Public-data File 86-1C

# PRELIMINARY BEDROCK GEOLOGIC MAP OF PART OF THE MT. MICHELSON C-3 QUADRANGLE, SADLEROCHIT MOUNTAINS, NORTHEASTERN ALASKA

By

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This public data file report contains preliminary information on the bedrock geology and structure of the Sadlerochit Mountains in northeastern Alaska. These data were collected during the 1985 field season by Alaska Division of Geological and Geophysical Surveys (DGGS), U.S. Geological Survey and University of Alaska geologists while conducting a program of detailed geological mapping and petroleum resource evaluation of the Arctic National Wildlife Refuge as part of the DGGS eastern North Slope appraisal project (ENSAP). Public-Data File 86-1B is a preliminary report on the bedrock geology of part of the Mt. Michelson C-4 quadrangle; Public-Data File 86-1C is a preliminary report on the bedrock geology of part of the Mt. Michelson C-3 quadrangle; and Public-Data File 86-1D is a preliminary report on the bedrock geology of part of the Mt. Michelson C-2 quadrangle.

# GEOLOGIC MAP SYMBOLS

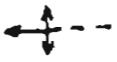

Strike and dip of beds


Strike and dip of beds where stratigraphic top is known


Strike and dip of overturned beds

Apparent strike and dip of beds

Horizontal beds



Strike of the axial trace and plunge of the axis of a large anticline; dashed where approximately located

Strike of the axial trace and plunge of the axis of a large syncline; dashed where approximately located

Contact, solid where known, dashed where approximately located, dotted where inferred, queried where questionable

Fault, solid where known, dashed where approximately located, dotted where inferred, queried where questionable

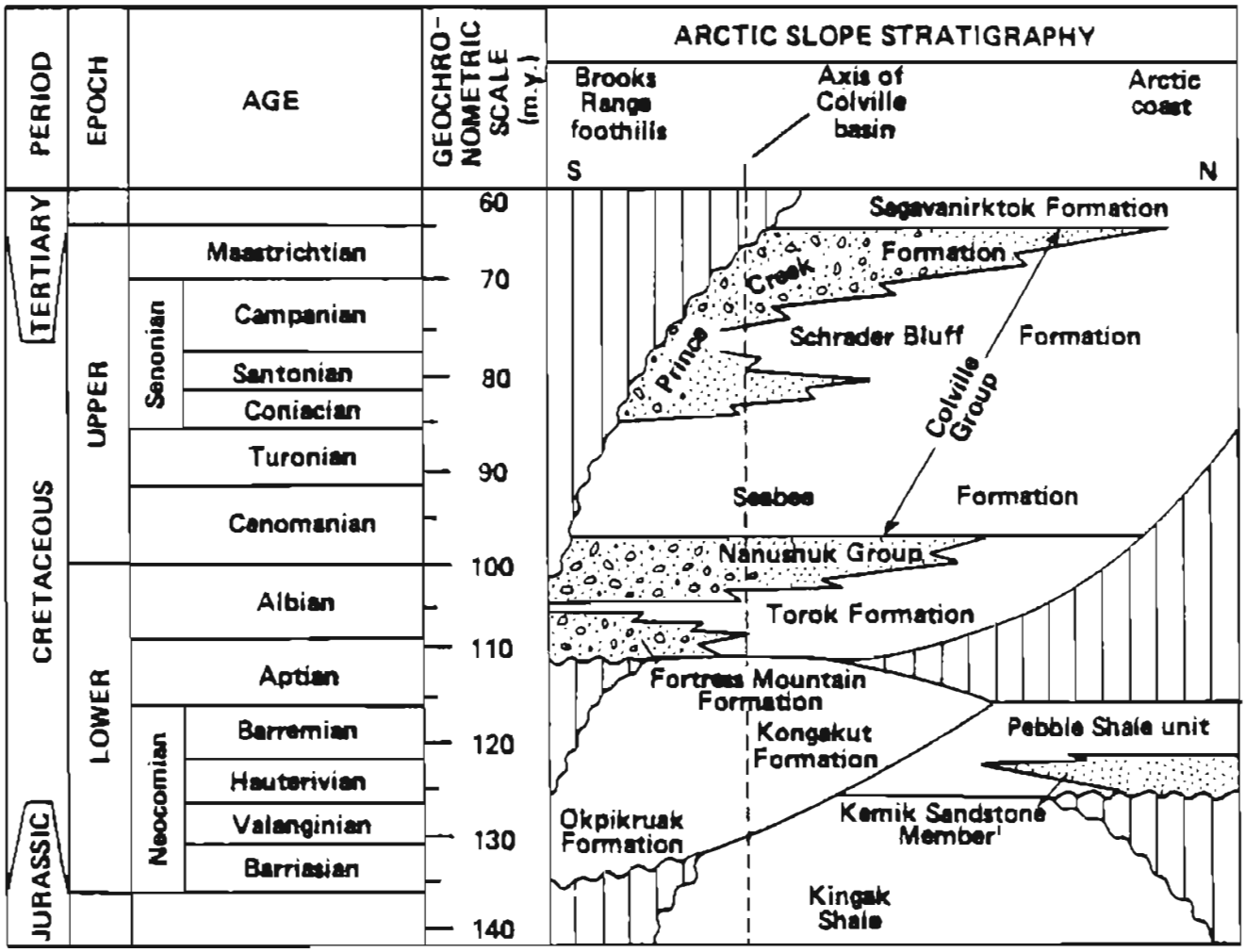
Thrust fault, solid where known, dashed where approximately located, dotted where inferred, queried where questionable



