PR104SH1

Base from U.S. Geological Survey Chandalar C-5 Quadrangle, Alaska, 1971

SCALE 1:63,360

1 ½ 0 1 2 3 4 MILES

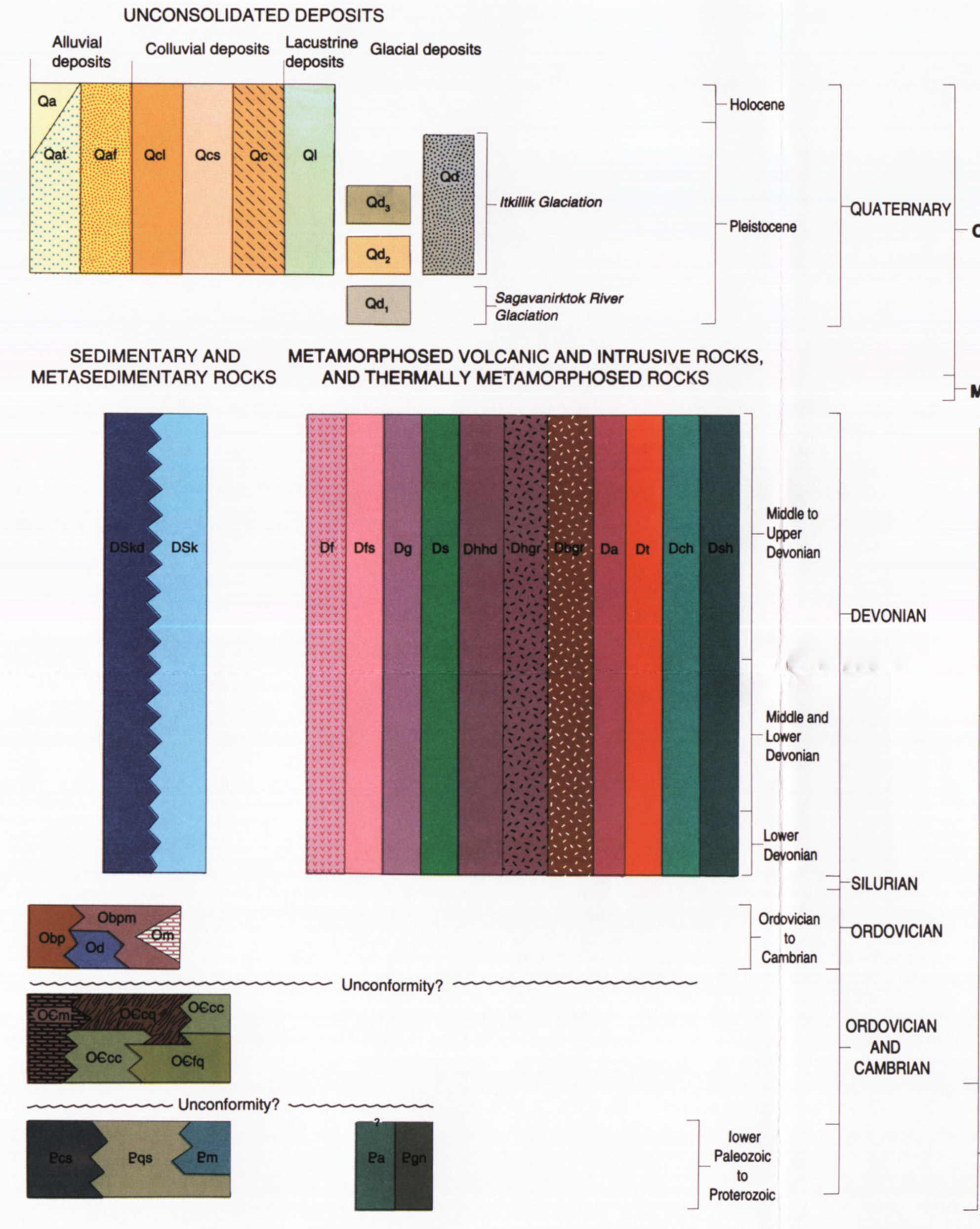
1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL

TRUE NORTH — MAGNETIC NORTH 29°
APPROXIMATE MEAN DECLINATION, 1971

Geology by: J.T. Dillon, 1977, 1981-1984; D.N. Solie, 1983-1984; P.A. Adler, 1983; D.D. Adams, 1981-1982; 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. Brosgé,1959; H.N. Reiser, 1967. E. Gressit, 1981; G. Ferrel, 1981, compiled by R.F. Clement, 1989. Surficial geology modified from T.C. Hamilton, 1979. Cartography by A-L. Schell.

