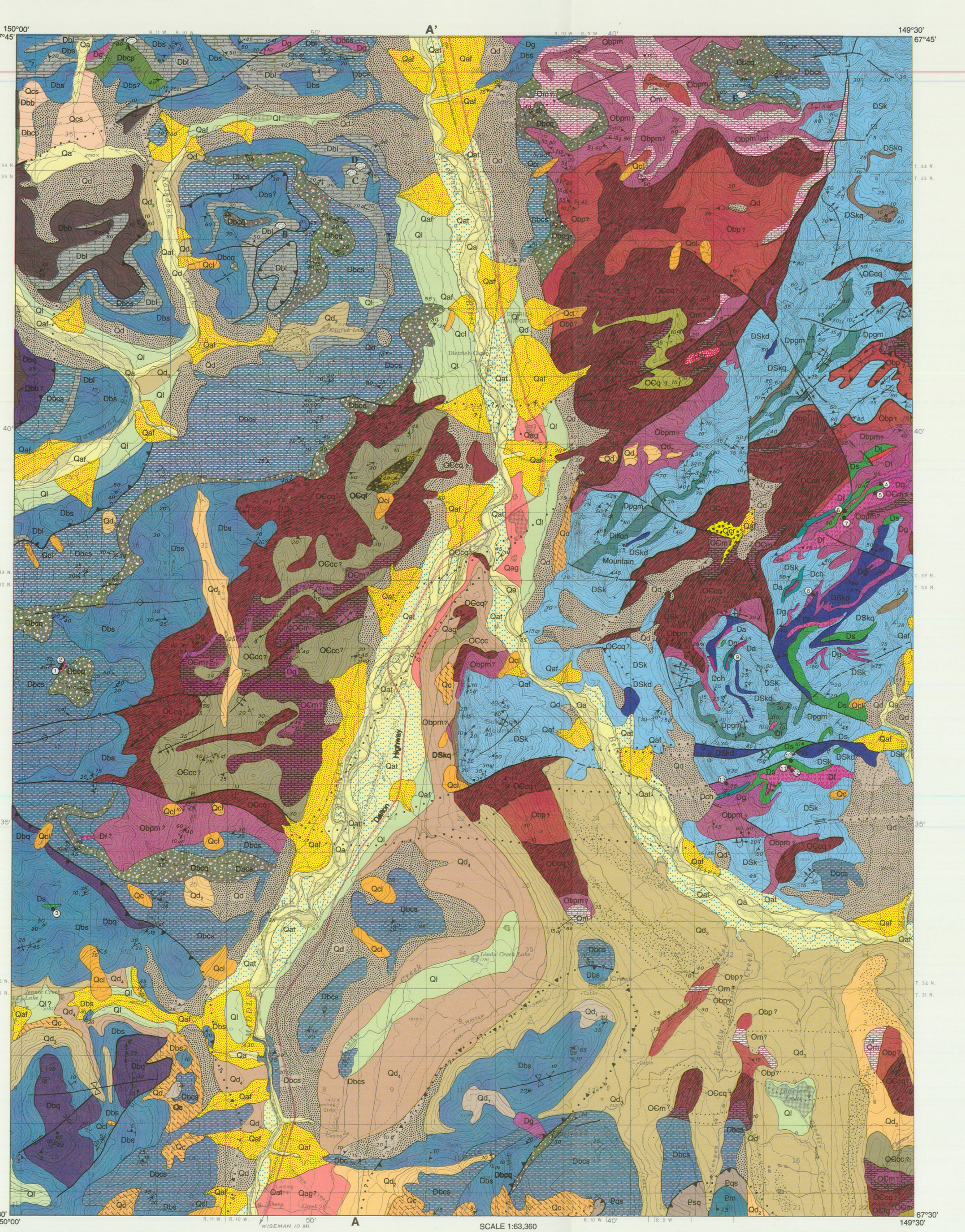
ALASKA DIVISION OF GEOLOGICAL &
GEOPHYSICAL SURVEYS

PROFESSIONAL REPORT 105
Dillon and Reifenstuhl (1995)



Base from U.S. Geological Survey Chandalar C-6 Quadrangle, Alaska, 1971.

Final compilation, editing, and development of this report occurred after John Dillon's death on July 26, 1987. I have made every effort to maintain consistency with John's previous geologic studies and to adhere to his high professional standards. However, I accept responsibility for any omissions or misinterpretations of the information presented in this report.

In 1990 the United States Board on Geographic Names accepted "Dillon Mountain" as the formal name for the 4,820-foot peak located 2 miles east of Milepost 206 on the Dalton Highway.

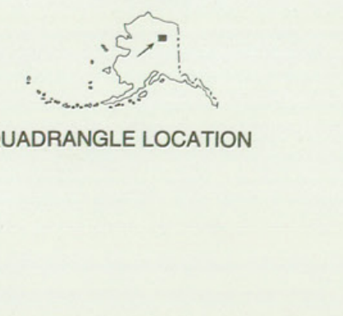
Rocky Reifenstuhl
Fairbanks, Alaska, April 1989

SCALE 1:63,360

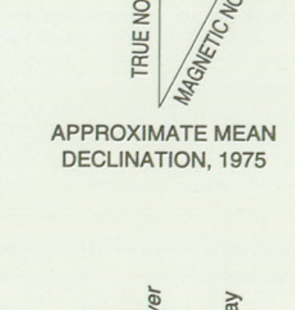
1 ½ 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