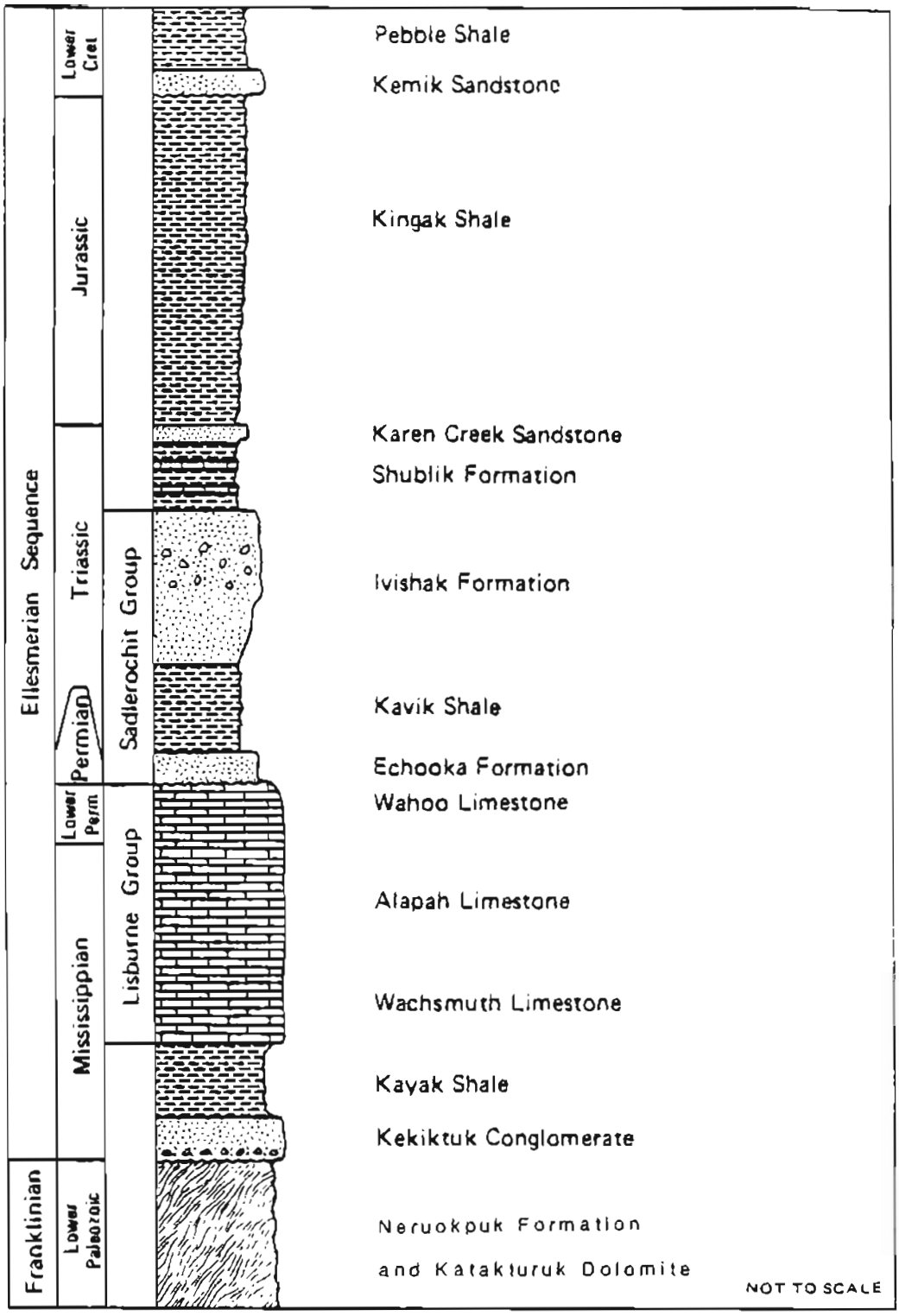
Form lines; trace of bedding



Brecciated zones




Generalized stratigraphic relationships, Brookian sequence northeastern Brooks Range and Arctic Slope




Generalized stratigraphic column, northeastern Brooks Range and Arctic Slope

## DESCRIPTION OF MAP UNITS

uKt Upper Cretaceous Turbidites

- -Interbedded lithic sandstone, siltstone and shale
- -Lithic sandstone is generally thin to thick bedded, gray, very fine- to medium-grained sandstone.
- -Bouma intervals are variable.
- -Sandstone turbidites and shale.
- -Petrographically similar to the Albian(?) turbidites.
- -Gradationally overlies the Shale Wall.
- -The contact located whenever possible at the first up-section occurrence of sandstone turbidites, minor tuff and bentonite.
- -Also present locally at the base of the section.
- -Unit shows evidence of shallowing-upward depositional environments.

uKs Shale Wall

- -Multi colored shale, siltstone, tuff and bentonite.
- -Distinguished from underlying Pebble Shale by brightly colored (generally shades of red, orange and maroon) low relief exposures, and the first up-section occurrence of bentonite.

