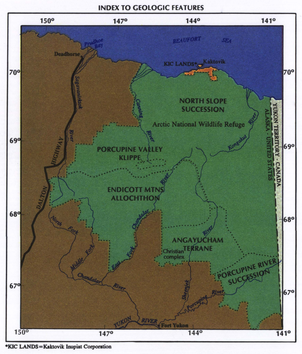
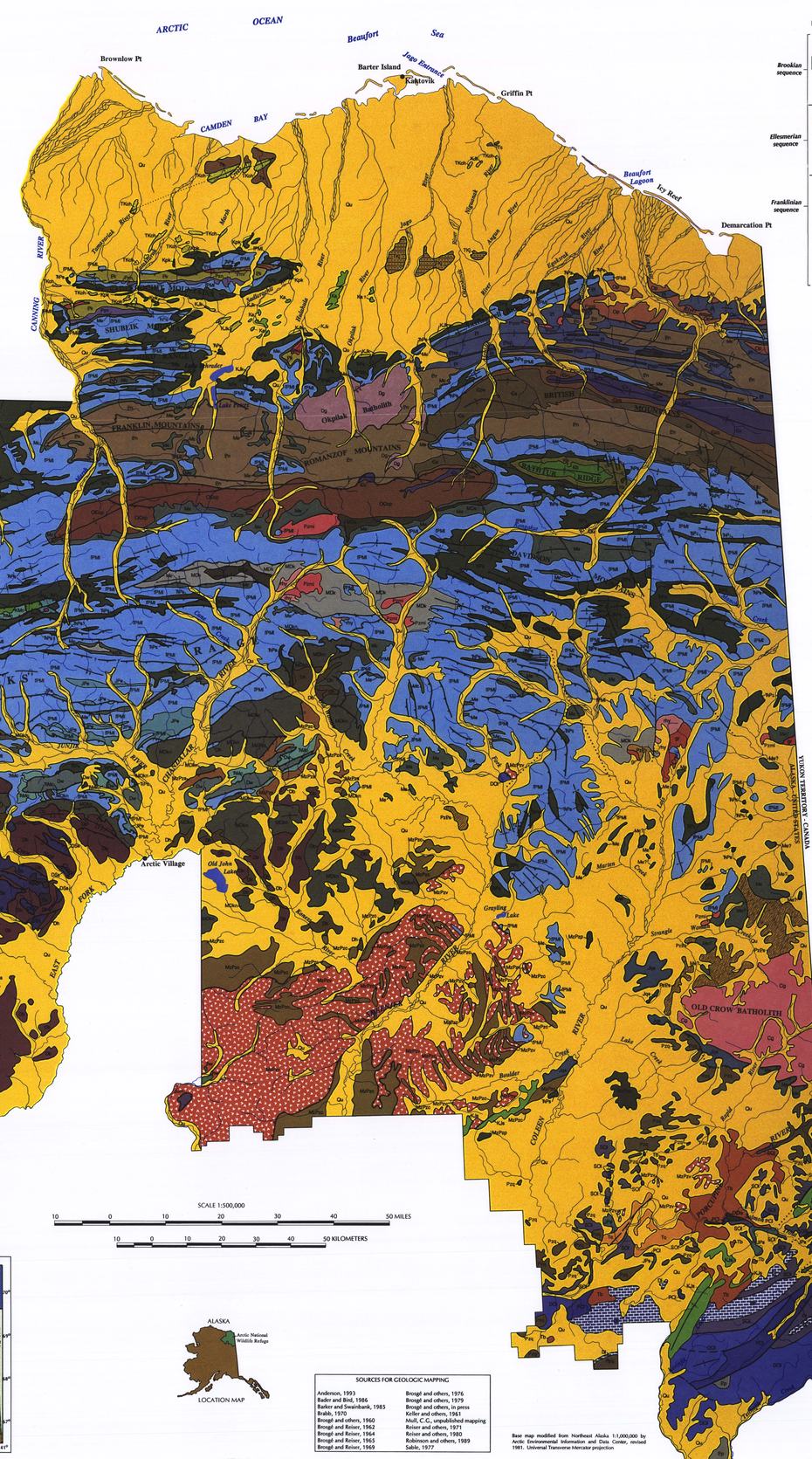
INDEX TO GEOLOGIC FEATURES



*KIC LANDS—Kaktovik Inupiat Corporation



SCALE 1:500,000

10 0 10 20 30 40 50 MILES

10 0 10 20 30 40 50 KILOMETERS

MAP SYMBOLS

- Contact
- High-angle fault—Dashed where approximately located, dotted where concealed. U, upthrown side; D, downthrown side
- Thrust fault—Dashed where approximately located; dotted where concealed. Sawteeth on upper plate
- Anticline—Showing trace of axial plane and direction of plunge, dotted where concealed
- Syncline—Showing trace of axial plane and direction of plunge, dotted where concealed
- Overturned anticline—Showing trace of axial plane and direction of dip of limbs

ACKNOWLEDGMENTS

The original version of this map was compiled in 1986-87 by John Dillon and Arne Bakke and was displayed at the 1987 meeting of the Cordilleran Section of the Geological Society of America in Hilo, Hawaii, after John T. Dillon's untimely death in July 1987. the map shown here is based on that work. We would like to thank Mark S. Robinson (DGGS), William P. Brogdi (USGS), Robert B. Blodgett (USGS), and especially Charles G. Mull (DGGS) for their thoughtful technical reviews, and Karen E. Adams (DGGS) for her thorough edit. Cartography by Ann-Lillian Schell and staff.

