ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

REPORT OF INVESTIGATION 2016.6
Hubbard, 2016
SHEET 1 OF 1
doi:10.14509/29472

SURFICIAL-GEOLOGIC MAP OF PARTS OF THE SAGAVANIRKTOK AND TOOLIK RIVER DRAINAGES, NORTHERN ARCTIC FOOTHILLS, ALASKA

by
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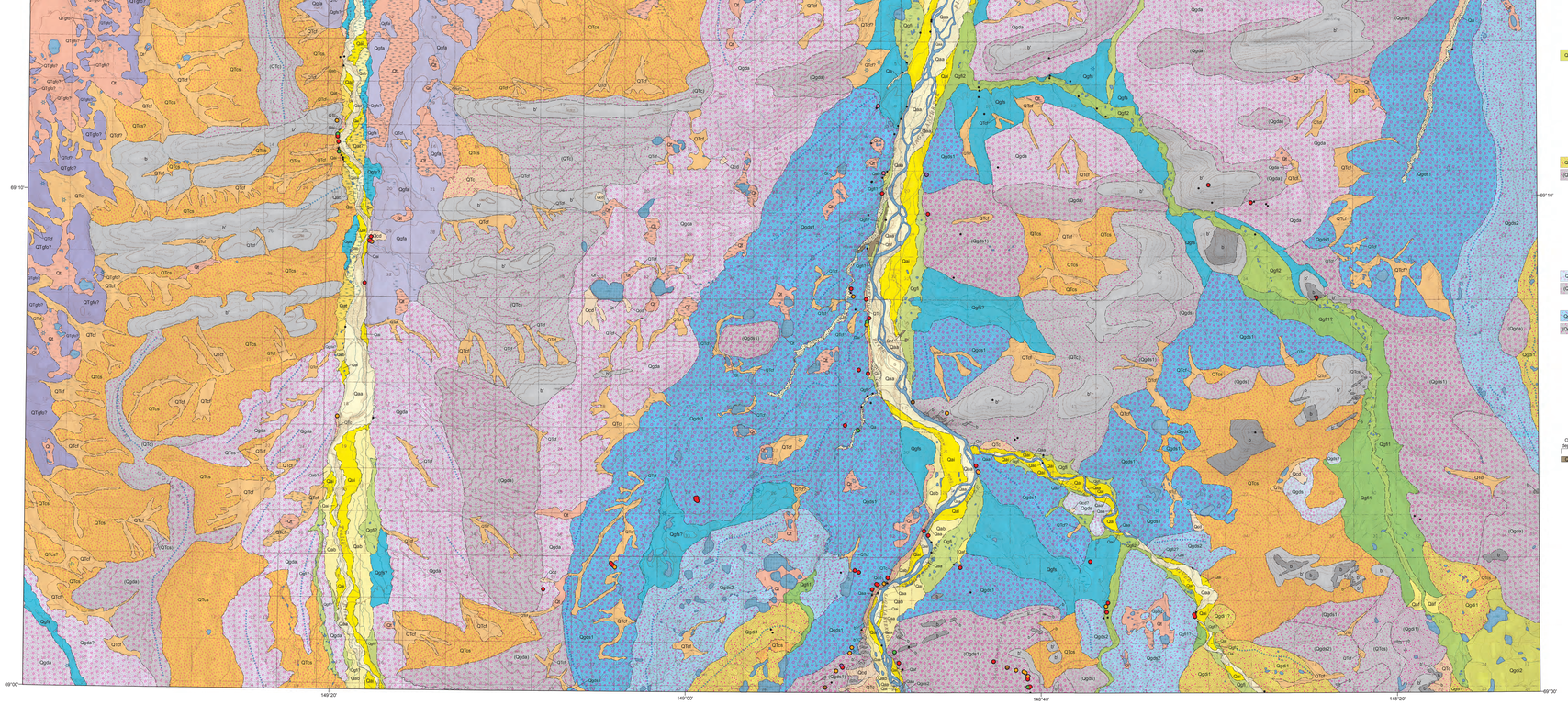
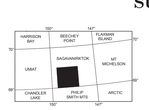
2016