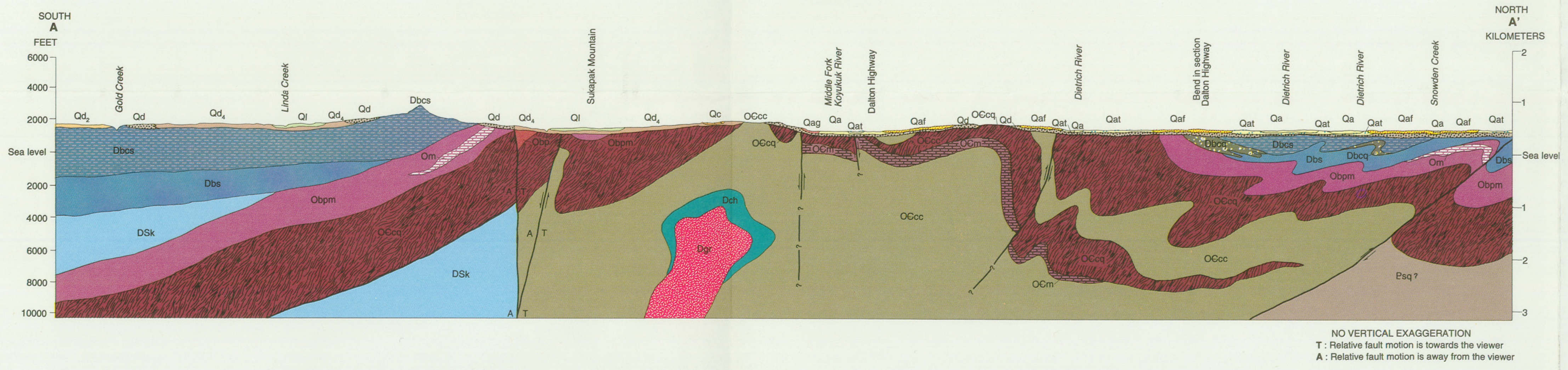


QUADRANGLE LOCATION



APPROXIMATE MEAN DECLINATION, 1975

Geology by J.T. Dillon, 1981-1984; P.A. Adler, 1982-1983; D.D. Adams, 1981-1982; G.M. Meyers, 1982; J.D. Blum, 1983; K.K. Lamal, 1984; J.A. Huber, 1984; W.P. Brosgé and H.N. Reiser, 1964; Ellen Gressit, 1981; V.A. Ferrel, 1981; R. Harris, 1983; R.R. Reifenstuhl, 1989. Surficial geology modified from T.D. Hamilton, 1979b. Compiled by G.W. Harris and R.R. Reifenstuhl, 1989; R.F. Clement, 1990. Reviewed by W.P. Brosgé and T.E. Moore, U.S. Geological Survey. Cartography by A-L. Schell.



NO VERTICAL EXAGGERATION
T : Relative fault motion is towards the viewer
A : Relative fault motion is away from the viewer

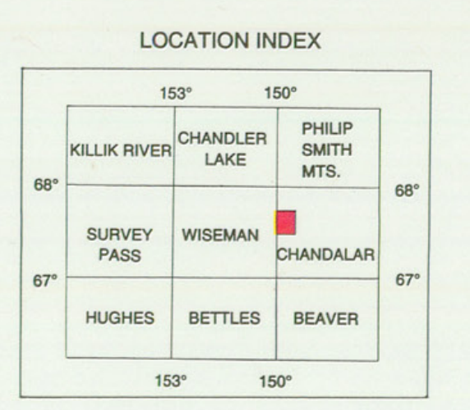
GEOLOGIC MAP OF THE CHANDALAR C-6 QUADRANGLE, SOUTHEASTERN BROOKS RANGE, ALASKA

by

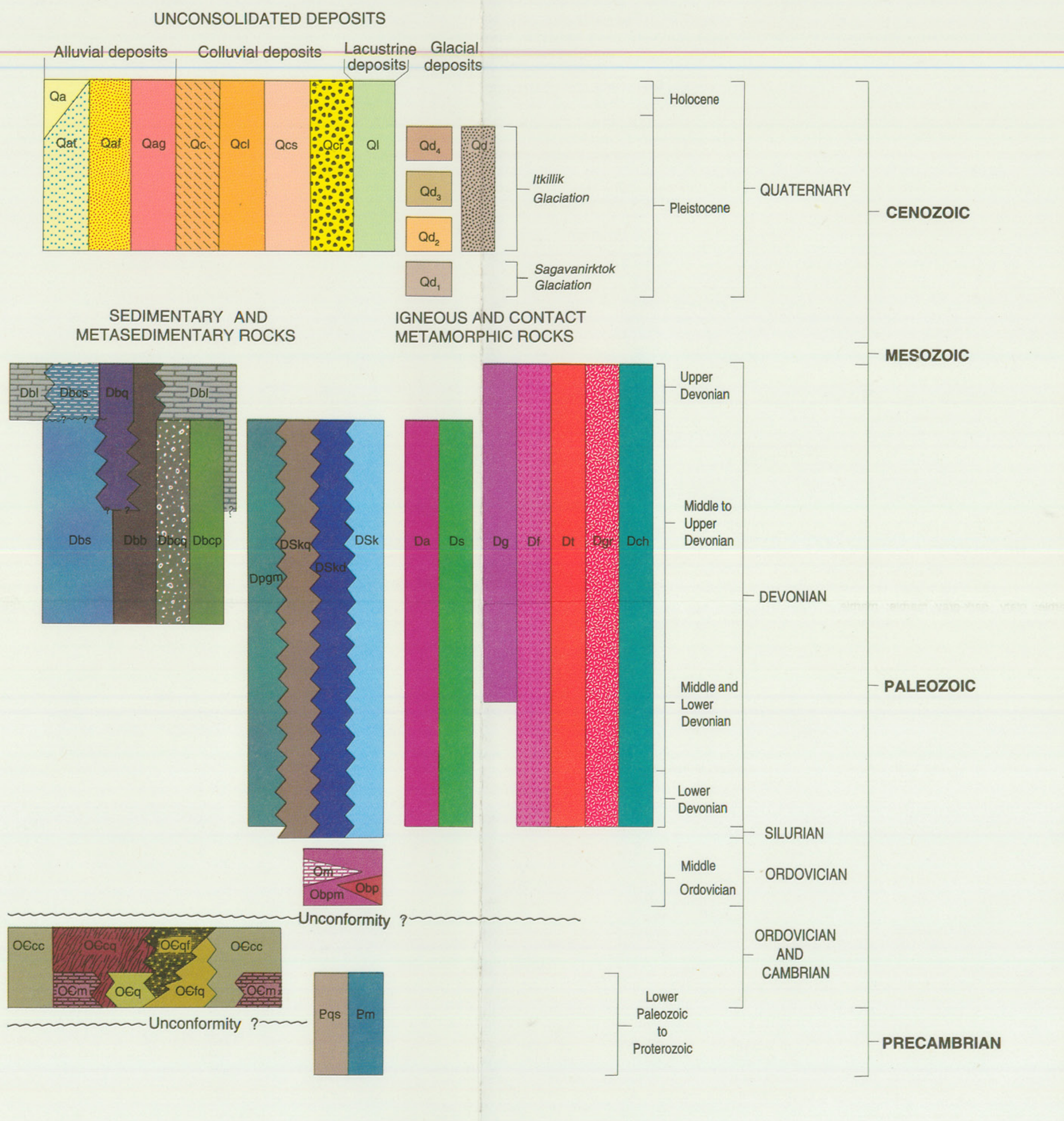
J.T. Dillon and R.R. Reifenstuhl

1995

LOCATION INDEX



CORRELATION OF MAP UNITS



GEOLOGIC MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed; queried where uncertain; dip direction shown where known; angle given where measured

