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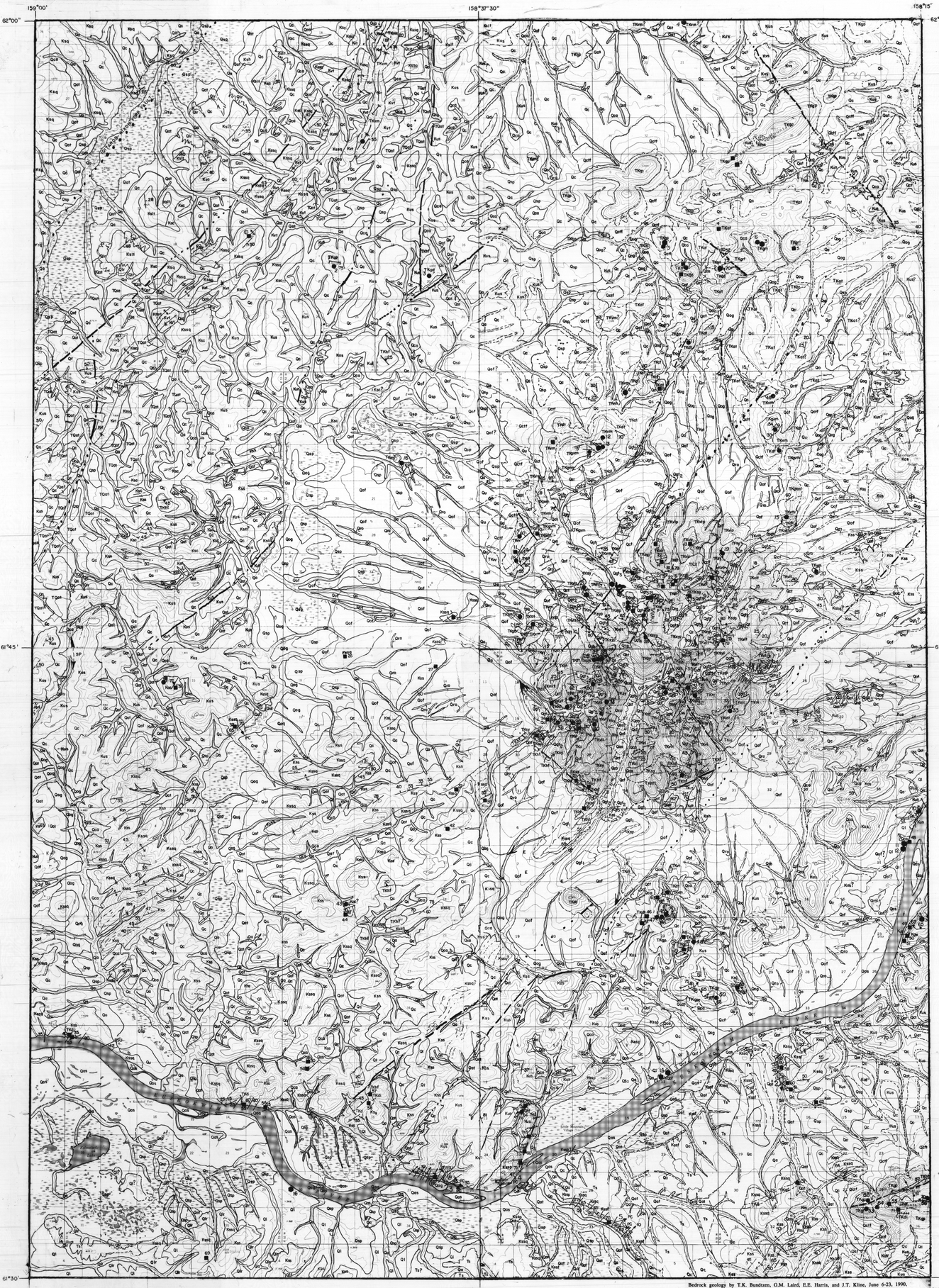

Bedrock geology by T.K. Bundtzen, G.M. Laird, R.E. Harris, and J.T. Kline, June 6-23, 1990, June 11-26, 1991, and June 14-19, 1992; and by M.L. Miller, June 14-19, 1992. Quaternary and photo-geology by T.K. Bundtzen, 1992-1993.

