DISCUSSION

INTRODUCTION

This geologic map is one of a series of maps that summarizes resource investigations by the Alaska Division of Geological and Geophysical Surveys in the eastern part of the upper Kuskokwim region during 1977-84. In addition to geologic maps (Gilbert, 1981; Bundtzen and others, 1982; Gilbert and others, 1982; Gilbert and Solie, 1983; Kline and others, 1986; Bundtzen and others, 1987; Gilbert and others, 1988), previous reports address the area's intrusive and stratigraphic relations (Potter and others, 1980; Solie and others, 1982; Blodgett and Gilbert, 1983; Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1983a; Kline, 1983; Savage and others, 1983; Solie, 1983; Dickey, 1984; Gilbert and Bundtzen, 1984; Hahn and others, 1985; Kline and Bundtzen, 1986); structure and tectonics (Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1983b; Gilbert and Bundtzen, 1984); and economic resources (Solie and Dickey, 1982; Bundtzen and Gilbert, 1983). Rocks in the McGrath B-3 Quadrangle range in age from Cambrian(?) to Holocene and display complex fault relations along the Farewell fault zone.

QUATERNARY GEOLOGY

About half of the McGrath B-3 Quadrangle is covered by unconsolidated Quaternary sediments that were deposited by glacial, glaciofluvial, fluvial, colluvial, and eolian processes. With the exception of the area of the Middle Fork Kuskokwim River and the Windy Fork Middle Fork Kuskokwim River (hereafter Middle Fork and Windy Fork), stream uplands throughout the quadrangle contain little surficial material, due to rapid stripping and flushing of weathered bedrock onto the piedmont slope. Thick accumulations of alluvial fan, outwash, and till deposits, however, are ubiquitous north of the outer strand of the Farewell fault. Locally, accumulations of loess, eolian sand, and peat (not depicted on the map) blanket deposits of the piedmont.

Four major periods of glaciation are inferred from drift deposits in the McGrath B-3 Quadrangle: two are probably of pre-Wisconsin age, one of early Wisconsin age, and one of late Wisconsin age. Bluff exposures of the oldest drift deposits just north of the Farewell fault system consist of tectonically deformed till-outwash sequences. The lower units of the sequences dip 35° NW.; the middle and upper units dip 15° to 20° NW.

From at least mid-Quaternary time through the present, the area was tectonically active, as evidenced by tilted, dissected middle to late Quaternary units and high-level strath terraces, and sharply defined, 10-m-high fault scarps in late Wisconsin and Holocene deposits. Fault-line scarps over 30 m high were observed along segments of the outer strand of the Farewell fault system. Just west of the quadrangle, early Wisconsin(?) moraines are vertically offset 25 m or more, and pre-Wisconsin moraines are offset at least 30 m. Episodic Quaternary uplift of a block of Tertiary sediments between the major strands of the Farewell fault system created accordant strath terraces about 30 m above and flanking antecedent streams that flow north from the Alaska Range. Some of the terrace treads tilt to the north-northwest.

Permafrost is discontinuous in the McGrath B-3 Quadrangle, occurring primarily on northerly slopes and in sediments with a high moisture content, such as organic silt and peat and locally in underlying gravel. Segregated ice and some massive ice were observed along the west bank of the Windy Fork 6.5 km downstream from the Farewell fault system in a peat and silty peat section that overlies late Wisconsin till. At this locality, the permafrost table is at a depth of 0.6 m (fig. 3); however, radiocarbon ages indicate that the permafrost table is aggrading as woody peat and loess accumulate at the surface. Radiocarbon ages from peat on the Windy Fork (fig. 3) indicate that the peat accumulated at a rate of 1 in. (0.3 m)/68 yr between 8,500 ± 120 B.P. and 2,810 ± 60 B.P. and 1 in. (0.3 m)/29 yr between 2,810 ± 60 B.P. and the present. Test pits in peaty material overlying early Wisconsin moraines on the piedmont showed that the permafrost table is 0.3 to 1 m below the surface. Local knobs of drift with little organic cover are thawed. East of the Windy Fork, thaw lakes have developed locally in silty peat on the early Wisconsin moraines.