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 sense of strike motion

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

Axis of anticline—Regional scale; showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of syncline—Regional scale; showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of anticline—Outcrop scale; showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of syncline—Outcrop scale; showing direction of dip of limbs and plunge of axis; bedding known or inferred

Axis of overturned syncline—Regional scale; showing direction of dip of limbs and plunge of axis; defined by transposed bedding

Axis of overturned anticline—Outcrop scale; showing direction of dip of limbs and plunge of axis; defined by transposed bedding

Axis of overturned syncline—Outcrop scale; showing direction of dip of limbs and plunge of axis; defined by transposed bedding

Axis of antiform—Regional scale; based on layer parallel schistosity, showing direction and dip of limbs and plunge of axis

Axis of synform—Outcrop scale; based on layer parallel schistosity, showing direction and dip of limbs and plunge of axis; defined by transposed bedding

Axis of overturned synform—Regional scale; based on layer parallel schistosity, showing direction and dip of limbs and plunge of axis

Axis of antiform—Outcrop scale; based on schistosity, showing direction and dip of limbs and plunge of axis

Axis of overturned synform—Outcrop scale; based on layer parallel schistosity, showing direction and dip of limbs and plunge of axis

Strike and dip of transposed bedding

Strike and dip of overturned transposed 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 where shown is estimated

Strike and dip of cleavage

Strike and dip of schistosity and parallel semipenetrative cleavage

Bearing and plunge of linear feature; fold (f), mineral (m), crenulation axis (c); asymmetric fold axis (af); isoclinal fold axis (if); may be used in conjunction with other structural symbols

Bearing and plunge of axis of small scale asymmetric fold, cross arrow indicates direction of rotation as viewed down fold axis; may be combined with other planar symbols

Bearing of horizontal lineation; may be combined with other planar symbols

Morainal ridge

Rock sample with major-oxide geochemistry—Number keyed to table 1, sheet 2

K/Ar age date locality—Number keyed to table 2, sheet 2

U/Pb age date locality—Number keyed to table 3, sheet 2

Direction of glacier flow across topographic divide

Generalized dip of schistosity on cross section

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

Qat ALLUVIAL-TERRACE DEPOSITS—Poorly sorted, moderately stratified mixtures of sand and gravel. Forms as terraces above the active alluvial plain

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. Distal 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 and mixed talus rubble (unit Qc) and solifluction deposits (unit Qcs)

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

Qc COLLUVIUM, UNDIFFERENTIATED—Mixed talus rubble and solifluction deposits, (see units Qcl, Qcs). Forms aprons > 1–2 m thick on slopes beyond limits of Itkillik phase II glaciation. Most common on phyllite, shale, and slate bedrock

LACUSTRINE DEPOSITS

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

GLACIAL DEPOSITS

Itkillik Glaciation

Qd ITKILLIK DRIFT, UNDIFFERENTIATED—Thick (>3 m), poorly to very poorly sorted, nonstratified to weakly stratified till that ranges in composition from muddy, sandy gravel to clayey stony silt. Includes local stratified ice-contact deposits that consist of moderately to poorly sorted sand, sandy gravel, and silty, sandy gravel

Qd_3 DRIFT OF ITKILLIK PHASE II—Till and stratified ice-contact deposits; ice-contact deposits more abundant than till in most valleys. Forms sharply defined drift lobes. Loess cover is generally thin to absent; exposed stones show slight to moderate weathering

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, 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. Estimated as middle Pleistocene (Hamilton 1979b)

METAMORPHOSED DEVONIAN SEDIMENTARY AND VOLCANIC ROCKS LOWER TO UPPER GREENSCHIST FACIES

Ds METAVOLCANIC ROCKS (Devonian)—Green to light-green, fine- to medium-grained, schistose, chlorite-epidote- and albite-bearing, mafic metavolcanic rocks (greenschist). These rocks consist of thin discontinuous lenses and layers and probably represent both flows and tuffs

Df FELSIC METAVOLCANIC ROCKS (Devonian)—Gray to tan, felsic schist and felsite; locally interlayered with metasedimentary rocks. Includes light-gray, fine-grained, calcareous, chlorite-muscovite-quartz-albite schist with accessory apatite, zircon, rutile, biotite and allanite, secondary talc, and pyrite, and rare microcline and garnet. Biotite is partially replaced by chlorite. Calcite content ranges from 3 to 20 percent, and more calcareous varieties may grade along strike into calc schist and talc schist. Includes interlayered (mm scale) calc-schist and talc schist thought to represent metamorphosed calcareous and bentonitic felsic tuffs. Also includes cherty, laminated felsite thought to represent airfall tuffs and locally blastoporphyritic textures indicative of a hypabyssal intrusive origin (felsic schist unit Dfs). Correlates with the felsic portion of Ambler volcanics and rocks of Whiteface Mountain (Dillon, Harris, and others, 1988; Dillon and others, 1986). Discordant U/Pb ages on six zircon separates from the eastern Wiseman and western Chandalar Quadrangles yield a maximum Pb-Pb age of 378 ± 15 Ma. This age is interpreted as equal to, or slightly less than, the magmatic crystallization age (Dillon and others, 1980)

Dfs FELSIC SCHIST (Devonian)—Light gray to tan, fine-grained locally, blastoporphyritic felsic schist (sheet 2, table1). Mineralogy includes white mica, quartz, albite ± biotite ± chlorite ± hornblende ± potassium ± feldspar. Thought to be time-equivalent and genetically related to the felsic meta-volcanic unit (Df). Contact relationships, blastoporphyritic textures, and local skarn and hornfels indicate a hypabyssal to plutonic origin. Felsic schist from the Wiseman A-6 Quadrangle yields a 365 ± 10 Ma Pb-Pb zircon age (Dillon and others, 1980)