GEOLOGIC MAP OF THE SLEETMUTE C-7, C-8, D-7 AND D-8 QUADRANGLES, HORN MOUNTAINS AREA, SOUTHWEST ALASKA

By

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CORRELATION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Alluvial Deposits: Qa, Qag, Qas, Qat, Qaf, Qatf, TQat, Ts

Glaciogenic Deposits: Qgfa, Qg?, Qgfp, Qgt, Qag, Qaf, Qra, Qrg

Eluvial and Colluvial Deposits: Q1, Qct, Qca, Qc, Qlr, Qsp, Ql

Placer Tailings: Qht

QUATERNARY — Holocene; Pleistocene; TERTIARY — Pliocene

SEDIMENTARY AND VOLCANIC ROCKS

Kvm, Kac, Kvt, TKth, TKvlt, TKg, TKvi, TKkp, TKpvm, TKsm, TKgvm, TKvv, TKnt, TKst, TKgr

INTRUSIVE ROCKS AND HORNFELS

TKhf, TKgp, TKsy, TKsyp, TKgr, TKgb, TKd, TKqd

CRETACEOUS — Late; Late Cretaceous; Early or Late Cretaceous

Ksc, Kssf, Ksq, Ksaq, Kus, Kss, Kslt

MAP SYMBOLS

- Contact--approximately located
- High-angle fault--Dashed where inferred; dotted where uncertain. U, upthrown side; D, downthrown side. Arrows show direction of movement.
- Anticline, showing trace of axial plane and direction of plunge; dashed where inferred or concealed; dotted where questionable.
- Syncline, showing trace of axial plane and direction of plunge; dashed where inferred or concealed; dotted where questionable.
- Strike and Dip of Beds: Inclined; Vertical; Overturned
- Strike and Dip of Cleavage: Inclined; Vertical
- Strike and Dip of Joints: Inclined; Vertical
- Fossil Locality (from Cady and others, 1955)
- Bearing of Paleocurrent (corrected for tilt; table 1)
- Major Oxide and Trace Element Chemical Analyses (tables 2 and 3)
- 40Ar-39Ar, K-Ar, and C14-C13 Age Localities (tables 4, 5, and 6)
- Geochemical Sample Locality (table 7)

DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Qs--Sandy, Flood-Plain Alluvium Unconsolidated, well stratified, gray to slightly tan weathered, fine to coarse grained, pebble rich, sand, silty sand, and silt deposited by modern streams in Holocene stream valleys. Some coarser grained alluvium found in Holokuk River drainage. Finer grained alluvium dominant in Iditarod and Kolmokof Rivers and tributaries. Edges of unit frequently covered by sphagnum moss, and thickets of willow (Salix sp.), alder (Almus sp.), and cottonwood (Populus balsamifera). Unit generally thawed due to thermal upgrading (base bulb) of active streams. Unit ranges in thickness from 3-10 meters, based on depth to bedrock in Horn Mountains and along Holokuk River.

Qag--Coarse Grained Gravel-Rich Alluvium Unconsolidated, moderately to well stratified, silt, medium to coarse grained pebbly sand, and gravel deposited by modern streams in Horn Mountains and as upper ends of point bars along Kuskokwim River. Gravel-rich deposits in Horn Mountains consist of clasts of volcanic and plutonic rocks reaching 0.5 meters in diameter. Deposits in nonglaciated lowlands and along Kuskokwim River contain sedimentary, metamorphic and igneous clasts derived from local sources and from as far away as the Alaska Range. Only deposits in active channel of Kuskokwim River shown on sheet 1. Deposits range from 1 to 20 meters thick with thickest sections based on dredging point bars near Aniak west of study area. Unit almost always thawed.

Qas--Flood plain Alluvium With Extensive Overbank Deposits Alluvium composed of interbedded, dark brown to gray, organic rich, fine grained, micaceous sand to silty sand ranging from 1 to 10 meters thick that frequently overlies sandy flood plain alluvium; overbank deposits represent flood cycles consisting of aggradational successions of rhythmically bedded silt. Each layer ranges from 0.2 to 0.5 meters thick and is usually capped by vegetation mattes. Unit forms broad, interchannel areas on the flood plain of Kuskokwim River. Unit is usually thawed due to proximity to thaw bulb of Kuskokwim River.

Qvp--Silt and Peat. Poorly stratified, black to brown, organic rich alluvial, lacustrine or bog silt and peat. In Getmuna Creek and the upper Kolmokof River drainage, unit contains multiply stacked palzas composed of well stratified peat layers 2 centimeters to 3 meters thick interwoven with gravel or silt lenses. Bog silt and peat generally mantled with tussocks, grasses sedges, and sphagnum in low wetlands, and lichen and sedges in alpine settings. C-14 age determinations of peat range from 1,900 years BP to >39,600 years BP for peat development in study area (table 6); most aerially extensive and thickest (up to 5 meters) deposits found in Iditarod and Kolmokof River drainages. Unit is usually frozen.

