Base by U.S. Geological Survey, 1954. Universal Trans-

1000'-

SEA LEVEL-

Approximate mea

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concentrates from placers of Julian, Moore, and Candle Creeks and

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The McGrath D-6 Quadrangle lies on the eastern edge of the Kuskokwim Mountains, a maturely dissected upland of accordant rounded ridges and broad lowlands. Two highlands, the Candle Hills and Takotna Mountain, are surrounded by sediment-filled troughs of the Takotna, Tatalina, and Kuskokwim River

INTRODUCTION

valleys. Elevations range from 300 to 2,600 ft. This report is the result of 40 man-days of reconnaissance geologic mapping in 1977, 1978, and 1982. Bedrock exposures were mapped on foot and by boat. Four-fifths of the quadrangle is covered by Quaternary deposits, which have been subdivided on the basis of a photogeologic reconnaissance and limited field checking. For further detail, see Fernald (1960) and Kline (1983).

The oldest exposed bedrock is part of a 6,500-ft-thick section of sublithic sandstone, shale, and conglomerate of the Kuskokwim Group (Cady and others, 1955). Upper Cretaceous volcano-plutonic complexes intrude and overlie the clastic sedimentary rocks at Takotna Mountain and Candle Hills. In both areas, ellipitical piles of andesite and basalt flank and overlie monzonitic plutons. Contact relationships suggest the volcanic strata were partially assimilated by underlying intrusive masses along concentric and linear high-angle fault zones. Monzonitic stocks are surrounded by extensive hornfels aureoles developed in both clastic sedimentary and overlying volcanic rocks.

intrusive rocks range from diorite to syenite, augite-biotite monzonite is the most common variety. Potassium-argon dating (table 1) and whole-rock chemistry (table 2) suggest alkalic trends, particularly for the volcanic suites of the coeval Upper Cretaceous complexes at Takotna Mountain and Candle Creek. The seven analyzed igneous-rock samples lack normative quartz and corundum but contain normative olivine; three of five volcanic samples contain nephe-

Volcanic units range in composition from rhyolite to basalt, but porphyritic and nonporphyritic varieties of pyroxene andesite predominate. While

All bedrock units have been deformed by chevron to open folding with northeast-trending axes. This deformation is better observed in the Iditarod D-1 Quadrangle (Bundtzen and Laird, 1983). High-angle, northeast-trending fractures formed in Late Cretaceous time are inactive, but similar features to the west, including the Nixon-Iditarod fault, show evidence of more recent activity. The northeast linear trend of the topography and drainages may be controlled by similar prominent fractures, or by the strike of sedimentary rock units.

Although the study area was not glaciated during Pleistocene time, glaciers from the Alaska Range probably approached within 30 mi of McGrath. During several glacial maxima, debris-laden glacial streams deposited silt, sand, and gravel on the Kuskokwim River flood plain, and strong winds blanketed much of the area with sand and loess from sources to the east and southeast(?). Modern rivers meander through the lowlands and form narrow, active flood plains, abandoned oxbow-lake marshes, and point-bar deposits. Small drainages such as Candle and Porcupine Creeks deposit aprons of material as they emerge from upland source areas. Widespread deposits of organic-rich silt and peat are accumulating over much of the lowland areas, and thermokarst processes actively modify all surficial deposits except those on steep slopes or in active alluvial channels.

## MINERAL RESOURCES

In 1913, gold deposits on Candle Creek were discovered by Louis Blackburn and Bert Eldridge, who by 1915 were mining gold from shallow, residual

Principal mineral resources in the quadrangle include gold, silver, mercury, sand and gravel, and peat. Gold production has been of primary importance in past years, mainly from placer deposits on Candle and Carl Creeks.

placers at the head of the creek. In 1916-17, a 4-ft<sup>3</sup>, diesel-driven stacker dredge was constructed by the Kuskokwim Dredging Company to mine the placers on Candle Creek. The dredge was operated in 1918, but encountered problems with clay and large (4-ft-diameter) igneous boulders in the paystreak. By 1919, the dredge successfully operated an entire season and became the largest producer of placer gold in the Kuskokwim River drainage. The largest output occurred in 1922, when the dredge recovered 21,400 oz gold and 2,000 oz silver. By 1926, problems with thick overburden on the lower end of the creek and with clay caused the operation to cease. Available records indicate the dredge recovered at least 110,000 oz of gold from 1918 to 1926.