Skajit Limestone

SKAJIT LIMESTONE (Devonian and Silurian?)—Gray marble and limestone, finely crystalline dolomite, massive dolomite breccia, carbonate conglomerate, with minor quartzite, and graphitic and calcareous schist interlayers. Rare fossils are Middle to Upper Devonian in Wiseman Quadrangle (Henning, 1982), Silurian to Upper Devonian in the Survey Pass Quadrangle (Adams, 1983) and Middle and Upper Devonian in the Chandalar Quadrangle (Brosgé and Reiser, 1971). Two of the Chandalar Quadrangle fossil collections may be as old as Silurian (W.P. Brosgé, oral commun., 1989). Mineral assemblages and conodont alteration indicies indicate lower greenschist facies metamorphism in the Sukakpak Mountain area (Chandalar C-6 Quadrangle, Huber, 1986)

DSk LIMESTONE (Devonian)—Massive gray marble, platy, dark gray marble, marble conglomerate, and undifferentiated carbonate rock with interlayers of pink-weathering dolomitic phyllite or schist and orange to gray dolomite (mapped separately as unit Dskd). Locally includes dolomite clast breccia and conglomerate and orange to pink-weathering, white mica quartzite interlayers. Interlayered with the purple and green phyllite of the Whiteface Mountain unit (Dwpg in the Chandalar D-6 Quadrangle of Dillon, Harris, and others, 1988)

DSkd DOLOMITE (Devonian)—Orange to gray-weathering, dolomite, dolomitic marble, and dolomite clast breccia and conglomerate occurring as interlayers and irregular replacements in the Skajit Limestone unit (Dsk). Algal laminations, fenestral structures, oolites, cut and fill structures, and some of the dolomite breccias suggest an intertidal environment of deposition

METAMORPHOSED DEVONIAN PLUTONIC AND RELATED AUREOLE ROCKS

Baby Creek Batholith

Dbgr BIOTITE GRANITE GNEISS (Devonian)—White to light gray, coarse-grained, equigranular to porphyritic, white mica-biotite granite and quartz monzonite gneiss. Informally known as the Baby Creek batholith (sheet 2, table 1, figs. 2, 3). Accessory minerals include apatite, garnet, pyrite, and magnetite. Hornblende is noticably absent. Coarse grained white mica of both primary (?) and secondary origin formed throughout the batholith. The secondary white mica is widespread and represents greisen alteration. The Baby Creek batholith yields Early Devonian Pb/Pb zircon ages (single separates, discordant; Dillon, 1989; Brosgé and Reiser, 1971, and sheet 2, table 3 of this study); an Early Devonian Rb-Sr errorchron is reported by Dillon (1989) and biotite and white mica K/Ar ages of 100-135 Ma represent metamorphic cooling ages (sheet 2, table 2) (Brosgé and Reiser, 1971)

Horace Mountain Plutons

Dhgr GRANITE GNEISS (Devonian)—Tan- to cream-colored, porphyritic biotite ± hornblende granite and granodiorite gneiss. Informally known as the Horace Mountain plutons (sheet 2, table 1, figs., 2, 3). Contains 3-8 mm blastoporphyritic potassium feldspar in a 1-2 mm groundmass. Accessory minerals include sphene, magnetite, and apatite. Pyrite and chalcopyrite are widely disseminated. The Horace Mountain plutons yield a 380 ± 25 Ma U/Pb concordia age (3 discordant zircon separates) and Early Devonian Pb-Pb ages (sheet 2, table 3). One K/Ar age on an amphibole separate yields an age of 390 ± 12 Ma (sheet 2, table 2). Biotite and white mica K/Ar ages are 100–135 Ma (sheet 2, table 2) (Turner and others, 1979; Brosgé and Reiser, 1971) and are interpreted as cooling ages following a Late Jurassic to Early Cretaceous metamorphic event

Dhhd HORNBLENDE GRANODIORITE GNEISS (Devonian)—Pale green to gray porphyritic hornblende-biotite granodiorite and granodiorite porphry of the Horace Mountain plutons. Distinctive blastoporphyrtic phenocrysts of 1–5 mm subhedral actinolitic hornblende in a very fine-grained groundmass of quartz, plagioclase, and potassium feldspar

Da APLITE (Devonian)—Light-gray, fine-grained, weakly foliated dikes and sills that occur as border facies and distal dikes and sills (sheet 2, table 1)

Dg METABASITE (Devonian)—Dark-green, medium-grained, metabasite with mineralogy consisting of actinolite, chlorite, epidote, clinozoisite, albite, and, locally, pyrite. Protoliths are dikes, sills and plugs of diabase, gabbro, and diorite (sheet 2, table 1). Whole-rock K/Ar ages on correlative metabasites intruding lower Paleozoic rocks of the Doonerak fenster (northeastern Wiseman Quadrangle) range from 373 to 388 Ma (Dutro and others, 1976)

Dt TACTITE (Devonian)—Green and brown, garnet-pyroxene skarn, and calc-silicate hornfels and skarnoid. Skarn includes minor to major amounts of bornite and chalcopyrite; retrograde minerals include epidote, amphibole, and chlorite

Dsh SILICIOUS HORNFELS (Devonian)—Medium and dark-gray, fine-grained, dense, cherty, quartz-rich hornfels, locally containing minor diopside and grossularitic garnet

Dch CALCAREOUS HORNFELS (Devonian)—Medium-gray and brownish medium-gray, coarse-grained, calcarious hornfels, and skarnoid containing minor to major amounts of euhedral grossularitic garnet. Locally consists of "pure" marble

ORDOVICIAN ROCKS

LOWER GREENSCHIST FACIES

Obpm BLACK PHYLLITE AND MARBLE (Middle Ordovician)—Black to dark gray, pyritic and graphitic phyllite, marble, dolomite, and schist. Commonly calcareous and locally contains thin dark crinoidal marble. Thicker marble layers mapped separately as map unit Om; phyllite as map unit Obp, and dolomite as map unit Od. Contains Middle Ordovician conodonts in the Chandalar D-6 Quadrangle (Dillon, Harris, and others, 1988)

Obp BLACK PHYLLITE (Middle Ordovician)—Black to dark gray, pyritic and graphitic, phyllite, and pelitic schist.