SCALE 1:63360

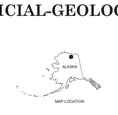
1 0 1 2 0 1 2 3 4 5 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 24000 27000 FEET
1 0 0 1 2 3 4 5 6 7 KILOMETERS

CONTOUR INTERVAL 50 FEET
SAGAVANIRKTOK A-5, B-3, B-4, AND B-5 – SUPPLEMENTARY COUNTOUR INTERVAL 25 FEET
SAGAVANIRKTOK A-3, A-4, AND B-2 – NATIONAL GEODETIC VERTICAL DATUM OF 1929
SAGAVANIRKTOK A-5, B-4, AND B-5 – DATUM IS MEAN SEA LEVEL





Location of Map Area



EXPLANATION

This map shows the distribution of unconsolidated deposits and undifferentiated bedrock exposed at the surface in the Sagavanirktok A-3, A-4, B-3, B-4, and portions of the Sagavanirktok A-5 and B-5 quadrangles. Units were mapped by interpretation of stereo pairs of ~1:65,000-scale false-color infrared aerial photographs taken in June and August 1978, as well as 2.5-m- and 10-m-resolution SPOT imagery collected in 2009 and 2010. Fieldwork was completed in 2008.

Map units are identified by the symbols described below. Those symbols shown in parentheses, such as (Qal), indicate combined map units consisting of bedrock overlain by thin or discontinuous deposits of the map unit. Map units with a question mark, such as (Qa?), indicate an uncertain identification.

DESCRIPTION OF SURFICIAL-GEOLOGIC MAP UNITS

Unconsolidated Deposits

ALLUVIAL DEPOSITS

Qa UNDIFFERENTIATED ALLUVIUM—Generally well-sorted to locally poorly-sorted, rounded to subangular polymictic gravels with fine silt to coarse sand comprising channel and overbank deposits of generally small or underfit streams where the frequency and timing of deposition is uncertain; permafrost generally absent

Qaa ACTIVE-FLOODPLAIN ALLUVIUM—Generally well-sorted to locally poorly-sorted, well-stratified silt to coarse sand and rounded to subangular polymictic gravel comprising active stream channels, stream banks, point-bar deposits, and low floodplains frequently inundated by streams; floodplain deposits are more extensive in areas of seasonal stream icings where rivers are braided, in part because the thick stream icings cause stream flow during breakup to be diverted onto adjacent floodplain and terrace surfaces (Harden and others, 1977); surfaces lack loess or ice-rich silt and are unvegetated or have sparse, open shrub vegetation; permafrost is absent; mapped distribution of deposits reflects extent at the time air photos and satellite imagery were collected and may change significantly as the active stream channel evolves and the extent and nature of stream icing changes

Qab ABANDONED-FLOODPLAIN ALLUVIUM—Poorly-sorted to well-sorted silt to coarse sand and rounded to subangular polymictic gravel; surfaces are former active floodplains subject to inundation only during rare, high-magnitude floods; may include multiple surfaces at different levels; surfaces typically have a thin organic mat and loess cover with numerous abandoned stream channels (Krieg and Reger, 1982) that are often at least partially infilled and commonly have numerous disconnected linear or arcuate lakes, especially in the Toolik River valley; lakes on older surfaces tend to coalesce and have a more irregular morphology as a result of thermoerosional processes; permafrost features are generally absent, except on older surfaces where ice-rich silt and thaw ponds may be present; colluvium (Qcf) and gelifluction deposits (Qcf?o) may be present along margins of abandoned floodplains; deposits, especially where surfaces abut steeper slopes; differentiated from inactive floodplains (Qai) based on the presence of numerous infilled former stream channels with disconnected lakes, and a more dense vegetative cover of willows and alders

Qaf ALLUVIAL-FAN DEPOSITS—Fan-shaped deposits of unsorted to well-sorted gravel, sand, and silt with numerous cobbles and boulders; clasts are locally derived from streams feeding the fan; typically formed at the mouths of small valleys and gullies at the bases of slopes where streams deposit material due to decreased stream gradient; may be mixed with debris-flow (Qcd) and gelifluction deposits (Qf?o), particularly in fan apex zones