High-angle fault—Dashed where approximately located; dotted where concealed; queried where uncertain; dip angle shown where measured; U, upthrown side; D, downthrown side; arrows indicate relative horizontal movement

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

Axis of syncline—Showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of overturned anticline—Showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of overturned syncline—Showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of antiform—Based on schistosity, showing direction and dip of limbs and plunge of axis; bedding unknown

Axis of synform—Based on schistosity, showing direction and dip of limbs and plunge of axis; bedding unknown

Strike and dip of bedding

Generalized strike and dip of planar structure; dip estimated

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

Generalized strike and dip of schistosity; dip estimated

Strike and dip of cleavage

Strike and dip of schistosity and parallel semi-penetrative cleavage

Bearing and plunge of linear feature; fold (f), asymmetric fold (af), isoclinal fold (if), lineation (l), mineral (m), crenulation (c), slickensides (sl); may be used in conjunction with other structural symbols; cross arrow indicates direction of rotation as viewed down fold axis. Horizontal lineation may be combined with other planar symbols

Morainal ridge

Direction of glacier flow across topographic divide

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

Fossil locality—Letter keyed to table 2

DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS
(modified from Hamilton, 1978b)

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 that 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. Grade into lacustrine and deltaic deposits of well-sorted, stratified silt, sand, and fine gravel at lower end of fan-delta

Qag GRAVEL, UNDIFFERENTIATED—Gravel and sandy gravel of variable composition, that forms glacial and non-glacial terraces of uncertain or composite origin

COLLUVIAL DEPOSITS

Qcl LANDSLIDE AND FLOW-SLIDE DEPOSITS, UNDIFFERENTIATED—Unsorted and non-stratified 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 includes 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 are subject to seasonal downslope movement

Qc COLLUVIUM, UNDIFFERENTIATED—Mixed talus rubble and solifluction deposits (see unit Qcs) that form aprons >1-2 m thick on slopes beyond limits of Itkillik Phase II glaciation. Most common on phyllite, shale, and slate

Qcr ROCK GLACIER DEPOSITS, ACTIVE AND INACTIVE—Very poorly sorted, nonstratified, coarse angular rock debris commonly in matrix of silt and fine rubble; form lobate and tongue-shaped deposits. Active deposits may contain interstitial ice

LACUSTRINE DEPOSITS

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

GLACIAL DEPOSITS

Itkillik Glaciation

Qd ITKILLIK DRIFT, UNDIFFERENTIATED—Poorly to very poorly sorted, nonstratified to weakly stratified till. Composition ranges from muddy sandy gravel to clayey stony silt with local stratified ice-contact deposits of moderately to poorly sorted sand, sandy gravel, and silty sandy gravel. Includes thick (>3 m) drift deposits not assigned to a specific Itkillik moraine system

Qd₄ DRIFT OF ITKILLIK PHASE III—Till and stratified ice-contact deposits (see unit Qd) that forms sharp-crested end moraines and very irregular ground moraine, ice-stagnation deposits, and glaciolacustrine deposits along the Middle Fork Koyukuk River valley. Loess cover is generally absent, and exposed stones are very slightly weathered. Deposited during stillstands or readvances of glaciers from 13,000 to 11,000 ^{14}C yr B.P. (Hamilton and Porter, 1975)

Qd₃ DRIFT OF ITKILLIK PHASE II—Till and stratified ice-contact deposits (see unit Qd) that form sharply defined drift lobes. Ice-contact deposits are more abundant than till in most valleys. Loess cover is generally thin to absent, and exposed stones show slight to moderate weathering

Qd₂ DRIFT OF ITKILLIK PHASE I—Very poorly sorted to poorly sorted, nonstratified to weakly stratified till. Composition 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

Qd₁ DRIFT—Poorly sorted, nonstratified till. Composition ranges from silty, sandy boulder gravel to clayey, stony silt with locally well-sorted, stratified gravel. Generally covered by blanket of loess, solifluction, and muskeg deposits <3 m thick. Forms broad morainal ridges and hummocky ground moraine south of the Brooks Range. Hamilton (1979b) estimated a mid-Pleistocene age for these deposits

DEVONIAN METAMORPHOSED SEDIMENTARY AND VOLCANIC ROCKS MIDDLE TO UPPER GREENSCHIST FACIES

Ds METAVOLCANIC ROCKS (Devonian?)—Light-green and medium-green, fine- to medium-grained chlorite, epidote, and albite-bearing, mainly basic metavolcanic rocks (greenschists) that occur in lenses and layers in polymetamorphic rocks. Probably represent flows and tuffs (table 1)

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 (table 1). Correlates with felsic part of Ambler volcanics and may correlate with rocks of Whiteface Mountain. Discordant U-Pb (zircon) ages on six zircon separates from metatuff in southwest Wiseman Quadrangle (lat 67°11'15", long 152°34'48") yielded maximum Pb-Pb age of 378 ± 15 Ma which is interpreted as equal to or slightly less than the magmatic crystallization age (Dillon, Pessel, and others, 1980). Includes 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. Calcite content ranges from 3 to 20 percent. 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 protolith was probably deposited in an oceanic environment. Felsic schist from the Wiseman A-6 Quadrangle yields zircon age of 365 ± 10 Ma Pb-Pb (Dillon, Pessel, and others, 1980)

BEAUCOUP FORMATION

BEAUCOUP FORMATION (Middle to Upper Devonian)—Carbonaceous, siliceous, and calcareous sedimentary and felsic volcanic rocks (Dutro, Brosgé, and others, 1979) that grade downward and toward the southwest into the Skajit Limestone (Henning, 1982). Laterally equivalent to the Whiteface Mountain and Ambler volcanic and sedimentary rocks (Dillon, Brosgé, and Dutro, 1986).

