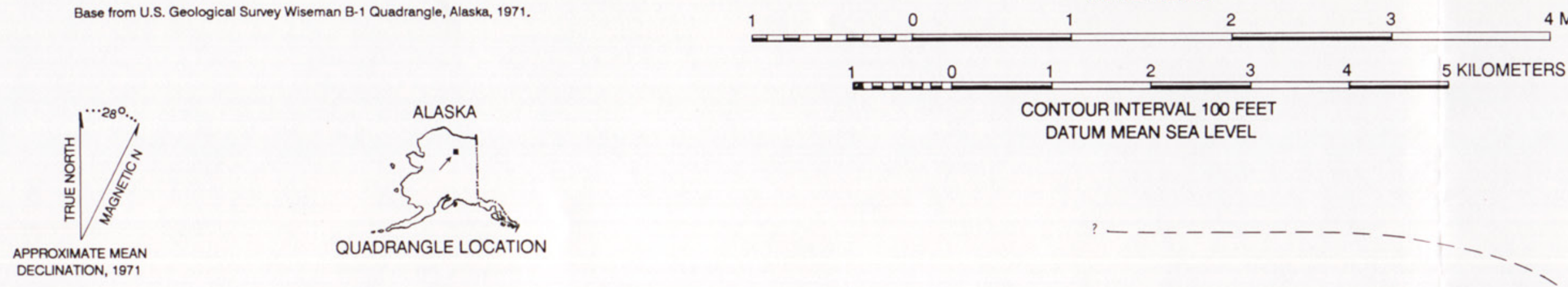
PR101-SH1

Base from U.S. Geological Survey Wiseman B-1 Quadrangle, Alaska, 1971.

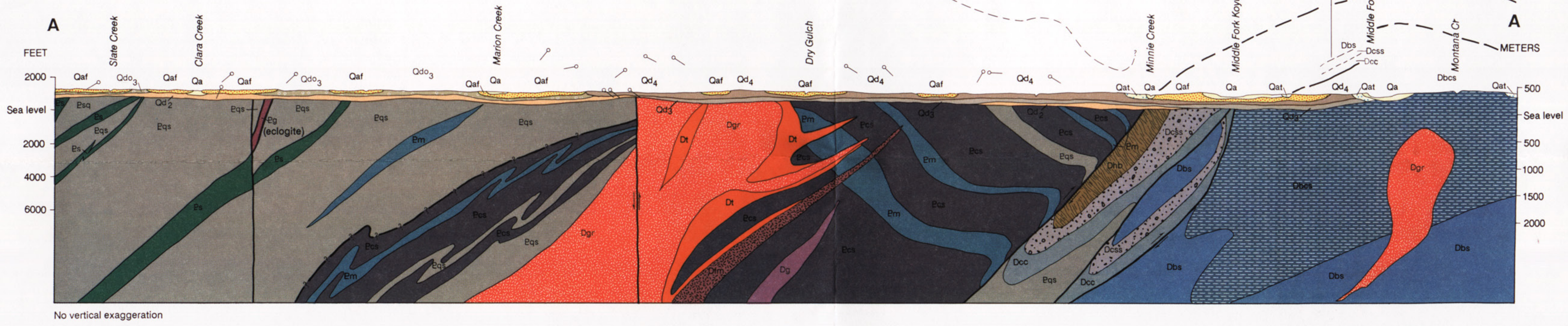


CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1971

QUADRANGLE LOCATION

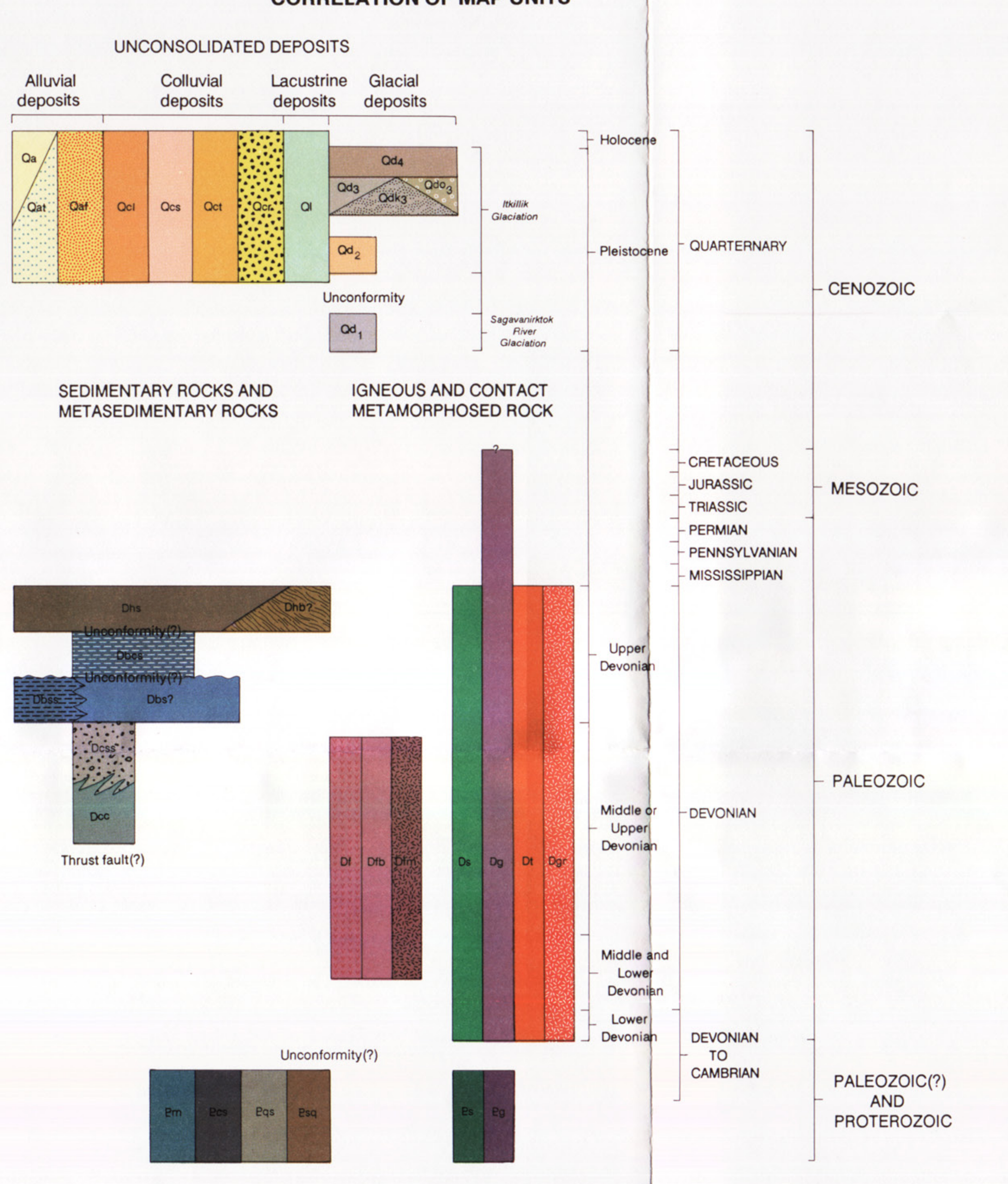
Geology by J.T. Dillon, 1981-1984; D.N. Solie, 1983-1984; P.A. Adler, 1983; D.D. Adams, 1982; G.M. Meyers, 1982; J.D. Blum, 1983; K.K. Lamal, 1984; Lisa Nicholson, 1984; R.R. Reifenstuhl, 1988; W.W. Patton, Jr., 1953; I.L. Tailleur, 1953; W.P. Brosge', 1959; H.N. Reiser, 1967. Western part of quadrangle modified from Dillon and others, 1986. Surficial geology modified from T.C. Hamilton, 1979. I thank D.N. Solie (DGGS) and W.P. Brosge' (USGS) for their thoughtful reviews. Cartography by A-L. Schell and A.G. Sturmann.