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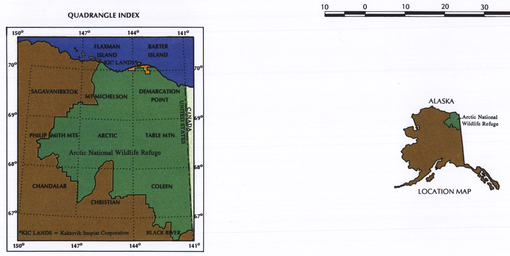
QUADRANGLE INDEX



SOURCES FOR GEOLOGIC MAPPING

Anderson, 1993	Brogdi and others, 1976
Bader and Bird, 1986	Brogdi and others, 1978
Barker and Swainbank, 1985	Brogdi and others, in press
Brabb, 1971	Keller and others, 1961
Brogdi and others, 1960	Mull, C.G., unpublished mapping
Brogdi and others, 1961	Reiser and others, 1971
Brogdi and Reiser, 1961	Reiser and others, 1980
Brogdi and Reiser, 1965	Robinson and others, 1989
Brogdi and Reiser, 1974	Sable, 1977

Base map modified from Northwest Alaska 1:1,000,000 by Arctic Environmental Information and Data Center, revised 1981. Universal Transverse Mercator projection

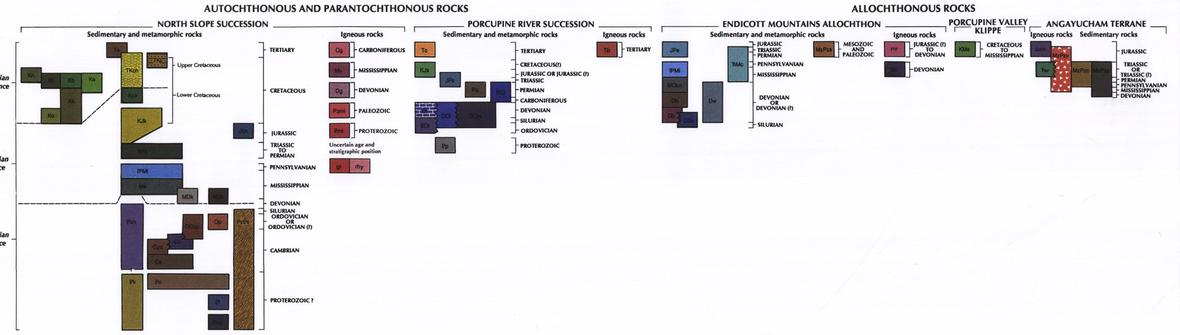
GENERALIZED GEOLOGIC MAP OF THE ARCTIC NATIONAL WILDLIFE REFUGE, NORTHEASTERN BROOKS RANGE, ALASKA

compiled by

Teresa A. Imm,[1] John T. Dillon,[2] and Arne A. Bakke[3]

1993

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qu UNCONSOLIDATED DEPOSITS (QUATERNARY)—Includes alluvial, colluvial, glacial, and lacustrine deposits

AUTOCHTHONOUS AND PARAUTOCHTHONOUS ROCKS

NORTH SLOPE SUCCESSION

Sedimentary and metamorphic rocks

Brookian sequence (Lerand, 1973)

The Brookian sequence is a thick package of northeasterly prograding basin, slope, shallow-marine, and nonmarine deposits that documents unroofing of the ancestral Brooks Range. Synorogenic deposits of the Brookian sequence were accumulating by mid-Jurassic time in the Arctic National Wildlife Refuge and have started to accumulate as early as Jurassic. (See Bird and Molenaar, 1987)

SAGAVANIRKTOK FORMATION (PLIOCENE TO PALEOCENE)—Nonmarine to shallow-marine deposits of poorly consolidated, fine- to medium-grained sandstone interbedded with shale and minor conglomerate. Thickness >1,500 m. Conformably overlies and intertongues with Canning Formation (Tkch). (See Bird and Molenaar, 1987)

Tkch CANNING FORMATION (PALEOCENE TO UPPER CRETACEOUS)—Nonmarine deposits of well-indurated, thick-bedded lithic sandstone, conglomerate, siltstone, and shale, containing thin coal beds. Thickness >2,000 m. Unit exposed only near Jago River. Relation with underlying rocks unknown; may overlie unconformity or thrust contact. (See Buckingham, 1987)