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. Correlates with the graywacke and limestone of the Whiteface Mountain wacke unit and with Middle Devonian(?) siliceous clastic rocks (Dsc) in the Chandalar D-6 Quadrangle (Dillon, Harris, and others, 1988)

Dbs BLACK SLATE AND PHYLLITE (Middle to Upper Devonian?)—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 the lower part of the unit near Nolan Creek to southwest (in the northern Wiseman B-1 Quadrangle), may include lower Paleozoic rocks

Dbcp CALCAREOUS AND CHLORITIC WACKE AND PHYLLITE (Middle to Upper Devonian?)—Interbedded calcareous quartz wacke, chloritic wacke, sandstone, conglomerate, limestone, and red and green phyllite (table 2)

Dbcg CONGLOMERATE (Middle to Upper Devonian?)—Chloritic(?) quartzite, conglomerate, and limonitic, locally calcareous, chlorite-muscovite quartzitic conglomerate and sandstone with interlayered purple, green, and black phyllite interlayered with the black rock unit (Dbb). Locally occurs as basal conglomerate

Dbb BLACK ROCKS (Middle to Upper Devonian?)—Black, partly calcareous phyllite and schist; black, very fine grained quartzite; black; gray; and brown-weathering limestone; and platy micaceous limestone and marble. Locally, brown-weathering limestone interbedded with calc-schist and phyllite predominates. Black quartzite unit (Dbq) forms interdigitated lenses

Dbl BLACK LIMESTONE (Upper to Middle to lower Upper Devonian)—Black and gray platy limestone interlayers in black rock unit (Dbb), chloritic siltstone unit (Dbcs), and black slate and phyllite unit (Dbs) in the northwest corner of the quadrangle. Locally, this unit weathers light gray or white and may be chloritic limestone. Fossil age control from Brosgé and Reiser (1964) and Dillon, Harris, and others (1988) (table 2)

Dbq BLACK QUARTZITE (Upper Middle to lower Upper Devonian)—Black quartzite, metasiltstone, and phyllite interlayers in the black rocks (Dbb) and black slate and phyllite (Dbs) unit

AMBLER VOLCANICS (Lower? Middle and Upper Devonian)—Felsic and mafic, bimodal volcanic and volcaniclastic rocks and associated carbonaceous, calcareous, and siliceous metasedimentary rocks that correlate with the Ambler sequence of Hitzman and others (1982).

Da METAVOLCANIC AND METASEDIMENTARY ROCKS OF AMBLER VOLCANICS, UNDIFFERENTIATED (Lower? Middle and Upper Devonian)—Graphitic quartz schist, phyllite, and some very fine grained, locally pyritic quartzite interbedded with marble, calcareous schist, mafic volcanic rocks, and felsic volcanic rocks (table 1)

SKAJIT FORMATION (Devonian and older)—Gray marble and limestone, finely crystalline dolomite, carbonate conglomerate, and minor quartzite and graphitic and calcareous-schist interlayers. Fossils are rare in the Chandalar Quadrangle, and none are older than Middle Devonian and Silurian(?) age (Brosgé and Reiser, 1964). In the Chandalar D-6 Quadrangle, Dillon, Harris, and others (1988) reported eight conodont assemblages ranging from Ordovician to Triassic in age. For a detailed description of the Skajit Formation, see Henning (1982). Mineral assemblages and conodont alteration indexes indicate lower greenschist-facies metamorphism in the Sukakpak Mountain area (Huber, 1988).

DSk LIMESTONE (Devonian and Silurian?)—Massive gray marble; platy, dark-gray marble; marble conglomerate; and undifferentiated carbonate rock with interlayers of schist; pink-weathering dolomitic phyllite; orange- to gray-weathering gray dolomite; dolomitic marble; and dolomite clast breccia; and conglomerate. Algal laminations, fenestral structures, oolites, cut-and-fill structures, and some dolomite breccias probably formed in an intertidal environment. Locally, orange- and pink-weathering muscovite quartzite is interlayered with marble. Unit is interstratified with the Whiteface Mountain purple and green phyllite unit (Dwpg) in the Chandalar D-6 Quadrangle (Dillon, Harris, and others, 1988)

DSkd DOLOMITE (Devonian and Silurian?)—Orange- and gray-weathering gray dolomite, dolomitic marble, and dolomite clast breccia and conglomerate that forms interlayers and irregular replacements in the Skajit Limestone (DSk). Algal laminations, fenestral structures, oolites, cut-and-fill structures, and some dolomite breccias probably formed in an intertidal environment

DSkq QUARTZITE (Devonian and Silurian)—Orange- and pink-weathering muscovite-quartzite interlayers in the Skajit Limestone (DSk)

Dpgm PURPLE AND GREEN PHYLLITIC MARBLE (Devonian)—Light-purple-gray and light-green-gray chlorite- and quartz-bearing phyllitic marble interlayered with the Skajit Limestone unit (DSk)

DEVONIAN METAMORPHOSED PLUTONIC AND RELATED AUREOLE ROCKS

Dg METABASITE (Devonian)—Dark-gray, medium-grained, blocky, dark-weathering metabasite. Protoliths are basic dikes and sills of diabase, gabbro, and diorite with local mafic metavolcanic rocks (table 1). Mineralogy includes clinozoisite, epidote, actinolite, chlorite, and albite. Accessory minerals are calcite, garnet, white mica, sphene, rutile, magnetite, quartz, allanite, and apatite. K-Ar dates on three sills that intrude lower Paleozoic rocks of the Doonerak fenster range from 373 to 388 Ma (Dutro and others, 1976)

Dgr GRANITE GNEISS (Devonian)—Cream-colored, intensely foliated, coarse-grained, muscovite-biotite quartz monzonite gneiss that locally contains garnet and blastoporphyritic megacrysts of microcline. Granitic rocks in the Chandalar C-5 Quadrangle are divided into biotite-muscovite and biotite-hornblende granite gneisses (Dillon, Reifenstuhl, and others, 1989). A discordant U-Pb (zircon) age on one zircon separate from the Wild River pluton (Wiseman B-3 Quadrangle) yielded a Late Devonian Pb-Pb age (Dillon, Pessel, and others, 1980). The Horace Mountain pluton (Chandalar C-5 Quadrangle) yielded a 380 ± 25 Ma U-Pb concordia age from three discordant zircon separates. The Phoebe Creek pluton (Chandalar C-5 Quadrangle) and Baby Creek pluton (Chandalar C-4 Quadrangle) yielded Early Devonian Pb-Pb zircon ages (single separates, discordant). The Phoebe Creek pluton also yielded an Early Devonian Rb-Sr errorchron. K-Ar ages are largely reset to 100-140 Ma (Brosgé and Reiser, 1964; 1971; Turner and others, 1979; Dillon, 1989; Dillon, Reifenstuhl, and others, 1989)

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 noncalcareous rocks

Dch CALCAREOUS HORNFELS (Devonian)—Calc-silicate hornfels formed by thermal metamorphism of calcareous sedimentary rocks during intrusion of Devonian igneous rocks

