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GEOLOGIC MAP OF MCGRATH A-3 QUADRANGLE, ALASKA

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INTRODUCTION

Gilbert Dillet
Introduction
7/10/85

This geological map is one of a series of reports summarizing resource investigations by the Alaska Division of Geological and Geophysical Surveys in the upper Kuskokwim region during 1977-1984. In addition to geologic maps (Gilbert, 1981; Bundtzen and others, 1982; Gilbert and others, 1982; Gilbert and Solie, 1983; Bundtzen and others, 1984 a-c; Gilbert and others, 198__; Kline and others, 1985), previous reports have discussed the area's intrusive and stratigraphic relationships (Potter and others, 1980; Solie and others, 1982; Blodgett and Gilbert, 1983; Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1983; Kline, 1983; Savage and others, 1983; Solie, 1983; Dickey, 1984; Gilbert and Bundtzen, 1984; Hahn and others, 1985), structure and tectonics (Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1983a), and economic resources (Solie and Dickey, 1982; Bundtzen and Gilbert, 1983; Bundtzen and others, 1984d). The McGrath A-3 Quadrangle contains rock units typical of the Cambrian to Devonian Dillinger sequence (Bundtzen and Gilbert, 1983; Bundtzen and others, 1984b), and displays the complex fold patterns and intrusive relationships characteristic of the southwestern Alaska Range.

QUATERNARY GEOLOGY

The morphology and surficial deposits of the McGrath A-3 Quadrangle are the result of multiple periods of glaciation followed by vigorous colluvial and fluvial activity characteristic of the western and central Alaska Range. Most glaciers occupy cirques located in and adjacent to major plutonic complexes and are in retreat following neoglaciation in mid to late Holocene time. Cirque base elevations where relict glaciers still exist are estimated to be between 4,800 and 5,200 ft. Glacier termini generally lie in a zone between 4,300 and 5,000 ft elevation with an average near 4,500 ft.

Ice-cored neoglacial moraines result from the last historic neoglacial advance (or 'little ice age') inferred to have taken place between 500 and 100 yr b.p. Climatic amelioration during the last 100 years has resulted in up to 1 mi of glacier retreat; with few exceptions this withdrawal is continuing at present. Earlier Holocene glacial advances are evidenced by moraines up to 2 mi down valley from cirques either presently occupied by glaciers or abandoned. Many cirques now contain only rock glaciers, most of which developed during late Holocene time.

Drifts of at least three major periods of glaciation are represented in the McGrath A-3 Quadrangle. At two locations in the northwest corner of the quadrangle the oldest known drift is indurated with calcareous cement forming tillites. Based on spatial relationships relative to younger drift in the area, the depth of weathering, occurrence of tillite, and lack of morainal surface morphology, this oldest drift is assigned a pre-Wisconsin age. Drifts representing both early and late Wisconsin glaciation occur in all major valleys and on the plateau in the northwest part of the quadrangle.

Copious sand and gravel deposits occur in all major drainages within the McGrath A-3 Quadrangle. Alluvial fans, floodplain alluvium, and outwash deposits constitute the best materials sources (table 1).

STRUCTURE

Terranes

Pre-Cenozoic rocks of the McGrath A-3 Quadrangle are part of the Dillinger terrane of Jones and others (1981, 1982) and the Dillinger-Mystic succession of Gilbert and Bundtzen (1984).

Folds

A low-grade dynamic metamorphic event deformed pre-Cenozoic rocks in the McGrath A-3 Quadrangle into a series of subisoclinal overturned folds from outcrop to nappe scale (F. of Gilbert and others, 1984). The largest such folds recognized in the quadrangle are the Middle Fork anticline (cross section A-A' and B-B') and North Fork anticline (cross section D-D') in the northwest and southwest parts of the quadrangle respectively (fig. 1). Other large isoclinal folds complexly repeat Paleozoic strata in the southern part of the quadrangle (cross sections C-C' and D-D'). Most major isoclinal folds verge west or northwest, but a reversal of isoclinal vergence is seen in the southeast part of the quadrangle (cross sections B-B' and C-C'), producing a series of subsidiary north-trending antiforms and synforms in the core of a double fold (cross section C-C') (fig. 1). A complementary reversal from northeast vergence to southwest vergence is mapped by Bundtzen and others (1984b) immediately to the east of the McGrath A-3 Quadrangle.

Faults

Local shears and thrust faults occur along bedding surfaces and within incompetent horizons parallel to axial surfaces of major subisoclinal folds; where mapped in the northwest part of the quadrangle they produce digitations on the upright limb of the Middle Fork anticline.

The most prominent high-angle fault in the McGrath A-3 Quadrangle is the Big River fault (and related splays), which diverges from the Farewell fault system approximately 4 km north of the quadrangle boundary, crosses the northwest part of the quadrangle, and can be traced south for approximately 30 km. This fault offsets late Quaternary deposits. Small drag folds, deflections in attitudes and the apparent bend of ridges adjacent to the fault suggest a component of right-lateral movement. Another high-angle fault in the western part of the quadrangle trends northwest for about 10 km and juxtaposes contrasting parts of the Middle Fork plutonic complex.