Ql--Eolian Loess Moderately well stratified, gray to tan weathered, highly micaceous eolian silt and minor fine grained sand. Forms extensive, deposits blanketing lowlands and broad ridges south of Kuskokwim River west of Napaimuit, and thin discontinuous sheets on hills east of Kolmokof River. Minor loess deposited southeast of Horn Mountains. C-14 determinations from extensive loess blanket near Napaimuit is 16,640 years BP; other loess deposits upstream from Holokuk River mouth range from 11,700 to 26,446 years BP, or late Wisconsin in age (table 6). Bulk of loess probably deposited by winds blowing off the Aniak outwash fan west of the study area; some loess may have been derived from glacial outwash trains radiating Horn Mountains massif.

Qlr--Reworked Loess Eolian loess and fine grained sand reworked by water in gullies and along lower slopes in southern part of study area downslope from Ql deposits.

Qcf--Fan and Terrace Deposits Composite unit containing poorly sorted, partially stratified silt, sand, gravel, and colluvium that form broad, coalescing colluvial-alluvial fans and buried ancestral terrace deposits. May include alluvial aprons near stream cuts. Maximum thickness of 20 meters near Aghaluk Mountain and north of Getmuna Creek. North facing exposures are generally frozen.

Qc--Undifferentiated Colluvial Deposits Mixed alluvial, eolian, and colluvial deposits that include bedrock-derived talus at toes of hillslopes and alluvium near stream cuts. Can be transitional to Qcf unit. Locally ranges from 2 to 5 meters thick. Generally frozen.

Qaf--Allavial Fan Deposits Generally poorly sorted, partially stratified sand and coarse grained gravel deposits as fans or cones where secondary second and third order streams enter floors of valleys with order trunk streams. Restricted to mature unglaciated terranes; can be transitional to Qca fan units of Horn Mountains. Thought to be pre-Late Wisconsin in age and usually frozen.

Qca--Colluvial Alluvial Fan Deposits Poorly to moderately sorted silt, sand, gravel, and diamicton, much of the latter of glacial origin. Commonly forms alternating stratified and unstratified zones and lenses in gullies and steep, intermittent or ephemeral, tributary streams. Colluvial-alluvial fans most active in streams active during spring runoff.

Qat--Youthful Terrace Alluvium Moderately to well sorted, gray to light tan weathered, well-stratified, sand and gravel weakly cemensed by iron oxides. Unit is 3 to 12 meters thick above active river flood plains and probably includes stripped strathe terraces in Kolmokof and Iditarod River drainages. Surfaces are usually covered with climax vegetation, dissected by Holocene streams, and mantled by eolian silt. No absolute age control is available, but unit may be equivalent to Middle Pleistocene deposits in interior Alaska (Pe'we, 1975), in the Beaver Mountains (Kline and Bundtzen, 1986), and in the Iditarod mining district (Bundtzen and others, 1992).

TQat--Older Terrace Alluvium Moderately to well sorted, well stratified sand and gravel, extensively cemented by iron oxides to a significantly larger degree than Qat deposits. Unit is 10 to 20 meters above active flood plains of present stream drainages, and probably includes strathe terraces largely stripped of sediments. Unit is ubiquitously covered by climax vegetation, which overlies eolian silt and ice-rich, poorly drained soils. Like many Quaternary deposits, absolute age control is not available, and conventional thinking would place the age of ancestral terrace alluvium as exclusively Quaternary in age. However, older terrace alluvium may be as old as late Tertiary, based on radiometric age dating of similar deposits in the Fairbanken district of the Seward Peninsula (Hopkins and others,1971), and the Livengood district north of Fairbanks (Karl and others,1988). TQat in headwaters of Iditarod River is probably ancestral outwash from Russian Mountains now captured by Sister Creek drainage. A similar stream capture north of Jungjuk Creek isolated high level TQat deposits. Unit in study area averages 5 meters thick, based on exposures in Iditarod River.

Qog--Ounwash Gravel Poorly consolidated, well stratified, sand and gravel deposited distally from glacial sources in the Horn Mountains. May include patches of Pleistocene till. Unit could range in age from Early to Late Pleistocene, but most depicted in Getmuna and Sue Creek drainages is probably Late Wisconsin in age. Unit ranges from 1 to 5 meters thick. Some coarse, boulder-rich gravels present in Jungjuk Creek area.