ORDOVICIAN ROCKS PREHNITE-PUMPELLYITE TO LOWER GREENSCHIST FACIES

Obpm BLACK PHYLLITE AND MARBLE (Middle Ordovician)—Black to dark-gray, pyritic and graphitic phyllite marble and schist. Commonly calcareous with thin, dark crinoidal marbles. Thicker marble layers (Om) are mapped separately. Contains Middle Ordovician conodonts (Dillon, Harris, and others, 1988)

Obp BLACK PHYLLITE (Middle Ordovician)—Black to dark-gray, pyritic and graphitic pelitic phyllite and schist in the black phyllite and marble unit (Obpm). Mapped separately in few areas

Om MARBLE (Middle Ordovician)—Dark-gray to white, 5- to 50-m-thick marble layers in the black phyllite and marble unit (Obpm). Contains crinoids and Ordovician conodonts. A thick layer of this unit in the northeastern Chandalar D-6 Quadrangle contains Ordovician corals (Dillon, Harris, and others, 1988). Unit is mapped separately from the black phyllite and marble unit (Obpm) where possible. Anita Harris and J.T. Dutro (oral commun., 1985) and Dillon, Harris, and others (1988) identified fossils

LOWER PALEOZOIC ROCKS PREHNITE-PUMPELLYITE AND LOWER GREENSCHIST FACIES

OЄm MARBLE (Ordovician to Cambrian?)—Medium-gray and brown, thin-bedded, unfossiliferous marble that includes marble interlayers in the chlorite calc-schist (OЄcc) and calcareous chlorite-quartz schist and quartzite units (OЄcq)

OЄqf QUARTZ-FELDSPAR SCHIST (Ordovician to Cambrian?)—Olive-weathering, locally graphitic, muscovite-chlorite-albite-quartz schist. Commonly calcareous with interlayers of calc-schist. Grades into chlorite calc-schist (OЄcc) and calcareous chlorite-quartz schist and quartzite (OЄcq) units

OЄfq FELDSPAR-QUARTZ SCHIST (Ordovician to Cambrian?)—Tan- to gray-weathering muscovite-chlorite-quartz-feldspar schist with accessory biotite and garnet. Probably laterally equivalent to quartz-feldspar schist unit (OЄqf). Crops out in the extreme southeast corner of the Chandalar C-6 Quadrangle, and is extensive in the adjacent Chandalar C-5 Quadrangle

OЄcq CALCAREOUS CHLORITE-QUARTZ SCHIST AND QUARTZITE (Ordovician to Cambrian?)—Pale-green-weathering, locally calcareous, muscovite-chlorite-quartz schist. Chlorite quartzite interlayers (OЄq) are locally differentiated

OЄq CHLORITE QUARTZITE (Cambrian?)—Light-greenish-gray and very light gray chlorite quartzite

OЄcc CHLORITE CALC-SCHIST (Ordovician to Cambrian?)—Tan-weathering, muscovite-chlorite-quartz-calcite schist and calcareous quartz schist that grades into the marble (OЄm), the calcareous chlorite-quartz schist and quartzite (OЄcq), and the quartz-feldspar schist (OЄqf) units

LOWER PALEOZOIC TO PROTEROZOIC(?) POLYMETAMORPHOSED ROCKS UPPER GREENSCHIST TO LOWER AMPHIBOLITE FACIES

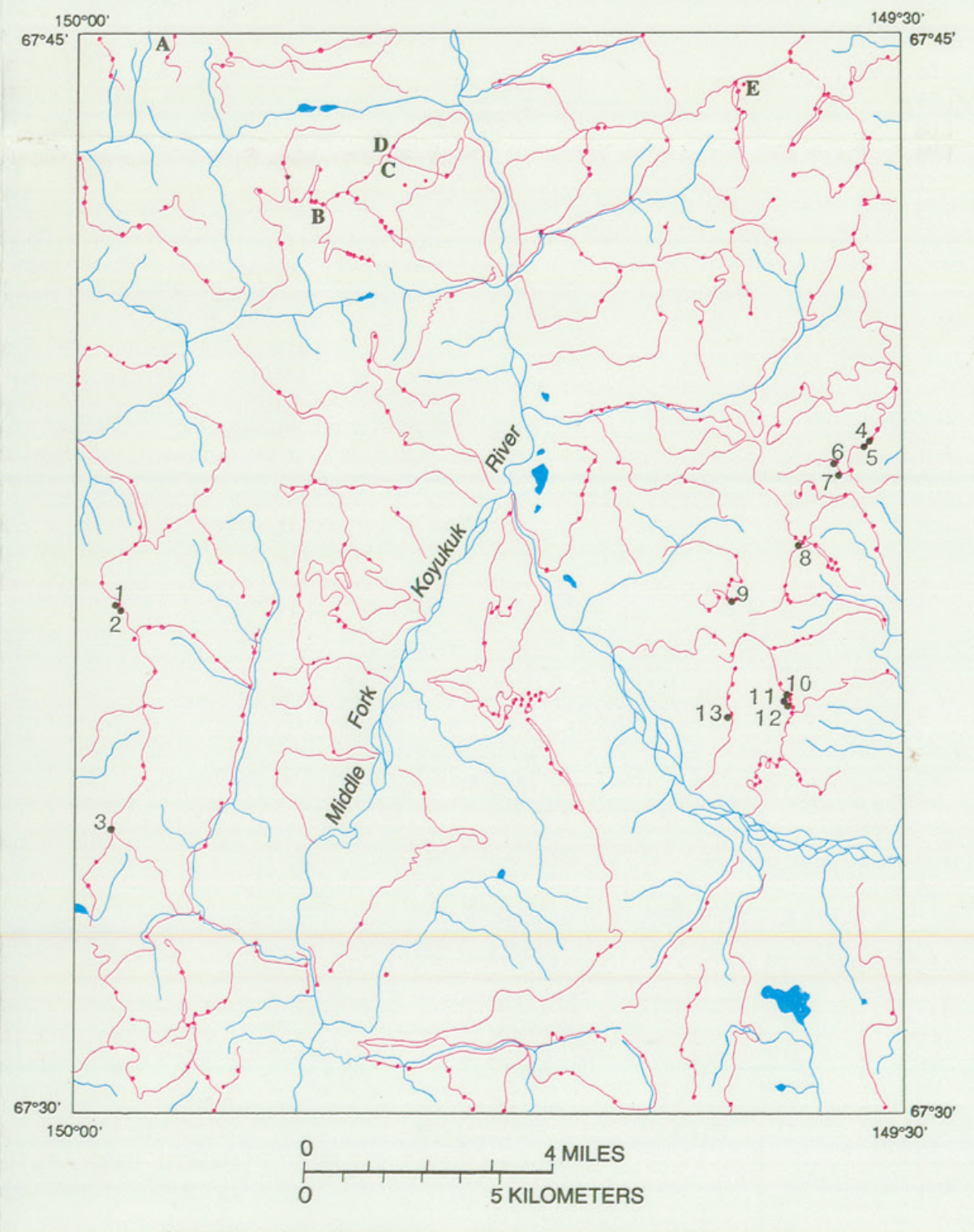
Pqs INTERBANDED QUARTZITE AND GRAPHITIC SCHIST (Lower Paleozoic to Proterozoic?)—Predominantly white, medium-grained quartzite bands <5 cm thick with numerous dark-gray, graphitic albite-chlorite-muscovite-quartz schist interbands and lenses or knots. Bands probably represent metamorphically differentiated relicts of interbedded quartzose and pelitic sediments. Accessory minerals are clinozoisite, pyrite, tourmaline, chloritoid, rutile, sphene, calcite, and allanite. To the south and southwest, this unit is extensive and includes rusty-weathering, coarsely crystalline mica schist and paragneiss with 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 includes gray, blocky-weathering, foliated, coarse- to very coarse grained biotite-quartz-feldspar orthogneiss(?) or paragneiss interlayers; may include garnet-epidote-chlorite-muscovite-biotite granite orthogneiss with thin aplitic veins. Locally contains K-feldspar megacrysts. Superposition of three intersecting schistosities yields the typical lenticular or "knotty" structure described by Dillon, Hamilton, and Lueck (1981) and Dillon, Tilton, and others (1987)