TERRANES

Paleozoic and Mesozoic rocks in the McGrath B-3 Quadrangle are part of three tectonostratigraphic terranes (Jones and others, 1981) (fig. 1). The older Paleozoic rocks are assigned to the Dillinger terrane, and most of the younger Paleozoic and Triassic rocks are assigned to the Mystic terrane. These two sequences are now thought to form one continuous succession (Bundtzen and Gilbert, 1983; Gilbert and Bundtzen, 1984). Triassic limestone (₮l) along the Windy Fork is most likely a fragment of the Pingston terrane, a continental-margin sequence unrelated to the Dillinger-Mystic succession (Gilbert and Bundtzen, 1983b).

STRUCTURE

FOLDS

A folding and low-grade dynamic metamorphic event deformed Paleozoic rocks in the McGrath B-3 Quadrangle, producing a series of subisoclinal, overturned folds (F_i) that range from outcrop to nappe scale (fig. 5A). The largest F_i fold recognized in the quadrangle is the Middle Fork anticline, whose axis crosses the southwestern part of the quadrangle (fig. 1). Accompanying the major F_i folds is a penetrative axial-plane foliation (S_i) that is subparallel to the limbs of the folds (fig. 5B). F_i folds locally grade into or are superseded by kink folds (F_k) and accompanying slip cleavage (S_k) (fig. 5C and D), commonly a crenulation cleavage developed on the limbs of minor F_k folds. Between F_i and F_k folds is a continuum of fold styles with the same gentle northeast plunge (fig. 5A and C), but where the two types of folds occur together, F_k folds and S_k cleavage generally cut F_i folds and S_i foliation. The orientation of S_k cleavage, however, is controlled by F_i folds, as shown by S_k cleavage surfaces inclined toward the axial surface of the Middle Fork anticline (fig. 5D). Such geometry indicates that F_i and F_k folds are genetically related to the same folding event. The type of fold response (F_i or F_k) may have depended on the stage of fold development or on structural position. F_i folds likely formed during early stages of fold development at a relatively deep structural position, whereas F_k folds formed at shallow levels, or at deep levels during and following tightening and dewatering of F_i folds.

Between the two main strands of the Farewell fault zone, Tertiary conglomerate (Tc) is deformed by several open folds that plunge gently southwest (Dickey, 1984). Paleozoic rocks are also broadly warped by a large, open, northeast-plunging anticline (fig. 5B). This fold may be either a large F_k fold or may reflect the same shortening that affected the Tertiary conglomerate.

FAULTS

In the McGrath B-3 Quadrangle, the Farewell fault system forms a 5-km-wide zone of high-angle faults along the northwest front of the Alaska Range (fig. 1). These trend northeast and northwest and bound several northeast-trending structural basins. The active trace of the fault system shifts to a more southerly strand from west to east across the quadrangle. Although regional relations suggest that there have been several tens of kilometers of pre-Quaternary right-lateral movement along the system (Blodgett and Gilbert, 1983), no evidence of recent strike-slip movement was observed. Vertical offset in the Quaternary units and numerous recently active, north-facing fault scarps, however, do indicate recent vertical faulting related to uplift of the Alaska Range. Further, offset glacial deposits and deformed river terraces suggest middle to late Quaternary vertical fault displacements to 30 m.

Thrust faults have been identified at three localities in the McGrath B-3 Quadrangle. In two areas along the eastern margin of the quadrangle, middle and upper Paleozoic rocks (lDl, lDsh) lie structurally above Silurian sandstone (Ss). These thrusts are mapped more extensively to the east (Bundtzen and others, 1982). In the southeastern part of the quadrangle on the ridge west of Windy Fork, a small klippe of Lower Devonian dolomite (lDd) rests on the Silurian sandstone (Ss). These thrusts are the most prominent of numerous shear surfaces that formed subparallel to axial surfaces of the major subisoclinal folds.

ECONOMIC GEOLOGY

MINERALS

The Farewell region of the Alaska Range contains a large number of mineral occurrences south of the Farewell fault system. These are associated with Paleozoic strata and Cenozoic igneous complexes. At present most interest is directed to areas east and southeast of the McGrath B-3 Quadrangle.

COAL

Coal is present in Tertiary conglomerate (Tc) at several localities, but the most notable exposure is in a cutbank on Windy Fork (coal loc. 1). At this site, the outcrop is composed of nonmarine sedimentary rocks that include 190 m of coal and carbonaceous shale (fig. 4). Coal-rich intervals, containing about 50 percent or more coal, consist of numerous seams that range from 1 cm to 1 m thick. Samples from one of the seams that contains abundant yellow amber were barren of pollen (Rena MacFarland, oral commun., 1983); however, pollen has been obtained from Tertiary conglomerate in the Windy Fork area that yielded Eocene to middle Oligocene ages (Atlantic Richfield Company in-house report, 1980).