Om MARBLE (Middle Ordovician)—Dark gray to white marble layer 5–50 m thick interlayered in black phyllite and marble unit (Obpm). The marble unit (Om) in this quadrangle may correlate with the marble unit (Om) in the Chandalar D-6 Quadrangle where it contains crinoids and Ordovician conodonts (Dillon, Harris, and others, 1988)

Od DOLOMITE (Middle Ordovician)—Orange to gray-weathering dolomite, mapped separately only in the northeast corner of quadrangle. Age assignment based on interlayering relationship within black phyllite and marble unit (Obpm)

LOWER PALEOZOIC ROCKS

LOWER GREENSCHIST AND PREHNITE - PUMPELLYITE FACIES

OЄm MARBLE (Ordovician to Cambrian)—Medium-gray and brown, thin-bedded, unfossiliferous marble. Includes marble interlayers in the chlorite calcareous schist unit (OЄcc) and the calcareous chlorite quartz schist and quartzite unit (OЄcq). This Ordovician to Cambrian age marble unit is distinguished from the Middle Ordovician marble unit (Om) by its association with the chlorite calcareous schist (OЄcc) and calcareous chlorite schist and quartztitic units (OЄcq)

OЄcq CALCAREOUS CHLORITE QUARTZ SCHIST AND QUARTZITE (Ordovician to Cambrian[?])—Pale-green, calcareous, muscovite-chlorite quartz schist; locally contains chlorite-quartzite interlayers

OЄcc CHLORITE CALC-SCHIST (Ordovician to Cambrian[?])—Tan-weathering muscovite-chlorite-quartz calc-schist and calcareous quartz schist (sheet 2, table 1). Locally gradational contacts with the marble unit (OЄm), the calcareous chlorite-quartz schist and quartzite unit (OЄcq), and the quartz feldspar schist unit (OЄfq)

OЄfq FELDSPAR QUARTZ SCHIST (Ordovician to Cambrian[?])—Tan- to gray-weathering muscovite-chlorite-feldspar-quartz schist with minor biotite, garnet, and kyanite (sheet 2, table 1). Probably the lateral equivalent to quartz feldspar schist unit (OЄqf) that crops out in Chandalar C-6 Quadrangle (Dillon and Reifenstuhl, 1995b). The lower Paleozoic age designation for these rocks is based on the mapped distribution of the Twin Lakes area in this report. Here, the feldspar-quartz-schist unit overlies the lower Paleozoic to Proterozoic (?) interbanded quartzite and graphitic schist (map unit Ᵽqs). To the north and northwest the feldspar-quartz-schist unit (OЄfq), or one of the three partially equivalent lower Paleozoic rock units, is overlain by the black phyllite and marble unit (Obpm)

LOWER PALEOZOIC TO PROTEROZOIC (?) POLYMETAMOPHOSED SCHIST AND PARAGNEISS

UPPER GREENSCHIST TO LOWER AMPHIBOLITE FACIES

Ᵽcs CALCAREOUS SCHIST (lower Paleozoic to Proterozoic)—Brown-weathering quartz calc-schist with local interlayers of unit Ᵽqs. Has some layers of knotty schist like interbanded quartzite and graphitic schist unit (Ᵽqs)

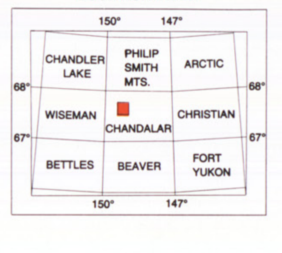
Ᵽqs INTERBANDED QUARTZITE AND GRAPHITIC SCHIST (lower Paleozoic to Proterozoic)—Predominantly white, medium-grained quartzite bands <5 cm thick with numerous interbands and lenses or knots of dark-gray, graphitic albite-chlorite-white mica-quartz schist (sheet 2, table 1). Bands probably represent metamorphically differentiated relics of interbedded quartzose and pelitic sediments. Accessory minerals are clinozoisite, pyrite, tourmaline, chloritoid, rutile, sphene, calcite,and allanite. This unit crops out extensively in the Wiseman 1° x 3° Quadrangle where it includes rusty-weathering, coarsely-crystalline mica schist and paragneiss and contains minor lenses and bands of black, graphitic schist in white mica quartzite; quartzo-feldspathic schist; marble and calcareous schist; and layers and dikes of mafic greenschist. Three intersecting schistosities yield typical lenticular or knotty structure (Dillon and others, 1981a, b). This unit correlates with the knotty mica schist (informal) of the southern Brooks Range schist belt. Thicker calc-schist layers mapped separately (unit Ᵽcs); marble layers as map unit Ᵽm, gneiss layers as map unit Ᵽgn and amphibolite layers as map unit Ᵽa