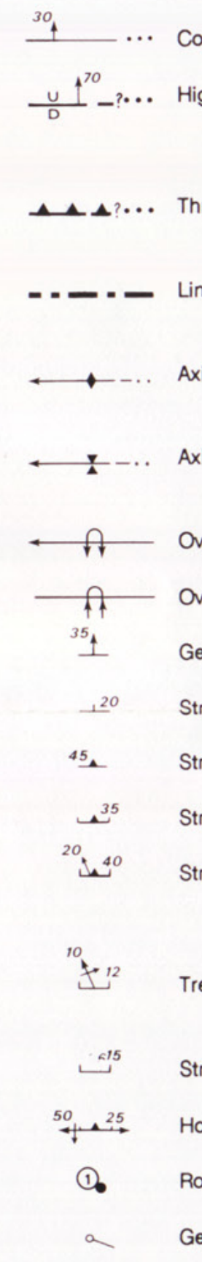
No vertical exaggeration

Final compilation, editing, and development of this map occurred after John Dillon's death, July 26, 1987. In his absence I have made every effort to maintain consistency with John's work and to continue his high geologic standards; however, I accept responsibility for any omissions or misinterpretations.
Rocky Reifenstuhl
Fairbanks, Alaska, February 1989

CORRELATION OF MAP UNITS



GEOLOGIC MAP SYMBOLS



Contact—Solid where located within 100 m; dotted where concealed; dip angle shown where measured

High-angle fault—Solid where located within 100 m; dashed where approximately located; dotted where concealed; queried where questionable; U, upthrown side, D, downthrown side; dip angle shown where measured

Thrust fault—Sawteeth on upper plate; solid where located within 100 m; dashed where approximately located; dotted where concealed; queried where uncertain

Lineament—Expressed in unconsolidated deposits (from Hamilton, 1979b)

Axis of antiform—Showing direction of dip of limbs and plunge of axis; dashed where approximately located; dotted where concealed

Axis of synform—Showing direction of dip of limbs and plunge of axis; dashed where approximately located; dotted where concealed

Overturned anticline—Showing direction of dip of limbs and plunge of axis

Overturned syncline—Showing direction of dip of limbs

Generalized strike and dip of planar structure, dip shown where measured

Strike and dip of bedding

Strike and dip of schistosity; S_1 = schistosity one, S_2 = schistosity two

Strike and dip of schistosity and parallel semipenetrative cleavage

Strike and dip of schistosity and parallel semipenetrative cleavage with plunge of asymmetric fold (af), isoclinal fold (if), crenulation (c), mineral lineation (m), and fold axis (f_1 = folding event one; f_2 = folding event two)

Trend and plunge of axis of asymmetric mesoscopic fold with axis in plane of schistosity; cross arrow indicates direction of rotation as viewed down fold axis

Strike and dip of cleavage

Horizontal lineation combined with other planar symbols

Rock-sample with major-oxide geochemistry—Number keyed to table 1

Generalized dip of schistosity on cross section

LOCATION INDEX

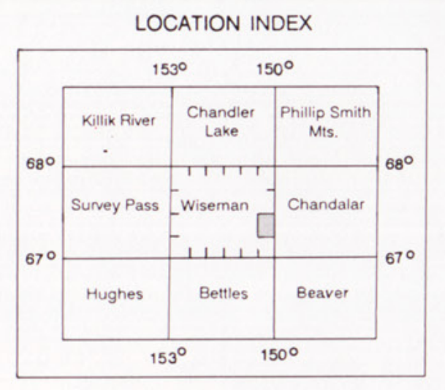


Table 1. *Major-oxide analyses and CIPW norms of rocks in the Wiseman B-1 Quadrangle, northern Alaska*