Eight coal samples from the Windy Fork section and one from a coal seam 17 km to the southwest (coal loc. 2) were submitted for laboratory analyses. The results are shown in tables 3 and 4. The samples range from lignite A to high volatile C bituminous when classified according to ASTM[1] standards and are low-rank bituminous when based on vitrinite reflectance (Ting, 1978).

Other mid-Tertiary(?) coals are found discontinuously along the Farewell fault system (Sloan and others, 1979; Solie and Dickey, 1982). These include deposits in the McGrath B-4 Quadrangle along the Middle Fork Kuskokwim River, about 4 km west of the McGrath B-3 Quadrangle; deposits in the McGrath A-5 Quadrangle along the Cheeneetnuk River, 75 km west of the McGrath B-3 Quadrangle; and deposits in the Talkeetna Quadrangle along the Little Tonzona River, about 150 km northeast of the McGrath B-3 Quadrangle. Of these, the Middle Fork exposure is the most likely stratigraphic equivalent of the McGrath B-3 coals. The outcrop consists of at least 35 m of coal and carbonaceous shale in a conglomerate similar to that found in the McGrath B-3 Quadrangle (Solie and Dickey, 1982).

[1]American Society for Testing and Materials.

Table 1. *Engineering properties of selected Quaternary units, McGrath B-3 Quadrangle, southwestern Alaska*