### Kongakut Formation

The Kongakut Formation (Detterman and others, 1975) is a lower and upper Cretaceous thick sequence of shale and siltstone that contains a distinctive sandstone unit near its base. The formation is divided into four members, they are in descending order; the Siltstone member, the Pebble shale member, the Kemik Sandstone Member, and the Clay Shale Member. Only the Pebble Shale and Kemik Sandstone members have been mapped in the Sadlerochit Mountains. The Pebble Shale Member is the most distinctive unit in the formation, is at least 160 meters thick and contains a manganese-rich zone near the middle of the section. Flattened, highly polished chert pebbles up to 2.5 cm in diameter as well as minor well rounded quartz grains are present throughout the section. Clay ironstone nodules are also common. The Pebble Shale Member has little fauna to offer as an indicator of depositional environment is interpreted by Detterman and others (1975) as indicating a deepwater, inhospitable environment. The Kemik Sandstone Member is mainly a fine-grained, medium- to thick-bedded subfeldspathic quartz arenite near the top of the member and is a feldspathic wacke in the lower part. White tripolitic chert is characteristic throughout the Kemik section.

uKp Pebble Shale Member

- -Dark gray to black shale and silty shale locally with shattered quartz and black chert pebbles.
- -Clay ironstone concretions are common and occur as weakly recrystallized beds and lenses which generally still display original sedimentary structures.