Ᵽm MARBLE (lower Paleozoic to Proterozoic)—Gray to black marble as small lenses and discontinous layers within the interbanded quartzite and graphitic schist unit (Ᵽqs)

Ᵽa AMPHIBOLITE (lower Paleozoic to Proterozoic)—Green to dark-green mafic meta-igneous rocks. Mineralogy includes biotite, chlorite, garnet, pyroxene, hornblende, and local calcite (sheet 2, table 1). This unit may be the higher grade metamorphic equivalent of greenschist unit (Ᵽs) which occurs in the Chandalar B-6 (Dillon and Reifenstuhl, 1995a) and Wiseman B-1 Quadrangles (Dillon and Reifenstuhl, 1990). These mafic igneous rocks may represent a range of ages from Proterozoic through Devonian

Ᵽgn GNEISS (lower Paleozoic to Proterozoic)—Gray, blocky-weathering, coarse- to very coarse-grained, biotite-quartz-feldspar orthogneiss or paragneiss (sheet 2, table 1). Includes garnet-epidote-chlorite-white mica-biotite granite orthogneiss with thin aplitic veins. Locally contains potassium feldspar megacrysts. Occurs as small bodies within the interbanded quartzite and graphitic schist (Ᵽqs). In the southwest Wiseman Quadrangle, Pb/Pb systematics from the granite orthogneiss yield Proterozoic ages (Dillon and others, 1980)

LOCATION INDEX



DISCUSSION

METAMORPHISM

The lower Paleozoic to Proterozoic rocks (map units Ᵽcs, Ᵽqs, Ᵽm, Ᵽa, Ᵽgn) the oldest rocks in the map area, are known informally as the "country rock schist" of the Brooks Range schist belt. These units have undergone two, or possibly three, regional metamorphic episodes (M_1, M_2, M_3) (Dillon and others, 1987a; Dillon, 1989). Metamorphic differentiation bands in the gneissic rocks (Ᵽgn) are evidence of the earliest metamorphic episode (M_1) and represent transposed bedding. *Metamorphic* events M_2 and M_3 are attributed to increases in temperature and pressure. These changes were caused by convergence and tectonic thickening that developed during the northward obduction of the Angayuchum terrane and of other rocks located to the south.

Locally a strong penetrative schistosity (S_2) cuts across the M_1 gneiss bands and transforms them into rods. But in most places the S_2 schistosity parallels the M_1 banding; therefore, the banding may have formed penecontemporaneously with schistosity (S_2) during M_2 metamorphism. The schistosity (S_2) and banding are disrupted and partially transposed by subsequent Late Jurassic to Early Cretaceous semipenetrative cleavage (S_3) that is defined by lower greenschist-facies minerals. Where the semipenetrative cleavage (S_3) cuts the schistosity (S_2) and gneissic banding at high angles a distinctive knotty structure develops. The youngest cleavage (S_3) is axial planar to major north-vergent isoclinal folds (fig. 5) that were probably formed during thrusting. Mineral lineations trend north-south, parallel to the apparent thrust-transport direction (fig. 5).

The minimum age of M_3 is confined by the deposition of onlapping Albian sediments that were unaffected by metamorphism (Mull, 1979, 1982, 1985; Dillon and Smiley, 1984). The M_2 metamorphism recrystallized Lower Triassic rocks in the northcentral Brooks Range, and most of the oldest K/Ar cooling ages are <140 Ma (sheet 2, table 2) (Turner and others, 1979; Dillon and Reifenstuhl, 1995a; Dillon and Reifenstuhl, 1995b; and Dillon and others, 1987b). This post-Triassic to pre-Albian age range for the M_2 and M_3 metamorphic events is supported by other workers (Roeder and Mull, 1978; Dillon and others, 1980; Dillon, 1982; Mull, 1982; Dusel-Bacon and others, 1989; Dillon, 1989). Furthermore, isotopic data from Devonian plutons that supports this age of metamorphism includes discordant zircon U/Pb ages (fig. 4) (Dillon and others, 1980), and preliminary Rb-Sr and Sm-Nd mineral and whole rock isochrons (J.T. Dillon, unpub. data,1980).

Maximum pressure-temperature conditions for the M_3 metamorphic event have been estimated from modal mineralogy and fluid inclusion data. Mineral assemblages from the adjacent Wiseman Quadrangle are similar to the facies series of the Alpine schist belt of New Zealand (Turner, 1981). Maximum temperatures (>450°C) in the southern Brooks Range are inferred from the local presence of oligoclase. Trapping conditions of fluid inclusions from syn- and post-metamorphic quartz veins also indicate maximum temperatures of prograde metamorphism were about 450°C (Ashworth, 1983). The presence of coexisting albite and chlorite and the absence of glaucophane in the map area, indicate maximum pressures for the M_3 event of 5-6 kilobars (kb). This pressure estimate is corroborated by fluid inclusion isochores. Kyanite is also locally present in upper greenschist-lower amphibolite facies rocks (unit OЄfq), which suggests a minimum pressure of around 4 kb. The pressure gradient must have increased substantially toward the south because pressures >7.5 kb are estimated from calcite-dolomite mineral pairs in correlative rocks in the Chandalar B-6 Quadrangle (Gottschalk and Oldow, 1988).