ECONOMIC GEOLOGY

The Farewell region of the Alaska Range contains a large number of mineral occurrences associated with Paleozoic strata or Cenozoic igneous complexes south of the Farewell fault. At present most economic interest is directed at areas northeast and south of the McGrath A-3 Quadrangle, but anomalous copper, cobalt, and nickle values occur in massive sulfide and mafic diabase (Tim) at the Chip Loy prospect in the western part of the quadrangle (table 3; Herreid, 1968). Geochemical data from the McGrath A-3 Quadrangle are reported by Bundtzen and others (1984d).

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DESCRIPTION OF MAP UNITS, A-3

QUATERNARY DEPOSITS

Qa STREAM ALLUVIUM UNDIFFERENTIATED - Fluvial silt, sand and gravel of floodplains, terraces, and fans. Size classification, degree of sorting and stratification vary according to the size, regime, and sources of bedload in streams which deposited sediments. Thickness varies from a few feet to several tens of feet.

Qaf ALLUVIAL FAN DEPOSITS - Poorly to moderately well sorted fluvial silt, sand and gravel occurring as deltoid fans where tributaries join higher order streams. Fan accumulations in mountain trunk valleys tend to be poorly sorted, and material size is coarse owing to steep stream gradient and drastic seasonal fluctuations in stream energy.

Qat ALLUVIAL TERRACE DEPOSITS - Fluvially derived silt, sand and gravel deposits of various ages occurring on cut/strath terraces or as fill terraces resulting from episodes of alternate downcutting and aggradation. In some places terrace alluvium may be mantled by appreciable thicknesses of colluvial silt as well as by a thick vegetation mat, especially where permafrost limits drainage. Older terrace deposits commonly contain highly weathered clasts and a high interstitial silt content and may not be suitable as materials sources (table 1).

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Qc COLLUVIUM UNDIFFERENTIATED - Usually unconsolidated and unsorted deposits (sorting may be inherited from sorted parent material) primarily derived from mass wasting processes, such as solifluction, creep mudflow, sheetwash, debris flow, debris and snow avalanche, and rockfall. Includes primary products of bedrock erosion as well as retransported surficial deposits. Colluvium is very widespread in the quadrangle but is mapped only where an appreciable thickness masks bedrock lithology and structure.

Qct TALUS - Angular bedrock derived from frost riving and rapid gravity transport on steep slopes, cirque headwalls, steep gullies and avalanche chutes. Forms cones or aprons lying at or near the angle of repose along valley walls. Distal ends may transition to rock glaciers.

Qcl LANDSLIDE DEPOSITS - Chaotically deformed deposits derived from relatively sudden mass movement of bedrock or surficial deposits along plane(s) of failure. Surfaces of Qcl units are characteristically very hummocky and lack integrated drainages. Recent slides display surface disturbances such as randomly tilted trees and ripped up vegetation mats. In the McGrath A-3 Quadrangle this unit also includes rockfalls, which are in some cases spectacular with blocks as large as 40 ft across. In the western portion of the quadrangle, where glacially oversteepened cirque headwalls occur. Rockfalls result from spalling along joints of plutonic rocks.

Qca MIXED COLLUVIAL AND ALLUVIAL DEPOSITS - Mixed poorly to moderately sorted silt, sand, gravel and diamicton of colluvial and occasionally fluvial origin. Deposits commonly contain alternating and interfingering stratified and unstratified lenses. Colluvial-alluvial fans generally are most active in early to late spring when intense freeze-thaw cycles and copious meltwater are present. They usually occur as relatively small steep fans along valley walls issuing from gullys and steep minor tributaries with intermittent stream flow.

Qrg ROCK GLACIERS AND ROCK GLACIER DEPOSITS - Very coarse deposits of unsorted, angular frost-shattered boulders and cobbles, commonly containing considerable interstitial ice (up to 55 percent in active rock glaciers). Deposits in the region are basically of three morphologic types, as described by Wahrhaftig and Cox (1954): 1) lobate, relatively small forms 250 to 1,500 ft across lying at the base of valley walls and whose direction of movement is toward the valley axis; 2) tongue shaped, heading in abandoned cirques, and having their longest dimension parallel to their direction of flow; and 3) transitional, elongated down valley in direction of flow with the head being a true glacier and terminus gradually transitioning into a rock glacier. Rock glaciers in the area commonly originate in north-facing cirques at elevations between 3,500 and 5,000 ft that erode blocky-weathering, relatively resistant rocks. Fronts of active rock glaciers in the area are very steep and unstable.

Qd GLACIAL DEPOSITS UNDIFFERENTIATED - Both stratified and unstratified drift may include till, outwash, ice contact deposits, and glaciolacustrine sediments. These deposits commonly are mantled by eolian and organic deposits (such as loess and peat) of varying thicknesses and extent, yet retain enough original morainal or outwash morphology to be identified. In the northwest portion of the map area preWisconsin drift units are discontinuously indurated and are classified as tillites. Cement is predominantly calcite.

Qd' THIN DRIFT OVER BEDROCK - Patchy thin drift including till and glaciofluvial deposits. Presence of deposits allows determination of former ice positions along valley walls but does not prohibit identification of underlying bedrock. Local geochemical soil and stream sampling could be affected by presence of mineralized material moved long distances from parent sources.