Qof--Outwash Fan Deposits Poorly consolidated, moderately well stratified, sand and gravel deposited as several large fans radially distributed around Horn Mountains massif. Sediments are derived from ice-marginal meltwater features proximal to Pleistocene glaciers in the Horn Mountains of several ages. Most Qof deposits in study area probably formed during Pre-Wisconsin and Early Wisconsin time and predate Qog deposits, which partially recycled outwash fan deposits. Qof deposits east of Sue Creek are ancestral to modern stream direction and may be of Early Pleistocene age. Volcanic ash interbedded with outwash gravel from this oldest unit near Sue Creek yields tentative Ar-40/Ar-39 age of 1.5 MA, which also suggests Early Pleistocene age. Unit reaches 25 meters in thickness as measured on stream cuts on west side of Horn Mountains.

Qro--Reworked Outwash Well sorted, unconsolidated, well stratified sand and gravel reworked from Qog and Qof deposits. Frequently discontinuous and found in intermittent stream drainages. Estimated 1 to 3 meters thick. Generally thawed.

Qrg--Rock Glacier Deposits Tongue-shaped masses of unsorted, angular, frost-shattered boulders and cobbles locally reaching 2 meters in diameter. Most rock glaciers in study area are believed to be inactive; however, some uncommon protalus rampart forms in Whitewing valley may be active.

Glacial Till Unsorted to poorly sorted diamicton composed of clay, silt, sand gravel, and talus deposited by glacial ice. Till divided into four units that correspond to glacial chronology delineated in Kuskokwim Mountains by Bundtzen (1980), Kline and Bundtzen (1986), and Bundtzen and Laird (1991): Qgt4-largely unmodified till of Crater Mountain Glaciation of early Holocene age; confined to northerly cirques; Qgt3-till from Tolstoi Lake Glaciation of late Wisconsin age; C-14 age of 13,600 years BP determined for Qgt3 till on Getmuna Creek (table 6), and mainly consisting of undissected moraines in northerly valleys and cirques in southern facing valleys; Qgt2-till from Bifurcation Creek Glaciation of early Wisconsin age; consists of dissected moraine and modified land forms in all valleys of Horn Mountains; Qgt1-till of Beaver Creek Glaciation; highly modified diamicton on planated summit levels beyond limits of Horn Mountains and erratic boulder trains; morainal morphology destroyed by erosion.

Qct--Coarse Collavium Unsorted, coarse-grained talus and mixed regolith along steep slopes in Horn Mountains. Can be transitional to talus cones.

Qt--Talus Cones Angular fragments of frost-riven bedrock talus transported downslope by gravity and deposited as aprons or fans at toes of slopes. Distal zones of talus cones or aprons may grade unto protalus ramparts and rock glaciers.

Qht--Placer Mine Tailings Irregular stacked piles of water-washed gravel and insitu bedrock slabs confined to New York Creek drainage. Originally stream alluvium and slope colluvium artificially processed to recover placer gold and other heavy minerals.

Ts--Holokuk Gravel High level gravel terrace exposed along lower Holokuk River valley consists of slightly consolidated, well sorted, iron oxide coated, coarse grained pebble sandstone and pebble to cobble rich gravels. Clasts composed of igneous rocks--namely granitic and volcanic rocks probably derived from mountainous area south of study area. Source also indicated by northerly dominated imbricate pebble orientations in three localities. Gravel may be inclined as much as 5 degrees; forms classic fluvial terrace erosional pattern. Age is not known, but gravel is situated nearly 100 meters above Holokuk River floodplains, and iron rich alteration is similiar to other Late Tertiary aged fluvial deposits in interior Alaska.

INTRUSIVE ROCKS AND HORNFELS

TKsy--Granodiorite, locally Granite and Quartz Syenite Light gray to greenish gray (altered), fine to medium grained, equigranular to hypidiomorphic, orthoclase rich, biotite bearing granodiorite, locally granite, and uncommonly quartz syenite. In a few thin sections original clinopyroxene (about 2% maximum of groundmass) always altered to magnetite, chlorite, and leucoxene. Quartz averages 25 to 28% of groundmass and average plagioclase composition determined to be An 27-29 or oligoclase-andesine (twinning method). Average differentiation index (DI) is 75.9 (table 2); color index (CI) is about 8-10. High level portions of TKsy in Jungjuk Creek drainage flooded with tourmaline probably related to hydrothermal breccias. Resistant and forms core of Horn Mountains massif.