Ka ARCTIC CREEK UNIT OF MOLENAAR AND OTHERS (1987) (UPPER AND LOWER CRETACEOUS)—Turbidite sequence composed of sandstone, siltstone, and shale; contains some rocks similar to Kongakut Formation (Kk) at Bathtub Ridge and may include Jurassic part of Kingak Shale (KJk) at base. Thickness about 1800 m. Contains Albian ammonites (Detterman and others, 1975). Probably in thrust contact with underlying rocks. Present southeast of Sadlerochit Mountains. (See Bird and Molenaar, 1987; Robinson and others, 1989)

Kk NANUSHUK GROUP, UNDIVIDED (CENOMANIAN TO ALBIAN)—Primarily marine deposits composed of interbedded gray fine-grained quartz wacke, siltstone, and shale of Tuktu Formation. Contains pelecypods and cephalopods of Albian age. Thickness is about 150 m. Grades upward into shallow-marine to nonmarine deposits of Chandler Formation northwest of map area. Chandler Formation composed of quartz-chert pebble conglomerate, sandstone, siltstone, shale, and coal. Thickness >500 m. Unit exposed north of Lupine River only. (See Brogdi and others, 1979)

FORTRESS MOUNTAIN FORMATION (ALBIAN TO APTIAN?)—Nonmarine to shallow-marine deposits of polymictic conglomerate, lithic wacke, siltstone, and shale. Forms crudely fining-upward sequences. Contains pelecypods of Albian age. Thickness about 1,300 m. Exposed locally along Brooks Range front from west of Sagavanirktok River east to Elusive Lake. (See Keller and others, 1961; Brogdi and others, 1979)

Kb BATHTUB GRAYWACKE (ALBIAN TO APTIAN)—Lithic graywacke cyclically interbedded with shale, siltstone, and conglomerate; some graywacke beds are graded. Thickness ranges from 800 to 1,200 m. Unit may be correlative in part to Fortress Mountain Formation (Kf). Exposed locally in southern part of Demarcation Point Quadrangle at Bathtub Ridge. (See Detterman and others, 1975)

Kk KONGAKUT FORMATION (LOWER CRETACEOUS)—In western part of map area, formation consists of interbedded gray fine-grained quartz wacke, siltstone, and shale; in eastern part formation largely interbedded with fine-grained graywacke. Contains pelecypods of Neocomian age. Thickness >300 m. (See Brogdi and others, 1979)

In northeastern part of map area near Bathtub Ridge, formation composed of marmolite shale and siltstone. Contains coquinoid limestone of Valanginian age near base. Thickness <700 m. Grades upward into Bathtub Graywacke (Kb). (See Reiser and others, 1980)

KJk ORPIKRUAK FORMATION (VALANGINIAN TO BERRIASIAN)—Marine deposits. Upper part composed of rhythmically bedded, coarsening-upward siltstone, graywacke, and minor conglomerate; lower part composed of locally pebbly siltstone and shale that contains rare pelecypods. Lower Cosquina contains pelecypods of Valanginian age near base of unit. Total thickness >600 m. Unit possibly correlative with Kingak Shale (KJk) in subsurface. Exposed locally in southern part of Sagavanirktok River east to Elusive Lake in northwestern part of map area. (See Brogdi and others, 1979)

Ellesmerian sequence (Lerand, 1973)

The Ellesmerian sequence is a package of marine to nonmarine rocks mostly deposited after formation of a regional pre-mississippian unconformity. Also contains middle Devonian rocks on south side of Buffalo Range. Rocks are bounded from underlying rocks by regional unconformity and consist of an unfolding, south-dipping post-orogenic platform. Lower regional unconformity associated with rise of the Arctic Alaska Plate, development during mid-Devonian time and marks the final stage of Ellesmerian deposition. Rift-related deposits of the Ellesmerian, represented on this map by the Kingak Shale (KJk) and the Kemik Sandstone and pebble shale unit (Kpk), have been assigned to the Ellesmerian sequence by Hubbard and others (1987). (See Bird and Molenaar, 1987)

PEBBLE SHALE UNIT (BARREMIAN AND KEMIK SANDSTONE (HAUTERIVIAN), UNDIVIDED)—Pebble shale unit consists of dark-gray to black, clayey shale with minor quartz grains. Commonly contains pebbles and abundant ironstone concretions. Thickness varies from 0 to 75 m. Unit may be conformably overlies Kemik Sandstone, but unconformably overlies Kingak Shale (KJk) where Kemik is absent. (See Bird and Molenaar, 1987)

Kemik Sandstone consists of shallow-marine deposits of medium- to lightgray siltstone and locally, pebbly, very fine-grained, quartzose sandstone. Formation is burrowed and contains pelecypods and ammonites of Hauterivian age. Thickness ranges from 30 m. Forms resistant ridges and prominent hogbacks. (See Bird and Molenaar, 1987; Bird and Molenaar, 1987; Hull, 1987; Robinson and others, 1989)