Qdt TILL AND TILLITES - Diamicton deposited directly by glacial ice. Characteristically unsorted to poorly sorted with varying percentages of clay, silt, sand, pebble, cobble, and boulder size material. Older tills are locally indurated with calcite cement. Cobble and boulder clasts are commonly polyhedrally faceted, striated, and tend to be subangular to subrounded. Areas of permafrost and thick surface peat deposits occur in moraines on the plateau in the northwest portion of the map area.

Qda ABANDONED OUTWASH CHANNEL DEPOSITS - Moderately sorted sand and gravel deposits in channels notched into bedrock or drift by meltwater issuing from former glaciers. May locally be a good source for small to moderate amounts of washed materials.

Qdo OUTWASH - Glaciofluvial stratified drift consisting of coarse, subrounded gravel with sand and silt lenses and partings deposited by side glacial and proglacial meltwater streams. Outwash deposits tend to be graded to former side and terminal glacial positions. Material deposited proximal to the glacier (or former glacier) is generally coarser than material distal to it. Distal portions of outwash bodies generally merge gradationally with other alluvial deposits and lose their identity.

Qg ACTIVE GLACIERS - Glaciers occur in cirques with baselevels above 4,800 to 5,200 ft (elevations varying with aspect). Termini are generally between 4,300 and 5,000 ft elevation. Most glaciers within quadrangle appear to be in gradual retreat.

BEDDED ROCKS

Tcg CONGLOMERATE - Crudely stratified beds (predominantly 5-15 m thick), moderately indurated, locally orange-weathering, gray-green, very poorly sorted, subangular, granule-pebble conglomerate. Clasts range from silt to 2.0 cm across, with scattered (<5 percent) subrounded clasts 2.0-8.0 cm across. Clasts appear locally derived, with approximately 50 percent Ss sandstone and phyllitic sandstone and 50 percent igneous clasts from dikes (Tids). In fault silver in northeast part of T. 23 N., R. 27 W. Age uncertain, but assigned to Tertiary by Herreid (1968) based on restricted occurrence and clast types.

MzPzg SHEARED GREENSTONE - Sheared, altered, locally schistose olive-green mafic volcanic flows, agglomerate, and tuff(?). Includes subordinate thin lenticular beds of recrystallized gray limestone.

Tva ANDESITIC FLOWS - Volcanic rocks in northeast corner of quadrangle. Intermediate to mafic in composition, display columnar jointing.

DSls LIMESTONE, CALC-SANDSTONE, AND SHALE - Intervals of very thin-bedded orange to buff weathering calc-siltstone to fine-grained sandstone (30 percent), cross-bedded silty limestone turbidites (30 percent), and dark gray phyllitic shale (30 percent); includes scattered lenses of dark gray laminated limestone up to 2.0 m thick (5 percent) and fine- to medium-grained calc-sandstone turbidites (as in unit Ss) up to 2.0 m thick (5 percent). Commonly sheared and complexly isoclinally folded on all scales. Equivalent to DSls of Bundtzen and others (1984b) to the east and to DSls and Dls of Gilbert (1981) to the southwest. The top of the unit is not exposed in the McGrath A-3 Quadrangle, but to the east Bundtzen and others (1984b) estimate that the unit reaches a maximum thickness of 400 meters.

Ss PHYLLITIC CALC-SANDSTONE - Very thin- to very-thick bedded, buff to orange-weathering, gray to gray green phyllitic calc-sandstone, interbedded with lesser amounts of thinly laminated to thin-bedded, orange to brown-weathering, black to gray or gray-green slate and phyllitic calc-siltstone. Locally contains intervals of very thin to thin-bedded gray silty limestone. In north-central part of quadrangle sandstones display graded bedding, oscillation ripple marks, and planar cross bedding indicative of deposition by turbidity currents. The calc-sandstone is very coarse-grained to very fine-grained, micaceous, and is a feldspathic litharenite (Folk, 1968). Coarser clasts are commonly flattened and stretched; original detrital mineralogy and texture is evident in thin section in some rocks (see Gilbert and others, 1984). Commonly, however, sandstones contain abundant secondary minerals and display a pervasive foliation defined by elongate, partially recrystallized framework grains and cataclastic shear planes. Phyllitic siltstone commonly grades into calc-sandstone or limy siltstone and rarely displays cross-beds and pyrite crystals on partings. Silver-weathering, thinly laminated gray phyllite occurs locally as partings in sandstone. Subparallel and cross-cutting quartz and calcite veinlets are common. Unit generally hornfelsed parallel to contacts with igneous units. Includes units correlative with mSs, mSa, mSl, uSl, Ss, and uSsl, of Bundtzen and others (1984a and 1984b). Unit is subisoclinally to isoclinally folded from outcrop to nappe scale. Original thickness unknown due to structural repetitions and faulting. ls - Thin to very thick-bedded, medium-gray weathering, dark-gray laminated limestone generally included as part of Ss, but locally mapped separately. g - Medium-grained chlorite-hornblende-augite greenstone.

lSl LIMESTONE - Gray finely laminated limestone that locally marks the base of Ss; may contain very thin layers of black chert. Correlative with lSl of Bundtzen and others (1984). Varies in thickness from 0-30 meters.