TKsyp--Granodiorite Porphyry, Quartz Syenite, and Minor Granite Porphyry Brownish gray, greenish altered, fine grained to porphyro-aphanitic, tourmaline bearing, biotite, muscovite granodiorite porphyry, locally quartz syenite and granite and rarely quartz monzonite. Averages about 22% quartz or about 5% less than TKsy unit- the other phase of Horn Mountains pluton. Average differentiation index (DI) is 71.6 (table 2), and average plagioclase composition is An33 or andesine. Color index (CI) is 10 to 12. Original clinopyroxene (up to 4% of groundmass) is altered to magnetite, and chlorite. In some thin sections, tourmaline (dravite) grains are overprinted by plagioclase and biotite, which suggests primary igneous crystallization similar to that reported for ferroaxinite in Russian Mountains pluton west of study area (Hietanen and Erd, 1978; Bundtzen and Laird, 1991). Resistant and with TKsy unit, forms Horn Mountains massif. Ar40-Ar39 age on biotite of 68.90 Ma (table 4).

TKgp--Peraluminous Granite Porphyry and Alkali Quartz Granite Light gray to distinctly tan weathered, usually bleached, aphanitic to porphyro-aphanitic, locally garnet bearing, biotite, muscovite granite porphyry, locally alaskite. Generally restricted to large dike swarms, and linear hybahyssal bodies. Largest is Juniggaira Mountain complex, which is 12 km long and 4 km wide. Unlike TKsy and TKsyp units, TKgp does not produce hornfels aureole in enclosing Kuskokwim Group flysch. Always contains normative corundum (table 2) and frequently modal garnet, and is peraluminous. Average differentiation index is 91.54, and average plagioclase composition (An 11) is albite (table 2). Color index is 5 or less. Ar40-Ar39 age of 68.72 Ma from Juniggaira Mountain complex (table 4) and K40-Ar40 age of 71.98 Ma from small stock north of Aghaluk Mountain (table 5). Forms moderately resistant hillslopes covered with distinct tan rubble.

TKgd--Quartz Monzodiorite and Diabase Medium gray to olive tan, aphanitic to fine grained, locally hyalophitic, diopside, biotite quartz monzodiorite and diabase. Restricted to small plutons northwest of Getmuna and Little Creeks and large dike swarm north of Aghaluk Mountain. Peculiar to these rocks are interlocking diopside and plagioclase in hyalophitic or ophitic textures. Differentiation index ranges from 46.72 to 72.04 and average plagioclase composition (An48) is labradorite (table 2). Color index is15 to 20. Moderately resistant.

TKgr--Granite Light gray, tan weathered, fine to medium grained, equigranular to hypidiomorphic, biotite, muscovite granite; probably a coarser grained version of TKgp unit on Aghaluk Mountain. Average differentiation index is 90.40 (table 2), and plagioclase (An13) is albite. Color index (CI) is 5 to 8. Forms resistant core of Aghaluk Mountain.

TKd;TKdi--Dikes and Dike Swarms Intermediate (TKdi) and undifferentiated (TKd) dikes and dike swarms, all of which are extensively altered to secondary minerals. Most original TKd dikes are believed to have originally been mafic or picritic in composition, now altered to silica, carbonate, chlorite, and magnetite. Original dikes rarely more than 4 meters wide and one kilometer in length.

TKgb--Gabbro and Quartz Diorite Dark gray, fine grained phaneritic, equigranular, clinoproxene-rich biotite bearing gabbro and quartz diorite; restricted to a small plug south of Horn Mountains. Contains abundant euhedral labradorite phenocryts (An53) near contact zones.

TKhf--Hornfels Brown to gray, massive to locally porphroblastic, chlorite, biotite, tourmaline, axinite hornfels. Dark massive varieties difficult to distinguish from fine grained volcanic rocks. TKhf forms one kilometer wide, southern boundary zone of Horn Mountains massif, and peculiar, isolated knobs in three localities within Kolmokof River drainage, the latter localities almost certainly indicating buried intrusions. Volcanics in Horn Mountains are also thermally altered by the intrusive rocks, but not shown as hornfels on sheet 1.

VOLCANIC AND SEDIMENTARY ROCKS

Horn Mountains Volcanic Field

TKvlt--Rhyolite and Latite Tuff Light greenish gray to nearly white, very fine grained to fine grained, platey, crystal lithic, air-fall tuff. Occurs as distinct graded sequences with each layer 10 to 20 cm thick; interupted by two thin augite-bearing trachyte flows. Plagioclase (An32) is andesine; average differentiation index (DI) is 72.82 (table 2). Unit is estimated to be 10 to 15 meters thick south of Getmuna Creek. Represents stratigraphically highest volcanic unit in Horn Mountains volcanic field. Forms nonresistant talus slopes.