Map no.	1	2
Sample no.	83Dn247b	83Dn256
Rock unit	Ᵽg	Ᵽs
RMS		
SiO_2	49.33	46.92
Al_2O_3	13.77	16.47
Fe_2O_3	11.65*	11.07*
FeO	0.00	0.00
MnO	0.25	0.20
MgO	8.00	7.86
CaO	10.76	4.36
Na_2O	2.88	4.47
K_2O	0.04	0.02
P_2O_5	0.12	0.14
TiO_2	1.74	1.91
CO_2	0.00	0.00
LOI	2.05	6.56
H_2O^+	0.00	0.00
H_2O^-	0.00	0.00
FeO*	10.48	9.96
Adjusted Fe_2O_3	3.24	3.41
Adjusted FeO	7.56	6.89
TOTAL OF OXIDES	97.69	92.64
NORMATIVE MINERALS - CIPW (Normalized data used in all following calculations)		
Orthoclase	0.24	0.12
Albite	24.94	40.82
Anorthite	25.10	22.36
Corundum	- -	1.61
Diopside	23.18	- -
Hypersthene	17.61	17.07
Olivine	0.43	8.39
Magnetite	4.80	5.33
Ilmenite	3.38	3.91
Apatite	0.28	0.35
TOTAL	100.00	100.00
Wollastonite (diopside)	11.99	- -
Enstatite (diopside)	7.75	- -
Ferrosilite (diopside)	3.43	- -
Enstatite (hypersthene)	12.21	12.55
Ferrosilite (hypersthene)	5.40	4.52
Forsterite (olivine)	0.29	6.01
Fayalite (olivine)	0.14	2.38
Differentiation index	25.18	40.95

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*Total iron shown as Fe_2O_3
Oxides determined by atomic-absorption spectrophotometry. Analyst - N.C. Veach, DGGS Minerals Laboratory.
LOI = Loss on ignition

DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS
(modified from Hamilton, 1979a)

ALLUVIAL DEPOSITS

Qa ALLUVIAL DEPOSITS, UNDIFFERENTIATED — Poorly sorted, moderately stratified mixtures of gravel, sand, silt, and clay. Mostly modern alluvium.

Qat ALLUVIAL-TERRACE DEPOSITS — Poorly sorted, moderately stratified mixtures of sand and gravels. Form stream terraces.

Qaf ALLUVIAL-FAN AND FAN-DELTA DEPOSITS, UNDIFFERENTIATED — Fan-shaped deposits of poorly sorted, nonstratified, angular rock debris in alpine fans and poorly to moderately sorted, stratified mixtures of subangular gravel and sand in larger stream valleys. At lower end of fan-delta, deposits grade into lacustrine and deltaic sediments of well-sorted, stratified silt, sand, and fine gravel.

COLLUVIAL DEPOSITS

Qcl LANDSLIDE AND FLOW-SLIDE DEPOSITS, UNDIFFERENTIATED — Unsorted and nonstratified to poorly sorted and stratified, coarse to fine, angular rubble in matrix of finer rock debris. Form lobes below detachment scars, slide tracks, and steep rock walls. Locally include undifferentiated colluvium, mixed talus rubble, and solifluction deposits.

Qcs SOLIFLUCTION DEPOSITS — Very poorly sorted, nonstratified to weakly stratified sheets and aprons of stony, sandy silt and organic-rich silt, typically 1 m thick; active lobes subject to seasonal downslope movement.

Qct TALUS — Angular, unsorted, nonstratified, and generally unvegetated, unweathered rock debris. Forms cones and aprons along lower walls of mountain valleys and cirques. Includes active talus rubble and inactive talus rubble.

Qcr ROCK GLACIER DEPOSITS, ACTIVE AND INACTIVE — Very poorly sorted, nonstratified, coarse angular rock debris, commonly with matrix of silt and fine rubble. Form lobate and tongue-shaped deposits and may contain interstitial ice (active deposits).

LACUSTRINE DEPOSITS

Ql LACUSTRINE DEPOSITS-UNDIFFERENTIATED — Well-sorted, stratified silt and clay that contain scattered dropstones; grade into sand near shorelines and fine gravel near stream mouths.

GLACIAL DEPOSITS

Itkillik Glaciation

Qd$_4$ DEPOSITS OF LATE ITKILLIK PHASE II UNDIFFERENTIATED — Till, stratified ice-contact deposits, and outwash. Form sharp-crested end moraines and very irregular ground moraine, ice-stagnation deposits and aprons and valley trains in front of late Itkillik moraines in the northwestern part of the Wiseman Quadrangle. Loess cover generally absent, and exposed stones very slightly weathered. Sandy gravel of local outwash usually with thin (<0.3 m) silt and sod cover.

Qd$_3$ DRIFT OF ITKILLIK PHASE II — Till and stratified ice-contact deposits. Forms sharply defined drift lobes with conspicuous knob-and-kettle morphology associated with undissected channel outwash trains. Loess and solifluction cover thin to absent over crests and slopes; exposed stones slightly to moderately weathered.

Qdo$_3$ OUTWASH OF ITKILLIK PHASE II — Moderately well sorted, stratified, sandy gravel that contains subrounded cobbles and small boulders near moraine fronts and rounded pebbles downvalley. Forms terraced remnants of aprons and valley trains 15 to 25 m above modern flood plains in front of Itkillik Phase II moraines. Usually covered by <0.3 m of loess. Hamilton and others (1980) reported radiocarbon ages of 13,000 and 30,000 yr B.P. for these deposits.

Qdk$_3$ KAME AND KAME-TERRACE DEPOSITS OF ITKILLIK PHASE II — Moderately sorted sand, gravelly sand, and sandy gravel that is extensive and thick (>30 m) with commonly <0.2 m cover of silt, organic silt, and sod.

Qd$_2$ DRIFT OF ITKILLIK PHASE I — Very poorly to poorly sorted, nonstratified to weakly stratified drift that ranges from silty, sandy gravel to clayey, stony silt with local stratified ice-contact deposits that consist of moderately to poorly sorted sand, sandy gravel, and silty, sandy gravel; contains faceted and striated boulders.

