swales and basins. Commonly ice rich, with conspicuous ice-wedge ploygons. Includes deposits of thaw lakes that are too small to be designated separately

tl THAW-LAKE DEPOSITS--Weakly stratified to nonstratified silt, organic silt, and clayey to sandy silt; generally contains abundant ice in form of lenses, wedges, and interstitial grains. Fills thaw basins on glacial-lake deposits along floor of Noatak valley

GLACIAL DEPOSITS

Fan Mountain glaciation (Neoglaciation)

nd FAN MOUNAIN DRIFT, UNDIVIDED--Nonsorted, nonstratified, coarse to fine, angular rubble in cirques near valley heads on Siniktanneyak Mountain. Generally forms stream-incised lobes and ridges with stable frontal slopes. Weathered and lichen encrusted, with partial sod cover in most localities

Subunit nd_2 (FAN MOUNTAIN DRIFT, YOUNGER) designates angular rubble, as described above, forming ice-cored lobes and arcuate ridges with steep, unstable frontal slopes. Unvegetated, unweathered to slightly weathered, with lichens sparse to absent. Occurs in one cirque on Siniktanneyak Mountain

Walker Lake glaciation

wd DRIFT OF WALKER LAKE AGE--Unsorted to poorly sorted, generally nonstratified, compact till ranging in composition from muddy-sandy gravel to gravelly-muddy sand, with local stratified ice-contact deposits consisting of moderately sorted sand and sandy gravel. Contains faceted and striated pebbles, cobbles, and boulders. Forms sharply defined drift belts with narrow-crested (generally 1-3 m) moraines, prominent knob and kettle morphology, and conspicuously channeled outwash trains in valleys of Siniktanneyak Mountain. Crests and upper slopes bear no loess or solifluction cover, exposed boulders are slightly to moderately weathered, and oxidation has penetrated 40-50 m into well drained deposits. Most swales lack solifluciton deposits, and abandoned meltwater channels commonly are floored with thin sod mats above coarse gravel

Subunit *wk* (KAME AND KAME-TERRACE DEPOSITS) designates thick and extensive sand and gravel deposits, as described above, associated with drift lobes of Walker Lake age around Etivlik Lake and in adjoining parts of Nigu valley

wd_2 DRIFT OF LATE WALKER LAKE AGE--Till and stratified ice-contact deposits, as described above. Forms sharp-crested irregular ground moraine and steep-sided ice-contact stratified drift deposits around Etivlik Lake and in adjoining parts of Nigu valley. Loess cover generally absent, and exposed stones very slightly weathered; oxidation has penetrated only 20-30 cm into well drained deposits

wd_1 DRIFT OF EARLY WALKER LAKE AGE--Till and stratified ice-contact deposits, as described above, in Nigu valley and Inyorurak Lakes area. Forms sharply defined drift lobes with narrow (generally 1-3 m) morainal ridges, prominent knob and kettle morphology, and conspicuously channeled outwash trains. Crests and upper slopes lack loess and solifluction cover, and exposed boulders and cobbles exhibit slight to moderate weathering; oxidation has penetrated 30-40 cm into better drained deposits. Most swales lack solifluction deposits, and abandoned meltwater channels commonly are floored with lichen-covered coarse gravel

wo WALKER LAKE OUTWASH--Moderately well sorted and stratified sandy gravel forming aprons and valley trains in front of Walker Lake moraines; also present as isolated terrace remnants farther downvalley. Largest stones decrease in size from subrounded cobbles and very small boulders near moraine fronts to rounded to subrounded pebbles and granules farther downvalley.

wo_2 OUTWASH OF LATE WALKER LAKE AGE--Sandy gravel, as described above, generally without loess or peat cover and oxidized to a depth of only 20-30 cm. Forms apron beyond drift of late Walker Lake age west of Etivlik Lake

wo_1 OUTWASH OF EARLY WALKER LAKE AGE--Sandy gravel, as described above, generally lacking loess. Stones etched, fractured, and pitted to 30-40-cm depth; oxidized to depths of 30-45 cm. Forms aprons and valley trains in front of outer moraines of Walker Lake age in Nigu valley and in Inyorurak Lakes area. Terraces near moraine fronts are up to 22 m high

wi INWASH OF WALKER LAKE AGE--Well to moderately well sorted and stratified gravelly sand and sandy fine gravel, commonly grading upvalley into sandy gravel. Deposited within nonglaciated eastern tributary blocked by glacier of Walker Lake age in Nigu valley. Forms benches and terraces that abut outer face of drift lobe