KJk KINGAK SHALE (VALANGINIAN TO LOWER JURASSIC)—Marine deposits. Upper part composed of shale and silty shale, with rare bentonite partings; lower part composed of dark-gray pyritic shale, clay shale, and claystone. Upper part contains Middle and Late Jurassic ammonites and Early Cretaceous pelecypods; lower part, Early and Middle Jurassic fossils. Thickness reaches 1200 m. Conformably to discontinuously overlies Karen Creek Sandstone or Shublik Formation (Rsh). (See Johnson and others, 1978; Bird and Molenaar, 1987; Robinson and others, 1989)

Kpk QUARTZITE, SILTSTONE AND SANDSTONE (JURASSIC)—Dark-gray to green slightly foliated quartzite and phyllitic siltstone, sandstone to granule conglomerate, and minor green-gray sandstone, unconformably overlying Old Crow batholith (Kg). Present only in southeastern part of map area. (See Bird and Reiser, 1969; Yeend, 1973)

KAREN CREEK SANDSTONE (UPPER TRIASSIC), SHUBLIK FORMATION (UPPER AND MIDDLE TRIASSIC), AND SADLEROCHIT GROUP (LOWER TRIASSIC AND PERMIAN), UNDIVIDED—Karen Creek Sandstone consists of bioturbated, well-indurated, very fine-grained quartz sandstone. Contains Late Triassic (Norian) pelecypods. Thickness ranges to 30 m. Karen Creek conformably overlies Shublik Formation. (See Detterman and others, 1975; Bird and Molenaar, 1987)

Shublik Formation consists of thinly interbedded black, calcareous shale and siltstone, and limestone; locally phosphatic and organic rich. Contains abundant fossils of Middle and Late Triassic age. Contains Norian) age. Thickness reaches 140 m. Oil-prone source rock, but overmature in outcrop belt. Conformably to discontinuously overlies Sadlerochit Group. (See Detterman and others, 1975; Bird and Molenaar, 1987)

SADLEROCHIT GROUP—Consists of Ivishak Formation and underlying Echooka Formation

Ivishak Formation composed of massive conglomerate member, Upper member, and Fire Creek Siltstone, consists of laminated siltstone and silty shale. Contains fossils of Early Triassic (Smithian) age. Thickness ranges from 60 to 75 m. Analysis of Ivishak Formation indicates it is a transgressive sandstone and local conglomerate. Contains Early Triassic ammonites and palynomorphs. Thickness up to 120 m. Forms main oil-producing reservoir at Prudhoe Bay. Lower member, Kavik Shale, consists of thin-bedded silty shale and fine-grained sandstone. Contains Early Triassic (Griesbachian) fossils. Thickness up to 200 m. Conformably overlies Echooka Formation. (See Keller and others, 1961; Detterman and others, 1975)

Echooka Formation composed of two conformable members: Upper member, Ikiakpaurak, consists of bioturbated, ferruginous, quartzose sandstone. Contains fossils of Late Permian (Guadalupian) age. Thickness ranges from 50 to 110 m. Lower member, Joe Creek Sandstone, consists of ferruginous, glauconitic, quartzose calcarenite; coquina; chert; siliceous, calcareous siltstone; calcareous mudstone; and basal conglomerate. Contains fossils of Early and Late Permian (Wordianian to Guadalupian) age. Thickness is up to 120 m. Deposited on regional unconformity above Lisburne Group. (See Detterman and others, 1975). Southern limit of paraautochthonous Permian rocks in Arctic and Philip Smith Mountains Quadrangle is uncertain

PMl LISBURNE GROUP, UNDIVIDED (MIDDLE PENNSYLVANIAN TO UPPER MISSISSIPPIAN)—Limestone and dolomite of Wahoo Limestone and underlying Alapah Limestone

Wahoo Limestone consists of lightgray- to buff-weathering, fine-grained limestone with accessory glauconite and red, green, and black chert nodules; dolomitic in part. Contains megafossils and microfossils of Late Mississippian age. Thickness ranges from 0 to 600 m. Mostly unfossiliferous Pennsylvanian(?) rocks at top. Thickness varies from 0 to 375 m. (See Armstrong and others, 1970; Reiser and others, 1980)

Alapah Limestone consists of gray- to dark-gray-weathering, platy bioclastic limestone, buff- to orange-weathering dolomite, and black chert; stratigraphic pseudomorphs are present in upper part of formation. Contains megafossils and microfossils of Late Mississippian (Meramecian and Chesterian) age. Thickness varies from 275 to 655 m. In Table Mountain Quadrangle lower part of unit is probably correlative with Kayak Shale of Endicott Group (Mel). (See Armstrong and others, 1970; Reiser and others, 1980; Reiser and others in press). Southern limit of paraautochthonous Lisburne in Arctic and Philip Smith Mountains Quadrangles is uncertain

Mel ENDICOTT GROUP, UNDIVIDED (LOWER TO UPPER MISSISSIPPIAN)—Composed of Kayak Shale and underlying Kekiktuk Conglomerate

Kayak Shale consists of dark-gray and black clay shale and siltstone, locally interbedded with fossiliferous, argillaceous limestone. Contains marine megafossils and microfossils of Early Mississippian (late Kinderhookian) to early Late Mississippian (Meramecian) age. Thickness reaches 250 m. Kayak grades downward into Kekiktuk Conglomerate. (See Nilsen, 1981; Nilsen and others, 1981)