Pm MARBLE (Lower Paleozoic to Proterozoic?)—Black to gray marble inferred to exist as discontinuous lenticular bodies in the interbanded quartzite and graphitic schist unit (Pqs). Exposed above thrust faults in the Chandalar B-6 (Dillon and Reifenstuhl, 1995) and C-6 Quadrangles

Table 1. *Major-oxide analyses and CIPW norms of rocks in the Chandalar C-6 Quadrangle, northern Alaska*

Sample	82DN118A	82DN118B	82DN122	82DN162	82DN161	82DN158	82DN157	82DN143B	82AD160C	82DN148	82AD142	82DN147	82DN154
Map unit	Df	Df	Ds	Df	Df	Df	Ds	Dg	Da	Ds	Df	Df	Dg
Map no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Rock type	Andesite tuff(?)	Dacite flow(?)	Altered basalt	Rhyolite	Rhyolite	Dacite	Andesite	Gabbro	Altered basalt(?)	Altered basalt	Rhyolite	Dacite	Gabbro
SiO_2	61.27	64.09	40.47	74.66	78.26	69.61	59.57	46.12	43.88	43.27	72.65	67.66	46.88
Al_2O_3	7.37	10.79	12.82	13.69	12.25	15.01	15.57	16.02	3.91	15.39	14.33	15.09	14.38
Fe_2O_3	0.87	2.87	1.73	0.82	1.25	3.10	3.20	3.04	2.64	3.80	2.12	4.42	3.60
FeO	5.18	2.98	7.98	0.65	0.36	0.43	10.39	8.21	0.65	6.46	0.87	ND	7.62
MgO	2.34	1.86	8.79	0.13	0.26	0.53	3.22	7.52	11.83	7.68	0.11	0.13	6.52
CaO	1.96	1.94	8.62	0.14	0.15	0.42	1.14	10.39	31.62	11.88	0.55	1.66	9.56
Na_2O	2.41	1.95	0.65	3.28	2.99	4.09	0.69	2.33	0.19	1.62	5.88	4.68	1.89
K_2O	0.91	2.42	2.40	5.58	2.30	4.94	0.47	ND	ND	0.03	2.69	3.98	1.08
TiO_2	0.42	0.53	1.12	0.16	0.19	0.49	1.18	2.31	0.08	1.53	0.17	0.19	1.94
P_2O_5	0.26	0.17	0.11	0.02	0.02	0.07	0.12	0.20	0.11	0.16	0.11	0.08	0.18
MnO	7.13	2.95	0.18	0.02	0.01	0.05	0.07	0.19	0.06	0.20	0.06	0.16	0.25
Total	90.12	92.47	84.87	99.15	98.04	98.63	95.57	96.33	94.86	91.94	99.54	97.76	93.88
*FeOx	5.96	5.56	9.54	1.39	1.48	3.22	13.27	10.95	3.03	9.88	2.78	3.98	10.86
Norms (%)													
Quartz	30.40	35.23	NA	33.95	52.44	25.66	41.45	NA	NA	NA	27.25	20.58	2.29
Corundum	NA	1.99	NA	2.07	4.71	2.37	12.70	NA	NA	NA	1.01	0.26	NA
Orthoclase	5.97	15.47	16.71	33.26	13.86	29.60	2.91	NA	NA	0.19	15.97	24.06	6.80
Albite	22.63	17.84	6.48	27.99	25.80	35.09	6.11	20.47	NA	14.91	49.98	40.50	17.03
Anorthite	7.33	9.21	29.43	0.57	0.63	1.65	5.10	34.52	10.35	37.67	2.02	7.89	29.36
Nepheline	NA	NA	NA	NA	NA	NA	NA	NA	0.92	NA	NA	NA	NA
Diopside	1.36	NA	16.32	NA	NA	NA	NA	14.26	54.60	20.41	NA	NA	16.15
Hypersthene	29.47	15.60	8.47	0.62	0.66	1.61	25.03	18.92	NA	14.07	0.28	3.85	18.70
Olivine	NA	NA	16.84	NA	NA	NA	NA	2.22	5.13	4.41	NA	NA	NA
Calcite-orthoclase	NA	NA	NA	NA	NA	NA	NA	NA	26.16	NA	NA	NA	NA
Magnetite	1.40	3.18	2.96	1.20	0.65	2.93	4.07	4.58	2.41	4.78	2.52	2.30	5.31
Hematite	NA	NA	NA	NA	0.82	NA	NA	NA	NA	NA	0.39	NA	NA
Ilmenite	0.89	1.09	2.51	0.31	0.37	0.94	2.35	4.55	0.16	3.16	0.32	0.37	3.92
Rutile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Apatite	0.67	0.43	0.30	0.05	0.05	0.16	0.29	0.48	0.27	0.40	0.27	0.19	0.44
Wollastonite (diopside)	0.66	NA	8.40	NA	NA	NA	NA	7.36	29.12	10.56	NA	NA	8.31
Enstatite (diopside)	0.15	NA	5.16	NA	NA	NA	NA	4.64	24.16	6.83	NA	NA	5.11
Ferrosilite (diopside)	0.55	NA	2.76	NA	NA	NA	NA	2.26	1.33	3.03	NA	NA	2.73
Enstatite (hypersthene)	6.32	5.01	5.52	0.33	0.66	1.34	8.39	12.73	NA	9.75	0.28	0.33	12.19
Ferrosilite (hypersthene)	23.15	10.59	2.95	0.29	NA	0.27	16.64	6.19	NA	4.32	NA	3.52	6.51
Forsterite (olivine)	NA	NA	10.59	NA	NA	NA	NA	1.45	4.84	2.96	NA	NA	NA
Fayalite (olivine)	NA	NA	6.24	NA	NA	NA	NA	0.78	0.29	1.45	NA	NA	NA
norm plag	24.46	34.04	81.95	1.99	2.37	4.49	45.49	62.78	87.12	71.64	3.88	16.30	63.28
Differentiation index	58.99	68.54	23.19	95.20	92.11	90.34	50.46	20.47	0.92	15.10	93.20	85.14	26.12