TKvi--Latite and Potassic Andesite Tuffs and Flows Medium green-gray, very fine grained, locally porphyritic; biotite rich latite and high-K andesite flows and subordinate amounts of light greenish gray platey weathered crystal lithic tuff, and rare tuffaceous sandstone. Plagioclase grains are oligoclase-andesine in composition (An29), and differentiation index (DI) is 72.25 (table 2). Ar40-Ar39 whole rock age of 68.09 Ma, the stratigraphically youngest dated volcanic rock from Horn Mountains volcanic field, and at least 1.32 Ma younger than oldest date in Horn Mountains volcanic field (TKst unit). Estimated to be 40 meters thick west of Whitewing Creek. Forms resistant ridgelines and hillslopes.

TKs--Nonporphyritic Andesite Flows Dark greenish gray, nonporphyritic, augite bearing andesite flows believed to be laterally equivalent to TKvti unit. Average plagioclase composition (An43) is labradorite; average differentiation index (DI) is 59.40 (table 2). Estimated to consist of two flow units totaling 20 meters in thickness; forms resistant hillslopes and ridges.

TKvi--Latite and Potassic Andesite Flows Porphyritic, medium gray, fine grained oligoclase-andesine rich, clinopyroxene, biotite, high-K andesite and latite flows with distinctive columnar joints. Nine major flows recognized west of Whitewing Creek. Individual flows range from 5 to 15 meters thick; minor interbedded tuff units separate some flows. Total TKvi unit estimated to be 200 meters thick, and it forms one of the dominant units in Horn Mountains volcanic field. Average differentiation index (DI) is 71.21 for flows (table 2). Forms resistant cliff faces in cirque headwalls.

TKvip--Highly porphyritic andesite flows and Subordinate Tuff Highly porphyritic, medium gray, porphro-aphanitic, oligoclase-andesine rich clinopyroxene bearing, andesite, and subordinate medium greenish gray air-fall tuffs. May be laterally equivalent to TKvi unit. Estimated to be 100 meters thick north of Jungjuk Creek; forms resistant slopes.

TKpvm--Porphyritic Basaltic Andesite Medium to dark gray, locally maroon, porphyritic with labradorite phenocrysts, clinopyroxene rich (15% of groundmass) basaltic andesite and minor agglomerate. Labradorite phenocrysts to 2 cm in long dimension comprise up to 30% of groundmass in many samples. Columnar jointed flows estimated to be about 50 meters in total thickness. Forms resistant knobs north of Horn Mountains.

TKvm Basaltic Andesite Flows Medium to dark green-gray, maroon or sooty locally, aphanitic to fine grained, clinopyroxene rich (15-20% in groundmass), basaltic andesite; locally containing labradorite-bytownite phenocrysts. Well developed columnar jointing exhibited in a series of six or seven individual flows; total unit thickness is at least 100 meters. Average differentiation index (DI) is 44.40 (table 2). Ar40-Ar39 whole rock ages of 69.52 and 68.93 Ma (table 4). Forms resistant knobs and elongate ridgelines north of Horn Mountains.

TKgvm--Geode Rich Basaltic Andesite and Agglomerate Dark green-gray, maroon, clinopyroxene rich basaltic andesite with conspicuous chalcedonic, agate-grade geodes up to 20 cm in diameter; also contains lapilli tuff and agglomerate with elliptical bombs and fragmental volcanic clasts up to 0.5 meters in diameter. Average differentiation index is 57.11; plagioclase is labradorite (table 2). Estimated to be 20 meters thick. Forms semi-resistant knobs north of Horn Mountains.

TKvv--Vitreous Andesite Flows Dark brown to dark gray, fine grained, vitreous andesite containing broken crystals of plagioclase (An 36), pale-green pyroxene, and rounded biotite flakes in a devitrified glassy matrix. Differentiation index (DI) from one flow is 68.97 (table 2). Estimated to be 10 to 15 meters thick west of upper Getmuna Creek; forms nonresistant hogbacks and rubble on rounded slopes.

TKdt--High-K Andesite and Latite Tuff Light to medium green-gray, ubiquitously altered, fine grained crystal lithic tuff, vitric tuff, and minor altered andesite flows. May include minor welded tuffs near base of unit. Some latitic vitric ash composed of cellular pumice, devitrified glass, and broken fragments of plagioclase and hypersene(?). Where fresh plagioclase determined to be andesine (An31). Differentiation index (DI) from six samples is 73.20 (table 2). Estimated to be 35 to 50 meters thick; forms semi-resistant slopes and hogbacks.