Itkillik glaciation

id DRIFT OF ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Moraine crests generally 3-10 m wide and partly bare of loess; upper slopes blanketed by stony organic silt (loess and colluvium) 0.5 to 2 m thick; swales filled with deposits of ice-rich organic silt 2-5 m thick. Forms hummocky drift bodies with subdued morphology beyond limits of Walker Lake drift in Nigu Valley, Inyorurak Lakes area, and around Siniktanneyak Mountain. Forms massive drift dams that enclose Desperation and Feniak Lakes

Subunit *(id)* designates thin (0.5-3 m) and generally discontinuous drift above bedrock along lower walls of mountain valleys. Commonly mixed with silt, rock rubble, and organic detritus by colluvial processes

Subunit *ik* (KAME AND KAME-TERRACE DEPOSITS) designates unusually thick and extensive gravel deposits, as described above, near Feniak Lake and in valley of Nigu River

id_B DRIFT OF LATE ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Forms separate inner moraines around Feniak Lake and in Noatak valley

id_A DRIFT OF EARLY ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Forms separate outer moraines around Feniak Lake and in Noatak valley

io ITKILLIK OUTWASH--Moderately well sorted and stratified sandy gravel forming continuous terraces as high as 25 m in front of Itkillik moraines; also present as isolated terrace remnants farther downvalley. Usually hasrs thick (0.5 to 4 m) widespread cover of silt, organic silt, and peat

io_A OUTWASH OF EARLY ITKILLIK AGE--Sandy gravel, as described above, associated with end moraine of early Itkillik age in Noatak valley

ii INWASH OF ITKILLIK AGE--Well to moderately sorted and stratified gravelly sand and sandy fine gravel. Deposited against outer flank of moraine in Nigu valley by unnamed stream that flows north from Inyorurak Pass

Sagavanirktok River glaciation

sd SAGAVANIRKTOK RIVER DRIFT--Poorly sorted nonstratified till, probably ranging in composition from silty-sandy-bouldery gravel to clayey stony silt, containing local deposits of moderately well sorted and stratified gravel. Generally covered by thick (more than 2-3 m) blanket of nonstratified to weakly stratified silt, stony silt, clayey silt, and organic silt (loess, solifluction, and marsh deposits), but crests of some ridges and knolls yield limited exposures of weathered gravel consisting of subrounded pebbles, cobbles, and small boulders of resistant lithologies

Subunit *(sd)* designates thin (0.5 to 3 m) and generally discontinuous drift above bedrock. Most common along lower walls of mountain valleys, where it commonly is mixed with colluvium (silt, rock rubble, and organic detritus)

Composite unit *igl/sd* is probable drift, as described above, that is covered by thin blanket of Itkillik glaciolacustrine sediments along north side of Aniuk River

sd_2 DRIFT OF LATE SAGAVANIRKTOK RIVER AGE--Till and stratified ice-contact deposits, as described above. Forms inner moraine belts within drift complexes along Flora Creek and Inyorurak Pass

sd_1 DRIFT OF EARLY SAGAVANIRKTOK RIVER AGE--Till and stratified ice-contact deposits, as described above. Forms outer moraine belts within drift complexes along Flora Creek, within Inyorurak Pass, and south of Fauna Creek. Generally more dissected and more subdued by mass wastage than deposits of unit sd_2

so SAGAVANIRKTOK RIVER OUTWASH--Moderately well sorted and stratified sandy gravel forming terraces 8-40 m high in front of end moraines of Sagavanirktok River age. Generally covered by 1-2 m of loess, solifluction, and marsh deposits. Most extensive along Kuna, Etivluk, and Nigu Rivers