Kekiktuk Conglomerate consists of white to lightgray, resistant, massive quartz sandstone, quartzite, and quartz- and chert-pebble to cobble-conglomerate, and chert breccia at some localities. Contains plant fossils of Early Mississippian age. Overlies a regional unconformity that locates a number of lithologic units. (See Nilsen, 1981; Nilsen and others, 1981). Contains interbedded volcaniclastic unit in upper Sheenjek River area (Anderson and others, 1993). Thickness is 0 to 60 m in eastern part of ANWR, but apparently thickens markedly in Table Mountain Quadrangle, where it resembles Kanayut Conglomerate (Pml). Resembles Kanayut Conglomerate in stratigraphic sequence. (C.G. Mull, unpub. data, 1992)

MDs CONGLOMERATE, QUARTZITE, AND SCHIST (LOWER MISSISSIPPIAN AND/OR DEVONIAN)—Consists of thick horizons of massive, coarse, pebbly to cobble conglomerate, quartzite, and probable interbedded schistose rocks in lower part of unit; forms cliffs and high mountains between Sheenjek River and upper East Fork of Chandalar River and in area of Bear Mountain in Table Mountain Quadrangle. Thickness probably >500 m. Contains thin Kayak Shale at top, underlies Lisburne Group (Pml). Resembles Kanayut Conglomerate in lithologic aspects and correlative with Kekiktuk Conglomerate (Mel) in regional stratigraphic sequence. (C.G. Mull, unpub. data, 1992)

SANDSTONE AND SHALE (LOWER MISSISSIPPIAN TO MIDDLE DEVONIAN)—Composed of two distinct lithologic packages, structurally complicated by thrust faults. Upper package consists of black shale and siltstone, associated with channel fills of quartz-chert pebble conglomerate. Includes minor black limestone at base. Contains fossils of Early Mississippian age (R.A. Spicer, oral commun., 1989); thus is time equivalent with Kekiktuk Conglomerate (Mel). Upper package conformably overlies Lisburne Group (Pml) and unconformably overlies lower package

Lower package consists of coarsegrained sequence of chert-pebble conglomerate and fossiliferous limestone. Contains Middle Devonian (Eifelian) gastropods and calcareous algal (R.B. Blodgett, written commun., 1992) as well as trilobites (A.R. Ormiston, oral commun., 1991). Structurally overlies purple-weathering chert breccia that also contains Early Mississippian plant fossils (R.A. Spicer, oral commun., 1989) correlative with those of Kekiktuk Conglomerate (Mel). Chert breccia unconformably overlies Cambrian to Ordovician chert and phyllite unit (Ꞓ€Ogu)

Packages total up to 400 m thick. Sandstone and shale unit exposed in southwest Demarcation Point Quadrangle, northwest Table Mountain Quadrangle, and possibly northeast Arctic Quadrangle. (See Brogdi and Reiser, 1965; Brogdi and others, 1976; Reiser and others, 1980; Anderson, 1989; Popov and others, in press)

Igneous rocks

Qg OLD CROW BATHOLITH (CARBONIFEROUS)—Biotite granite, and quartz monzonite with minor muscovite; locally porphyritic. Biotite from granite yielded Carboniferous K-Ar ages, which range from 295 ± 5 Ma (Dillon and Reiser, 1969) to 345 ± 10 Ma (Sable, 1977)

Mu VOLCANIC ROCKS (MISSISSIPPIAN)—Extrusive and hypabyssal andesitic basalts and tuffaceous limestone, intermixed with carbonates of Lisburne Group (IPMl). About 100 m thick. Exposed in southeast part of map area and north and east of Ivishak River in Sagavanirktok Quadrangle. (See Brogdi and others, 1979; Robinson and others, 1989)

Dg OKPILAK BATHOLITH AND JAGO STOCK (DEVONIAN)—Light- to medium-gray, medium- to coarse-grained leucocratic granite and hornblende granodiorite, associated with rhyolite to quartz diorite dikes. Biotite from granite yielded Early Cretaceous K-Ar age of 128 ± 5 Ma (Sable, 1977), zircons from batholith and stock yielded Devonian U-Pb age of 382 ± 10 Ma (Dillon and Bakke, 1982). Discordant ages indicate emplacement in Devonian, followed by metamorphism in Early Cretaceous. (See Sable, 1977)

PZm MAFIC IGNEOUS ROCKS (EARLY AND MIDDLE PALEOZOIC)—Mafic intrusive or extrusive rocks in Demarcation Point and Table Mountains Quadrangles. Includes early Paleozoic volcaniclastic rocks on Bedwell River (Brogdi and others, 1960) and early Mississippian and/or Devonian volcanic rocks associated with conglomerate, quartzite, and schist (MDs and Mel) in Arctic and Table Mountain Quadrangles (Brogdi and others, 1976; C.G. Mull, unpub. data)