Sagavanirktok River Glaciation

Qd$_1$ DRIFT — Poorly sorted, nonstratified drift that consists of silty, sandy gravel (with minor boulders) to clayey, stony silt with locally well-sorted, stratified gravel. Generally covered by blanket of loess, solifluction deposits, and muskeg deposits >3 m thick. Forms broad morainal ridges and hummocky ground moraine south of the Brooks Range. Hamilton (1979b) estimated a middle Pleistocene age for these deposits.

TWICE-METAMORPHOSED DEVONIAN SEDIMENTARY AND IGNEOUS ROCKS; MIDDLE TO UPPER GREENSCHIST FACIES

Dhs PELITIC SCHIST (UPPER DEVONIAN ?) — Black quartz schist; locally very dark gray, graphitic schist and chlorite-white mica-albite quartz schist with accessory graphite, apatite, ilmenite and tourmaline. Relict graded bedding, and sedimentary quartz and plagioclase porphyroclasts occur locally. In the Bluecloud Mountain area this pelitic schist contains quartz, white mica, chlorite, albite, and garnet, and locally may contain biotite. This unit is correlative with the Hunt Fork Shale which crops out in the Wiseman Quadrangle 'D' tier, 'C' tier, and 'B' tier (except in the B-1 Quadrangle, Dillon and others, 1986). The Upper Devonian Hunt Fork Shale in these quadrangles consists of black slate and phyllite, minor fossiliferous limestone, lithic wacke locally in upper part, and a basal quartz-chert-clast conglomerate and sandstone. The Hunt Fork Shale grades downward into the Middle and Upper Devonian Beaucoup Formation in some places; unconformably overlies upper Middle Devonian and older rocks in other places.

Dhb BLACK SCHIST — Black, fine-grained, rusty-orange-brown-weathering, biotite-bearing quartz schist and phyllite, with local thin, discontinuous marble layers. This unit crops out structurally below Proterozoic(?) or lower Paleozoic(?) calcareous schist unit (Ᵽcs).

Ds METAVOLCANIC ROCKS — Light-green and medium-green, fine- to medium-grained, schistose chlorite, epidote, and albite volcanic rocks. These basic volcanic rocks, which occur in lenses and layers in polymetamorphic rocks (Dcc; Dcss), probably represent flows and are mapped in the field as 'greenschists.'

Dcss CHLORITIC SANDSTONE AND CONGLOMERATE (MIDDLE TO UPPER DEVONIAN) — Gray-green chloritic quartz schist, calcareous quartz schist, and quartzite with interlayers of carbonate clast conglomerate.

Dcc CHLORITIC AND CARBONATE ROCKS (MIDDLE TO UPPER DEVONIAN) — Interbedded green and gray phyllite, chloritic calcareous metasandstone, and finely crystalline orange dolomitic marble; and local chloritic, calcareous schist, carbonate-clast conglomerate, and quartzite clast conglomerate. Commonly weathers green or orange.

BEAUCOUP FORMATION

BEAUCOUP FORMATION (MIDDLE TO UPPER DEVONIAN) — Carbonaceous, siliceous, and calcareous sedimentary and felsic volcanic rocks. The Beaucoup Formation (Dutro and others, 1977) grades laterally and downward into the Whiteface Mountain volcanic rocks (Dillon and others, 1986) and Skajit Limestone (Henning, 1982) and is laterally equivalent to the Ambler volcanic rocks (Dillon and others, 1986). Regionally, the Beaucoup Formation lies unconformably on lower Paleozoic rocks (Dutro and others, 1977; Dillon and others, 1986). Whiteface Mountain metavolcanic rocks are laterally equivalent to parts of the Beaucoup Formation, Skajit Limestone, and unnamed Middle Devonian siliceous clastic rocks (Dillon and others, 1986) which occur in the northwestern Wiseman C-1 Quadrangle and in the central and westcentral Wiseman 1° x 3° Quadrangle.

Dbcs CHLORITIC SILTSTONE (MIDDLE TO UPPER DEVONIAN?) — Limonitic, partly calcareous, banded quartz siltstone and dull gray phyllite with chlorite along foliation planes. Locally contains chloritic quartzite, sandstone, conglomerate, and limestone and marble interlayers. Correlative with graywacke and limestone of the wacke unit of Whiteface Mountain and with the Middle Devonian(?) siliceous clastic rocks (Dsc unit of Dillon and others, 1986).

BEAUCOUP FORMATION (?)

Dbss METASILTSTONE (DEVONIAN? OR OLDER) — Gray and black, laminated siltstone and locally black, partly calcareous phyllite and schist with thin calcareous interlayers.

Dbs BLACK SLATE AND PHYLLITE (DEVONIAN? OR OLDER) — Black, partly pink-weathering, partly calcareous, silty phyllite and slate with lenses of brown, finely crystalline dolomite and a few beds of black, very fine grained quartzite. Banded black and gray metasiltstone in lower part around Nolan Creek may include lower Paleozoic rocks.

FELSIC METAVOLCANIC ROCKS OF BOTH AMBLER VOLCANICS AND ROCKS OF WHITEFACE MOUNTAIN

Df FELSIC METAVOLCANIC ROCKS (DEVONIAN) — Light-colored, felsic flows, and airfall(?) tuff with interlayers of metasedimentary rocks; may contain albite + microcline + white mica ± biotite ± garnet. Equivalent to felsic portion of Ambler volcanic sequence and rocks of Whiteface Mountain (Dillon and others, 1986; Dillon and others, 1988a). Discordant U-Pb on six zircon separates from the eastern Wiseman and western Chandalar Quadrangles yields maximum Pb-Pb age of 378 ± 15 Ma, interpreted as equal to or slightly less than the magmatic crystallization age (Dillon and others, 1980). Includes light-colored, fine-grained, calcareous, chlorite-white mica-quartz-albite schist with accessory apatite, zircon, rutile, biotite, allanite, talc, and pyrite. Biotite is partially replaced by chlorite. Calcite content ranges from 3 to 20 percent, and more calcareous varieties grade along strike into calc schist and talc schist. Fine-grained, calcareous, felsic schist with intermixed calc-schist and talc schist may represent metamorphosed calcareous and bentonitic felsic tuffs. Calcareous metatuff was probably originally deposited in an oceanic environment. Felsic schist from the Wiseman A-6 Quadrangle yields a 365 ± 10 Ma Pb-Pb zircon age (Dillon and others, 1980).