TKst--Welded (?) Vitric Tuff Light gray, locally hematitically stained, fine to medium grained, quartz saturated, biotite rich, muscovite bearing, vitric, welded (?) tuff. Broken phenocrysts of quartz, sanadine, and sedimentary rock clasts appear to float in a matrix of devitrified glass shards, and undetermined dust in a classic vitroclastic texture. Forms the base of Horn Mountains volcanic field. The unit markedly thins to the southwest, where grain size also decreases, suggesting that the eruptive center for the vitric tuff was north of the Horn Mountains. One sample yields differentiation index (DI) of 62.06 (table 2). Ar40-Ar39 ages on biotite of 70.12 and 70.78 Ma (table 2) represent the oldest igneous crystallization ages obtained from Horn Mountains volcanic field. Estimated to be 150 to 200 meters thick south of Juniggaira Mountain. Generally nonresistant and forms eroded hogbacks and flat upland terrain.

TKgrt--Coarse Grained Vitric Tuff Light gray, yellowish tan weathered, fluggy, coarse grained, muscovite bearing, biotite rich, quartz saturated, vitric tuffs and pyroclastic breccias, the latter of which contains sedimentary clasts up to 30cm in long dimension. Contains devitrified glass (?), and broken quartz grains in a vitroclastic texture. TKgrt represents a coarse grained variant of the TKst unit, and possibly formed proximal to a vent system. Differentiation index (DI) of one sample is 85.23 (table 2). Unit thickness is unknown. Unit is more resistant than TKst, and forms more massive outcrops.

Iditarod Volcanics

Kvm--Basaltic Andesite Dark maroon to gray, fine grained, clinopyroxene, labradorite-rich, basaltic andesite flows and minor agglomerate. Plagioclase grains (An51) occur in a fine grained matrix of clinopyroxene and undetermined feldspar and opaque minerals. Kvm unit is part of Iditarod Volcanics as described by Miller and Bundtzen, 1988;1993), and is compositionally similiar to TKvm, TKpvm, and TKgvm units in Horn Mountains volcanic field. Unit is estimated to be 20 to 30 meters thick. Forms moderately resistant hogback ridges.

Kvt Altered Intermediate Tuffs and Flows and Sandstone Heterogeneous, light tan to iron red, aphanitic to fine grained, altered andesite, dacite, and lithic tuff interbedded with quartzose, sublithic sandstone near unit base. Groundmass of most volcanic samples altered to silica (tridymite), carbonate, and chlorite; pseudomorphs of clinopyroxene found in andesitic rocks. Estimated to be about 100 meters thick. Forms nonresistant, rounded and subdued ridge rubble. Correlated with base of Iditarod Volcanics as defined by Miller and Bundtzen (1988) and mapped near Moore Creek in central Iditarod Quadrangle by Bundtzen and others (1988), where K40-Ar40 ages range from 75 to 77 Ma.

Kac--Agglomerate, Chert, Tuff, and Sandstone Medium to dark green agglomerate, chert, lapilli tuff, andesite breccia, and flow rock. Where recognizable, contains minor aniegurited olivine, orthopyroxene(?), and hornblende grains in altered groundmass. Two major oxide analyses indicate high-K andesite classification; with andesine-labradorite (An32- 43) and differentiation index (DI) of 63.71 and 60.63 respectively (table 2). Miller and Bundtzen (1993) report K40-Ar40 age of 77 Ma from Kac in Iditarod Quadrangle. Hence Kac may represent initial Iditarod Volcanics eruptive activity, and similiar in age to Kvt unit. Thickness of unit unknown due to isolated outcrop pattern; forms very resistant knobs and isolated hogback hills.

Kuskokwim Group

Ksq--Quartzose Sublithic Sandstone and Siliceous Shale Gray to light gray, fine to coarse grained, moderately well sorted, subangular to rounded, quartz-rich sandstone, pebble conglomerate, siliceous siltstone and shale. Sand layers lack graded sequences and contain crossbeds, coalified organic matter, and shell coquina, all of which are thought to indicate shallow water shoreline facies environmental conditions. Regional petrographic studies indicate mixed provenance of metamorphic, sedigenic, and volcaniclastic source areas. Estimated to be at least 200 meters thick in study area. Resistant as compared to all other Kuskokwim Group lithologies, and forms steep ridgeline terrain.