SOsh BLACK SHALE - Dark-gray to black shale, siltstone, argillite, phyllite, and very fine-grained sandstone in northwest and southwest parts of quadrangle. Locally pyritic and includes beds of fine- to medium-grained sandstone and scattered beds of silty limestone. Slightly to intensely sheared and folded. For 20 m above contact with silty limestone (OCls), the black shale contains scattered beds of dark limestone 0-5 cm thick. Upper Ordovician to Lower Silurian graptolite-bearing horizons occur in SOsh (table 2). In the McGrath A-3 Quadrangle the unit is approximately 250 m thick, but is structurally thickened in the cores of the Middle Fork and North Fork anticlines.

OCls SILTY LIMESTONE - Thin to very thin bedded, orange-weathering, light gray silty limestone in discontinuous lenticular beds up to 25 cm thick in northwest and southwest parts of quadrangle. Interbedded with 1 to 5-cm-thick beds of gray siltstone and gray carbonaceous phyllite. Silty laminae commonly cross-bedded in form of several stacked cosets. Unit rarely cut by calcite veinlets. Generally sheared along limestone-siltstone contacts and siltstone-phyllite partings. Deformed by tight chevron to subisoclinal folds ranging from crenulations to nappe-scale. Base not exposed in map area; in adjacent quadrangles to southwest Gilbert (1981) estimates a minimum thickness of 1,000 m.

INTRUSIVE ROCKS

Tids DIKE SWARM - Swarm of subparallel mafic dikes with minor felsic dikes. Contact with host rock (Ss) mapped where dikes too numerous to show separately; slivers of Ss are particularly abundant in Tids within 500 m of contact. Fine-grained andesine laths, biotite, clinopyroxene (titanaugite in some mafic dikes), olivine, and opaque minerals are common; chlorite and carbonate alteration is pervasive.

Tif FELSIC SILLS AND DIKES - Felsic sills and dikes up to 5 m thick, generally light-pinkish tan to white, aphanitic to fine-grained, commonly altered and coated by brown to orange gossan.

Tim MAFIC DIABASE - Diabase intrusion of the Chip Loy prospect on 'Straight Creek.' Contains unaltered labradorite laths (up to 50 percent), clinopyroxene (25 percent), tremolite (20 percent), biotite (1 percent), magnetite (3 percent), and apatite (1 percent) (Herreid, 1968). A 12-m-thick sulfide-rich zone along the iron-stained contact between diabase and Ss contains pyrrhotite (50 to 70 percent) with minor chalcopyrite, pentlandite, magnetite, and possible bravoite (W.S. Roberts, personal commun., 1984). Results of geochemical analyses are shown in table 1. Age uncertain; assigned to Tertiary on basis of similarities to Tertiary pyrrhotite-rich intrusions in McGrath B-2 Quadrangle (Bundtzen and others, 1982).

Tg GRANITE, QUARTZ MONZONITE, MONZODIORITE - Fine- to medium-grained, hypidiomorphic-granular biotite- and hornblende-bearing lithologies with variable quartz content and feldspar ratios; predominantly quartz monzonite and monzodiorite (Streskeisen, 1973). Plagioclase composition ranges from andesine to labradorite. Minor clinopyroxene is generally present and rimmed by hornblende. Locally contains alkali feldspar phenocrysts. Opaque minerals, zircon, and apatite are ubiquitous accessories tourmaline is present locally. Intruded locally by leucocratic veinlets of quartz and alkali feldspar. In places includes alkali and gabbro (Tag) and syenite (Tsy). Fine-grained mafic enclaves are common. Most enclaves have wholly igneous texture, though some retain layering of sedimentary origin. Contact between Tg of peak 6,375' and syenite below is sharp and near horizontal. Elsewhere, contact with Tsy unit is diffuse, possibly due to mixing of units in semicrystalline state. Three K-Ar samples (map numbers 2, 3, 4, table 3) yield ages of 56.1 ± 1.7 m.y. 56.6 ± 1.7 m.y., and 57.2 ± 1.7 m.y.

Tag ALKALI GABBRO - Dark-greenish-brown, fine- to medium-grained, subophitic, biotite-olivine-pyroxene gabbro; typically composed of andesine (30 to 55 percent), clinopyroxene (10 to 25 percent), olivine (5 to 20 percent), biotite (2 to 30 percent), and greenish to brown hornblende replacing pyroxene (1 to 2 percent). Minor constituents are alkali feldspar (0 to 5 percent), orthopyroxene (0 to 5 percent), opaque minerals (1 to 10 percent), and ubiquitous accessory apatite. Secondary minerals include chlorite, iddingsite, serpentine, actinolite, carbonate, and apophyllite. Crystallization sequence is olivine-pyroxene-plagioclase-biotite-hornblende. Typically weathers as brown grus, resulting in rounded outcrops. Commonly intruded by crosscutting leucocratic veinlets of quartz and alkali feldspar, locally in graphic intergrowth, with traces of biotite and opaque minerals. In places includes small bodies of unit Tg. Layering due to segregations of mafic minerals occurs locally. Layered alkali gabbro (Tag) in Sec. 1, T. 23 N., R. 28 W. intrudes syenite (Tsy) with sharp contact; elsewhere contact generally gradational.