PMd MAFIC IGNEOUS ROCKS (PROTEROZOIC)—Mafic intrusive and extrusive rocks in Shublik and Romanzof Mountains and on Hulahula River in Mt. Michelson Quadrangle (Reiser and others, 1971; Robinson and others, 1989)

Ꞓg GRANITE, DIORITE, SYENITE—Granitic rocks in Table Mountain Quadrangle near Bear Mountain and Lois Creek (Brogdi and others, 1976; Barker and Swainbank, 1985; C.G. Mull, unpub. data) and along United States-Canada border (Maddern, 1912). At Bear Mountain and Lois Creek it is associated with abundant hypabyssal porphyry, breccia, and numerous felsic dikes. Age uncertain. Biotite from syenite and rhyolite yielded Paleocene-Eocene age (Barker and Swainbank, 1985); zircon yielded discordant Cambrian Pb-Pb age (J.T. Dillon, unpub. data); stratigraphic data suggest possible Mississippian age (C.G. Mull, unpub. data)

Ꞓr RHYOLITE—Felsic extrusive rocks in Arctic Quadrangle (Reiser and others, in press); intrusive and possible extrusive rocks associated with granitic rocks at Bear Mountain and Lois Creek on Table Mountain Quadrangle (Brogdi and others, 1976; C.G. Mull, unpub. data)

PORCUPINE RIVER SUCCESSION

Sedimentary and metamorphic rocks

Te CLAY (MIOCENE)—Pebbly clay and lignite, with minor tuff and ironstone. Contains bivalves of Tertiary (Moscovic) age. (See Brogdi and Reiser, 1969)

Kpt QUARTZITIC SANDSTONE (CRETACEOUS TO JURASSIC)—Gray, massive, ferruginous, locally calcareous, fine-grained quartz sandstone. Contains fossils of Jurassic or Cretaceous age. Thickness about 100 m. (See Brogdi and Reiser, 1969)

Jp SHALE, SILTSTONE, ARGILLITE, AND CONGLOMERATE (JURASSIC TO PERMIAN)—Upper part consists of gray shale and argillite; contains minor sandstone and chert. Fossils of Early Jurassic age near top. Thickness >300 m. Lower part consists of shale, siltstone, and limestone; includes Step Conglomerate at base. Limestone contains fossils of Permian age. Thickness >300 m. (See Brogdi and Reiser, 1969)

Pzp QUARTZITE AND CONGLOMERATE (PALEOZOIC)—Quartzite and chert-pebble conglomerate, ferruginous and micaceous in part; may be up to 650 m thick. Mostly unfossiliferous. In Colleen Quadrangle (Brogdi and Reiser, 1969), locally contains Permian fossils but may also include early Paleozoic and Mesozoic strata in Black River Quadrangle (Brabb, 1970)

Pl LIMESTONE AND CHERT (PERMIAN TO CARBONIFEROUS)—Dark-gray shaley limestone and chert. Thickness ranges from 80 to 200 m. Gradationally underlain in part by siltstone and shale of Porcupine River Formation (Pzs). (See Brogdi and Reiser, 1969)

Pml LIMESTONE OF SALMONTROUT FORMATION (MIDDLE TO LOWER DEVONIAN)—Dark, fine-grained wackestone underlain by stromatoporoid-coral floatstone in a matrix of crinoid packstone. Thickness about 60 m. (See Brogdi and Reiser, 1969)

Pzs LIMESTONE AND DOLOMITE (DEVONIAN TO ORDOVICIAN)—Massive limestone and dolomite, sporadically interlayered with red and green argillite, black chert, and local quartzite. Contains fossils of Late Ordovician to Middle Devonian age. Thickness about 360 m. (See Brabb, 1970; Lane and Ormiston, 1978). Includes massive limestone, phyllite, and mafic igneous rocks of uncertain structural affinity near East Fork of Sheenjek River

Ꞓo OLD CAMP FORMATION (MIDDLE DEVONIAN), SALMONTROUT LIMESTONE (MIDDLE TO LOWER DEVONIAN), ROAD RIVER FORMATION (SILURIAN), AND UNNAMED DOLOMITE AND LIMESTONE UNIT (ORDOVICIAN), UNDIVIDED—Light- to medium-gray, massive, fine-grained calcareous siltstone and shale, interbedded with crinoidal limestone. Thickness is about 30 m. Unit conformably overlies Salmontrout Limestone

Salmontrout consists of light- to dark-gray coral and stromatoporoid floatstone and dark-gray wackestone. Thickness is about 260 m. Unit conformably overlies Road River Formation.