NA = Not analyzed
ND = Not detected
FeOx = FeO + (0.9 x Fe_2O_3)
Oxides determined by atomic-absorbtion spectrophotometry. Analyst - N.D. Veach, DGGS Minerals Laboratory, Fairbanks, Alaska.



Chandalar C-6 Quadrangle, Alaska, showing traverses, station locations (red), location of major-oxide sample locations keyed by number (table 1) and fossil-collection locations keyed by letter (table 2). Stream-net (in blue) from U.S. Geological Survey Quadrangle, 1:63,360, 1982.

DISCUSSION

METAMORPHISM

The Proterozoic(?) to lower Paleozoic rocks (units Pqs, Pm) are known informally as the country rock schist of the Brooks Range schist belt. These units have undergone two and possibly three metamorphic episodes (M_1, M_2, M_3) (Dillon, Pessel, and others, 1987; Dillon, 1989). These units crop out only in the extreme southern part of the Chandalar C-6 Quadrangle, but are areally extensive within the adjacent Chandalar B-6 Quadrangle (Dillon and Reifenstuhl, 1995). The Cambrian and younger bedrock units have been affected by metamorphic episodes M_2 and M_3. M_2 metamorphism produced a schistosity (S_1) that is disrupted and partially transposed by subsequent Late Jurassic or Early Cretaceous semipenetrative cleavage (S_2) that is defined by middle greenschist-facies minerals. The age of M_3 metamorphism is constrained by K-Ar cooling ages of 100-140 Ma (Dillon, 1989; Turner and others, 1979; and Dillon and Reifenstuhl, 1990).

FAULTS

Thrust Faults

The southwest-northeast-trending thrust faults were a result of north-directed Brookian compression, followed by uplift of the schist-belt rocks. Typically, these thrusts juxtapose lower Paleozoic schistose lithologies against Devonian marbles and calc-schists. The sequence of the Brookian events in the Wiseman A-4 Quadrangle is well documented by Dillon, Pessel, and others (1987).

High-angle Faults

A major west-trending, high-angle, strike-slip fault zone crosses the Chandalar C-6 Quadrangle south of Sukakpak Mountain. This fault forms a brecciated and slickensided zone on the south side of Sukakpak Mountain and contains an important stibnite-gold-bearing vein occurrence (Huber, 1988). Slickensides in the fault zone are subhorizontal, and lithologic relations across the fault indicate at least a few kilometers of right-lateral displacement (Dillon, 1989). This fault and the Snowden Mountain fault (to the north) displace and postdate structures related to the Jurassic to Neocomian thrusting and metamorphism (M_2). The faults may have formed during the same tectonic episode that created the larger Malamute-South Fork fault system to the south (Grantz, 1966; Dillon, Pessel, and others, 1987; Dillon, 1989).

FOLDS

Many macro- and mesoscopic folds of bedding and foliation were identified in the field. The megascopic thrust-related drag folds and north-vergent recumbent folds shown on the cross section are schematic. The repetition of lithologic units within the quadrangle is most easily explained by these folds and related thrust faults. Structures with similar symmetry have been recognized in the Wiseman A-5, A-6, B-3, B-5, and B-6 Quadrangles and are inferred to exist in the Wiseman A-1 and B-1, and Chandalar B-6 and C-5 Quadrangles (Dillon, 1989; Dillon, Lamal, and Huber, 1989; Dillon and Reifenstuhl, 1990; 1995; Dillon, Reifenstuhl, and Harris, in press).

GRANITIC PLUTONISM

Devonian granitic rocks (Dgr) that crop out in the Chandalar C-6 Quadrangle are probably part of the belt of granitic bodies that extends east into the Chandalar C-5 Quadrangle (Dillon, Reifenstuhl, and Harris, in press). The granitic pluton shown at depth on the cross-section is inferred from aeromagnetic and gravity profiles (Smith and Dillon, 1989). Within the adjacent Chandalar C-5 Quadrangle, the granites have been subdivided into two major bodies: the Horace Mountain plutons and the Baby Creek batholith. The subdivision is based upon differences in mineralogy, chemistry, normative mineralogy, alteration, and associated mineral occurrences (Dillon, Reifenstuhl, and Harris, in press). Overlapping Middle Devonian U-Pb and Pb-Pb ages are reported for both rock bodies (Dillon, 1989; Dillon, Reifenstuhl, and Harris, in press).

The stratigraphic and structural positions of the granitic rocks in the Chandalar C-6 Quadrangle are similar to those of the Horace Mountain plutons. In the adjacent Chandalar C-5 Quadrangle, the Horace Mountain plutons contain porphyry copper-molybdenum mineralization and associated proximal copper-silver and distal lead-zinc skarns (Newberry and others, 1986; Nicholson, 1989; Dillon, Reifenstuhl, and Harris, in press).

ECONOMIC GEOLOGY

The southern Chandalar C-6 Quadrangle lies within the upper Koyukuk gold district, the most productive gold district in the Brooks Range. From 1900 to 1970, the Chandalar mining district (50 km to the east-southeast) and the upper Koyukuk gold district produced more than 330,000 oz of placer gold (Bliss and others, 1988a). The richest deposits lie in a belt extending from the towns of Nolan and Wiseman (northern Wiseman B-1 Quadrangle) to the gold camps of Gold Creek and Linda Creek (Chandalar C-6 Quadrangle). Gold-bearing gravels occur in three units in the region: (1) active stream gravels (unit Qa); (2) elevated terrace gravels (units Qat, Qgr); and (3) deep, buried gravels. Nokleberg and others (1987) divided the gold-bearing gravels into preglacial and a postglacial deposits.