Qai INACTIVE-FLOODPLAIN ALLUVIUM—Poorly-sorted to well-sorted sand and rounded to subangular polymictic gravel deposited by periodic stream flooding; may include surfaces at more than one level; includes alluvial deposits in areas of stream icings that are not part of the active floodplain; abandoned channels are numerous and generally connected, with few lakes; surfaces lack silt cover, permafrost features are absent, and the organic mat is thin to absent; surface characterized by low, shrubby vegetation that includes willows and alders; differentiated from abandoned floodplains (Qab) by the presence of more numerous abandoned channels that have not been infilled with sediment, fewer lakes, and a less dense vegetative cover

Qat STREAM-TERRACE ALLUVIUM—Organic sandy silt and silty sand overlying poorly-sorted to well-sorted clay to coarse sand, and rounded to subangular polymictic gravel; surfaces are no longer subject to inundation by the streams that deposited the alluvium and may include several levels (Krieg and Reger, 1982); outwash may be incorporated in the highest terraces; abandoned channels are typically filled with ice-rich organic silt (Krieg and Reger, 1982); thaw lakes are more numerous and larger than on abandoned-floodplain (Qab) surfaces and typically have rounded shorelines (Weber and Péwé, 1961; Péwé, 1970); colluvial processes may be active at thaw-lake margins and on terrace margins where material is being shed onto the terrace tread

COLLUVIAL DEPOSITS

Qcd DEBRIS-FLOW DEPOSITS—Tongues of chiefly poorly-sorted, matrix-supported pebble-cobble gravel with some boulders deposited on slopes by flowing slurries of mud, sand, rock debris, and gravel; deposits may result from thawing permafrost, snowmelt, spring flooding, or intense summer rains

Qc / **(Qc)** UNDIFFERENTIATED COLLUVIUM—Heterogeneous blankets, aprons, cones, and fans of angular to subangular rock fragments, gravel, sand, and silt formed by complex, gravity-driven mass movements involving sliding, flowing, gelifluction, and frost creep; common at the margins of alluvial and glaciofluvial deposits, on drift of Sagavanirktok River and older glaciations, and on lower bedrock slopes

Qtsf MIXED COLLUVIUM AND ALLUVIUM—Elongate deposits of organic-rich silt mixed with minor rounded to subangular pebble-cobble gravel; colluvial processes > fluvial processes; may represent a transitional phase between the development of thermokarst lakes and more-integrated stream drainages; deposits may develop in part as a consequence of the thawing of ice-rich permafrost; common on Sagavanirktok River-age and older surfaces, where deposits may be complexly mixed with gelifluction (Qf?o) and mobilized ice-rich silt deposits (Qf?sss); generally not present on Ikhillik and younger surfaces

Qf?o / **(Qf?o)** GELIFLUCTION DEPOSITS—Poorly-sorted, nonstratified to weakly stratified, generally matrix-supported, silt-rich, boulder- and pebble-cobble gravel; forms lobes on moderate to steep slopes and older, low-relief surfaces where colluvial processes are very active; includes modified glacial drift and glaciofluvial deposits of Sagavanirktok River, Anaktuvuk River, and Gunsight Mountain glaciations where primary drift morphology has been nearly or completely obliterated by slope processes; may include some modified deposits of Ikhillik I glaciation, but generally absent on younger surfaces

COMPLEX DEPOSITS

Qt THERMOKARST LAKE AND BASIN DEPOSITS—Deposits of ice-rich, organic silt in closed depressions or basin complexes formed in poorly-drained low areas, areas of undifferentiated frozen silt (Qusx), and low-relief deposits of Sagavanirktok age and older; widespread north of the Arctic foothills; polygonal ground is common and deposits may be modified by colluvial processes