Map unit	Description	Topography	Drainage	Permafrost	Frost susceptibility	Slope stability	Bearing strength	Possible uses	Avoidances
Alluvium, undifferentiated (Qa)	Poorly to well-sorted fluvial silt to small boulder gravel of fans, terraces, and trunk and tributary streams. May grade into distal outwash (Qdo) deposits	Horizontal to gently sloping surfaces. Older surfaces may be dissected, and mantled with eolian and colluvial deposits. Older, uplifted, deformed terrace and pediment surfaces commonly consist of a thin veneer of alluvium only	Good in recently deposited alluvium above stream level; fair to poor in older alluvium where permafrost has developed and where covered by silty colluvium and peat	Absent in younger deposits; occasionally present in older deposits mantled with silt and peat	Minimal in well-drained modern alluvium; may be moderate to intense in permafrost-bearing active layer mantled with silt and peat	Generally stable, except ice-rich permafrost-bearing deposits subject to thaw instability and areas adjacent to cutbanks or free faces, where sudden, rapid collapse may occur due to stream erosion or surface loading	Good to fair	Thawed, well- to moderately sorted alluvium generated by larger streams useful as source of sand and gravel	Older terrace and fan deposits that contain permafrost and have significant cover of eolian, organic, or colluvial sediments
Terrace alluvium (Qat)	Poorly to moderately well sorted fluvial silt, sand, and gravel above flood plains of active streams	Horizontal to gently sloping surface, except for older deposits that have been tectonically deformed, resulting in exaggerated surface tilt. Older surfaces may also be dissected, and mantled with eolian and colluvial deposits	Good in younger permafrost-free deposits without significant cover of organic silt	Present discontinuously in older deposits. May be ice rich in organic silt or where silt infiltrated into gravels by percolating ground water	Terrace gravels generally not susceptible to heave, but occurs in organic silt that caps older terrace alluvium	Generally stable, except free faces and ice-rich permafrost-bearing deposits. Fill terraces may be subject to slumping and rapid erosion along stream cuts and free faces; strath terraces may be susceptible to slumping along stream cuts	- -	Terraces along larger streams and rivers are generally the most productive materials sites	Large, ancient strath terraces in west-central part of quadrangle where streams breach foothills. These terraces have a much thinner veneer of gravel
Alluvial-fan deposits (Qaf)	Fluvial sediment that forms fan-shaped deposits. May be of two types: 1) poorly to moderately sorted, coarse-grained sediment interbedded with discontinuous beds of finer grained material. Deposited where steep low-order streams emerge into trunk valleys. Deposits subject to large, rapid fluctuations in stream discharge; and 2) moderately sorted, medium-to coarse-grained material that becomes finer and better sorted distally. Deposited where mountain streams emerge onto a gentle piedmont slope	Mountain fans (type 1) slope 1.5° to 5° (average 2°) and are commonly vegetated, except on highly active fans. Both stable and aggrading fans contain numerous abandoned channels. In places, fans are deeply dissected due to fluctuating base level or diminished sediment supply. Surface area of mountain fans generally less than 4 mi² (6.5 km²). Piedmont fans (type 2) are broad and slope 2° or less. They are also scarred by numerous abandoned channels. Near northern boundary of quadrangle, loess, sand, and peat locally accumulate on fan surfaces. Surface areas of piedmont fans generally greater than 4 mi² (6.5 km²)	May be inhibited in older, inactive fans	May be present in older, inactive fans at higher elevations or those mantled by appreciable thickness of silt and organic material	Frost stable, except silt and organic material on old fan surfaces, especially where shallow zones of permafrost inhibit drainage	Generally stable, except where overburden is susceptible to frost heaving. Permafrost-bearing, silt-mantled fans are stable where kept frozen, if excess ground ice is absent	Good	Younger fans are good source of aggregate sand and gravel. In general, fans are suitable construction sites, except where susceptible to mudflow or avalanche	Very steep, short tributaries, where potential for mudflow is greatest; and older fans mantled with silt and organic material, which may be frozen or have high interstitial silt content
Colluvial-alluvial deposits (Qca)	Poorly to moderately sorted, interbedded colluvial and alluvial material that forms steep fan- and apron-shaped deposits. Generally found on valley floors and piedmont slopes, where steep-gradient ephemeral streams merge with higher order streams	Similar to, but generally steeper and smaller than, alluvial fans	Moderate. Deposits subject to avalanche and torrential flooding during periods of snowmelt or heavy precipitation	Common along north-facing slopes, especially in older deposits. Percentage of segregated ice may be high where silt and organics are prevalent	High in deposits with high silt content and poor drainage	Thaw unstable where perenially frozen or where containing excess ice. Deposits of predominantly silty material susceptible to creep, especially where saturated by near-surface ground water, such as springs along faults	Variable, but generally fair to poor	Local pods or lenses in fans may be source of small quantities of moderately sorted, gravel-rich fluvial sand	Fan surfaces, which may be subject to avalanche, mudflow, subsidence, and local liquefaction. Caution should be exercised during excavation and construction activities
Colluvium, undifferentiated (Qc)	Generally unsorted, unstratified to crudely stratified deposits derived from mass-wasting processes, such as solifluction and landslide. Include talus and mixed slope colluvium. Deposits that resulted from episodic mass movement may be interbedded with surface organics or thin layers of fluvial sediment	Variable, ranging from hummocky lobes (landslide debris) to very steep cones and aprons with smooth, convex-upward profiles (talus). Some cones have been channelized by mudflows	Variable, depending on percentage of silt- to clay-sized material and stage of permafrost development	Present in toes of thick talus accumulations, sometimes with significant interstitial ice, and in talus that grades into rock glaciers containing permafrost; present discontinuously in deposits at lower levels of north-facing slopes	High in deposits that contain large proportions of silt or organic silt	Steep colluvial deposits, such as talus aprons at or near angle of repose, generally unstable. In addition, talus subject to snow avalanches, mudflows, and rock falls	Variable, but generally fair to poor	Generally unsuitable as materials source, although finer grained colluvium may be used as fill	Deposits that show signs of recent deposition or shifting. These should not be used as building sites
Till (Qdt)	Unsorted, unstratified drift deposited by glacial ice as ground, terminal, and lateral moraines Cobble- and boulder-size clasts subangular to subrounded, polyhedrally faceted, and lithologically varied, representing wide variety of sources up valley. Till units vary in composition, depth of weathering, and surface morphology because of age, aspect, elevation, exposure, vegetation, and dominant clast types, all of which control ratio and duration of surface modification. Thickness of unit ranges from few centimeters to greater than 60 m	Varies with age, slope, aspect, elevation, and vegetation: pre-Wisconsin till subdued to completely masked; early Wisconsin till commonly blanketed with peat and eolian deposits but exhibits subdued hummocks and wholly or partially filled kettles; and late Wisconsin till discontinuously covered with peat and loess, showing primary morainal morphology	Integrated in pre-Wisconsin till; moderately integrated in early Wisconsin till; and poorly integrated in late Wisconsin till	Widespread in till covering foothills plateau in southwestern part of quadrangle near Middle Fork. In areas with thick peat development, permafrost table lies about 1 m below surface of deposit; interstitial ground ice masses common throughout upper 5 m of deposit, especially in areas of thick peat and loess cover	Subject to moderate to intense seasonal frost heave. May be thaw unstable following surface disturbance if deposit contains ice-rich permafrost	Stable in permafrost areas if kept frozen. Subject to failure where saturated or where oversteepened by stream erosion. Areas of recent forest fires show development of ponds and thaw depressions. Ponds especially pronounced 0.5 to 5 km east of Windy Fork on early Wisconsin moraines	Good in permafrost-free till on low to moderate slopes with no appreciable peat and loess accumulation; poor in thawed, thick peat mantle along cutbanks and steep valley walls	Poor source of clean sand and gravel because of poor sorting and variable clay and silt content. Till commonly overlies outwash gravels, which may be extracted if shallow	- -
Outwash (Qdo)	Stratified drift deposited by glacial meltwater in channels and as large fans and terraces. Deposits become finer grained and better sorted with increasing distance from source, eventually becoming indistinguishable from nonglacial alluvium. Material proximal to source consists of cobble and boulder gravel and stringers of silt and sand. Cut-and-fill structures and clast imbrication can be seen in cutbanks and test pits	Gently sloping, relatively flat surfaces that exhibit abundant braided channel scars, often accentuated by differences in vegetation. In northwest part of quadrangle, peat and eolian material, including sand sheets and small local dunes, mask much original morphology	Good where outwash gravels are at or near surface of deposit; very poor where overlying peat and silt promoted permafrost development and near springs where water table is close to ground surface	Sporadic, occurring where accumulations of peat and organic silt promoted development of segregated ice. Ice typically limited to fine-grained overburden	None, unless thickly mantled by silty organic material	Stable, except cutbanks along active streams	Good in gravel below peat and silt overburden	Good materials source, although may need mechanical sizing for some applications because of poor to moderate sorting. Provides good foundation where peat and silt overburden is stripped or absent	Cutbanks along active streams. These may slough; thus are not recommended for structure sites