lKk Kemik Sandstone Member

-3 units.
-1) The northeast flank of the Sadlerochit Mtns.
-Unit consists predominantly of muddy medium to dark gray siltstone and very fine grained sandstone with common scattered pebbles. Unit is extensively burrowed, typically with vertical, and possibly U-shaped, trace fossils.
-Unit unconformably overlies Ledge Sandstone Member of the Ivishak Formation with an angular discordance of less than 2 degrees.
-2) The Ignek Mesa unit
-Consists in general of a lower thin to medium bedded hummocky cross stratified sandstone alternating with highly bioturbated muddy sandstone.
-A middle unit of clean cross bedded conchoidally fracturing sandstone, and an upper unit of muddy sandstone with vertical, possibly U-shaped burrows.
-3) The Ignek Creek unit
-consists of a lower section similar to the lower Ignek Mesa unit but also includes burrowed cross bedded sandstone, a middle unit of dark gray siltstone and silty shale with scattered pebbles, and an upper siltstone and very fine grained sandstone unit.

lKt Albian(?) Turbidites

-Poorly exposed sandstone turbidites and shale at the east end of Ignek Valley and along cutbanks of the Hulahula River.
-Sandstone is generally medium bedded to massive, medium gray, medium grained.

## Kingak Shale

The Kingak Shale (Leffingwell, 1919) consists primarily of dark shale, siltstone, claystone and clay ironstone that conformably to disconformably overlie rocks of the Shublik Formation, Karen Creek Sandstone and Kemik Sandstone in northeastern Alaska. The lowest part of the Kingak consists of as much as 180 meters of fissile black shale that contains cannonball concretions locally. Overlying the basal shale unit is a unit composed of at least 100 meters and possibly as much as 300 meters of dark gray clay shale and claystone. The upper part of this unit contains beds and nodules of clay ironstone that weather to a characteristic brick red (Detterman and others, 1975).

JKk Kingak Shale

-Black fissile shale, rarely silty, very rarely containing pebbles.
-Common clay ironstone concretions, typically completely recrystallized with no relic structure preserved; quartz crystals common along fractures.
-Iron oxide more common than in the pebble shale.

## Shublik Formation

The contact between the Karen Creek Sandstone and the underlying Shublik Formation appears to be conformable. Fossils in the lowest part of the Karen Creek and in the upper-most part of the Shublik indicate that no significant break in deposition occurred between the two units (Detterman and others, 1975).

The Shublik Formation forms a distinctive and readily recognizable unit in northern Alaska. In northeastern Alaska, the unit occurs in a narrow belt along the north flank of the Brooks Range and along the Sadlerochit and Shublik Mountains. In structurally complex areas, the Shublik may be missing, or duplicated. In most of northeastern Alaska, the Shublik Formation is divided informally into three members: the lowest member is the siltstone member, an overlying limestone and dolomite member, which is in turn overlain by a clay shale member. The siltstone member is composed predominantly of dark siltstone and calcareous siltstone with a high organic content. Calcite constitutes between 20 and 40 percent of the siltstone and is of secondary origin (Detterman and others, 1975). The limestone and dolomite member contains many coquinite layers, most of which contain significant amounts of phosphate. Calcite is the dominant component of rocks in this member and constitutes as much as 90 percent of the rock. Secondary dolomite may constitute up to 20 percent of the rock locally. The clay shale member at the top of the formation is predominantly a very fine-grained, silty, calcareous sandstone. The Shublik Formation forms a widespread sequence of rocks that ranges from 100 to 150 meters thick. Locally, structural duplication may account for much thicker sections.
Porosities in the Shublik Formation range from 5 to 30 percent (Jones and Speers, 1976) and total organic carbon contents range from 0.5% to 2%. The formation has fairly good source rock potential and reservoir potential. It has produced gas at the Kemik field and it is part of the main reservoir at Prudhoe Bay.