During the 1920s and 1930s, small nonfloat operations continued on Candle Creek. From 1938 to 1941, Strandberg and Sons successfully operated a dragline-equipped, nonfloat venture on the eastern limit of the paystreak, and in 1949 they rebuilt the old Kuskokwim Dredging Company dredge, which they operated through 1951 (Holdsworth, 1952). There is no record of gold production on Candle Creek since that time.

Through the 1920s and 1930s, Schuttler and Schuler intermittently ground-sluiced on Carl Creek south of Candle Hills (Wimmler, 1925; Smith, 1939),

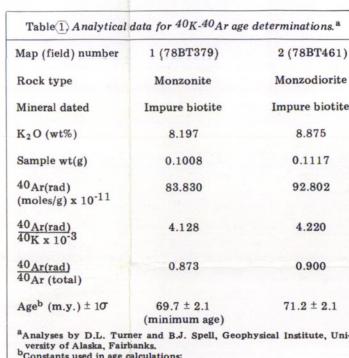
but records of activity are scant. According to available records, total production from both creeks is about 129,500 oz gold and 12,210 oz silver. Placers in the Candle Creek area are derived from a deeply eroded, mineralized contact zone between a monzonite plug and hornfelsed clastic rocks, a geologic setting that is remarkably similar to the Black Creek-Golden Horn mineralized area near Flat, 70 mi to the southeast (Mertie, 1936). Much upper Candle Creek ground is believed to be a residual placer deposit formed by in-place weathering of an underlying bedrock source with minimal to no downstream transport by alluvial processes. Gravel that overlies the contact near the head of the creek averages 9-15 ft thick, but thickens to over 100 ft less than 1 mi downstream. This feature, coupled with recognition of a prominent northeast-trending lineament in the Candle Creek valley, suggests subsidence along the monzonite-hornfels contact--perhaps along a shear zone or fault. According to Mertie and Harrington (1924), the richest ground was confined to the

headward part of Candle Creek, where the bedrock is monzonite; gold values drop off rapidly downstream in gravels overlying hornfelsed sedimentary rocks. Gold fineness varies from 900 to 910, and flour gold is rare. Very coarse, angular, 1- to 2-oz nuggets were common in cleanups (Smith, 1939). Heavy minerals identified from concentrates include cinnabar, scheelite, monazite(?), chromite, and zircon (White and Killeen, 1950). A 4-in-diameter cobble of cinnabar and interlocking euhedral quartz crystals was found on the Candle dredge tailings during recent investigations. Cinnabar has been recovered from the concentrate, retorted, and sold to local mine operators for mercury amalgam. The source of gold placers in Carl Creek is unknown. Sus-

pected sites of placer tailings are shown on the geologic map. Base-metal sulfide mineralization in the overlying hornfelsed volcanic strata and hornfelsed shale (table 3) suggests that the volcano-plutonic complex at Candle Creek contains varying degrees of mineralization.

Promising deposits of horticultural-quality peat in bog deposits near McGrath are discussed by Kline (1983). Coarse-grained point-bar deposits on the

Kuskokwim River (Qag) and dredge tailings at Candle Creek (Qht) could provide construction materials for the McGrath area.



Analyses by X-ray fluorescence, DGGS Minerals Laboratory

40K/K total = 1.19 x  $10^{-4}$  mol/mol.