Dfb FELSIC PORPHYROBLASTIC ROCKS (DEVONIAN) — Light-colored, medium-grained, albite-porphyroblastic intrusive rocks (button schist) with interlayers of metasedimentary rocks; may contain albite + microcline + white mica ± biotite ± garnet. This unit is part of the felsic portion of Ambler volcanics and rocks of Whiteface Mountain. May include light-colored, fine-grained, calcareous, chlorite-muscovite-quartz-albite schist with accessory apatite, zircon, rutile, biotite, allanite, talc, and pyrite. Biotite is partially replaced by chlorite.

Dfm METAMORPHOSED BIMODAL IGNEOUS ROCKS (DEVONIAN) — Complexly interlayered felsic and mafic extrusive and intrusive rocks undivided. Bimodal volcanic rocks of Ambler volcanics; predominantly bimodal hypabyssal intrusive complexes. Intrusive rocks may represent roots of temporally and spatially associated Ambler volcanic sequence.

Dg METABASITE (DEVONIAN AND DEVONIAN?, LOCALLY JURASSIC?) — Dark-gray, medium-grained, blocky- and dark-weathering metabasite. Protoliths are basic dikes and sills of diabase, gabbro, and diorite with local basic metavolcanic rocks. Consists of clinozoisite, epidote, actinolite, chlorite and albite. Accessory minerals include calcite, garnet, white mica, sphene, rutile, magnetite, quartz, allanite, and apatite. K-Ar dates on three sills intruding lower Paleozoic rocks of Doonerak fenster (Wiseman D-1 Quadrangle) range from 373 to 388 Ma (Dutro and others, 1976).

Dt TACTITE (DEVONIAN) — Varicolored skarn and calc-silicate hornfels formed by thermal metamorphism and metasomatism of calcareous rocks during intrusion of Devonian igneous rocks. Includes minor occurrences of noncalcareous rocks.

Dgr GRANITE GNEISS (DEVONIAN) — Cream-colored, intensely foliated, coarse-grained, muscovite-biotite quartz monzonite gneiss. Locally contains garnet and blastoporphyritic megacrysts of microcline. Age is inferred due to lithologic similarities with other Devonian plutons in nearby Chandalar and Wiseman Quadrangles. A single zircon separate from Wild River Pluton (Wiseman B-3) yields Late Devonian discordant Pb-Pb age (Dillon and others, 1980). Horace Mountain Pluton (Chandalar C-5) yields 380 ± 25 Ma U-Pb concordia age (3 discordant zircon separates); Phoebe Creek pluton (Chandalar C-5) and Baby Creek pluton (Chandalar C-4) yield Early Devonian Pb-Pb zircon ages (single separates, discordant); Phoebe Creek pluton also yields Early Devonian Rb-Sr errorchron; K-Ar ages largely reset to 100 Ma (Brosge' and Reiser, 1964; Brosge' and Reiser, 1971; Dillon and others, unpublished data).

LOWER PALEOZOIC(?) OR PROTEROZOIC(?) BANDED SCHIST, PARAGNEISS, AND ORTHOGNEISS THAT MAY HAVE BEEN REGIONALLY METAMORPHOSED THREE TIMES. HIGH GREENSCHIST FACIES ROCKS PREDOMINATE, BUT INCLUDE AMPHIBOLITE FACIES PARAGNEISS, AND LOCAL RELICT BLUESCHIST AND ECLOGITE FACIES METABASITE

Ᵽm MARBLE — Gray marble and schistose marble and local interlayers of calcareous schist. This unit is closely associated with and gradational into the calcareous schist unit (Ᵽcs).

Ᵽcs CALCAREOUS SCHIST — Brown-weathering calcareous schist with abundant thick and thin layers of marble and some layers of non-calcareous knotty schist like greenschist unit (Ᵽqs).

Ᵽqs INTERBANDED QUARTZITE AND GRAPHITIC SCHIST — Predominantly grayish-white, medium-grained quartzite bands <5 cm thick with numerous dark-gray, graphitic albite-chlorite-muscovite-quartz schist interbands and lenses or knots. Bands probably represent metamorphically differentiated relicts of interbedded quartzose and pelitic sediments. Accessory minerals are clinozoisite + pyrite + tourmaline + chloritoid + rutile + sphene + calcite + allanite. The rusty-weathering, coarsely crystalline mica schist and paragneiss contain minor lenses and bands of the following: black, graphitic schist in muscovite quartzite; quartzo-feldspathic schist; marble and calcareous schist; and layers and dikes of mafic greenschist. Locally include gray and blocky-weathering, foliated, coarse- to very coarse grained, biotite-quartz-feldspar orthogneiss(?) or paragneiss interlayers, and may include garnet-epidote-chlorite-muscovite-biotite granite orthogneiss with thin aplitic veins. Locally contain potassium-feldspar megacrysts. Yield Proterozoic Pb-Pb ages (Dillon and others, 1980). Superposition of three intersecting schistosities yields typical lenticular or 'knotty' structure described by Dillon, Hamilton, and Lueck (1981) and Dillon and others (1987a).

Ᵽsq INTERBANDED GRAPHITIC SCHIST AND QUARTZITE — Light-gray to white, medium-grained and fine-grained graphite-bearing quartzite. Quartzite bands are <5 cm thick with numerous dark-gray, graphitic albite-chlorite-muscovite-quartz schist interbands and lenses or knots. Bands probably represent metamorphically differentiated relicts of interbedded quartzose and pelitic sediments. Accessory minerals are clinozoisite + pyrite + tourmaline + chloritoid + rutile + sphene + calcite + allanite. Lithologically this unit is similar to interbanded quartzite and graphitic schist (Ᵽqs) but contains <25 percent quartzite. Quartz veins are especially noticeable because the graphite-rich rocks are darker. Locally includes graphitic schist.