Table 2. *K-Ar analyses[a] for selected rock samples, McGrath B-3 Quadrangle, southwestern Alaska*

Map (field) no.	1(81WG162)	2(81DB337)
Map unit	Tva	Tia
Mineral dated	Whole rock	Whole rock
K (%)	2.25	1.65
Sample wt (g)	0.82381	0.58985
$\frac{^{40}Ar^*}{(moles/g) \times 10^{-10}}$	0.1466	1.3178
$\frac{^{40}Ar^*}{^{40}K \times 10^{-3}}$	2.18	2.68
$\frac{^{40}Ar^*}{^{40}Ar\ (total)}$	0.20	0.42
Age[b] ± 1σ (m.y.)	37.2 ± 2.9	45.5 ± 1.4

[a]Analyses by Daniel Krummenacher and Donna Martin, San Diego State University, San Diego, California.
[b]Constants used in age calculations: $\lambda_\epsilon = 0.581 \times 10^{-10}\ yr^{-1}$; $\lambda_\beta = 4.962 \times 10^{-10}\ yr^{-1}$; and $^{40}K/K_{total} = 1.167 \times 10^{-4}$ mol/mol.
*Radiogenic isotope.
σStandard deviation.

Table 3. *Proximate and ultimate analyses for 1.6-specific-gravity float samples of coal and lignite from Tertiary conglomerate (Tc), McGrath B-3 Quadrangle, southwestern Alaska. Modified from Solie and Dickey (1982)*