Trs Shublik Formation

- Dark, sooty limestones and calcareous siltstone
- Very fossiliferous
- Poorly exposed
- Contains distinctive, white phosphoresence

## SADLEROCHIT GROUP (Detterman and others, 1975)

### Ivishak Formation

The Ivishak Formation (Keller and others, 1961) is the upper-most formation of the Sadlerochit Group in northern Alaska. The contact between the Ivishak and the overlying Shublik Formation is probably a minor unconformity. Fossils from the upper-most Ivishak and the lowest Shublik indicate that there was apparently some local pre-Shublik erosion of the Ivishak section (Detterman and others, 1975).

The Ivishak Formation is broken into three formal members in northeastern Alaska. The Fire Creek Siltstone Member consists of thin-bedded to massive siliceous siltstone and minor silty shale and argillaceous sandstone. Most of the rocks are cemented by silica, and secondary authigenic calcite has replaced the silica locally (Detterman and others, 1975). Detterman and others (1975) believe that the silica content decreases to the north in the Fire Creek Member. Mud lumps, worm trails and clay ironstone concretions as well as flute and load casts are common in rocks of the Fire Creek Member.

Conformably underlying the the Fire Creek Member is the Ledge Sandstone Member of the Ivishak. The Ledge Sandstone is dominated by a resistant, massive sandstone unit that forms prominent hogbacks ridges and questas along the north flank of the Brooks Range and in the Sadlerochit and Shublik Mountains. The Ledge Sandstone Member in outcrop averages from 15 meters thick near Wahoo Lake to as much as 120 meters thick near the Alaska-Canada boundary. Thicker sections are known in the Sadlerochit Mountains, where structural thickening has produced as much as 220 meters of section. The Ledge Sandstone is primarily a clean, massive, quartz arenite, that occurs in beds that range from .5 to 3 meters thick. Locally the sandstone is conglomeratic, generally in zones in the upper part of the member. A few thin siltstone and silty shale intervals occur . Compositionally, the siltstones are fine-grained versions of the sandstone with a sericitic clay matrix (Detterman and others, 1975). Chert forms between 30 and 40 percent of the rock. Some of the chert is highly weathered and tripolitic. Tripolitic chert grains are characteristic of this member of the Ivishak. The provenance of this unit suggests a northerly source area and the Ledge Sandstone unit becomes thinner and finer grained to the south. Regional isopachs of the thickness of the Ledge suggest that it may have been deposited in several depositional centers; one at Prudhoe Bay, one north and east of the Sadlerochit Mountains and a third near and to the east of the Alaska-Canada boundary. Thick accumulations of the Ledge Sandstone Member correspond to these depocenters.

Conformably underlying the Ledge Sandstone Member is the Kavik Member of the Ivishak Formation. The Kavik Member is a recessive-weathering unit of silty shale and siltstone, that varies between 15 meters and 75 meters thick in undisturbed section to structurally repeated sections of over 250 meters thick. Lithologically, the Kavik Member consists of thin-bedded, laminated, silty shale, siltstone and minor argillaceous sandstone. Quartz forms about 30 to 40 percent of the rock, generally in well-rounded grains. Most of the sandstone layers are very fine-grained quartz arenites with a clay-rich matrix.

Porosities in the Ivishak range between 2 and 10 percent for surface samples in the ANWR compared to porosities as high as 30 percent for similar units at Prudhoe Bay. Jones and Speers (1976) suggest that the average porosities in the Ivishak may improve northward away from the mountain front. Therefore, there is a high probably that good reservoir quality sandstones occur in the Ivishak Formation.