Qfsx / **(Qfsx)** UNDIFFERENTIATED FROZEN-SILT DEPOSITS—Ice-rich, well-sorted, massive- to finely-bedded silt with sand forming a blanket over much of the broad, low-gradient northern map, where syngenetic permafrost is widespread; deposits may have as much as 50–75 percent ice by volume (Krieg and Reger, 1982); characterized by landforms typical of yedoma, including flat hills with gentle slopes penetrated by deep thaw lakes and thaw-lake basins that are divided by erosional valleys (Kanevskiy and others, 2011); deposits commonly mantle high-level, terrace-like features that may be remnants of older outwash (Stevens and others, 2003); complexly mixed with undifferentiated colluvium (Qf?c), gelifluction deposits (Qf?so), and older drift, especially where deposits thin to the south along the margins of the Arctic foothills

Qgfs FROZEN SILT AND ANAKTUVUK RIVER DRIFT—Generally ice-rich silt, of unknown thickness, covering broad, low-relief surfaces highly modified by freezing and thawing and gravity driven processes; syngenetic permafrost is widespread; deposits generally form slightly higher surfaces surrounded by low-lying areas of more extensive permafrost degradation and thermokarst development; may include pebble-cobble gravel at depth; identification is based on terrace-surface morphology and position ≥45–55 m above major stream drainages, and relations to Anaktuvuk River moraines (Hamilton, 1986); pingos may be present in northern map area in ice-rich silt or frost heave in thaw-lake basin deposits, thermokarst features are widespread, and yedoma development is extensive (Kanevskiy and others, 2011)

QTgfs FROZEN SILT AND PRE-SAGAVANIRKTOK DRIFT—Generally ice-rich silt of unknown thickness, covering broad, low-relief surfaces highly modified by freezing and thawing and gravity driven processes; syngenetic permafrost is widespread; deposits generally form slightly higher surfaces surrounded by low-lying areas of more extensive permafrost degradation and thermokarst development; may include pebble-cobble gravel at depth; identification is based on terrace-surface morphology and position ≥45–55 m above major stream drainages (Hamilton, 1986); deposits are likely remnants of outwash or drift that cannot be associated definitively with either Gunsight Mountain or Anaktuvuk River glaciations (Hamilton, 1986); pingos may be present, thermokarst features are widespread, and yedoma development is extensive (Kanevskiy and others, 2011)

GLACIAL DEPOSITS

Ikhillik Glaciation

Qgdi2 DRIFT OF IKHILLIK PHASE II GLACIATION (25–11 ka, Hamilton, 2003)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand; deposited by ice of younger Ikhillik advance and locally reworked by meltwater and mass-movement processes; deposits contain abundant rounded to subangular clasts that may be striated and polyhedral; locally includes moderately-well-sorted sand and gravel; surfaces slightly weathered with oxidation to depths of 0.3 m; sharp, multicrested moraine ridges have steep flanking slopes that are generally devoid of loess and solifluction cover (Walker and others, 2009; Hamilton, 1978, 1994, 2003); erratic boulders are more varied lithologically than on older surfaces and may protrude up to 80 cm (32 in) (Hamilton, 1994, 2003); surface morphology is reflective of ice stagnation, with knob-and-kettle topography more prominent than on Ikhillik I drift (Qgdi1); deep, steep-sided kettle lakes are commonly isolated from streams and have angular to subangular morphology and islands or peninsulas (Hamilton, 1994, 2003; Walker and others, 2009); deposits may form first-generation ice-wedge polygons (Hamilton, 1978, 2003); vegetation generally consists of discontinuous cover of *Dryas* heath, blueberries, lichens, and Labrador tea with dwarf birch and dwarf willow present in the deepest swales (Hamilton, 2003; Pinney, 2000); streams are typically small and poorly integrated, forming arcs around moraine margins (Hamilton, 1978, 1986); surfaces are generally more irregular, steeper, stonier, and less vegetated than Ikhillik I drift (Hamilton, 1994)