Composite unit *igl/so* is probable outwash, as described above, that is covered by thin blanket of Itkillik glaciolacustrine sediments

so_2 OUTWASH OF LATE SAGAVANIRKTOK RIVER AGE--Sandy gravel, as described above, associated with end moraines of late Sagavanirktok River age in Inyorurak Pass area

so_1 OUTWASH OF EARLY SAGAVANIRKTOK RIVER AGE--Sandy gravel, as described above, forming apron in front of end moraine of early Sagavanirktok River age in Inyorurak Pass area

Anaktuvuk River glaciation

ad ANAKTUVUK RIVER DRIFT--Bouldery glacial deposits of uncertain composition overlain by continuous cover of organic silt (loess, solifluction, and thaw-lake deposits) generally more than 2-3 m thick. Erratic boulders generally protrude less than 0.2 m above ground surface and consist only of most resistant rock types (quartzites and granites). Forms subdued till plains and low broad morainal ridges with gentle (1°-2°) flanking slopes where steepened by postglacial erosion. Former swales and kettles generally filled with ice-rich silty organic colluvial and lacustrine deposits more than 5 m thick. Deeply and broadly dissected to widths up to 5-6 km and depths to 50-80 m along Kuna and Etivluk Rivers

Subunit *(ad)* designates thin (0.5 to 3 m) and generally discontinuous drift above bedrock

ad-E ANAKTUVUK RIVER DRIFT, ERODED--Glacial deposits, as described above, profoundly modified by stream erosion along valley centers and by mass wastage on lower valley sides. Forms bouldery lag concentration on terrace surfaces along Etivluk and Kuna Rivers and boulder-rich colluvial deposits that overlie till on adjoining valley sides. Primary relief has been entirely removed by erosion. Generally continuous with oldest of the lower terrace gravels (unit tg_1)

ao OUTWASH OF ANAKTUVUK RIVER AGE--Oxidized coarse gravel, containing clasts up to very small boulder size, form terrace remnants that originate at outer limits of drift lobes of Anaktuvuk River age in upper valleys of Hardway and Blankenship Creeks. Generally overlain by 3-5 m of organic silt (frost-churned loess and solifluction deposits)

Gunsight Mountain glacial interval

Tgmd DRIFT OF GUNSIGHT MOUNTAIN AGE--Highly eroded bouldery glacial deposits of unknown initial composition, lacking primary relief and overlain by continuous cover of organic silt generally more than 2-3 m thick. Occurs beyond limits of Anaktuvuk River drift in valleys of Kuna, Ipnavik, and Etivluk Rivers. Corresponds in general height to terrace gravel of Tertiary age (unit Ttg), and has been eroded to heights of 75-85 m above modern river levels by postglacial streams

Subunit *(Tgmd)* designates thin (0.3-3 m) and generally discontinuous drift and bouldery lag concentrates above bedrock east of Kuna River

Tgmd-E DRIFT OF GUNSIGHT MOUNTAIN AGE, HIGHLY ERODED--Glacial deposits, as described above, strongly eroded along valley centers. Generally consist of lag concentrates of rounded to subrounded boulders and cobbles

GLACIOLACUSTRINE DEPOSITS

wgl WALKER LAKE GLACIOLACUSTRINE DEPOSITS--Stony silt to stony-silty clay, massive to faintly bedded, containing sparse to abundant subangular to subrounded pebbles, cobbles, and small boulders that commonly are striated. Extends along center of Noatak valley floor up to altitudes that rise from 340 m in the west to 375 m in the east. Confined by glacier that blocked Noatak valley just beyond west margin of map

igl ITKILLIK GLACIOLACUSTRINE DEPOSITS--Stony silt to stony-silty clay, as described above, grading laterally into sandy-gravelly beach deposits around former lake shores. Widespread across entire floor of Noatak valley south of Siniktanneyak Mountain and eastward to Howard Pass. Maximum altitudes rise from 425 m in the west to 525 m in the east. Confined by glacier that blocked Noatak valley near southwest corner of map. Also occurs at Itkillik drift margin near head of Flora Creek. Shown as composite units where thin blankets of Itkillik glaciolacustrine sediments cover Sagavanirktok River drift (igl/sd), outwash (igl/so), and deltaic deposits (igl/sdt)