Ᵽs GREENSCHIST — Light-green to medium-green, fine- to medium-grained, actinolite-epidote-chlorite-albite greenschist. Lithologically identical to Devonian(?) greenschist (Ds) and may be confused with it locally; differentiated by structural position and lithologic association with other rocks of apparent Proterozoic(?) or early Paleozoic(?) age. (For whole-rock major oxide analysis, see table 1, number 2.)

Ᵽg METAMORPHOSED GABBRO AND DIABASE — Green, medium- to coarse-grained, actinolite-epidote-chlorite-albite schist with accessory sphene + apatite + pyrite, and relict gabbroic and diabasic textures. Richterite identified by X-ray diffraction in the Wiseman A-1 Quadrangle. Eclogite was mapped at the mouth of Clara Creek and consists of reddish-brown garnet and light-green clinopyroxene. More recent work (Gottschalk, 1987) indicates that: (1) the garnet (35 to 65 percent of the rock) is almandine rich--about 50 mole percent almandine--and typical of garnets associated with glaucophane schists; (2) the sodic augites range from $Ac_3Jd_{20}Aug_{77}$ to $Ac_9Jd_{11}Aug_{80}$, from 10 to 20 mole percent jadeite, and fall into the compositional field of eclogitic clinopyroxenes; and (3) garnet-clinopyroxene geobarometers yield crystallization temperatures of 655 ± 90°C to 730 ± 100°C (at 10 kb) for the texturally early and texturally late garnets, respectively. (For whole-rock major oxide analysis, see table 1, number 1.)

DISCUSSION

LOWER PALEOZOIC(?) OR PROTEROZOIC(?) AND DEVONIAN(?) POLYMETAMORPHIC SCHIST UNITS; AGES OF PROTOLITH

Because no fossils have been found in these units in the Wiseman B-1 Quadrangle and because K-Ar ages are reset by multiple metamorphic events protolith ages are uncertain. Correlative rocks in adjacent quadrangles, however, have been dated as Late Proterozoic and Devonian (Dillon and others, 1979; Turner and others, 1979; Dillon and others, 1980). For example, marble units correlative with the Ambler volcanics in the Wiseman A-5 Quadrangle contain Devonian(?) conodonts, and felsic schist interlayers within 'compositionally uniform schists' in the Wiseman A-6 (equivalent to the felsic porphyroblastic rocks in the Wiseman B-1 Quadrangle) have been radiometrically dated as Devonian (366 Ma, Pb-Pb on zircon; Dillon and others, 1980).

Graphitic, quartzose feldspathic, and mafic schists of probable Devonian age are lithologically similar to schists of Late Proterozoic(?) age, except that the Devonian(?) schists lack banding and contain interlayers of felsic schist, blastoporphyritic felsite, talc schist, black quartzite, black marble, and platy, locally fossiliferous gray marble. Together these Devonian(?) units form a package described as the Ambler volcanics that can be traced into faunally and radiometrically dated Devonian rocks in the Wiseman A-5 and A-6 Quadrangles and the Survey Pass and Ambler River Quadrangles (Pessel and Brosge', 1977; Nelson and Grybeck, 1980; Hitzman and others, 1982; Dillon and others, 1986). Devonian(?) units are also either stratigraphically or structurally higher than lithologically similar Proterozoic(?) units, or both.

Upper Proterozoic(?) or lower Paleozoic(?) units are distinguished from Devonian(?) units described above in the Wiseman B-1 Quadrangle by the absence of well-defined metavolcanic rocks and the presence of compositionally heterogeneous bands and knots in the schist. In addition, Upper Proterozoic(?) or lower Paleozoic(?) units indicate a more complex metamorphic history than Devonian(?) units. These banded and knotty, compositionally heterogeneous units (Ᵽqs, Ᵽsq, Ᵽg, Ᵽs, Ᵽm, Ᵽcs) appear, structurally and metamorphically, to be the oldest rocks in the map area.

Some Proterozoic(?) rocks, especially the marble (Ᵽm) and the greenschist (Ᵽs), are compositionally uniform at the outcrop scale. Locally they occur as conformable bands with relict sedimentary contacts with the knotty schist (Ᵽqs). These compositionally uniform Proterozoic(?) units, however, may be Devonian(?) rocks incorporated into the Proterozoic(?) rocks by unrecognized structures.

METAMORPHISM

At least two episodes of metamorphism (M_2 and M_3) have affected the Devonian schist units, and three metamorphic events (M_1, M_2, and M_3) appear to have affected the Proterozoic(?) schist units. The youngest metamorphic event (M_3) is represented by semipenetrative, schistose, axial-plane cleavage (S_3) and probably occurred during Late Jurassic or Neocomian time. In Devonian(?) rocks, an older metamorphic event (M_2) is evident from a penetrative schistosity (S_2) that is parallel to a lithologic layering and partially transposed by the younger schistosity (S_3). Schistosities were developed during two greenschist-facies events. A third, older metamorphic event (M_1) may have formed the gneissic bands in the Proterozoic(?) schist units. In the knotty schists (Ᵽqs, Ᵽsq) the bands were deformed into lens- and rod-shaped structures during the younger metamorphic events (M_2 and M_3), forming the characteristic knots commonly observed in these units.

Units Ᵽqs and Ᵽsq are known as the 'country rock schist' of the southern Brooks Range 'schist belt.' Two or more metamorphic episodes have produced a distinct tectonic fabric within the country rock schist. Gneissic lithologic bands transposed from bedding are evidence for the oldest metamorphic event (M_1?). A strong penetrative schistosity (S_2) locally cuts across the bands and deforms them into rods, but in most places the schistosity parallels the banding; therefore, the banding may have formed penecontemporaneously with schistosity (S_2) during metamorphism M_2. The schistosity and banding are disrupted and partially transposed by subsequent Late Jurassic or earliest Cretaceous semipenetrative cleavage (S_3) that is defined by middle greenschist-facies minerals and shows some slippage. Where semipenetrative cleavage cuts schistosity and banding at high angles, bands of quartzite and graphitic schist are disrupted into black and white lenses and rods that result in the distinctive 'knotty' structure.