Tsy SYENITE - Medium- to coarse-grained, hypidiomorphic-granular, olivine-clinopyroxene syenite of the Middle Fork pluton, composed of perthitic alkali feldspar (45 to 90 percent), clinopyroxene (3 to 10 percent), olivine with magnetite alteration rims (1 to 7 percent), plagioclase (3 to 10 percent), interstitial quartz (0 to 10 percent), and green-brown hornblende after pyroxene (1 to 20 percent). Minor constituents are biotite (0 to 3 percent), opaque minerals (1 to 2 percent), rutile needles, apatite, zircon, fluorite(?), and monazite(?). Secondary minerals include chlorite, carbonate, iddingsite, actinolite, and epidote. Commonly forms massive, jointed cliffs. Fresh surfaces are greenish gray. Weathers whitish gray; locally pervasively iron-stained. Commonly encompasses bodies of country rock and unit Tg.

Twgr WINDY FORK GRANITE - Medium- to coarse-grained, hypidiomorphic-granular, peralkaline arfvedsonite granite of the Windy Fork pluton. Composed of perthite (40 to 60 percent), quartz (25 to 45 percent), and arfvedsonite (5 to 10 percent) with secondary riebeckite (<2 percent). May contain minor plagioclase and reddish-brown biotite; accessory minerals include opaque minerals, zircon, apatite, fluorite, monazite(?), and carbonate. Color of rock ranges from white to pink to blue-gray. Areas of radioactivity (up to 2,500 cps) in the Windy Fork pluton may be due to the presence of uranothorite or thorianite (Reed and Miller, 1980). Eudialyte and aegirine-augite occur in veins that cut granite and adjacent country rock. One K-Ar sample from eudialyte-bearing dike on margin of Windy Fork pluton (map number 7, table 3) yields an age of 23.5 ± 0.7 m.y. on aegirine-augite. Reed and Lanphere (1972) report K-Ar ages from biotite and hornblende in the Windy Fork pluton of 30.1 ± 0.9 m.y. and 29.0 ± 0.9 m.y.

Tmgr MIDDLE FORK GRANITE - Medium to coarse-grained, hypidiomorphic-granular, peralkaline granite of the southeast margin of the Middle Fork pluton. Mineralogy very similar to that of Windy Fork granite (Twgr). Modal color index ranges from 3 to 10 percent. Eudialyte noted at two locations in granite talus. Middle Fork granite appears gradational with syenite (Tsy). Outcrops typically massive, weathering in large blocks. Two K-Ar samples (map numbers 5 and 6, table 3) yield ages on amphibole of 57.7 ± 1.7 m.y. and 55.6 ± 1.7 m.y.

Tgr GRANITE - Fine- to coarse-grained, hypidiomorphic-granular granite to quartz syenite of the Middle Fork pluton. Contains hornblende (0 to 10 percent), biotite (0 to 5 percent), and clinopyroxene (0 to 10 percent), with ubiquitous minor opaque minerals, apatite, and zircon. Arfvedsonite and riebeckite present locally. Alkali feldspar is generally perthitic and commonly pink in hand specimen. Modal quartz content ranges from 10 to 25 percent; color index up to 25. Typically weathers to a white grus. Fine-grained mafic enclaves are pyroxene-rich.

Tqm QUARTZ MONZONITE - Fine- to medium-grained, hypidiomorphic-granular biotite-quartz monzonite of small plug in northwest corner of quadrangle. Alkali feldspars are perthitic, and hornblende is present in minor amounts. Accessory minerals include zircon, titanite, and apatite. A K-Ar sample (map number 1, table 3) yields an age from biotite of 56.6 ± 1.7 m.y. Reed and Lanphere (1972) report a K-Ar age on biotite of 56.0 ± 1.6 m.y.

Tm MONZONITE - Medium-grained, hypidiomorphic-granular, clinopyroxene-hornblende-monzonite intruding MzPzg in northwest corner of quadrangle. Pyroxenes (pink in thin section) surrounded by hornblende constitute 35-40 percent of rock; also present are labradorite (30 to 40 percent), alkali feldspar (20 to 25 percent), anhedral opaque minerals (3 to 5 percent), minor biotite and apatite, as well as secondary white mica and green amphibole forming after hornblende.

Depositional contact, dashed where very approximately located or gradational.

High angle fault, dashed where inferred, dotted where covered.

Thrust fault, saw teeth on upper plate, dashed where inferred.

Anticline, showing trace of axial surface.

Syncline, showing trace of axial surface.

Strike and dip of beds. Commonly parallels shear foliation.

Inclined.

Vertical.

Horizontal.

Overturned on lower limbs of Middle Fork and North Fork anticlines.

Strike and dip of foliation in igneous rocks.

Strike and dip of jointing in igneous rocks.

Bearing and plunge of minor fold axis.

Fossil locality (table 2).

K-Ar sample locality (table 3).

Mineral prospect.

(Table)

<u>Table 1</u> - Materials and properties of selected Quaternary units.

