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DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Tony Knowles, *Governor*

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Milton A. Wiltse, *Director and State Geologist*

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Reconnaissance surficial-geologic map of the
Sagavanirktok B-1 Quadrangle,
eastern North Slope Alaska
by
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RECONNAISSANCE SURFICIAL-GEOLOGIC MAP OF THE SAGAVANIRKTOK B-1 QUADRANGLE, EASTERN NORTH SLOPE ALASKA

by
DeAnne S. Pinney[1]

DISCUSSION

This map shows the distribution of unconsolidated deposits and undifferentiated bedrock in the Sagavanirktok B-1 Quadrangle. It was prepared principally by the interpretation of 1:63,360-scale, false-color, infrared aerial photographs and is only locally verified by ground observations during brief field visits. The results should be considered reconnaissance in nature. This quadrangle was previously mapped (also at a reconnaissance level) by C.F. Waythomas in 1991 as part of a cooperative project between the Alaska Division of Geological & Geophysical Surveys (DGGS) and the U.S. Geological Survey (USGS), and his mapping was used as a baseline from which to target areas for closer inspection in an effort to update interpretations by re-examining the deposits. While the current map shows distinct differences in many of its details as well as in the larger-scale interpretation of some of the glacial stratigraphy, much of the general breakdown of geologic units owes credit to the Waythomas (1991) map.

The northern part of the study area is characterized by a subdued, silt-covered landscape in which bedrock exposures, where they exist, are largely reduced to frost rubble. The most prominent geomorphic features are an extensive series of river terraces flanking the major streams draining to the north and northwest. These deposits reflect former channels and flow regimes that are probably related to multiple Wisconsin-age glaciations in the stream headwaters. While beyond the scope of the present study, future research opportunities could include focused sampling for datable organics and detailed mapping of the individual terrace levels in an effort to work out the chronology and relationships to glacier fluctuations in the mountains.

The southern part of the study area extends into the Brooks Range and its foothills. Bedrock exposures dominate the rugged mountain terrain, which has been carved by streams and glaciers. The bedrock slopes are drained by numerous short, steep streams that commonly feed into local debris fans. Echooka River valley supported a large glacier system during Pleistocene time that left a series of glacial deposits where the river exits the mountain front, as well as where ice spilled over into east-west trending structural troughs along the north side of range. Correlation with mapped deposits of known age and glacial sequences in other areas was accomplished by comparison of the physical appearance and extent of the deposits on satellite imagery, and by matching observed field characteristics of deposits in the study area with published descriptions.

The oldest glacial deposits recognized in the study area are assigned to Sagavanirktok River drift based upon the descriptions and mapping of Detterman (1953), Detterman and others (1958), Hamilton (1986), and Waythomas (1991). These deposits form a prominent broad, arcuate ridge that encircles younger moraines where Echooka River exits the mountain front. The moraine is up to 200 m above the present stream bottom, displays a smooth, broad, gentle crest, and has slope angles of less than about 10 degrees. Vegetation is well-established cottongrass tussocks, with some willow and abundant moss. Exposed ground between tussock mounds is fine-grained muddy silt with scattered, small, rounded to subangular pebbles. No large cobbles or boulders were observed on the surface. Possible Sagavanirktok-age deposits are also present as a scattered lag of exotic cobbles and boulders on ice-scoured bedrock and bedrock rubble in the east–west trending trough between Echooka River and Shaviovik River, although the scope of this study cannot preclude the possibility that this material might be related to an older glacial episode. Hamilton (1986) considers the Sagavanirktok River glaciation to encompass multiple ice advances of middle Pleistocene age.