The Ivishak Formation contains "dead" oil near the Nularvik River in the Sadlerochit Mountains (Gar Pessel, personnel communication, 1985), it has produced gas at the Kavik field, and it contains the main reservoir. at Prudhoe Bay.

lTrl Ledge Sandstone

-Bone to brownish weathering, fine- to medium-grained, well sorted, mature quartz sandstone with silica cement.
-Layers of poorly sorted, coarse-grained conglomerate occur near the top of the unit. Clasts range up to 15mm in diameter and are composed of gray and black chert and black shale in a clean quartz sandstone matrix.
-Unit is thin to massive-bedded and occurs in beds that range from 2cm to 30cm thick. The beds are graded locally.
-Some good porosity developed in the northern exposures in the Sadlerochit Mountains.
-Exposures of massive sandstone in the northern Sadlerochit Mountains may contain dead oil.
-Bottoms of some massive beds contain lobate bed forms.
-Unit is feldspathic locally.
-Numerous round clots of quartz grains and limonite, may represent old burrows or concretions; may also be some diagenetic feature.
-Forms blocky to flaggy, angular rubble.
-South side of Sadlerochit Mountains has two or three beds of Ledge Sandstone separated by thin shale or gray, crumbly soil horizons, some of which are pyrite rich.
-Contact between the Ledge Sandstone and the underlying Kavik Shale is conformable and is marked by a change in overall bedding character and decrease in grainsize of the sandstone.
-The sandstone of the Ledge unit contains abundant pyrite locally, the pyrite occurs as blobs to ten mm in diameter and as concentrations along bedding surfaces.
-Thickness probably at least 170 meters.

lTrk Kavik Shale

-Overlies the Echooka Formation, and underlies Ledge Sandstone.
-The contact with the Echooka appears to be gradational. Fine-grained sandstone of the Kavik Shale grades downward into a dark-gray to black shale and then into a distinctive glauconitic sandstone of the Echooka.
-Locally fossiliferous, contains brachiopods and crinoid debris.
-Some flaky black shale occurs near the top of the unit.
-Contains spheroidal-weathering sandstone clots (concretions?).
-Often bone weathering, has trace fossil zoophycus(?).
-Some olive mudstone layers containing brachiopod occur locally.
-Unit also contains dark reddish-brown, finely laminated, and crossbedded sandy-siltstone.
-Contains ripup clasts locally.
-Contains pyrite concentrations locally, as blobs and disseminations along bedding surfaces.
-Up to 15 meters thick locally.

Echooka Formation

Conformably to disconformably underlying the Kavik Member of the Ivishak Formation is the Echooka Formation (Keller and others, 1961). The Echooka is subdivided into two members, the upper member is the Ikiakpaurak Member and the lower member is the Joe Creek Member. The Ikiakpaurak Member consists of a sequence of orthoquartzite, quartzitic sandstone and siltstone that form the main part of the Echooka Formation (Detterman and others, 1975). The sandstones are generally dark, fine-grained quartz arenites. Quartz grains are generally subround to subangular and are cemented together by silica that has formed overgrowths. Calcite is a dominant cementing agent locally, and where calcite is the dominant cement, the rocks commonly contain abundant glauconite. Siltstones and shales are essentially fine-grained versions of the quartz arenite in a siliceous clay-rich matrix. The Ikiakpaurak Member ranges from less than 10 meters thick to as much as 110 meters thick near the mountain front and it thins rapidly to the north.

Underlying the Ikiakpaurak Member conformably is the Joe Creek Member of the Echooka Formation a unit dominated by calcareous siltstone, limy mudstone, chert, and limestone. The calcareous siltstone and limy mudstone is composed of 15 to 30 percent detrital quartz and 15 to 30 percent rounded detrital calcite. Euhedral dolomite grains are present and suggest dolomitization of the unit. The limestones in the upper part of the member are quartz calcarenites and contain 10 to 30 percent detrital quartz. Some of the limestone beds are bioclastic limestone or microcoquinite (Detterman and others, 1975) composed of rounded fragments of brachiopods, bryozoans, corals, gastropods and foraminifera. Glauconite is a common constituent of this unit. The Joe Creek Member ranges from 10 meters to 120 meters thick.