STREAM ALLUVIUM UNDIFFERENTIATED - Qa (Row heading)

<u>entries</u>

GENERAL DESCRIPTION (Column heading)

Includes all fluvially derived sediments of trunk and tributary streams, terraces and fans. Sediments range from poorly to well sorted with size ranges from silt to small boulder gravel. May grade into distal outwash deposits.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE (Column heading)

Flat to gently sloping surfaces. Older surfaces may be modified by stream dissection and gullying, mantling by eolian deposits and accumulations of slope wash and colluvium from adjacent valley walls.

Drainage good on recently deposited alluvium standing above stream level.

Drainage fair to poor on older alluvium where permafrost has developed and where covered by silty colluvium and peat.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost generally absent in youthful deposits; occasionally occurring in older deposits which have developed thick secondary silt and peat accumulations on their surfaces.

Frost heaving minimal on modern well drained alluvium; may be moderate to intense within the active layer where secondary organic silt and peat cover and permafrost is present.

STABILITY AND BEARING STRENGTH (Column heading)

Generally stable with moderate to high bearing strength. Exceptions include deposits containing ice rich permafrost which are subject to thaw instability, and areas immediately adjacent to cutbanks and free faces, where sudden rapid collapse may occur due to stream erosion or surface loading.

SOME POSSIBLE USES/AVOIDANCES (Column heading)

Well to moderately sorted and thawed alluvium generated by larger streams is a useful source of sand and gravel.

Older terrace and fan deposits containing permafrost and having significant thicknesses of organic, eolian and/or colluvial overburden are generally undesirable as materials sources. Deposits of this type must be evaluated on an individual basis.

ALLUVIAL FAN DEPOSITS - Qaf (Row heading)

GENERAL DESCRIPTION (Column heading)

Fan-shaped deposits of fluvially derived sediment occurring where a lessening of stream gradient favors deposition rather than transport.

Deposits occur where a steep low order tributary stream emerges into a trunk valley. Material mostly coarse with discontinuous interbeds of finer grained material; sorting poor to moderate. Subject to large rapid fluctuations in discharge and rates of deposition. Surface area generally less than 10 square kilometers.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE (Column heading)

Mountain fans have a surface slope averaging 2° with a range from 5° down to 1.5°. Their surfaces are commonly forested or brushy with the exception of highly active fans. Abandoned channel scars are readily apparent on building and stable fans. Due to changes in local base level and/or diminished upstream sediment supply, deep stream entrenchment and erosion into previously deposited fan materials has occurred in places.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Older inactive alluvial fans whose surfaces have accumulated appreciable thicknesses of silt and organics may have developed permafrost, which in turn may inhibit surface drainage.

Organics and silt on old fan surfaces are subject to frost heave, especially where a near surface permafrost table inhibits drainage, keeping the ground very moist or saturated. Otherwise fan gravels are frost stable.

STABILITY AND BEARING STRENGTH (Column heading)

Generally good except where overburden accumulations on old fans have resulted in frost and thaw susceptible surfaces. Bearing strength on gravel and sand is good.

SOME POSSIBLE USES/AVOIDANCES (Column heading)

Younger fans are good sources for aggregate gravel and sand.

Fans are a suitable locality for construction except where subject to avalanche and mudflow potential. The latter occur mostly in very steep short tributaries.

ALLUVIAL TERRACE - Qat (Row heading)

GENERAL DESCRIPTION (Column heading)

Fluvially derived sediments. Poor to moderately well sorted, silt, sand and gravel lying above the active flood plain of streams. Strath terraces with treads cut on bedrock generally contain less fluvial material than fill terraces.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE (Column heading)

Horizontal to gently sloping downstream. Older terrace surfaces have been modified by gullying or the presence of colluvial or eolian cover. Surface drainage good on younger terrace deposits lacking permafrost and/or significant organic silt mantle.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost is present discontinuously in older deposits. May be ice rich in organic silt or where silt has infiltrated into gravels carried by downward percolating water.

Frost heaving occurs in organic silts capping older terraces. Terrace gravels themselves are generally not susceptible to heave and other severe active-layer disturbances.

STABILITY AND BEARING STRENGTH (Column heading)

Terrace deposits are generally stable away from free faces and where they lack ice rich permafrost. Fill terraces may be subject to rapid stream erosion and slumping along stream cuts and free faces. Bedrock strath terraces may be susceptible to rotational failure where they flank modern stream cuts.

SOME POSSIBLE USES/AVOIDANCES (Column heading)

Unless altered by weathering or infiltration of fine-grained material over time, terrace alluvium has essentially the same properties as flood plain gravel and sand. Properties of terrace alluvium vary according to size, gradient and dominant parent material. Terraces along larger streams and rivers are generally the most productive sites for material.

COLLUVIUM UNDIFFERENTIATED - Qc (Row heading)

GENERAL DESCRIPTION (Column heading)

Mass movement deposits have gravity as their primary agent of transport. They are generally unsorted unless sorting is inherited from parent material. Unstratified to crudely stratified. Deposits resulting from episodic mass movement may be interbedded with surface organics or thin fluvial layers. Includes talus, landslides, solifluction and mixed slope colluvium.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE (Column heading)

Surface morphology variable from very steep cones and aprons of talus having relatively smooth convex upward longitudinal profiles to hummocky lobes of landslide debris.