The lack of knotty structures in the Devonian rock units and intrusion of the Upper Devonian Wild River pluton (Dillon and others, 1980) into the interbanded graphitic schist and quartzitic unit (Ᵽsq) in the Wiseman B-3 Quadrangle are evidence of a pre-Late Devonian metamorphism of the banded schist. Greenschist and gabbro layers within the banded schist can be correlated with Proterozoic(?) mafic rocks interlayered with country rock in the Brooks Range 'Hub Mountain' area (Mt. Angayukaqsraq, northeastern Baird Mountains Quadrangle) and the Ambler mining district (Turner and others, 1979). Karl and others (in press) report 750 Ma U-Pb zircon dates (three samples) from the Mt. Angayukaqsraq intrusive complex. This places an upper age of Late Proterozoic for the age of amphibolite facies metamorphism of the host rock.

The eclogite (Ᵽg) outcrop at the mouth of Clara Creek indicates a high pressure-temperature (P-T) metamorphic history for at least some southern Brooks Range rocks, and Grybeck and others (1977) recognized local blueschist facies conditions elsewhere in the Brooks Range schist belt. Gottschalk (1987) concluded that the Clara Creek eclogite was emplaced into the surrounding schist belt rocks, and subsequently retrograde metamorphosed during regional high-pressure greenschist facies metamorphism that affected the schist belt rocks. A mechanism for juxtaposition of high (P-T) eclogite and high-pressure greenschist facies assemblages is explained in Ernst's model (Ernst, 1988). Here, tectonically induced cessation of convergent plate closure velocity causes overprinting of blueschists by lower P-T phase compatibilities accompanying upthrusting or diapiric uplift. Decoupled high-P rocks may then be incorporated as imbricate slices into lower grade metamorphic rocks of a subduction zone.

At least three generations of quartz veins are distinguished by crosscutting relationships among veins and cleavages, and by folds formed during metamorphic events. Metamorphic structures are postdated by the youngest veins and predated by the oldest veins. Intermediate-age veins cut S_2 but are cut by S_3 schistosities. Preliminary analyses of fluid inclusions in quartz veins from the Wiseman and Chandalar Quadrangles show that the youngest veins were emplaced during cooler and more hydrous conditions than existed during emplacement of the older two generations of veins (Dillon and others, 1987b).

Physical rock properties for metamorphic rocks in the Wiseman Quadrangle are listed in Hackett and Dillon (1982).

FAULTS

The Wiseman thrust fault occurs 1.5 km north of the town of Wiseman, trends east-northeast, and juxtaposes Proterozoic(?) or lower Paleozoic(?) calcareous schist (Ᵽcs) of the Brooks Range schist belt over Devonian age metasediments. We interpret this major fault as evidence for north-directed Mesozoic compression and thrusting, and subsequent uplift of the schist belt rocks. The sense of movement on this major thrust fault is well documented 50 km west in the Wiseman A-4 Quadrangle (Dillon and others, 1987a). Uplift on this and related faults is recorded by: (1) K-Ar cooling ages which range between 100 and 130 Ma (Turner and others, 1979); (2) metamorphic detritus in Albian clastic rocks of the Yukon-Koyukuk basin (Patton and Miller, 1973; Dillon and others, 1987a; Dillon and others, 1989); and (3) the inverse clast stratigraphy of the Albian conglomerates which records the progressive unroofing of the Brooks Range stratigraphy (Dillon and Smiley, 1984; Dillon and others, 1987a; Dillon and others, 1989). Gottschalk (1987) refers to the Wiseman thrust fault as the Minnie Creek thrust and also envisions north-directed Mesozoic thrusting along this fault. Subsequent listric normal faults to the south would allow uplift of the high-pressure metamorphic terrane by tectonic denudation, thinning, and rotation of the overlying rocks.

FOLDS

Many megascopic folds were identified in the field. Larger, north-vergent recumbent folds, though not defined by mapping, are inferred, based on our mapping, and schematically shown on the cross section. Four lines of evidence indicate the existence and geometry of the larger folds: (1) folds of this size and symmetry have been recognized in the Wiseman A-5, A-6, B-3, B-5, and B-6 Quadrangles; (2) the repetition of lithologic units is best explained by folding even where hinge areas were not located; and (3) semipenetrative cleavage (S_3) is axial-planar to the mapped mesoscopic and megascopic folds; measurements of this axial-planar cleavage provide reference surface control for the geometry of the unmapped folds. The fourth line of evidence is the intersection of the younger semipenetrative axial-planar cleavage (S_3) with the older, layer parallel penetrative cleavage (S_2), which indicates the location of major fold axes.

ECONOMIC GEOLOGY

Wiseman B-1 Quadrangle lies within the Upper Koyukuk gold district, the most productive gold district in the Brooks Range. The Chandalar gold district lies just 40 miles to the east. Lode gold deposits in these districts are the source of spatially associated placer gold deposits. The lodes were probably emplaced during intrusion of Devonian granitic plutons. Locally these intrusions formed skarn deposits and high-temperature metasomatic deposits akin to porphyry copper deposits. Lode gold deposits in these districts are predominantly associated with quartz-arsenopyrite-gold veins that outcrop discontinuously throughout the districts.

Between 1900 and 1970, placer miners in the Upper Koyukuk and Chandalar gold districts reportedly produced more than 330,000 oz of gold (Bliss and others, 1988a; 1988b). The richest deposits lie in a belt that cuts eastward across the Dalton Highway from the historic towns of Nolan and Wiseman (Wiseman Quadrangle) to the gold camps of Gold Creek and Linda Creek (Chandalar Quadrangle). In the Nolan Creek and Hammond River areas more than 122,000 oz of gold production is reported. Three varieties of gold-bearing stream gravels occur in the Upper Koyukuk district: (1) active stream gravels (Qa); (2) elevated bench gravels (Qat); and (3) deeply buried gravels.