The next group of glacial deposits in the study area are assigned to Itkillik drift based upon the work of Detterman (1953), Detterman and others (1958), and Waythomas (1991). Hamilton (1986) prefers to designate deposits of this age as Itkillik I drift. The surfaces of these deposits are irregular and hummocky and generally retain primary morainal morphology. Compared to the outer, older, Sagavanirktok-age moraine that encircles these deposits, the Itkillik moraines are characterized by much more abundant surface clasts, more open ground, and numerous kettle

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lakes, many of which retain steep embankments. Itkillik moraine crests are narrower and slopes are steeper, and the maximum moraine height is approximately 110 m above modern stream level, some 90 m lower than the older, encircling moraine. Vegetation consists of low heath, blueberries, lichen, shrub birch, and labrador tea. In an effort to obtain a radiocarbon date for these deposits, a sample of dense, black peat was collected from an 8-cm-thick mat directly overlying more than 5 m of till along the southern margin of four small kettle lakes (147°33'55"W, 69°19'55"N). The resulting date of 3,450±80 yr B.P. (GX-26140) gives only a distant minimum limiting date for the underlying glacial deposits. Hamilton (1986) determined that ice advances of Itkillik I age are older than 55 ka, and therefore beyond the effective range of radiocarbon dating.

Proximal to the mountain front the surface of the Itkillik moraine has been extensively reworked by water. Deposits here are locally capped by more than 3 m of bedded sand and gravel that are probably the result of meltwater release from retreating glacial ice. Organic silt exposed at the base of a 3-m-high cutbank into thaw lake deposits developed on these reworked deposits along the eastern margin of Cache One Lake (147°25'2"W, 69°17'53"N) was radiocarbon dated at 4,800±150 yr B.P. (GX-26136). Peaty silt collected at a depth of approximately 2 m immediately adjacent to a melting ice wedge approximately 1 mi northeast of Cache One Lake (147°26'30"W, 69°18'40"N) was radiocarbon dated at 12,340±180 yr B.P. (GX-26138), giving a minimum limiting date for the underlying reworked glacial deposits. A fan delta mapped at the mountain front appears to have been deposited by glacial meltwater into a short-lived, shallow lake impounded behind Itkillik moraine deposits as ice retreated.

The youngest glacial deposits recognized in the study area are assigned to Echooka drift based upon the descriptions and mapping of Detterman (1953), Detterman and others (1958), and Waythomas (1991). Hamilton (1986) assigns deposits of this age to Itkillik II drift. Moraines of this age in the study area are small compared to those formed by previous ice advances, with crests that measure approximately 15–20 m higher than the elevation of the modern Echooka River channel. The surfaces of Echooka moraines are hummocky with scattered glacially striated boulders up to 75 cm diameter, and the deposits generally retain well-preserved, primary morainal morphology. Soil development is nominal, and was measured at up to 20 cm thick with a well-established tussock vegetation. Drift of Echooka (Itkillik II) age was deposited between about 24 and 11.5 ka (Hamilton, 1982; 1986; Porter and others, 1983; Ashley and others, 1984).

DESCRIPTION OF MAP UNITS

QUATERNARY UNCONSOLIDATED DEPOSITS

Alluvial Deposits

Qa **Stream Alluvium**—Elongate deposits of moderately to well sorted, well stratified, pebble–cobble gravel, sand, and silt, with few[2] to numerous boulders, deposited in active stream channels, floodplains, and associated low terraces. Deposit is medium to thick bedded, locally crossbedded, and shows fining-upward cycles. Cobbles generally rounded. Extensive willow–alder thickets grow on many Qa deposits in mature valley fills. Seasonal icings (aufeis) are prevalent along some streams, notably Echooka River, in much-widened areas of alluvial deposition. Surface smooth except for local low scarps.

Qac **Abandoned-Channel Deposits**—Elongate deposits of variable grain size, sorting, and bedding style deposited in channels of former meltwater streams not related to modern stream regimens and subsequent underfit streams. Composition ranges from slightly washed drift with thin, local surface lags of cobbles and boulders to well-sorted, clean pebble–cobble gravel, and gravelly medium to coarse sand with rare to numerous cobbles to 0.5m diameter; thin to thick bedded, locally crossbedded. Surface smooth with local low scarps and bogs.