Map no.	Field no.	Basis[a]	Heating value (Btu/lb)	Proximate analyses (%): Moisture	Volatile matter	Fixed carbon	Ash	Ultimate analyses (%): Carbon	Oxygen	Hydrogen	Nitrogen	Sulfur: Pyritic	Total	Caloric value limits (Btu/lb)[b]	Rank[c]
1	81DB126	2	9,482	13.24	29.37	46.88	10.51	56.33	31.42	5.10	1.41	0.12	0.33	10,725.5	Subbituminous A
		3	10,929	- -	33.85	54.04	12.11	64.93	20.95	4.17	1.62	0.14	0.38		or high volatile
		4	12,435	- -	38.52	61.48	- -	73.88	19.09	4.75	1.84	0.15	0.44		C bituminous
1	81DB135	2	8,912	10.77	31.18	39.96	18.09	51.69	27.57	4.90	1.93	0.15	0.72	11,135.9	Subbituminous A
		3	9,988	- -	34.94	44.78	20.27	57.93	18.83	4.14	2.16	0.16	0.80		or high volatile
		4	12,567	- -	43.83	56.17	- -	72.66	18.83	5.19	2.71	0.21	1.01		C bituminous
1	81DB139C	2	9,841	11.48	32.08	45.54	10.90	57.39	29.46	5.28	1.64	0.23	0.61	11,189.4	Subbituminous A
		3	11,117	- -	36.24	51.44	12.31	64.83	20.31	4.51	1.86	0.26	0.69		or high volatile
		4	12,678	- -	41.33	58.67	- -	73.93	18.02	5.15	2.12	0.30	0.79		C bituminous
1	81DB139D	2	9,990	12.79	30.72	48.87	7.62	58.87	31.19	5.28	1.81	0.04	0.51	10,910.0	Subbituminous A
		3	11,455	- -	35.23	56.04	8.74	67.51	21.10	4.41	2.07	0.04	0.59		or high volatile
		4	12,552	- -	38.60	61.40	- -	73.97	18.29	4.83	2.27	0.05	0.65		C bituminous
1	81DB139F	2	10,808	9.58	33.16	49.41	7.85	62.46	27.81	5.32	1.37	0.04	0.51	11,836.1	High volatile C
		3	11,953	- -	36.67	54.64	8.68	69.08	20.16	4.70	1.52	0.04	0.56		bituminous
		4	13,089	- -	40.16	59.84	- -	75.64	16.93	5.15	1.66	0.04	0.62		
2	81DB329A	2	6,709	26.42	30.99	32.09	10.50	42.27	45.25	5.66	1.65	0.06	0.33	7,587.9	Lignite A
		3	9,118	- -	42.12	43.61	14.27	57.45	25.59	3.67	2.24	0.09	0.45		
		4	10,636	- -	49.13	50.87	- -	67.01	25.57	4.28	2.61	0.10	0.52		
1	DNS-1	1	5,771	8.39	21.69	23.52	46.40	32.05	16.61	3.60	1.06	0.14	0.28	- -	- -
		2	5,883	6.61	22.11	23.97	47.30	32.67	15.21	3.45	1.08	0.14	0.28		
		3	6,299	- -	23.68	25.67	50.65	34.99	12.90	2.90	1.16	0.15	0.30		
		4	12,765	- -	47.98	52.02	- -	70.89	20.25	5.89	2.35	0.31	0.12		
1	DNS-2	1	6,415	9.68	24.66	28.13	37.54	37.52	19.39	4.09	1.07	0.13	0.40	- -	- -
		2	6,584	7.30	25.31	28.87	38.53	38.51	17.56	3.90	1.10	0.13	0.41		
		3	7,103	- -	27.30	31.14	41.56	41.54	15.27	3.33	1.19	0.14	0.44		
		4	12,154	- -	46.71	53.29	- -	71.09	20.44	5.69	2.03	0.24	0.75		
1	DNS-3	1	6,120	8.29	24.60	26.19	40.92	36.46	17.07	3.96	1.21	0.17	0.38	- -	- -
		2	6,170	7.54	24.80	26.40	41.26	36.76	16.49	3.90	1.22	0.17	0.38		
		3	6,673	- -	26.82	28.56	44.62	39.75	13.89	3.30	1.32	0.18	0.42		
		4	12,051	- -	48.43	51.57	- -	71.78	19.12	5.96	2.38	0.33	0.75		

[a]1 = as received; 2 = equilibrium bed moisture; 3 = moisture free; and 4 = moisture and ash free.
[b]Analyses on moist, mineral-matter-free basis.
[c]Base on classification adopted by American Society for Testing and Materials (ASTM).
- - = Not determined.