Qgdi1 / **(Qgdi1)** DRIFT OF IKHILLIK PHASE I GLACIATION (>53 ka, Hamilton, 2003)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand, deposited by glacial ice of older Ikhillik advance; surfaces oxidized to depths of 1.2 m and characterized by slightly flattened, concentric moraine crests approximately 5–10 m wide with flanking slopes of approximately 20–25 degrees (Hamilton, 1978, 1994, 2003); lower morainal slopes are modified by gelifluction but generally lack thick accumulations of ice-rich silt typical of older deposits (Hamilton, 2003); erratic boulders protrude up to 50 cm above a silt cover as thick as 100 cm, and are more widespread, lithologically diverse, and less weathered than in older drift deposits (Hamilton, 1994, 2003); vegetation, including *Dryas* heath, blueberries, lichen, and Labrador tea, is interspersed with areas of bare gravel and is less continuous and more variable than on older drift surfaces; frost boils, as well as secondary and tertiary ice-wedge polygons, are common (Hamilton, 2003); primary glacial morphology of deposits is well preserved; kettle lakes typically have grassy flanks and marshy shores and are more rounded than on Ikhillik II (Qgdi2) drift as a result of partial infilling by mass-movement processes on surrounding side slopes; small streams commonly connect lakes, reflecting the beginnings of drainage integration following deglaciation (Walker and others, 2009; Hamilton, 1994, 2003); deposits may be inset by outwash terraces of Ikhillik II (Qgfi2) age (Hamilton, 1978)

Sagavanirktok River Glaciation

Qgds / **(Qgds)** DRIFT OF SAGAVANIRKTOK RIVER GLACIATION, UNDIFFERENTIATED (?50–125 ka, Middle Pleistocene; Hamilton, 1994, 2003)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand, containing abundant rounded to subangular clasts that may be striated and polyhedral; locally includes moderately-well-sorted sand and gravel; includes drift younger than Anaktuvuk River drift (Qgda) but older than Ikhillik drift (Qgdi) that cannot be related to a specific Sagavanirktok advance; vegetation is typically tussock tundra (Hamilton, 2003)

Qgds2 / **(Qgds2)** DRIFT OF SAGAVANIRKTOK RIVER GLACIATION, LATE ADVANCE (Middle Pleistocene; Hamilton, 1994)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand, containing abundant rounded to subangular clasts that may be striated and polyhedral; locally includes moderately-well-sorted sand and gravel

Primary glacial morphology is widely recognizable with hummocky topography locally preserved; moraine crests are locally devoid of loess and generally less modified by solifluction than older Sagavanirktok deposits (Qgds1) (Hamilton, 1978, 2003); kettle lakes are more common than on older drift surfaces; stream channels through ice-rich sediments (silts) have beaded drainage patterns; sandstone-cobbles and boulders of Kanayut Formation may protrude as much as 1 m above the surface (Hamilton, 1978, 2003; Krieg and Reger, 1982)

Qgdi3 DRIFT OF SAGAVANIRKTOK RIVER GLACIATION, EARLY ADVANCE (Middle Pleistocene; Hamilton, 1994)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand, comprises abundant rounded to subangular clasts that may be striated and polyhedral; locally includes moderately-well-sorted sand and gravel

Drift surfaces are ~15–20 m above modern floodplains and are oxidized to depths >8 m (Hamilton, 1994); deposits are characterized by generally continuous, completely vegetated, smooth, broad moraine crests ~100–200 m wide with slope angles of ~2.5–3.0 degrees (Hamilton, 1978, 1994); organic-rich loess and silt, ≤5 m thick cover morainal crests and upper slopes with sandstone cobbles and boulders of Kanayut Formation locally protruding ≥1 m (Hamilton, 1978, 2003; Krieg and Reger, 1982); surfaces are generally modified by colluvial processes with depressions and lower slopes having thick loess accumulations, retransported by gelifluction; kettle lakes uncommon (Hamilton, 2003)

Primary glacial morphology is widely recognizable, but hummocky topography is rarely preserved; stream channels through ice-rich sediments (silts) have beaded drainage patterns; small thaw ponds have developed in some low areas as a result of thermal erosion of permafrost; compound thaw lakes, patterned ground, and secondary drainage development are common

Vegetation is typically well-established cottongrass tussocks with some willow and abundant moss (Hamilton, 2003; Pinney, 2000)