Ksaq--Fine Grained Sublithic Sandstone and Siltstone Light to dark gray, sometimes olive green, mostly fine to very fine grained, light, siliceous volcaniclastic, sublithic sandstone, and light gray, organic rich, leaf bearing siltstone. Invertebrate fossils rare or absent. Thought to be interbedded with Kvt unit of Iditarod Volcanics. Estimated to be about 150 meters thick in study area; similiar unit is 400 meters thick near Flat in Iditarod Quadrangle (Bundtzen and others, 1992). Generally nonresistant and forms rubble on rounded slopes.

Ksc--Coarse Sandstone and Pebble Conglomerate Gray to medium greenish gray, indurated, fine to coarse grained, volcaniclastic sandstone interbedded with pebble sandstone and pebble conglomerate. Some layers exhibit high calcium carbonate content; clast composition, based on three thin sections, is polycrystalline quartz (24%), mixed volcanic fragments--mainly intermediate composition (35%), chlorite (8%), white mica (5%), calcite (10%), shale ripups (15%), and other (2%). Bulk of Ksc formed by turbidity currents as exhibited by coarse Bouma Tabc intervals recognized in outcrop. Inoceramus sp. prisms found in samples indicate Cretaceous age. Unit estimated to range from 150 to 250 meters thick; wedge shaped in cross section. Moderately resistant as compared to other Kuskokwim Group lithologies.

Kslt--Limey Sandstone and Shale Heterogeneous unit of medium greenish gray, distinctly tan weathered, fine to coarse grained, limey sandstone and shale. Sandstone and siltstone exhibit flute casts, ripups, and Bouma Tbcde intervals indicative of turbidity current deposition. Sand-shale ratio is about 1:3. Equivalent to much of the basal portions of Kuskokwim Group described by Bundtzen and others (1992) and Miller and Bundtzen (1993). No thickness estimate available. Forms very nonresistant rubble-covered hillslopes and depressions.

Ksa--Noncalcareous Lithic Sandstone and Shale Light to medium gray, subangular to rounded, medium grained lithic sandstone and micaceous shale. Hand speciman and limited thin section examination show variable sedigenic, and metamorphic provenance for sands in Ksa unit. Graded Tabcd Bouma intervals and flutes suggest deposition by turbidity currents. No reliable thickness estimate available; repeated section on Kuskokwim River may be at least 500 meters thick. Generally nonresistant.

Kus--Undifferentiated Sandstone, Shale, and Siltstone Heterogeneous unit of generally gray to green gray, fine to medium grained, lithic sandstone and micaceous shale and siltstone. No petrology completed on this unit. Forms monotonous repeated section along Kuskokwim River and undifferentiated unit throughout study area. No specific thickness estimate available; repeated section along Kuskokwim River in eastern C-8 Quadrangle estimated to be 1,200 meters thick. Forms generally nonresistant upland rubble and moderately resistant bluffs along river banks.

Kssp--Coarse Grained, Proximal Turbidite Sandstone and Siltstone Medium gray, medium to coarse grained, lithic and sublithic sandstone, and minor siltstone. Flutes and graded Bouma Tab and Tabc intervals, coupled with sand-ratio ratio exceeding 10:1, suggest proximal turbidite depositional environment. In addition, death assemblege of Inoceramus sp. up to a meter thick found at Gibraltar Point fossil locality would indicate proximity to shoreline or shallow water capable of supporting fauna. Cady and others (1955) report Inoceramus athabaskensis and I. sahwii from this locality both regarded as Turonian stage or early Late Cretaceous age. Kssp unit is overturned; we estimate unit is 150 meters thick at this locality. Unit is moderately resistant.

Kssf--Quartzite Sandstone, Shale, and Slump Breccia Unusual section of light gray to nearly white, bleached, quartz-rich, sandstone interbedded with organic rich shale, bone coal, and fragments of plant rich beds each 10 to 20 cm thick. Large scale rotated blocks of quartzite sandstone up to 4 meters in diameter in upper part of the section might suggest marine foreslope environment, or channel slumping in a marine estuary. Sand-shale ratios vary from 1:1 in plant rich zones to up to 10:1 in massive channel (?) facies. Section is best exposed along Holokuk River about 4 kilometers above its mouth. Kssf section estimated to be about 600 meters thick; it is apparently enclosed on upper and lower limits by deeper water turbidite or shallow marine facies (Ksaq, Ksap) of Kuskokwim Group. Generally friable and nonresistant and forms eroded lowlands in lower Holokuk River valley.

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SCALE 1:63,360

1 0 1 2 3 4 MILES

0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET

DATUM MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 19[illegible]

ALASKA — STUDY AREA

QUADRANGLE LOCATION