Table 4. *Float-and-sink analysis[a] of raw coals from McGrath B-3 Quadrangle, southwestern Alaska. After Solie and Dickey (1982)*

Map no.	Field no.	Product	Weight (%)	Moisture[b] (%)	Ash[b] (%)
1	81DB126	Float	75.26	3.79	11.65
		Sink	24.74	1.91	58.00
		Raw coal (calculated)	100.00	3.32	23.12
1	81DB135	Float	24.12	2.98	19.67
		Sink	75.88	2.26	58.15
		Raw coal (calculated)	100.00	2.43	48.87
1	81DB139C	Float	61.03	4.15	11.80
		Sink	38.97	2.51	60.15
		Raw coal (calculated)	100.00	3.51	30.64
1	81DB139D	Float	78.22	3.40	8.44
		Sink	21.78	1.64	58.65
		Raw coal (calculated)	100.00	3.02	19.38
1	81DB139F	Float	43.29	2.44	8.47
		Sink	56.71	1.49	63.81
		Raw coal (calculated)	100.00	1.90	39.85
2	81DB329A	Float	17.67	6.22	13.38
		Sink	82.33	3.04	56.14
		Raw coal (calculated)	100.00	3.60	48.58

[a]Coals separated at 1.6 specific gravity.
[b]Analyses on air-dry basis.

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Table 5. *Major-oxide analyses[a] and CIPW normative mineralogy for selected igneous rocks, McGrath B-3 Quadrangle, southwestern Alaska*

Map no.	1	2	3	4	5	6	7	8	9	10	11
Field no.	81WG34a	81DNS234	81DNS179	81DNS179a	81DNS180c	81WG10b	81WG14	81DNS190a	81WG163	81DNS181a	81DNS181b
Sample	Tvr	Tva	Tva	Tva	Tva	Tim	Tia	Tva	Tvr	Tvr	Tvr
Major oxides (wt%)											
SiO_2	72.10	47.75	62.95	67.44	54.52	46.16	60.16	59.21	77.06	75.79	73.88
TiO_2	0.12	1.45	0.76	0.64	2.15	1.61	0.69	0.78	0.07	0.09	0.10
Al_2O_3	13.74	16.75	15.63	14.06	17.29	16.73	15.97	16.84	12.21	12.09	12.80
Fe_2O_3	0.27	2.09	2.09	1.18	2.04	3.33	2.05	2.45	0.07	0.19	0.30
FeO	1.57	7.34	3.06	2.80	5.31	6.17	2.94	2.80	0.60	0.86	0.58
MnO	0.05	0.18	0.09	0.08	0.09	0.15	0.11	0.12	0.04	0.02	0.03
MgO	0.07	7.95	1.24	1.03	1.52	6.81	2.72	2.77	0.20	0.09	0.11
CaO	0.31	10.10	2.34	2.39	4.50	10.67	4.20	5.66	0.30	0.41	0.55
Na_2O	3.84	2.73	4.39	3.18	4.33	2.71	3.92	2.85	3.36	3.32	3.85
K_2O	5.03	0.75	3.87	3.50	3.54	0.35	1.93	2.12	4.03	4.62	5.02
P_2O_5	0.06	0.26	0.28	0.20	0.64	0.28	0.24	0.32	0.07	0.13	0.07
H_2O^-	0.02	0.10	0.15	0.17	0.04	0.18	0.09	0.09	0.04	ND	ND
LOI[b]	0.59	2.35	0.75	1.81	1.51	3.76	3.96	2.48	0.84	0.47	0.41
Total	97.77	99.80	97.60	98.48	97.48	98.91	98.98	98.49	98.89	98.08	97.70
CIPW norms (wt%)[c]											
Quartz	28.75	- -	15.25	27.97	3.74	- -	16.33	18.23	40.89	37.56	30.81
Orthoclase	29.72	4.43	22.87	20.68	20.92	2.07	11.40	12.53	23.81	27.30	29.66
Albite	32.49	23.10	37.15	26.91	36.64	22.93	33.17	24.12	28.43	28.09	32.58
Anorthite	1.15	31.23	9.78	10.55	17.29	32.45	19.27	25.99	1.03	1.18	2.27
Nepheline	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Diopside	- -	13.90	- -	- -	0.71	14.98	- -	- -	- -	- -	- -
Hypersthene	2.72	6.58	5.89	5.83	8.11	8.96	9.54	8.95	1.50	1.53	0.98
Olivine	- -	11.73	- -	- -	- -	5.04	- -	- -	- -	- -	- -
Magnetite	0.39	3.03	3.03	1.71	2.96	4.83	2.97	3.55	0.10	0.28	0.43
Hematite	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Ilmenite	0.23	2.75	1.44	1.22	4.08	3.06	1.31	1.48	0.13	0.17	0.19
Apatite	0.14	0.60	0.65	0.46	1.48	0.65	0.56	0.74	0.16	0.30	0.16
Corundum	1.56	- -	0.64	1.17	- -	- -	0.37	0.33	1.94	1.19	0.20
Sphene	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