Constants used in age calculations:  $\lambda \in 0.585 \times 10^{-10} \text{ yr}^{-1}$   $\lambda \beta = 4.72 \times 10^{-10} \text{ yr}^{-1}$ 

# Table (2) Major-oxide analyses and CIPW norms of igneous rocks.

Map number Field number	1 78BT461	2 78BT363 Porphyritic	3 78BT379	4 77BT234	5 78BT381	6 78BT356	7 78GL303 Basaltic
Rock type	Monzonite	basalt	Monzonite	Basalt	Basalt	Basalt	andesite
SiO <sub>2</sub>	55.40	51.40	55.10	49.80	53.00	51.30	56.40
$Al_2O_3$	16.60	16.40	17.00	17.20	16.20	16.30	17.60
Fe <sub>2</sub> O <sub>3</sub>	1.26	1.84	0.95	2.46	1.47	1.65	2.07
FeO	5.17	7.70	5.83	6.12	6.67	6.86	5.49
MnO	0.13	0.16	0.14	0.18	0.16	0.17	0.14
MgO	4.00	3.38	3.16	5.14	2.72	3.63	2.42
CaO	6.37	5.57	5.32	9.92	5.19	5.78	5.67
Na <sub>2</sub> O	3.43	3.55	3.80	2.50	4.48	3.12	4.06
K <sub>2</sub> O	3.78	4.33	4.07	2.04	4.16	5.02	4.62
TiO <sub>2</sub>	0.82	1.36	0.76	0.92	1.38	1.29	1.04
H <sub>2</sub> O	0.30	0.25	0.25	0.17	0.25	0.34	0.19
LOIp	0.47	0.78	1.10	0.26	1.17	1.64	0.12
Total	97.73	96.72	97.48	96.71	96.85	97.10	99.82
			Norn	ns			
Quartz	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthoclase	22.34	25.59	24.05	12.05	24.58	29.66	27.30
Albite	29.02	26.87	32.15	21.15	32.05	22.28	34.35
Anorthite	18.74	16.03	17.31	27.69	11.81	15.65	16.15
Nepheline	0.00	1.72	0.00	0.00	3.17	2.23	0.00
Diopside	10.54	9.68	7.55	15.92	11.65	10.79	9.95
Hypersthene	11.42	0.00	10.01	9.74	0.00	0.00	3.33
Olivine	0.53	10.56	2.24	2.40	7.42	9.66	3.44
Magnetite	1.83	2.67	1.38	3.57	2.13	2.39	3.00
Corundum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Differentiation							
index	51.36	54.18	56.21	33.21	59.81	54.18	61.65

\* Table 3. Description and analytical results of mineral occurrences and prospects, McGrath D-6 Quadrangle, Alaska (all values in ppm).

Map no. Field no. Au Ag Cu Pb Zn Ni Cr Co W V Zr 200 200 Gossan in amygdaloidal basalt. 14 75 50 ND 30 ND 500 200 Basalt. ND 0.7 78BT381 ND 0.2 48 11 67 ND ND 10 ND 500 200 Iron-stained contact zone, monzonite 78BT375 ND 0.6 313 107 72 20 20 20 ND 200 Gossan in basalt. 77BT243 0.03 12.9 240 18 68 17 NA NA NA NA NA Iron-stained basalt with sulfide-bearing epidote blebs. 78BT382a ND 1.4 169 130 246 50 ND 10 ND 200 500 Ferricrete gossan in hornfels-breccia zone. 77BT242 0.01 2.23 33 122 27 20 NA NA NA NA NA Gossan in border phase and hornfelscontact zone. Porphyritic basalt with visible chalcopyrite 78BT369 ND 0.4 173 9 65 50 20 ND ND 150 200 Hornfels breccia with manganese-iron vein-

77BT230 0.06 12.2 116 167 16 139 NA NA NA NA NA Sulfide nodules in shear zone of deformed

78BT462 ND 0.2 70 100 36 20 20 ND 200 500 Altered border phase, monzonite

Cretaceous sediments.