Most conodont alteration indexes from the Wiseman Quadrangle indicate temperatures of 350° to 400°C (A.G. Harris, oral commun., 1984). Maximum pressure is controlled by the albite + chlorite = glaucophane transition. Peak pressures and temperatures occur in the south and grade to lower pressures and lower temperatures in the north.

In the Chandalar C-5 Quadrangle, contact metamorphic aureoles associated with Devonian plutonism remain relatively intact despite the effects of regional metamorphism. Many of these zones contain mineral assemblages of hornblende-hornfels facies dominated by diopside, grossularitic garnet, idocrase, and lesser tremolite. Calcareous hornfels (map unit Dch) formed where slightly impure carbonate rocks intruded; cherty, siliceous hornfels (map unit Dsh) where quartz schists or quartzites intruded. Garnet-pyroxene skarn, layered, garnet-rich skarnoid and tactite (map unit Dt; intermixed hornfels and skarn) all formed during prograde metasomatism. Actinolite-chorite vein skarn formed during retrograde metasomatism.

FAULTS

The prominent south-dipping thrust fault trending southwest-northeast across the northwest quarter of the quadrangle juxtaposes the Ordovician to Cambrian age schist unit (OЄcq) and the Devonian Skajit Limestone (unit Dsk). Normally, these units are stratigraphically separated by Ordovician units (black phyllite and marble, Obpm; black phyllite, Obp; marble, Om; and dolomitic marble; Od) elsewhere in this quadrangle and in the Chandalar C-6 Quadrangle (Dillon and Reifenstuhl, 1995b). This thrust fault is consistent with north-directed Brookian compression and thrusting (Dillon and others, 1990; Gottschalk and Oldow, 1988), has apparently cut upsection, is typical of thrust fault geometry in fold and thrust belts, and is our preferred explanation. A possible alternative explanation for the juxtaposition of Devonian Skajit Limestone above the calcareous chlorite quartz schist and quartzite unit (OЄcq) is an unconformity or a faulted unconformity.

GRANITIC PLUTONISM

The metamorphosed granitic to granodioritic rocks of the Chandalar C-5 Quadrangle are petrologically subdivided into two major bodies: (1) the Horace Mountain plutons (map units Dhgr and Dhhd) and (2) the Baby Creek batholith (map unit Dbgr). The subdivision is based upon differences in mineralogy, geochemistry, normative mineralogy, alteration, and associated mineral occurrences. Overlapping Early Devonian ages have been reported for both plutonic bodies (sheet 2, tables 2, 3) (Dillon, 1989). The following summary of the petrographic and petrologic differences listed above is modified from Newberry and others (1986).

Horace Mountain Plutons

The Horace Mountain plutons (HMp) are metaluminous and moderately to highly differentiated. Their differentiation index (D.I.= normative Q + Or + Ab + Ne + Ks + Lc) ranges from 50 to 90; 84 percent of samples have a D.I. of 65–85. The HMp includes porphyritic biotite ± hornblende granite gneiss (unit Dhgr), hornblende-biotite granodiorite gneiss porphry (unit Dhhd), and porphyritic hornblende-biotite granodiorite gneiss (unit Dhhd) with accessory sphene, magnetite, and apatite. These rocks have been classified as I-type granites on the basis of their $K_2O/K_2O + Na_2O$ ratios, $Al_2O_3/K_2O + Na_2O + CaO$ ratios and normative corundum contents. Alteration in the Horace Mountain plutons includes widespread, weak to pervasive sericitic alteration zones and porphery Cu-Mo mineralization in lower Big Spruce Creek. Mineralization associated with the Horace Mountain plutons consists of proximal Cu-Ag and distal Pb-Zn skarns associated with the rocks mapped as tactite (map unit Dt).

Baby Creek Batholith

The Baby Creek batholith (map unit Dbgr) is a peraluminous and highly differentiated biotite-muscovite granite gneiss with minor biotite-muscovite quartz monzonite gneiss. The differentiation index (D.I. = normative Qt + Or + Ab + Ne + Ks + Lc) ranges from 37 to 97; 80 percent of the samples range from 80 to 97). Accessory phases include white mica and apatite and local garnet, pyrite, and magnetite. Hornblende is noticeably absent. These rocks are characterized as S-type granites (Chappel and White, 1974) based on their $K_2O/K_2O + Na_2O$ and $Al_2O_3/K_2O + Na_2O + CaO$ ratios. Normative corundum contents overlap extensively with the Horace Mountain plutons. Greisen-like alteration occurs locally with associated pan concentrate tin anomalies downstream.

Dillon (1989) proposed that the overlap in igneous textures, phases, ages, and geochemistry of the Horace Mountain plutons and the Baby Creek batholith does not rule out consanguinity (sheet 2, figs 2, 3, table 1). White and others (1986) have shown that the $K_2O/K_2O + Na_2O$ and $Al_2O_3/K_2O + Na_2O+CaO$ ratios do not distinguish magma types in the southwestern United States. Dillon (1989) concluded that the differences in compositions and textures could be attributable to varying levels of erosion or contamination of a consanguineous suite, or both.

The large range of differences in alkalinity, differentiation index, mineralogy, normative mineralogy, metal content, alteration, and associated mineral occurrences may be best explained if the two suites are not consanguineous. However, more detailed work is necessary to resolve the relationship between the Horace Mountain plutons and the Baby Creek batholith. Dillon (1989) and Newberry and others (1986) recognized that the two suites may share some ultimate genetic commonality.