**Pe** Echooka Formation (undifferentiated)

- -Unit contains poorly bedded shale and dense, silicified siltstone locally.
- -Silicified siltstone contains quartz veining.
- -A very distinctive glauconitic sandstone unit occurs stratigraphically above the orange-weathering lag deposit. The glauconitic sandstone contains as much as 50% glauconite locally. This unit also contains abundant pyrite locally.
- -Unit contains a very distinctive member that is widespread and composed of bright orange-weathering, calcareous pebble conglomerate, pebbly lithic sandstone (calc-arenite ?), dark gray shale and siltstone and glauconitic sandstone.
- -Unit forms a ledge above the upper-most units of the Wahoo Limestone.
- -Forms remarkably widespread unit on top of the Lisburne.
- -Seems to be a mild unconformity between the Echooka and the Lisburne locally.
- -Black chert pebbles are the most common pebbles on the lag surface of the orange-weathering member, gray and white chert clasts also occur; and have a angular to rounded, poorly sorted character.
- -Parts of this unit in the south-central Mountains are silica cemented, and almost quartzitic in nature.
- -Unit varies from a few inches thick to as much as 15 meters thick locally.

## LISBURNE GROUP

Schrader (1902) described and named a thick sequence of light gray limestone in the Anaktuvak River area, of the central Brooks Range, the Lisburne Formation. Later, Leffingwell (1919) referred to similar rocks in northeastern Alaska as the Lisburne Limestone. Detailed work by Bowsher and Dutro (1957) in the Shainin Lake area, subsequently raised the Lisburne Formation (Limestone) to the Group status and subdivided the rocks into two formations. The lower formation, the Wachsmuth Limestone is of Lower and Upper Mississippian age and consists of banded dolomitic, bioclastic, crinoidal and shaly limestones and minor chert (Sable, 1977). The upper formation, the Alapah Limestone is of Upper Mississippian age and consists of clastic limestone, silicified limestone, shale, chert, and oolitic limestone. The Wachsmuth Limestone apparently thins to the east and northeast and is absent near Lake Peters in the Arctic National Wildlife Refuge. The Alapah Limestone thickens to the northeast of the Shainin Lake area. In the northeastern Brooks Range, the Alapah Limestone is overlain by the Wahoo Limestone (Brosge and others, 1962). The Wahoo Limestone is of Late Mississippian to Early Pennsylvanian age (Armstrong and others, 1970).

PMl Lisburne Group (undifferentiated)

- -Broken into three parts for mapping; an upper cliff-forming unit that corresponds to the Pennsylvanian Wahoo Limestone; an underlying talus-forming unit that corresponds to the upper Alapah Limestone; and a lower cliff-forming unit that corresponds to the lower Alapah Limestone; both of Mississippian age.

Pw Upper Cliff-former (Wahoo Limestone)

- -Is abundantly fossiliferous, with a rich fauna of crinoids, brachiopods and bryozoans. The limestone occurs in thin to massive-beds that range from a few centimeters to as much as 10 meters thick. Irregular blobs and layers of gray and black chert are common in the upper cliff-forming unit. The unit is predominantly a grainstone composed of bioclastic debris.
- -Some tan, thin-laminated beds occur locally.
- -Top is marked by a slight unconformity, on which the orange-weathering unit of the Echooka Formation occurs.
- -Some local channeling on the unconformity surface is present.

Mau Talus Forming Unit (upper Alapah Limestone)

- -is composed of thin bedded limestone that weathers into small irregular pieces and forms distinctive talus aprons below the upper cliff-forming unit.
- -The contact between the upper cliff-forming unit and the talus unit is marked by a massive bed of yellow-brown weathering limestone. This contact marks the Pennsylvanian-Mississippian boundary.

Mal Lower Cliff-Forming Unit (lower Alapah Limestone)

- -is composed of thick to massive bedded limestone that forms a distinctive cliff-forming unit below the talus forming unit.
- -The contact between the talus-forming unit and the lower cliff-forming unit appears to be conformable.
- -Bedding in the lower unit ranges form less than 1 meter to over 10 meters thick.
- -The entire Lisburne section is at least 375 meters feet thick near the Katakturuk River canyon in the central Sadlerochit Mountains.