Road River consists of thick, black graptolitic shale interbedded with thin limestone. Thickness is about 35 m. Unit structurally(?) overlies unnamed dolomite and limestone and coarse-grained limestone that contains Ordovician fossils. (See Lane and Ormiston, 1979; Coleman, 1985)

Ꞓl LIMESTONE DILURIAN TO ORDOVICIAN—Medium- to darkgray, fine-grained limestone; locally includes dolomite, cherty dolomite, and carbonate conglomerate. Contains fossils of Middle and Late Ordovician and Silurian age. (See Brogdi and Reiser, 1969; Brabb, 1970)

Ꞓp PHYLLITE (PROTEROZOIC)—Red, green, and black phyllite; black and white, banded siltstone and slate; brown and red quartzite; and orange-weathering limestone and dolomite. Thickness >1,000 m. (See Brabb, 1970)

Igneous rocks

Tb OLIVINE BASALT (TERTIARY)—Flat-lying, vesicular to massive basalt flows. Thickness reaches 100 m. Whole rock analysis indicated Tertiary K-Ar age of 16.8 ± 8 Ma. (See Brogdi and Reiser, 1969; Plumley and others, 1989)

ALLOCHTHONOUS ROCKS

ENDICOTT MOUNTAINS ALLOCHTHON

Sedimentary rocks

MzPzs SLATE AND QUARTZITE (MESOZOIC AND PALEOZOIC)—Dark-gray slate and siltstone, partly siliceous and manganiferous; thinly bedded, very fine-grained quartzite; green-gray slate; and minor gray chert and brown, calcareous sandstone. Associated with chert and shale unit (TRAs). Thrust over allochthonous Endicott Group (MDes, Dls) along northern limit of allochthonous Endicott exposure and represents a remnant of a higher allochthon in southeastern Arctic Quadrangle. (See Yeend and Brogdi, 1973)

JTRv ETIVLUK GROUP, UNDIVIDED (MIDDLE JURASSIC TO LOWER PERMIAN)—Composed of Otuk Formation and underlying Sikubpuk Formation

Otuk Formation (Jurassic-Triassic) consists of rhythmically interbedded chert, siliceous shale, and limestone. Contains fossils of Triassic to Middle Jurassic age. Thickness <100 m. Disconformably overlies Sikubpuk Formation. (See Mull and others, 1982)

Sikubpuk Formation (Permian) consists of variegated cherty shale, siliceous siltstone, and chert. Contains fossils of Early Permian age. Thickness >100 m. Unconformably overlies Lisburne Group (IPMl). (See Mull and others, 1982). Northern limit of allochthonous Permian rocks in Arctic and Philip Smith Mountains Quadrangles is uncertain

Ettivluk Group is exposed along western edge of map area, where it appears transitional with Sadlerochit Group and Shublik Formation (RPu). (Bodnar, 1984; Adams, 1991)

TRAs CHERT AND SHALE (TRIASSIC TO MISSISSIPPIAN)—Black, red, and green radiolarian chert; and red and green pyritic, manganiferous, partly siliceous slate and argillite. (See Brogdi and Reiser, 1965; Yeend and Brogdi, 1973)

IPMl LISBURNE GROUP, UNDIVIDED (MIDDLE PENNSYLVANIAN TO LOWER MISSISSIPPIAN)—Comprises Alapah and Wachsmuth Limestones and Kuna Formation

Alapah Limestone consists of gray- to dark-gray-weathering, dark-gray, fine- to coarse-grained bioclastic limestone and dolomite, with minor black chert nodules. Contains faunal assemblage of Early to Late Mississippian age. Thickness ranges from 300 to 600 m. Alapah overlies and intertongues with Wachsmuth Limestone. (See Armstrong and others, 1970; Brogdi and others, 1979)

Upper part of Wachsmuth Limestone composed of bioclastic limestone, dolomitic limestone, and dolomite; lower part composed predominantly of argillaceous limestone with minor shale. Wachsmuth contains faunal assemblage of Early to Late Mississippian (Osagean to Meramecian) age. Thickness ranges from 260 to 670 m. Exposed in western (south of Ribdon River) and southern parts of map area. (See Brogdi and others, 1979)

ENDICOTT GROUP (LOWER MISSISSIPPIAN TO UPPER DEVONIAN)—Composed of Kayak Shale, Kanayut Conglomerate, Noatak Sandstone, and Hunt Fork Shale. (See Brogdi and others, 1960)

Kayak Shale, Kanayut Conglomerate, and Noatak Sandstone—Kayak Shale consists of marine deposits of dark, fissile clay shale and silty shale, locally interbedded with limestone near top and sandstone near base. Contains fossils of Early Mississippian age. Thickness varies from 100 to 350 m. Grades downward into Kanayut Conglomerate. (See Nilsen and Moore, 1984)

Kanayut Conglomerate consists of fluvial and deltaic deposits composed of conglomerate and sandstone. Comprises three members. Upper member, Stuver Member, consists of meandering-stream deposits of variegated shale, siltstone, quartzose sandstone, and minor conglomerate. Middle member, Shainin Lake Member, consists of braided-stream deposits of chert-pebble conglomerate, quartzite, and sandstone, interbedded with shale and siltstone. Thickness varies from 10 to 70 m. Lower member, Far Peak Member, consists of meandering-stream deposits of marginal-marine, brown shale interbedded with ferruginous, brown sandstone and conglomerate, and local coal. Kanayut contains fossils of Late Devonian (Famennian) age. Total thickness ranges from 900 to 1,500 m. Grades downward into Noatak Sandstone. (See Nilsen and Moore, 1984)