ECONOMIC GEOLOGY
(modified from Newberry and others, 1986, and from Nicholson, 1990)

Known mineralization within the Chandalar C-5 Quadrangle consists of small porphyry Cu-Mo occurrences, Cu-Ag and Pb-Zn skarns, and isolated quartz-galena vein occurrences. Most of the skarns occur in the northwestern portion of the C-5 Quadrangle and in zones adjacent to the north flank of the Horace Mountain plutons. Exploration drilling has been conducted on a few of the prospects, but distance to the Dalton Highway has prevented further development.

Cu-Mo porphery mineralization within the Horace Mountain plutons consists of quartz-sericite-pyrite-chalcopyrite-chlorite stockworks within areas of widespread but weak sericitic alteration. The hornblende granodiorite gneiss unit (Dhhg) in lower Big Spruce Creek contains zones up to several hundred meters thick with sulphides averaging 5 percent and grades of up to 0.6 percent Cu, 0.02 percent Mo, and 0.1 percent Ag.

Skarn mineralization in the Chandalar C-5 Quadrangle follows a district zoning pattern similar to that seen in porphyry districts of the southwest United States. Proximal Cu-Ag skarns are located very near the Horace Mountain intrusives in lower Spruce Creek, whereas Pb-Zn skarns on the northeast are not directly linked to any major intrusive body.

Cu-Ag skarns consist of brown andraditic garnet, green diopsidic pyroxene, and local sulfides or magnetite formed during a prograde event. Very late andraditic garnet forms veins and replacements in the earlier skarn and is associated with bornite and chalcopyrite. A retrograde assemblage dominated by epidote and actinolite also forms veins and replacements particularly near contacts with prograde skarn. The Cu content of the prograde skarn averages about 1 percent to 12 percent. Ag content is also variable but correlates positively with Cu content. The tonnage of one Cu skarn deposit just north of Horace Mountain is estimated at 1 million tons of 5 percent Cu (DeYoung, 1978).

Mineralogical data for Pb-Zn skarns is sparse, but they are dominated by sphalerite and galena and contain lesser pyrite and chalcopyrite. Gangue minerals include epidote, actinolite, chlorite, and calcite. Major fault structures found near the trend of Pb-Zn skarns are known to be post ore.

No significant mineralization has been found within the Baby Creek batholith in the Chandalar C-5 Quadrangle. Greisen-like alteration occurs locally within the batholith, and local calc-silicate skarn occurs adjacent to the intrusive contact. Sn anomalies occur downstream in pan concentrates (Detra and others, 1977; Adams and Dillon, 1988) which suggests detrital cassiterite, Sn-bearing calc-silicates, or other minerals. The lack of significant skarn development in this area is due partly to the sparsity of carbonate rocks.

Potential exists for auriferous vein deposits in the right-lateral transform-fault zone south of the Horace Mountain plutons. A quartz-suphide-gold vein deposit occurs in the fault zone near the south end of Sukakpak Mountain in the Chandalar C-6 Quadrangle (Huber, 1988). At the Sukakpak Mountain locality an epithermal quartz-stibnite-gold vein is exposed for a distance of 135 m and has an average thickness of 0.75 m. This vein contains an average of 17.4 percent stibnite and 0.44 oz/ton gold (Huber, 1988).

Devonian felsic volcanic and hypabysal intrusive rock units (Df, Dfs) correlate with the Ambler sequence of Hitzman and others (1982). This sequence contains at least 14 major Cu-Pb-Zn volcanogenic massive sulphide deposits in the Survey Pass and Ambler River Quadrangles; most are associated with felsic volcanic rocks. However no mineralization of this type has been reported for the felsic rocks in the Chandalar C-5 Quadrangle

Our lower Paleozoic to Proterozoic metasedimentary map units (Ᵽcs, Ᵽqs, Ᵽm, Ᵽa, Ᵽgn) are part of the Brooks Range schist belt and have been identified as potential sedimentary-exhalative and Kuroko massive sulfide mineral-assessment tracts in the adjacent Wiseman 1° x 3° Quadrangle (Bliss and others, 1988a, b). However, no known occurrences of either type have been reported in the Chandalar C-5 Quadrangle.

GEOCHEMISTRY

A geochemical investigation of the Chandalar C-5 Quadrangle, which was conducted concurrently with the geological mapping, evaluated the mineral potential of the district. This investigation included collection of 1,319 stream-sediment and 323 pan-concentrate samples in the Chandalar C-5 and C-6 Quadrangles. Samples were analyzed for 23 elements (sheet 2, table 1). Both single and multiple population statistical methods were used to select anomaly thresholds. Specific geochemical signatures were evident in certain geographic areas as summarized below (see Adams and Dillon, 1988, for a comprehensive treatment of the geochemical data).

A northeast-southwest trend of anomalous Cu, Pb, Zn, Mo, As, Ag, Fe, and W corresponds to a belt of known Cu-Ag and Zn-Pb-Ag skarns in the northcentral portion of the map area. The Horace Mountain plutons and adjacent contact aureole contains anomalous Cu, Pb, Zn, As, Sb, Co, Ni, Cr, Ba, Ag, Sn, and W. This mixed-element suite of anomalies suggests mutiple sources, which might include Cu and Pb-Zn skarn, porphyry Cu, greisen and/or epithermal vein mineralization. A northeast-trending fault zone, which yields anomalous As and Sb, parallels the Bettles River and continues westward into the Chandalar C-6 Quadrangle. The southcentral portion of the map area contains the anomalous metal suite Sn-W-Zn-Pb-Co-Ni-Cr-Ba-Mn-Fe; this suite could have the same source as the Sn or Pb-Zn skarn and greisens.