igl_B GLACIOLACUSTRINE DEPOSITS OF YOUNGER ITKILLIK AGE--Stony silt and stony-clayey silt, as described above. Inset within glaciolacustrine deposits of older Itkillik age (unit igl_A) east of Desperation Lake

igl_A GLACIOLACUSTRINE DEPOSITS OF OLDER ITKILLIK AGE--Stony silt and stony-clayey silt, as described above, confined by outer moraine of Itkillik age west of Feniak Lake

sgl SAGAVANIRKTOK RIVER GLACIOLACUSTRINE DEPOSITS--Stony silt to stony-silty clay, as described above, but more heavily dissected by postglacial stream erosion. Occurs beyond limits of Itkillik glaciolacustrine deposits near Siniktanneyak Mountain and in Howard Pass area

sgl_1 GLACIOLACUSTRINE DEPOSITS OF OLDER SAGAVANIRKTOK RIVER AGE--Stony silt and stony-clayey silt, as described above, in valley of Flora Creek. Confined behind moraines of older Sagavanirktok River age in Howard Pass area. Lacustrine limits at three apparent levels (540, 575, and 600 m) may reflect successive positions of ice dams

sdt SAGAVANIRKTOK RIVER DELTAIC DEPOSITS--Moderately well sorted and stratified very sandy pebble-small cobble gravel; possibly overlies sand or gravelly sand. Occurs as flat-topped deposit 15 m high on south side of Flora Creek at distal end of outwash terrace of Sagavanirktok River age

Composit unit *igl/sdt* is probable deltaic deposit, as described above, that is covered by thin Itkillik glaciolacustrine sediments on south side of Howard Pass

OTHER DELTA AND BEACH DEPOSITS

dt DELTAIC DEPOSITS--Sand, gravelly sand, and sandy fine gravel. Cover valley floors at north ends of Feniak and Desperation Lakes and extend south into the lakes. Subject to extensive aufeis formation

b BEACH DEPOSITS--Fine gravel and sandy fine gravel containing subrounded to rounded granules, pebbles, and sparse larger stones. Deformed by ice-shove into series of mounds and ridges. Occur locally around most lakes, but forms large mappable unit only along east shore of Feniak Lake

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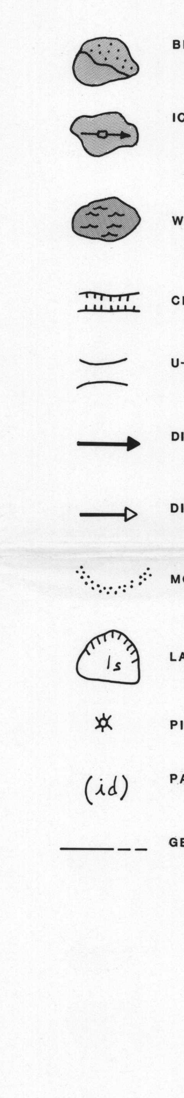
SYMBOLS



BEDROCK--Stippled where discontinous exposures are separated by sheets of silt and colluvium

ICE-SCOURED BEDROCK--Arrow shows direction of ice movement and meltwater drainage

WAVE-ERODED BEDROCK

CHANNEL--Abandoned or underfit

U-SHAPED PASS--Where glacier crossed topographic divide

DIRECTION OF GLACIER FLOW ACROSS TOPOGRAPHIC DIVIDE

DIRECTION OF GLACIAL MELTWATER FLOW ACROSS TOPOGRAPHIC DIVIDE

MORAINAL RIDGE

LARGE LANDSLIDE--Hachures show headwall

PINGO

PARENTHESIS--Indicates thin and discontinuous deposit above bedrock

GEOLOGIC CONTACT--Dashed where gradational or inferred

Interior—Geological Survey, Reston, Va.— 1984

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