Noatak Sandstone consists of nonmarine to shallow-marine deposits of thin-bedded, calcareous, limonitic sandstone interbedded with black shale and rare intervals of quartzite and conglomerate. Contains fossils of Late Devonian age. Grades downward into Hunt Fork Shale (Dh). (See Nilsen and Moore, 1984)

Hunt Fork Shale—Marine deposits composed dominantly of shale. Comprises five lithologic units. Upper unit, wacke member, consists of dark-green to gray, micaceous, manganiferous shale and siltstone, and quartz-chert wacke. Upper middle unit, shale member, consists of sooty-weathering, dark-gray to dark- to medium-gray fissile slate, clay shale, siltstone, and sandstone, interbedded with argillaceous limestone. Middle unit, limestone member, consists of yellow-weathering, dark-gray, nodular limestone and argillaceous limestone. Lower middle unit, calcareous sandstone member, consists of brown to orange-weathering, partly to very calcareous, fine- to medium-grained sandstone. Lower unit, quartzite member, consists of dark-gray- to orange-weathering, fine-grained quartzite; minor calcareous sandstone, and shale. Intraformational contacts are gradational; limestone member grades laterally, as well as vertically, into calcareous sandstone member. Hunt Fork contains fossils of Late Devonian (Frasnian to Famennian) age. Total thickness ranges from 1,000 to 1,500 m. Gradationally overlies Beaucoup Formation (Db) and, in southern part of map area, unconformably overlies Skajit Limestone (Ds). (See Brogdi and others, 1979)

Db WACKE (DEVONIAN)—Gray and green lithic graywacke interbedded with quartzite sandstone and slate. Contains spores of Devonian age. On basis of lithology, however, unit may be Cretaceous; thus spores would be reworked (W.P. Brogdi, oral commun., 1989). Thickness ranges from 500 to 700 m. (See Brogdi and Reiser, 1965)

Ꞓb BEAUCOUP FORMATION (UPPER TO MIDDLE DEVONIAN)—Heterogeneous marine deposits of calcareous shale and sandstone, limestone, conglomerate, and volcanic rocks. Comprises four lithologic units. Upper unit, brown shale member, consists of calcareous and noncalcareous shale, slate, and wacke, locally interlayered with thin limestone. Upper middle unit, limestone member, consists of gray, fossiliferous limestone that forms mounds, lenses, or beds. Lower middle unit, brown sandstone, shale, and limestone member, consists of interbedded shale, sandstone, limestone, chert, slate, and quartz-pebble conglomerate. Lower unit, conglomerate member, consists of chert, slate, limestone, and quartz pebbles, interbedded with minor red green argillite. Total thickness varies from 200 to 600 m. Beaucoup represents lateral and upward facies transition from carbonate rocks of Skajit Limestone (Ds) to siliceous clastic rocks of Hunt Fork Shale (Dh) and intertingering volcanic rocks (Dv). Beaucoup typically overlies Skajit Limestone, but locally interfingers with it. (See Dillon and others, 1979; Dillon and others, 1980)

Ds SKAJIT LIMESTONE (MIDDLEO DEVONIAN TO UPPERI SILURIAN)—Light-gray-weathering limestone, marble, and dolomite, with isolated chert nodules. Contains pelecypods of Middle(?) Devonian age and brachiopods of Late(?) Silurian age. Thickness up to 600 m. Forms high cliffs. Grades laterally and upward into Beaucoup Formation (Db). (See Brogdi and others, 1979)

Igneous rocks

TRgs MAFIC ROCKS (JURASSIC TO DEVONIAN)—Mafic intrusive and extrusive rocks, including diabase, gabbro, and diabase commonly altered to calcific greenstone. Albite from sill yielded Devonian K-Ar age of 363 ± 11 Ma. (See Brogdi and others, 1979)

Dv VOLCANIC ROCKS (DEVONIAN)—Intermediate to mafic volcanic and hypabyssal rocks. Contains fossils of Late Devonian age. Thickness ranges from 0 to 80 m thick. Interfingers with lower part of Hunt Fork shale (Dh). (See Brogdi and others, 1979)

PORCUPINE VALLEY KLIPPE

The Porcupine Valley klippe consists of allochthonous rocks locally preserved in Porcupine Valley, between the North Fork of the Canning River and the Ivishak River. Isolated exposures capping high peaks in southern part of valley probably represent remnants of the Endicott Mountains allochthon, Picnic Creek allochthon, and Ignavik River or Copter Peak allochthon

Ꞓs GRAYWACKE, CHERT, LIMESTONE, AND VOLCANIC ROCKS (CRETACEOUS TO MISSISSIPPIAN)—Structurally complicated rocks consisting of upper part of volcanic rocks, graywacke, and mudstone, and lower part of thin-bedded chert, shale, and limestone. Igneous rocks at top may represent part of Ignavik River or Copter Peak allochthon. Graywacke and mudstone of upper part may be equivalent to Okpilokak (Ko) and some rocks of lower part may be equivalent to Akmalik Chert of Lisburne Group on