Map no.	12	13	14	15	16	17	18	19	20	21
Field no.	81WG214	81DNS131a	81DNS191	81DNS217	81WG92	81WG91a	81DNS116a	81WG168a	81DNS153	81DNS220
Sample	Tif	g	Tif	Tia	Tif	g	Tif	Tim	Tia	Tim
Major oxides (wt%)										
SiO_2	70.41	47.29	71.17	59.57	75.86	45.39	74.14	46.72	56.36	48.92
TiO_2	0.29	0.69	0.26	0.74	0.14	2.79	0.16	3.21	0.97	2.99
Al_2O_3	14.12	15.51	14.07	16.69	13.24	18.37	13.54	15.48	15.91	16.00
Fe_2O_3	0.11	1.55	0.59	2.05	1.80	2.49	0.93	2.24	2.16	4.31
FeO	0.09	7.08	1.03	2.75	0.16	9.63	0.11	10.42	4.61	6.92
MnO	0.01	0.17	0.02	0.14	0.04	0.14	0.01	0.23	0.13	0.19
MgO	0.01	8.95	0.15	1.77	0.07	4.29	0.05	3.34	4.71	3.77
CaO	1.27	11.00	0.42	5.74	0.56	3.53	0.25	7.58	5.93	8.38
Na_2O	2.69	3.09	4.78	3.98	3.20	5.38	4.73	3.46	3.92	2.50
K_2O	5.88	0.59	4.82	1.77	2.61	0.49	3.51	2.14	1.38	1.54
P_2O_5	0.06	0.16	0.07	0.29	0.07	0.45	0.06	0.99	0.33	0.97
H_2O^-	0.59	ND	ND	0.05	0.12	0.03	0.04	0.14	0.10	0.70
LOI[b]	1.97	3.38	0.29	1.96	1.35	4.05	0.79	2.01	2.79	1.45
Total	97.50	99.46	97.67	97.50	99.22	97.03	98.32	97.96	99.30	98.64
CIPW norms (wt%)[c]										
Quartz	29.83	- -	23.53	15.33	46.15	- -	32.77	- -	8.25	7.15
Orthoclase	34.75	3.49	28.48	10.46	15.42	2.90	20.74	12.65	8.15	9.10
Albite	22.76	21.09	40.45	33.68	27.08	45.52	40.02	29.28	33.17	21.15
Anorthite	5.29	26.70	1.63	22.45	2.32	14.57	0.76	20.39	21.74	27.89
Nepheline	- -	2.74	- -	- -	- -	- -	- -	- -	- -	- -
Diopside	- -	21.70	- -	3.35	- -	- -	- -	9.02	4.46	5.95
Hypersthene	0.02	- -	1.38	5.17	0.17	0.61	0.12	3.12	14.90	11.08
Olivine	- -	16.43	- -	- -	- -	15.75	- -	9.73	- -	- -
Magnetite	- -	2.25	0.86	2.97	0.24	3.61	- -	3.25	3.13	6.25
Hematite	0.11	- -	- -	- -	1.63	- -	0.93	- -	- -	- -
Ilmenite	0.21	1.31	0.49	1.41	0.27	5.30	0.25	6.10	1.84	5.68
Apatite	0.14	0.37	0.16	0.67	0.16	1.04	0.14	2.29	0.76	2.25
Corundum	1.39	- -	0.39	- -	4.30	3.65	1.68	- -	- -	- -
Sphene	0.44	- -	- -	- -	- -	- -	0.06	- -	- -	- -

[a]Analyzed with X-ray fluorescence by DGGS Minerals Laboratory.
[b]Loss on ignition.
[c]Calculated to anhydrous oxide total.
ND = Not detected.
- - = Not present in norm.

Available from Alaska Division of Geological and Geophysical Surveys, 3700 Airport Way, Fairbanks, 99709, and 400 Willoughby Avenue (3rd floor), Juneau, 99801. Also available from U.S. Geological Survey, Public Information Office, 701 C Street, Anchorage, 99513, and Information Specialist, 4230 University Drive, Room 101, Anchorage, 99508. Mail orders should be addressed to the DGGS office in Fairbanks.

SUPPLEMENTAL DATA FOR GEOLOGIC MAP OF THE MC GRATH B-3 QUADRANGLE, ALASKA

By

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1989