Drainage variable depending on percentage of silt- to clay-sized material in matrix and on presence or absence of permafrost. Some talus cones have surface leveed channels created by mudflow activity.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost present in toes of thick talus accumulations, sometimes with significant interstitial ice. Some talus accumulations are gradational into rock glaciers where permafrost occurs. Permafrost also discontinuously present in Qc units occupying lower north-facing slopes.

Susceptibility to frost action high where material contains high percentage of silt or organic silt.

STABILITY AND BEARING STRENGTH (Column heading)

Steep colluvial deposits such as talus aprons lying at or near the angle of repose are generally unstable and susceptible to shifting when loaded. Talus accumulation areas are also subject to snow avalanches, mudflows, and rock falls.

POSSIBLE USES/AVOIDANCES (Column heading)

Generally unsuitable as materials source. Finer grained colluvial material lacking boulders may be used as fill. Colluvial deposits showing signs of recent shifting or depositional activity should be avoided as building sites.

COLLUVIAL-ALLUVIAL FAN DEPOSITS - Qca (Row heading)

GENERAL DESCRIPTION (Column heading)

Relatively steep fan or apron shaped deposits of poorly to moderately sorted, interbedded colluvial and fluvial material, generally found where steep-gradient ephemeral streams and gulleys emerge onto higher order stream valley floors and piedmont slopes.

SURFACE MORPHOLOGY (Column heading)

Appear similar to but generally steeper and smaller than alluvial fans. Surface drainage moderate to poor. Subject to torrential flooding and avalanche activity during heavy precipitation and snowmelt periods.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost is common in deposits along north-facing slopes especially in older deposits having little or no current activity.

Content of segregated ice may be high where admixtures of silt and organics are prevalent.

Susceptible to frost heaving when silt content high and drainage is poor.

STABILITY AND BEARING STRENGTH (Column heading)

Thaw unstable if perennially frozen and containing excess ice.

Deposits of predominantly silty material susceptible to creep and flowage especially where saturated by near surface ground water such as that from springs along faults.

Bearing strength variable but generally considered fair to poor. Forms sag ponds along fault traces.

SOME POSSIBLE USES/AVOIDANCES (Column heading)

Small quantities of moderately sorted gravel-rich fluvial sand may be obtained very locally from pods or lenses within Qca fans.

Fan surfaces may be subject to avalanche, mud flow, subsidence and locally liquefaction under dynamic loading. Caution should be exercised in placing structures and during excavations.

TILL - Qdt (Qd') (Row heading)

GENERAL DESCRIPTION (Column heading)

Deposits of glacial origin (drift) deposited directly by glacier ice as ground, terminal and lateral moraines. Characteristically unsorted unstratified diamicton. Cobble and boulder sized clasts commonly polyhedrally faceted, subangular to subrounded, and represent a wide variety of lithologies from up valley.

Till units vary in composition, depth of weathering, and surface morphology due to dominant clast lithologies, age, elevation, exposure, aspect and vegetation cover, all of which control the duration and rate of surface modification following primary deposition. Till thickness varies from a few inches (Qd') to more than 60 m in places. In the extreme northwestern portion of the quadrangle some older till units are indurated and are classified as tillites. The cement in all tillites observed is calcite.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE

Surface modification such as degree of dissection, subduing of microrelief and burial by depositional agents are variable with age, elevation, aspect, vegetation cover and slope.

Pre-Wisconsin till deposits exhibit very subdued to completely masked or removed morainal morphology and integrated drainage. Early Wisconsin drift is commonly covered by relatively thick blankets of peat and/or eolian deposits with drainage development showing some stream integration subdued hummocky morainal topography, and wholly or partially infilled and drained kettles.

Late Wisconsin till exhibits distinct primary morainal morphology on the piedmont with poorly integrated drainage. Thick accumulations of peat and loess occur discontinuously on the surface of most drift units of the piedmont.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost is widespread in till covering the foothills plateau in the vicinity of Middle Fork. Permafrost table in areas with thick peat development lies approximately 3 ft below the surface. Interstitial ground ice development in upper 15 ft is common with occasional large ice masses especially where thick peat and loess mantle occurs. The entire unit is subject to moderate to intense seasonal frost heave. Local thaw instability following surface disturbance can occur if ice rich permafrost is present.

STABILITY AND BEARING STRENGTH (Column heading)

Stable if kept frozen in permafrost areas.

Bearing strength is good on permafrost-free drift with no appreciable peat and loess accumulation and with moderate to low slope angles; poor on thick cover peat if thawed, along steep valley walls and cut banks. Subject to failure when saturated or oversteepened by stream erosion.

SOME POSSIBLE USES/AVOIDANCES (Column heading)

Till, due to its poor sorting and variable clay and silt content, is generally a poor source of clean sand and gravel. Occasional pods of sorted material occur locally in till. Till commonly overlies outwash gravels which may be extractable where not buried too deeply.