Anaktuvuk River Glaciation

Qgda / **(Qgda)** DRIFT OF ANAKTUVUK RIVER GLACIATION (Early Pleistocene; Hamilton, 1994, 2003)—Poorly-sorted, nonstratified boulder- and pebble-cobble gravel with a matrix of silt and sand; comprises abundant rounded to subangular clasts that may be striated and polyhedral; deposits consist of discontinuous, broad moraine crests with gently flanking slopes of <2 degrees (Hamilton, 1994); surfaces may be oxidized to depths >30 m and are continuously covered by organic silt that may be >15 m thick with only a few widely-scattered, highly-weathered cobbles and boulders of the Kanayut Formation protruding (Hamilton, 1978, 1994)

Gelifluction deposits are extensive, and generally obscure primary glacial morphology; deposits are dissected by well-integrated major and minor stream systems and are generally found >50 m above modern stream floodplains of major streams (Hamilton, 1978); fens, strangmoor, boggy areas, thaw lakes, and drained thaw-lake basins filled with loess and slopewash deposits are common; in upland areas, patchy deposits on bedrock often form hills with morphology distinctly different than the general east–west bedrock structures in the region

GLACIOFLUVIAL DEPOSITS

Qgfi UNDIFFERENTIATED OUTWASH OF IKHILLIK GLACIATION—Moderately- to well-sorted, clast-supported, massive to weakly stratified, polymictic, sandy, pebble-cobble gravel with rounded to subangular clasts, deposited by glacial meltwater streams of Ikhillik age; includes locally-derived materials as well as clasts transported from sources in the Brooks Range; forms continuous to discontinuous terraces ~5–25 m above modern streams, and valley-bottom deposits with underfit streams; deposits can be traced upvalley to moraine fronts of Ikhillik age; QaS drainage systems dissect surfaces of Sagavanirktok age; deposits commonly contain small, rounded kettle lakes and may be blanketed by a thin veneer of ice-rich silt (Hamilton, 1978; Pinney, 2000); Ikhillik outwash deposits are common along the Sagavanirktok River and in tributary valleys to the east, but are much less extensive in the Toolik River drainage

Qgfi2 OUTWASH OF IKHILLIK PHASE II GLACIATION—Polymictic sandy pebble-cobble gravel, as described above, that forms generally continuous terrace surfaces ~5–15 m above the level of modern streams (Hamilton, 1978); deposits can be traced upvalley to Ikhillik Phase II moraines (Qgdi2); surfaces have a thin (≤0.3 m) loess cover and are only slightly modified by colluvial processes

Qgfi1 OUTWASH OF IKHILLIK PHASE I GLACIATION—Polymictic sandy pebble-cobble gravel, as described above, that forms discontinuous surfaces ~15–25 m above modern streams and can be traced upvalley to older Ikhillik Phase I moraines (Hamilton, 1978); surfaces are covered by a thin (~0.1–3 m) blanket of ice-rich silt and may be slightly modified by colluvial processes; terraces are commonly inset into older outwash or drift deposits and may be dissected by younger Ikhillik outwash (Qgfi2) or modern streams (Qas, Qai)

Qgfs OUTWASH OF SAGAVANIRKTOK GLACIATION—Moderately- to well-sorted, clast-supported, massive to weakly stratified, polymictic sandy pebble-cobble gravel with rounded to subangular clasts, deposited by meltwater streams of Sagavanirktok age; gravels include locally derived materials as well as clasts transported from sources in the Brooks Range; deposits are typically irregular, highly dissected, discontinuous terrace surfaces extensively modified by solifluction and thermokarst processes; surfaces are ~8–20 m above modern stream bottoms, and are commonly blanketed by ~1–3 m of ice-rich silt with numerous closed, kettle-like basins containing thaw lakes (Hamilton, 1986, 1994); deposits are oxidized to a depth of ~1.5 m (Hamilton, 1986)

OTHER DEPOSITS

Qhf ARTIFICIAL FILL—Mixed coarse and fine material emplaced by human activity during land development; airstrips and areas along the trans-Alaska oil pipeline consist of fill material, much of which is locally derived

BEDROCK DEPOSITS

b UNDIFFERENTIATED BEDROCK—Outcrops of sedimentary rock with essentially no cover; ridges generally trend east–west parallel to local geologic structure

b' THINLY-COVERED BEDROCK—Subcrops <0.9 m covered with a thin veneer of unconsolidated material; bedrock structure commonly visible