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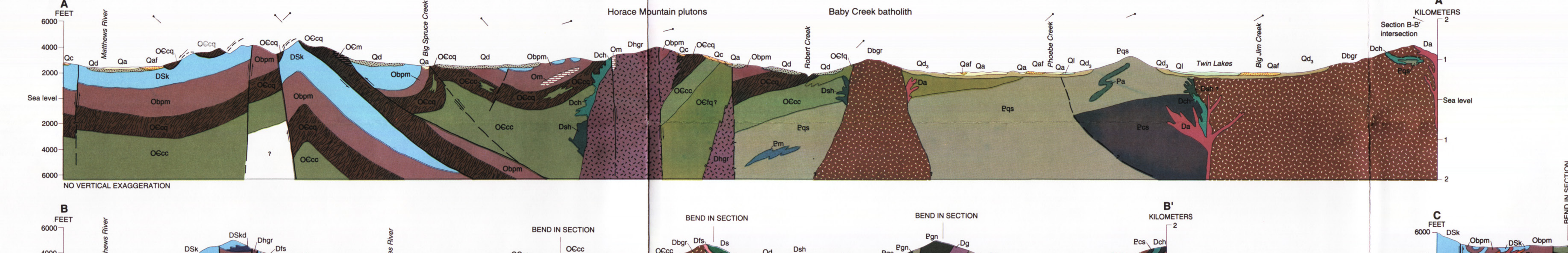

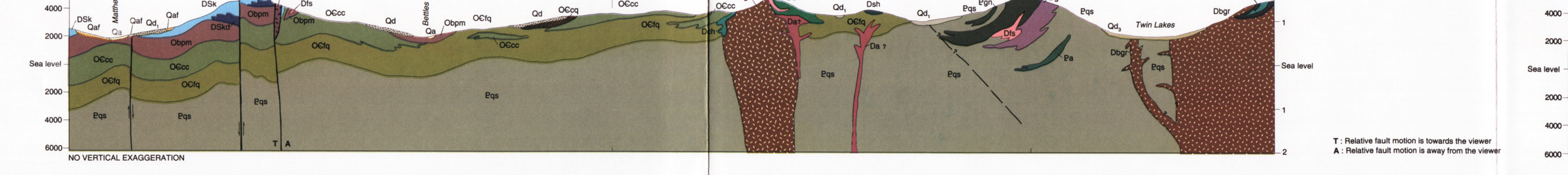

T : Relative fault motion is towards the viewer
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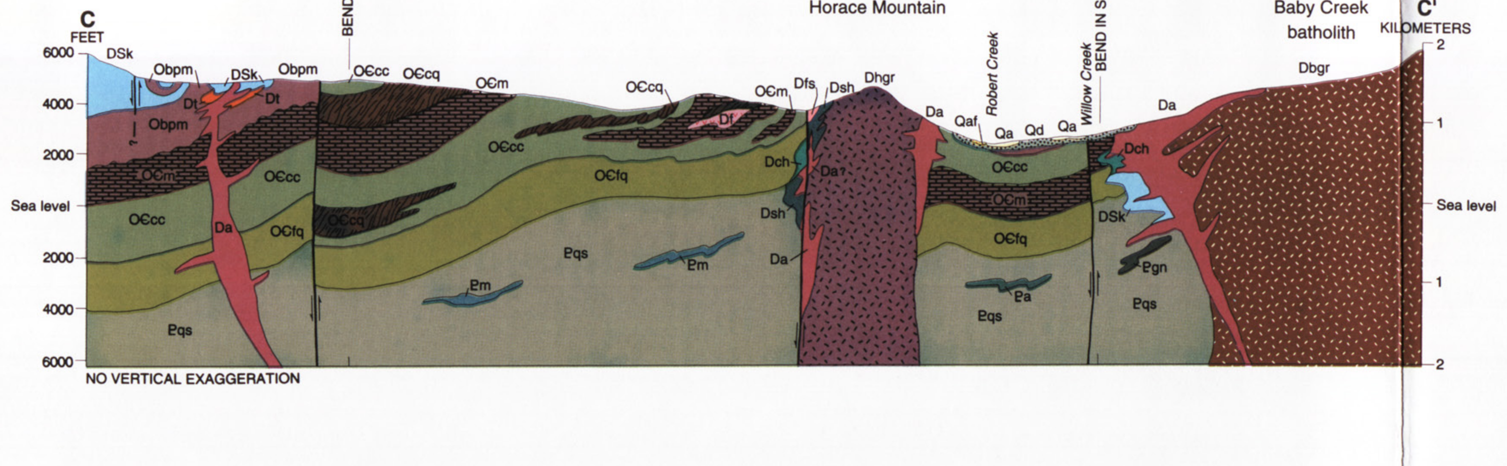

GEOLOGIC MAP OF THE CHANDALAR C-5 QUADRANGLE, SOUTHEASTERN BROOKS RANGE, ALASKA

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

by
J.T. Dillon, R.R. Reifenstuhl, and G.W. Harris
1996