OUTWASH - Qdo (Row heading)

GENERAL DESCRIPTION (Column heading)

Stratified drift deposited as large fans, terraces, and in channels by glacial meltwater. Deposits proximal to their original glacial source are coarse cobble-boulder gravels with thin stringers of silt and sand. Cut and fill channel structure and imbrication of clasts can be seen in test pits and cutbanks. Deposits become progressively better sorted and finer grained with increasing distance from source, eventually becoming undistinguishable from nonglacial alluvium.

SURFACE MORPHOLOGY AND NATURAL DRAINAGE (Column heading)

Outwash deposits are gently sloping with relatively flat surfaces exhibiting an abundance of braided channel scars. Channel scars are often accentuated by differences in vegetation. Most distinguishable outwash in the quadrangle occurs as fans or valley trains.

Surface drainage is good in areas where outwash gravels occur at or near the surface and very poor both where peat and silt cover has allowed the development of permafrost and near springs where the water table is near the ground surface.

PERMAFROST AND SUSCEPTIBILITY TO FROST ACTION (Column heading)

Permafrost is sporadic to discontinuous in outwash of the quadrangle. It occurs where organic silt and peat accumulation have allowed freezing and development of segregated ice which is usually limited to fine-grained overburden.

Outwash gravels are not susceptible to frost heave unless thickly mantled by silty organic materials.

STABILITY AND BEARING STRENGTH

Stable except along active cutbanks.

Good bearing strength in gravels below peat and silt mantle.

SOME POSSIBLE USES/AVOIDANCES

Outwash gravels are a good material source. They commonly underly tills and may be extractable if covering deposits are relatively thin.

Since sorting is poor to moderate, mechanical classification may be necessary for some applications. Provides good foundation if capping peat and silt deposits are stripped or absent. Cutbanks along actively eroding stream channels may slough gradually or suddenly and are not recommended as sites for structures.

Figure 1. Major structural elements in McGrath A-3 Quadrangle.

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Table 2. Fossil identifications from McGrath A-3 Quadrangle.[1]

Map number (field number) museum number[2]	Description
F-1 (82WG241) A-1893	In black argillite 5.0 m stratigraphically below 3.0 m thick laminated limestone that marks base of Ss. Retiolites cf. R. geinitzianus angustidens Elles & Wood (r), Monograptus spiralis cf. subsp. contortus Perner (c), M. sp. aff. M. priodon (Bronn), Monoclimacis sp. aff. M. crenulata (Tornquist)(f). M. spiralis Zone of Lenz, 1982, Royal Ontario Museum 130. Late Early Silurian.
F-2 (83JC63)	Sheared SOsh. Fragmentary specimens tectonically distorted and poorly preserved. Retiolites geinitzianus geinitzianus (Barrande), Monograptus cf. M. exigus primulus Boucek and Pribyl, M. aff. M. proteus (Barrande), M. sp. (with tubed thecae like M. flemingii), Pristiograptus sp., Monoclimacis sp. Approximately Monograptus crispus Zone; late Early Silurian.

[1]Faunel identifications by Claire Carter, U.S. Geological Survey.

[2]Paleontological collection, University of Alaska Museum, Fairbanks, Alaska.

F-3	SOsh. Sparse fauna, poorly preserved. *Glyptograptus* sp., *Climacograptus*? sp, (83JC59) *Didymogiaptus*? sp. Probably Middle Ordovician.
F-4 (82WG306a) A-1934	Near top of SOsh. *Monograptus turriculatus* (Barrande)(r), *M. exiguus primulus* Boucek and Pribyl (a). *M. turriculatus* Zone. Late Early Silurian.
F-4 (82WG306c) A-1932	In laminated limestone and siltstone 2.0 m stratigraphically above contact with SOsh. *Monograptus* sp., *Pristiograptus* sp., possible diplograptid. Early Silurian.
F-4 (82WG306d) A-1933	In black siltstone resting stratigraphically on top of laminated limestone (1Sl) that marks base of phyllitic sandstone (Ss). *Monograptus* aff. *M. flemingii* (Salter), *Cyrtograptus* aff. *C. rigidus* Tullberg. Wenlockian (early Late Silurian).
F-5 (82WG286a) A-1951	In organic black siltstone of SOsh. *Climacograptus* sp. (resembles *C. caudatus* and *C. tubuliferus* in its semicircular apertural excavations, but lacks the distinctive appendages of those species, which are late Middle Ordovician).

F-5 (82WG287c) A-1948	Just above 82WG286a. Poorly preserved diplograptids, including Climacograptus? and Glyptograptus?. Probably Middle or Late Ordovician.
F-5 (82WG287d) A-1949	Just above 82WG287c. Orthograptus cf. O. amplexicaulis (Hall)(f), Dicranograptus? sp. (r). late Middle or Late Ordovician.
F-5 (82WG287c) A-1950	Just above 82WG287, and just below 1S1. Akidograptus sp. (or Orthograptus acuminatus), Atavograptus sp., Dimorphograptus? sp., Climacograptus sp. Earliest Silurian, approximately O. acuminatus - A. atavus zones.
F-6 (83WG88b)	Lower part of SOsh. Tetragraptus of the T. quadribrachiatus type. Approximately Early Ordovician.