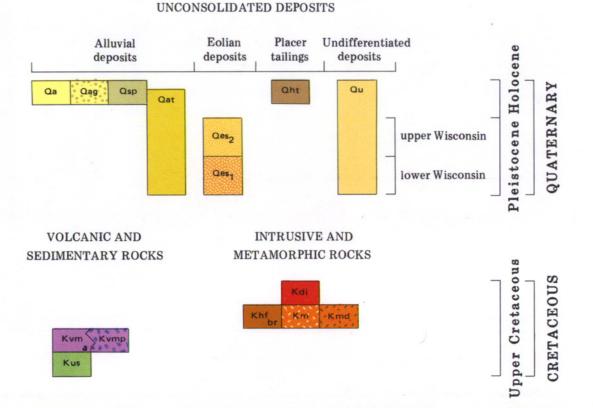
500 Altered porphyritic basalt.

Analytical work by M.R. Ashwell and N.C. Veach, DGGS Minerals Laboratory. Cu, Pb, Zn, Ag, Au, and Ni analyzed by atomic-absorption spectrophotometry. All remaining elements in 1978 samples (see field-number prefix) analyzed by emission spectrography. Underlined samples are considered anomalous. Be, Sn, Mo, Co, W, Sb, Bi, Zr, and Nb were below limits of detection in all rock samples; NA = not analyzed, ND = not de-

78BT467 ND 0.6 222 10 107 ND ND 20 ND 500

77BT238 0.02 4.10 78 8 102 47 NA NA NA NA NA Iron-stained hornfels.

CORRELATION OF MAP UNITS



### DESCRIPTION OF MAP UNITS

## UNCONSOLIDATED DEPOSITS

SANDY FLOOD-PLAIN ALLUVIUM - Unconsolidated, well-stratified layers of gray, finegrained sand, silty sand, and silt deposited by modern streams on flood plain. Locally interbedded with thin peat lenses and wood fragments. Covered by extensive pioneer to climax vegetation except in active channels and numerous oxbow lakes and marshes. Older areas may be perennially frozen.

COARSE-GRAINED FLOOD-PLAIN ALLUVIUM - Unconsolidated, well-stratified, gray, medium- to coarse-grained sand locally grading to sandy pebble gravel at depth. Usually confined to point bars of present or past channels of Kuskokwim River; deposits proximal to active channels shown. Generally thawed. Suitability as gravel resource discussed

SILT AND PEAT - Poorly stratified, black to brown, organic -rich, alluvial, lacustrine, or bog silt. Locally contains well-stratified peat lenses 6 in. to 5 ft thick. Bog silt mantled with vegetation and thin peat horizons. Water-saturated and undersaturated deposits not differentiated. Suitability of peat as a horticultural or energy resource discussed by Kline

TERRACE ALLUVIUM — Well-sorted, moderately stratified gravel and sand locally cemented by iron oxides; mainly deposited on alluvial and colluvial aprons but may be deposited on some strath terraces. Vegetated surfaces dissected by modern streams, mantled by eolian silt, and modified by thermokarst processes.

YOUNG DUNE SAND - Light-yellowish-brown to light-gray, well-sorted, fine- to medium-grained sand; where vegetated sand is generally gray. According to Fernald (1960), major mineralogical constituents include amphibole, chlorite, quartz, altered feldspar, and opaque minerals. Sand generally vegetated with incipient soil profile; contains small 'blowouts' locally. Increasingly oxidized near surface. Dune fields contain gently curved, parabolic, ridge-like, and V-shaped dunes and flat sandy plains. Ridge-like and parabolic forms generally trend northeast with steep (10-20°) northwest and gentle (5-10°) southeast slopes. Dune forms indicate a complex eolian history involving several possible prevailing wind directions; probably related to late Wisconsinan glaciation. Generally

OLD DUNE SAND - Light-yellowish-brown to gray, well-sorted, medium-grained sand miner alogically identical to, but more oxidized than Qes,. Dune forms significantly modified and characterized by thicker loess mantle, rounded to irregular-shaped hillocks, and flat sandy plains. Holocene stream dissection common; dune orientations generally not identifiable. Dissected dune field on Kuskokwim River 3 mi southeast of Candle landing is over 100 ft thick. Probably related to early Wisconsinan or older glaciation. Incipient soil horizon developed on all dune surfaces, with resultant forested slopes and plains. Generally thawed.