Placer grades vary according to bedrock type, and the highest grade placer deposits occur immediately downstream from the lode deposits. Work from the western Chandalar Quadrangle indicates that fragments in placer concentrates of auriferous vein material, mineralogically like the veins found upstream, provide a genetic link between the lode deposits and the placer deposits. The three favored models for the genesis of lode deposits are: (1) the lodes were derived from metamorphism of pre-existing skarn and high-temperature metasomatic deposits--both originally formed during intrusion of Devonian granitic plutons (Dgr) that outcrop in the district--akin to porphyry copper deposits (Dillon, 1982); (2) the lodes were derived from metamorphism of spatially associated Devonian volcanogenic massive sulfide deposits; (3) the lodes were derived from metamorphism of Precambrian basement rocks beneath the veins (Newberry and Harris, 1989). Pb^{207}/Pb^{206} systematics (Newberry and Harris, 1989) suggest that the veins were derived from a Precambrian source reservoir.

Sand and gravel deposits in the Middle Fork of the Koyukuk River valley were extensively exploited during construction of the Dalton Highway, the trans-Alaska pipeline, and the local road system. The best quality sand and gravel deposits occur in the modern flood plain (Qa), terraces (Qat), and glacial outwash deposits (Qdo$_3$). Deposits of lower grade occur in alluvial fans (Qaf) and kame-and-kettle (Qdk$_3$) deposits.

Devonian volcanic rocks (Df, Dfm) discordantly overlying the Proterozoic(?) or lower Paleozoic(?) rocks in the Wiseman B-1 Quadrangle are correlated with the Ambler sequence of Hitzman and others (1982)--and the coeval Whiteface Mountain volcanic rocks (Dillon and others, 1986). Economically, the Ambler volcanics are one of the most important lithologic units in Alaska. At least 14 major volcanogenic copper-zinc-silver massive sulfide prospects have been found in the Ambler mining district in the Survey Pass and Ambler River Quadrangles of the southern Brooks Range (Hitzman and others, 1982). The ore in most deposits is closely associated with felsic volcanic rocks.

The Ambler volcanics can be traced nearly 300 km east across the southern Brooks Range schist belt from the Ambler mining district to the central Wiseman Quadrangle at the west edge of the Dalton Highway corridor. Mixed felsic-mafic plutonic complexes [Dfm (and Dfb?)] and Devonian granites (Dgr) that intrude the older banded and knotty schist (Ᵽqs) and the calcareous schist (Ᵽcs) and marble (Ᵽm) may represent the exhumed roots of bimodal and felsic intrusive complexes related to the Ambler volcanics. However, this relationship between the felsic-mafic plutonic complexes and the Ambler volcanics is uncertain because the Wiseman B-1 Quadrangle is beyond the easternmost exposures of the Ambler volcanics. The distribution of the Ambler volcanics to the east of the Dalton Highway is largely unknown.

Zircons from the Ambler volcanic rocks and the granitic plutons in the Wiseman Quadrangle (but not the Wiseman B-1) and the Chandalar Quadrangle have been dated as Devonian (Dillon and others, 1980; Newberry and others, 1986). Overlapping distribution, age, and chemistry of the volcanic and plutonic rocks suggest a cogenetic origin. East of the Dalton Highway (and north and east of the Wiseman B-1 Quadrangle), felsic volcanic rocks occur interlayered in the Devonian Skajit Limestone, Beaucoup Formation, and Whiteface Mountain volcanic rocks near the large Devonian plutons. We infer from these spatial and temporal relationships that the granitic plutons are also related to the Whiteface Mountain volcanics.

The Devonian Whiteface Mountain volcanic rocks (Dillon and others, 1986) are similar in lithology, age, and stratigraphic position to the mineral-rich Ambler volcanic rocks. These two rock packages are, in turn, equivalent to Devonian felsic units (Df, Dfb, Dfm) in the Wiseman B-1 Quadrangle, and all the above rocks probably formed during the same magmatic event. Stream-sediment, pan-concentrate, and rock samples from the Ambler and Whiteface volcanic units commonly contain anomalously high concentrations of copper, lead, zinc, and silver.

Proterozoic(?) or lower Paleozoic(?) metasedimentary rocks of the B-1 Quadrangle along and west of the North Fork of the Koyukuk River comprise a kuroko massive sulfide, 'mineral resource assessment tract' (Bliss and others, 1988b) that is geochemically anomalous in copper, lead, zinc, gold, silver, arsenic, antimony, and tungsten values. However, no known deposits occur in these rocks. Formations of similar age and lithology in the Selwyn Basin of the Yukon Territory do contain large lead-zinc-silver deposits (Abbott and others, 1986).

Within the Wiseman 1° x 3° Quadrangle three rock sequences are considered to have potential for shale-hosted lead-zinc and barite deposits: (1) the Hunt Fork Shale, ranging from slightly metamorphosed shale and quartzose sandstone to phyllite and schist, yields pan-concentrate samples with exceedingly high background values of copper (0.5 percent), lead (0.7 percent), zinc (1.0 percent); (2) highly metamorphosed shales in the Brooks Range schist belt yield clusters of copper, lead, zinc, barium, and silver anomalies from stream-sediment and pan-concentrate samples--although statistically set anomaly thresholds are lower in the schist belt than in the Doonerak area or in Hunt Fork rocks (Cathrall and others, 1987); and (3) the Beaucoup Formation, which consists of Devonian and lower Paleozoic rocks lithologically suited for shale, carbonate, and shale-carbonate interface lead-zinc deposits. The Beaucoup Formation yields high geochemical background values of lead, zinc, copper, silver, and barium, and numerous anomalies occur in a belt trending southwestward from Snowden Mountain (Chandalar D-6 Quadrangle) to and beyond the town of Nolan (Cathrall and others, 1987; Bliss and others, 1988b).

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GEOLOGIC MAP OF THE WISEMAN B-1 QUADRANGLE, SOUTHCENTRAL BROOKS RANGE, ALASKA

by

J.T Dillon and R.R. Reifenstuhl

1990

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