Qaf **Alluvial Fan Deposits**—Fan-shaped, heterogeneous mixtures of poorly to moderately sorted, partially stratified gravel with some sand and silt and scattered to numerous, subangular to rounded boulders, especially in proximal areas. Deposits are locally channelized across fan surface. Clasts generally locally

[2]Terms used to describe the estimated percentages of cobbles and boulders are 'numerous', 'scattered', and 'rare.' 'Numerous' implies that drilling through the layer would encounter two cobbles or boulders in an interval of 0.6 m; 'scattered' implies that drilling would encounter two cobbles or boulders in an interval of 3 to 4.5 m; and 'rare' implies that drilling would encounter two cobbles or boulders in an interval of more than 4.5 m.

derived from the immediate vicinity along the short, steep streams feeding the fans. May include torrential fluvial deposits and debris-flow deposits. Thick to thin bedded. Generally form at intersection between tributary and trunk streams. Surface smooth except for numerous shallow, interconnected channels.

Qas **Silty Alluvium**—Irregular, elongated deposits of moderately well stratified silt and minor fine sand deposited by streams traversing areas of thick silt cover. May include fine-grained debris-flow deposits, especially in the upper reaches adjacent to actively melting frozen silt deposits. Lower reaches may be deeply incised. Deposit is generally composed of reworked eolian silt. Moderately to well sorted and medium to thin bedded; locally crossbedded. Surface smooth except for numerous shallow, interconnected channels, local low scarps, and local small ponds forming beaded drainage.

Qat **Terrace Alluvium**—Elongate deposits of well sorted, well rounded to subrounded pebble-cobble gravel and sand with trace to some silt and rare to numerous boulders forming stream terraces bordering floodplains. Deposits reflect former channels and flow regimes related to multiple Wisconsin-age glaciations in the stream headwaters. Generally thickly mantled by ice-rich, reworked silt deposits. Surface smooth to hummocky with local low scarps and bogs.

Qfp **Floodplain Alluvium**—Elongate deposits of moderately to well sorted, well-stratified, fluvial gravel, sand, and silt with few to numerous boulders in floodplains and associated low terraces. Deposits may reflect former channels and flow regimes. Typically mantled by thin layer of silty overbank deposits. Generally finer grained than similar deposits in Qa unit because of deposition during flood-stage events. May locally include Wisconsin to Holocene terrace alluvium. Lower surfaces may be flooded during periods of maximum stream discharge. Ground ice content highly variable. Surface smooth to hummocky with local low scarps and bogs.

Colluvial Deposits

Qc **Undifferentiated Colluvium**—Irregular, heterogeneous blankets, aprons, and fans of angular to subrounded rock fragments, gravel, sand, and silt that are left on slopes, slope bases, or high-level surfaces by residual weathering and complex mass-movement processes, including rolling, sliding, flowing, gelifluction, and frost creep. May include greatly modified drift of older glaciations. Locally washed by meltwater and slope runoff. Medium to thick bedded; thickness highly variable. Surface smooth, lobed or terraced and, if deposit is thin, generally reflects configuration of underlying bedrock surface.

Qca **Colluvial–Alluvial Valley Fill, Fan and Apron Deposits**—Fan- and tongue-shaped and elongate heterogeneous mixture of subangular rock fragments and pebble–cobble gravel with some sand and silt deposited at the bases of steep walls and upper stream courses primarily by debris flows and brief, intense (torrential) summer streamflows May include or be capped by a considerable amount of redeposited eolian silt. Locally washed by meltwater and slope runoff. Alluvial–colluvial fan deposits are formed or modified when seasonal snowpack is melting. Surface steep to gently sloping and smooth, except for local low scarps.

Qcr **Talus and Rubble Deposits**—Irregular cones, drapes, and sheets of coarse (1 m diameter and larger blocks are common), heterogeneous, angular rock fragments and rubble with minor silt, sand, and gravel deposited more or less in place at the base of steep slopes by block weathering, frost riving, snow avalanches, free fall, tumbling, rolling, and sliding. Deposits are widely subjected to secondary reworking by cryoturbation, including frost heave and frost jacking of rock fragments. Surface steep, irregular, generally unvegetated, covered with numerous angular rock fragments, and characterized by openwork rubble mounds.

Qdf **Debris–Fan Deposits**—Fan-shaped heterogeneous mixture of sand, silt, and gravel with rare to numerous angular rock fragments deposited at the mouths of steep bedrock couloirs by debris flows and seasonal meltwater. Surface smooth to locally irregular.