The only known lode-gold occurrence in the Chandalar C-6 Quadrangle is located on the south side of Sukakpak Mountain (Huber, 1988). Mineralization consists of early sulfide-poor quartz-chalcopyrite (Q_1) and late quartz-stibnite-gold veins (Q_2). Shear zones and marble-schist contacts control the locus of crystallization of both vein types. Huber (1988) reported unimodal fluid-inclusion-trapping temperatures of 150° to 300°C for Q_1 and Q_2 veins and salinities of 0.18 to 4.9 weight-percent NaCl equivalents. Q_1 inclusions average 11.5 weight-percent CO_2, and Q_2 inclusions average 5.8 weight-percent (CO_2). Traces of methane (CH_4) occur in both vein types. Additional fluid-inclusion work by Dillon and Reifenstuhl (1990) yielded uncorrected Q_1 trapping temperatures of 199° to 293°C at salinities of 6.5 weight-percent NaCl equivalents and Q_2 trapping temperatures of 212° to 254°C. Samples with up to 19.7 oz/ton gold, 0.16 oz/ton silver, 54 percent antimony, and 1.7 percent molybdenum have been reported from Sukakpak Mountain and the Mikado and Little Squaw mines (Nokleberg and others, 1987, p. 14-15). Dillon and Reifenstuhl (1990) reported an average grade of 17.4 percent antimony and 0.44 oz/ton gold from 13 channel samples distributed over a 135 m by 0.75 m exposure of veined material.

Three lode-gold genesis theories are favored by most workers for the upper Koyukuk and Chandalar mining district occurrences: (1) gold originally concentrated in the cupolas of Devonian granites was remobilized into quartz veins during the waning stages of metamorphism in Jurassic to Neocomian time (Dillon and Reifenstuhl, 1990); (2) gold originally concentrated in Devonian volcanogenic massive-sulfide deposits was remobilized into veins during M_3 metamorphism; and (3) gold was remobilized from the Proterozoic(?) to lower Paleozoic schist belt rocks during the M_3 metamorphic event (R.J. Newberry, and G.W. Harris, written commun., 1989). Pb-Pb isotope systematics of the vein sulfides indicate that the vein metals were derived from a Proterozoic source (R.J. Newberry, and G.W. Harris, written commun., 1989)

Geophysical evidence indicates that the Devonian granitic rocks (unit Dgr) that crop out in the northeast quarter of the quadrangle probably exist in the subsurface (Smith and Dillon, 1989). The unit is not known to be associated with any mineralization. Correlative(?) granitic rocks with a similar structural and stratigraphic position in the adjacent Chandalar C-5 Quadrangle contain porphyry copper-molybdenum mineralization and are associated with proximal copper-silver and distal lead-zinc skarns (Newberry and others, 1986; Nicholson, 1989; Dillon, Reifenstuhl, and Harris, in press). Other granitic rocks in the Chandalar C-5 Quadrangle (Baby Creek batholith) are spatially associated with stream-sediment tin anomalies (Detra and others, 1977).

The Devonian black slates, phyllites, and marbles assigned to the Beaucoup Formation crop out extensively in a belt across the northern and western portions of the Chandalar C-6 Quadrangle. This belt continues into the adjacent Wiseman C-1 Quadrangle. Within the Wiseman C-1 Quadrangle, Bliss and others (1988b) identified these rock types as possible hosts for sedimentary-hosted lead-zinc deposits and carbonate-hosted base-metal deposits. Neither type of mineralization has been identified in the Chandalar C-6 Quadrangle.

Only minor Devonian felsic volcanic and volcaniclastic rocks (unit Df) crop out in the Chandalar C-6 Quadrangle. These rocks may correlate with the Ambler sequence of Hitzman and others (1982). Within the Ambler sequence in the Survey Pass and Ambler River Quadrangles, at least 14 major copper-lead-zinc volcanogenic massive-sulfide deposits have been located (Hitzman and others, 1982). The mineralization in most of these deposits is closely associated with felsic volcanic rocks. Mineralization has not been recognized in the Devonian felsic rocks in the Chandalar C-6 or C-5 Quadrangles.

Although the lower Paleozoic to Proterozoic(?) metasedimentary rocks (units Pqs, Pm) are part of the Brooks Range "schist belt" and have been identified as potential sedimentary-exhalative and Kuroko-type massive sulfide "mineral-assessment tracts" in the adjacent Wiseman 1° × 3° Quadrangle (Bliss and others, 1988b), no mineral occurrences of either type have been discovered in the Wiseman Quadrangle. The schist-belt rock units crop out in the extreme southern part of the Chandalar C-6 Quadrangle and are inferred to lie stratigraphically below the Cambrian rock units that occur within the quadrangle.

Sand and gravel deposits in the Koyukuk and Dietrich river valleys were exploited during construction of the Dalton Highway, the Trans-Alaska Pipeline, and the local road system. The highest quality deposits occur in the modern flood plain (units Qa, Qag) and ancient flood-plain terraces (unit Qat). Lower grade deposits occur in alluvial fans (unit Qaf).

Table 2. *Fossils-collection localities in the Chandalar C-6 Quadrangle, northern Alaska*

Map letter (rock unit)	Field number (USGS collection no.)	Fossils, age, identified by remarks
A (Dbl)	82Ad326	Crinoid ossicles, brachiopods?; coral; Phanerozoic; D.D. Adams
B(Dbl)	83Ad121	Crinoid columnal; Phanerozoic; D.D. Adams
C (Dbl)	82Dn227	Corals, brachiopods; Devonian(?); J.T. Dillon
D (Dbl)	82Dn228	Amphiporid, corals; Devonian(?); J.T. Dillon
E (Dbcp)	85Tr62A & B (11264-SD & 11265-SD)	Conodonts; *Icriodus* spp., *Ozarkodina* sp. indeterminent; Devonian (Middle - Late), A.G. Harris; CAI=5, most specimens deformed and incomplete, shallow-water biofacies.

CAI (conodont color-alteration index) is an index of organic metamorphism that has been calibrated in laboratory experiments. CAI values are time and temperature dependent and indicate a minimum temperature experienced by the conodont host rock; CAI=5 (300°-480°C). The CAI values of conodonts from carbonate rocks in the Chandalar C-6 and D-6 Quadrangles (Dillon, Harris, and others, 1988) are consistent with lower to middle greenschist-facies metamorphism indicated by the mineralogy of the associated pelitic and volcanic rocks.

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