PLACER-MINE TAILINGS - Symmetrical to irregular stacked piles of sorted gravels; fine fractions artificially removed or diluted during placer-mining process. Contains approximately 60 percent intrusive, 35 percent volcanic, and 5 percent sedimentary float.

QUATERNARY DEPOSITS, UNDIFFERENTIATED — Unconsolidated alluvial, colluvial, and eolion deposits. Dominantly consists of mixed loess and colluvial rubble on lower ridges and valley slopes. Terrace escarpments mark break in slope with lower valley fill. Lower valley fill dominantly consists of eolian deposits substantially modified by stream dissection and thermokarst processes. Generally ice rich.

# VOLCANIC AND SEDIMENTARY ROCKS

MAFIC TO INTERMEDIATE VOLCANIC ROCKS - Dark-greenish-gray, aphanitic to fine grained olivine-pyroxene basalt and andesite, locally porphyritic with plagioclase, clinopyroxene, and olivine grains to 5 mm in diameter. Usually hornfelsed; contains tourmaline andalusite porphyroblasts and amygdules (a).

PORPHYRITIC VOLCANIC ROCKS — Dark-greenish-gray, porphyro-aphanitic, pyroxenepotassium feldspar basaltic andesite to dacite. Feldspar phenocrysts up to 2 cm long are usually zoned with calcic cores and sodic rims. SEDIMENTARY ROCKS, UNDIFFERENTIATED — Predominantly a heterogeneous package

of medium-grained lithic sandstone and siltstone with shale, siltstone, conglomerate, and

## INTRUSIVE AND METAMORPHIC ROCKS

DIKE - Medium-gray, aphanitic to very fine grained dike of intermediate composition:

HORNFELS OR METASOMATITE - Brown to gray, massive to porphyroblastic chlorite ± cordierite hornfels, locally tourmaline rich. Massive dark-gray varieties sometimes difficult to distinguish from aphanitic basalt; tourmaline-manganese breccia (br).

MONZONITE - Light- to medium-greenish-gray medium- to coarse-grained, porphyritic to locally equigranular, tourmaline-bearing biotite-augite monzonite. Feldspar phenocrysts commonly zoned within altered, finer grained groundmass. Color Index (CI) = 15-35; finegrained border phase (bp). Mertie (1936) reports olivine in Km in study area.

SEA LEVEL

Geology by T.K. Bundtzen and G.M. Laird, August

1978, August 1979, and September 1982. Reviewed by M. S. Robinson and J.T. Kline, Cartography by

ALASKA

Quadrangle location

MONZODIORITE — Medium- to dark-greenish-gray, coarse-grained, usually porphyritic tourmaline-augite-biotite monzodiorite; plagioclase-feldspar phenocrysts usually zoned with potassic rims and sodic cores; secondary biotite common; groundmass commonly

-? Contact, approximately located, queried

MAP SYMBOLS

High-angle fault - Dashed where ap proximately located, queried where questionable, dotted where concealed. U, upthrown side; D, downthrown side; arrows show direction of relative movement

where questionable

Photogeologic lineament

Strike and dip of foliation

Strike and dip of beds

Strike and dip of cleavage 10 - Trend and plunge of flow lineation

Strike and dip of joints Inclined Vertical (1) K-Ar age-date locality (table 1)

1) Major-oxide analysis (table 2)

1★ Mineral occurrence, prospect (table 3)

1983

# T.K. Bundtzen and G.M. Laird

GEOLOGIC MAP OF THE MC GRATH D-6 QUADRANGLE, ALASKA

SCALE 1:63,360

CONTOUR INTERVAL 100 FEET DATUM IS MEAN SEA LEVEL