Glacial Deposits

Echooka Drift

[after Detterman (1953), Detterman and others (1958), and Waythomas (1991)]
(Itkillik II drift of Hamilton, 1986)

Qde **Undifferentiated Drif of Echooka Age**—Heterogeneous blanket of pebble–cobble gravel, sand, and silt, with rare to numerous boulders. Deposited directly from glacial ice and by glacial meltwaters. Sorting, bedding, and clast roundness highly variable, depending on degree of water reworking. Deposit locally includes or is gradational with outwash. Surface smooth to slightly irregular.

Qdme **Moraine Deposits of Echooka Age**—Heterogeneous mounds and ridges of pebble–cobble gravel, sand, silt, and clay in varying proportions deposited directly from glacial ice; contains rare to numerous boulders. Clast roundness varies from rounded to subangular. Nominal soil development up to 20 cm thick with well-established tussock vegetation. Surface is hummocky and generally retains primary morainal morphology. Moraine crest is approximately 15–20 m higher than elevation of Echooka River channel.

Qoe **Outwash Deposits of Echooka Age**—Elongate heterogeneous mixture of washed, rounded to subrounded pebble–cobble gravel with some sand and silt and scattered to numerous subangular to rounded boulders deposited by meltwater streams draining margins of former glaciers. Thin to thick bedded, locally crossbedded. Surface generally smooth and gently sloping, except for local low scarps.

Qofe **Outwash Fan Deposits of Echooka Age**—Fan-shaped heterogeneous mixture of washed, rounded to subrounded pebble–cobble gravel with some sand and silt and scattered to numerous subangular to rounded boulders deposited by meltwater streams draining margins of former glaciers. Thin to thick bedded, locally crossbedded. Surface generally smooth and gently sloping, except for local low scarps of anastomosing former stream channels.

Itkillik Drift

[after Detterman (1953), Detterman and others (1958), and Waythomas (1991)]
(Itkillik I drift of Hamilton, 1986)

Qdir **Reworked Drift of Itkillik Age**—Heterogeneous blanket of pebble–cobble gravel, sand, silt, and clay in varying proportions deposited by glaciers; contains rare to numerous boulders deposited directly from glacial ice. Sorting, bedding, and clast roundness highly variable, depending on degree of water reworking. Deposit locally includes or is gradational with outwash. May be blanketed by up to a meter of ice-rich organic silt and peat. Observed thickness ranges from a thin and patchy veneer or lag of pebbles and cobbles over ice-scoured bedrock at the mountain front to more than 3 m of bedded sand and gravel northwest of Cache One Lake. Maximum thickness is likely much greater. Surface smooth to highly irregular with local bogs and ponds.

Qdmi **Moraine Deposits of Itkillik Age**—Heterogeneous mounds and ridges of pebble–cobble gravel, sand, silt, and clay in varying proportions deposited directly from glacial ice; contains rare to numerous large (1 m diameter and greater) angular to subangular boulders. Till typically consists of rounded to subangular pebbles and cobbles up to 20 cm diameter in a dark bluish-gray, plastic, silty clay matrix. Steep banks of kettle ponds in frozen till are subject to slumping and flowing as they thaw. Includes local deposits of abundant, mostly rounded, pebbles and cobbles in sandy matrix that are interpreted as kame and kame terrace deposits. May be blanketed by up to a meter of ice-rich organic silt and peat. Surface is irregular and hummocky and generally retains primary morainal morphology.

Qfdi **Fan-Delta Deposits of Itkillik Age**—Fan-shaped deposit of sand and pebble gravel laid down near margin of former meltwater lake by stream entering lake. Well sorted and medium to massive bedded, locally crossbedded. Surface smooth and mantled in tussock-tundra, has some standing water. Abundant frost boils bring well-rounded pebbles, cobbles, and sand to the surface.

Sagavanirktok River Drift

[after Detterman (1953), Detterman and others (1958), Hamilton (1986), and Waythomas (1991)]

Qdms **Moraine Deposits of Sagavanirktok River Age**—Heterogeneous mounds and ridges of pebble–cobble gravel, sand, silt, and clay in varying proportions deposited directly from glacial ice. Forms prominent

broad, arcuate ridge that encircles younger Itkillik-age moraines where Echooka River exits the mountain front.