EXPLANATION OF MAP SYMBOLS

ERRATIC BOULDERS—Boulders and cobbles consisting of rock types foreign to the areas where found; protrude from surface of unconsolidated deposits; may or may not be associated with recognizable drift but provide evidence for former glacial extents

- Erratic boulder that protrudes 0–20 cm above the surface
- Erratic boulder that protrudes 21–40 cm above the surface
- Erratic boulder that protrudes 41–60 cm above the surface
- Erratic boulder that protrudes 61–80 cm above the surface
- Erratic boulder that protrudes 81–100 cm above the surface
- Erratic boulder that protrudes more than 101 cm above the surface

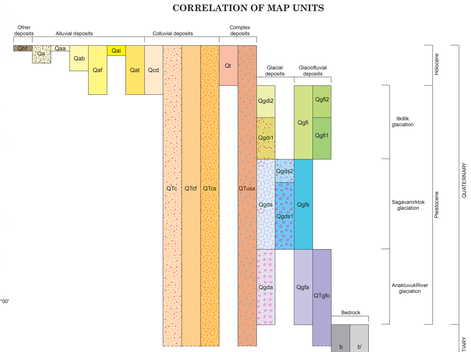
PINGOS—Conical-shaped, ice-cored hills; some may be closed-system pingos, which result from expulsion of pore water beneath the freezing bottoms of drained thaw lakes (French, 2007); generally found in northern map area in ice-rich silt or thaw-lake basin deposits

PHOTOINTERPRETED CONTACT—All boundaries are inferred or approximately located

MORAINE CRESTS—Crests of end and lateral moraines of glacial deposits; identified from imagery and field observation

FIELD STATION LOCALITY

CORRELATION OF MAP UNITS



ACKNOWLEDGMENTS

The author gratefully acknowledges Bob Gillis, Marwan Wartes, and Dave LePain from the Alaska Division of Geological & Geophysical Surveys (DGGS) Energy Section, and Paul Decker from the Alaska Division of Oil and Gas, who provided field support and engaged in useful discussions about North Slope geology. Many thanks to De Anne Stevens and Tom Hamilton for their time in the field helping to educate me about Quaternary geology of the region; Andrea Loveland of the DGGS Energy Section, who provided digital data and answered GIS questions during map preparation; and Tom Hamilton and Dick Reger, who reviewed the map. Completion of the map was made possible by funding from a variety of sources, including operating and capital improvement project funds from the State of Alaska (Division of Geological & Geophysical Surveys and Division of Oil & Gas), and the National Cooperative Geologic Mapping Program's STATEMAP program, administered by the U.S. Geological Survey (award 08HQAG0051).

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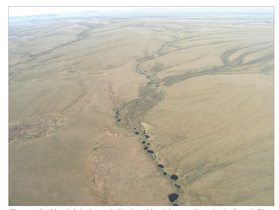
View south of beaded drainage, indicative of ice-rich permafrost, in Anaktuvuk River drift, south-central Sagavanirktok B-4 Quadrangle (photograph taken 7/03/2008 by T.D. Hubbard)

View southeast across Sagavanirktok River, showing active retrogressive thaw slump on eastern bank, west-central Sagavanirktok B-3 Quadrangle (photograph taken 6/20/2008 by T.D. Hubbard).

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Topographic base map from:
U.S. Geological Survey topographic maps
Sagavanirktok A-3 (1971 - minor revisions 1975)
Sagavanirktok A-4 (1971 - minor revisions 1975)
Sagavanirktok A-5 (1971)
Sagavanirktok B-3 (1971 - minor revisions 1975)
Sagavanirktok B-4 (1971)
Sagavanirktok B-5 (1971)
Projection:
Universal Transverse Mercator Zone 6 North
Datum:
North American Datum of 1927

Interpreted field verification by:
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Geologic interpretation by:
T.D. Hubbard[1] (2008-2012)
Airphoto interpretation by:
T.D. Hubbard[1] (2012)
Geologic-GIS data layers created by:
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