Qds **Undifferentiated Drift of Sagavanirktok River(?) Age**—Very thin and patchy veneer of pebbles, cobbles, and boulders deposited directly from glacial ice of Sagavanirktok age and older. Commonly preserved as only a scattered lag of exotic cobbles and boulders on ice-scoured bedrock and bedrock rubble. May be blanketed by a meter or more of ice-rich organic silt and peat in low-lying areas.

Complex Deposits

Qs **Swamp Deposits**—Elongate to blanket deposits of complexly interbedded peat, organic silt, and organic sand accumulated as surface deposits in local basins and in former stream channels, and downslope from springs and seeps. Saturated and locally frozen and ice rich. Thickness highly variable, but may locally exceed 5 m. Surface smooth, hummocky, or pitted. May have standing water.

Qsr **Retransported Silt**—Heterogeneous blankets, fans, and aprons of silt and organic silt originally laid down by eolian processes and subsequently extensively reworked by fluvial and colluvial processes; includes silt-rich debris-flow deposits. May contain angular clasts of local origin. Massive to thinly bedded, with some wavy bedding and crossbedding. Thickness highly variable. Commonly perennially frozen and ice rich. Surface steep to gently sloping with numerous shallow, interconnected channels and local low scarps.

Qsu **Perennially Frozen Silt, Undifferentiated**—Irregular blankets of massive, generally homogeneous, unconsolidated silt of eolian origin, largely retransported from original hillside sites of eolian deposition to lower slopes and valley bottoms by mudflows, slopewash, and gullying. May include areas of primary upland silt. Locally organic-rich and fetid with interbedded peat and woody layers. Permafrost in valley bottoms creates poor drainage, manifesting as beaded drainage and local bogs. Ground ice is abundant. Slope failures and small-scale earthflows are common along streamcuts and on slopes. Maximum observed thickness was approximately 3 m, but total thickness is potentially much greater. Surface generally smooth to gently sloping with local low-center ice-wedge polygons; locally pitted and gullied by melting of ice-rich permafrost (thermokarst). Wood collected from a depth of approximately 160 cm in a frozen silt cutbank along a small tributary stream of Shaviovik River (147°14'23"W, 69°20'49"N) was radiocarbon dated at 2,580±40 yr B.P. (GX-26137) and peat collected from a depth of 133 cm in melting ice-rich fetid silt on the low ridge north of Fin Creek (147°8'28"W, 69°30'8"N) was radiocarbon dated at 4,110±140 yr B.P. (GX-26139), providing minimum limiting dates for these deposits.

Qts **Thawed Silt Deposits**—Heterogeneous blankets of poorly to moderately stratified silt and organic silt generally equivalent to Qsu unit and subsequently extensively modified by extreme melting of ice-rich permafrost and overland stream flow. Includes semicircular to irregularly shaped deposits of moderately stratified, heterogeneous, silt, sand, and organic silt filling small, often interconnected basins resulting from the melting of ice-rich permafrost in silt. Saturated and locally refrozen, locally ice rich. Surface may be pitted and hummocky or characterized by numerous shallow, interconnected channels; small ponds and boggy areas are abundant.

Manmade Deposits

Qh **Artificial Fill Deposits**—Pebble–cobble gravel with trace to some sand and silt forming base for drill pad. Well to poorly sorted. Surface smooth.

BEDROCK

b **Undifferentiated Bedrock**—Undifferentiated bedrock with essentially no cover.

b' **Shallowly Buried Bedrock**—Undifferentiated bedrock that is covered by a thin (generally 1 m thick or less) veneer of colluvium, drift, undifferentiated glacial or glaciofluvial deposits, or combinations of these deposits. Cover is sufficiently thin that planar bedrock structures, like joints, foliation, and bedding, or glacier-scoured bedrock subcrops are reflected at the ground surface by linear and curvilinear shallow troughs and bands of moist ground or hydrophyllic vegetation.

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