## ENDICOTT GROUP

Brosge and others (1962) described the Kekiktuk Conglomerate as a thin quartzitic chert-pebble conglomerate that occurs beneath the Kayak Shale (Bowsher and Dutro, 1957) and unconformably above rocks of the Neruokpuk Formation (Leffingwell, 1919) throughout much of northeastern Alaska. The formation is almost entirely conglomerate and coarse-grained quartzitic sandstone. Clasts in the conglomerate consist of sub angular to rounded granules, pebbles and cobbles of black, gray, and white chert, quartz, quartzite and sandstone and siltstone (Dutro and others, 1962). Thickness of the Kekiktuk Conglomerate ranges from 0 to more than 100 meters thick, and the unit grades upward from a conglomeratic base into finer grained paralic sediments near the top of the unit (Armstrong and Mamet, 1975). Locally the Kekiktuk Conglomerate contains thin discontinuous coal bed in a sequence of interbedded coarse-grained conglomerate and coarse-grained, calcareous sandstone. A coal sample from a bed in the Kekiktuk Conglomerate collected during the 1985 field season on Leffingwell Ridge just east of the Jago River had a vitrinite reflectance of 4.0 and an average air dried BTU content of 13,516 (Roy Merrit, DGGS unpublished data). A conglomerate sequence in the Kekiktuk Conglomerate just east of the Jago River on Leffingwell Ridge is at least 75 meters thick and contains dead oil (DGGS, unpublished data).

Conformably overlying the Kekiktuk Conglomerate and disconformably underlying rocks of the Lisburne Group in the northeastern Brooks Range is the Kayak Shale (Bowsher and Dutro, 1957), a formation dominated by dark gray to black noncalcareous shale and containing minor siltstone and thin-bedded ferruginous sandstone locally.

The Endicott Group in the Sadlerochit Mountains is highly variable in nature and ranges from 0 to 25 meters thick. The variability in thickness is either due to non-deposition of the unit or more likely due to removal of the unit by faulting along the pre-Mississippian unconformity.

lMe **Kayak Shale and Kekiktuk Conglomerate** (undifferentiated)

-Rocks of the lower Mississippian Endicott Group include; dark gray to black shale and siltstone of the Kayak Shale and sandstone and conglomerate of the Kekiktuk Conglomerate. These rocks occur only sporadically in the Sadlerochit Mountains.

## Nanook Limestone

The Nanook Limestone (Dutro, 1970) is a thick sequence of limestone, dolomite and minor shale that disconformably overlies rocks of the Katakturuk Dolomite in the Shublik and Sadlerochit Mountains. The Nanook in the Shublik Mountains is at least 1,000 meters thick. Dutro (1970) described fossils found near the top of the unit as Middle Devonian and suggested that the entire sequence, including the lower units were Middle Devonian in age. Recent work by Blodgett, Clough of the DGGS and others (unpublished) in the central Shublik Mountains has resulted in the discovery of fossiliferrous horizons below Dutro's unit within the Nanook Limestone . Trilobites and gastropods in these rocks indicate indicate that Ordovician, Silurian and mid Upper Cambrian strata are present.

lPzn **Nanook Limestone** (Central Sadlerochit Mountains)

-unconformably overlies Katakturuk Dolomite with slight angularity and is unconformably overlain by lower Lisburne Group rocks.
-Mostly dolomite, some limestone.
-Contains sponge-like webs of quartz and laminated siliceous carbonate.
-Gray to tan weathering.
-Mostly light tan or creamy; light gray on the fresh surface.
-Sparry calcite in clots and veins.
-Unit contains pelletal texture.
-Irregular spotty occurrences of unit suggests they are erosional remnants over which Lisburne was deposited.
-Thickly bedded (>10 meters are common).

## Katakturuk Dolomite

The Katakturuk Dolomite (Dutro, 1970) unconformably underlies rocks of the Lisburne Group, Endicott Group, and Nanook Limestone in the Sadlerochit and Shublik Mountains, and structurally overlie rocks of the Sadlerochit Group, Lisburne Group, and Neruokpuk Formation in the same ranges. Dutro (1970) named a 3400 foot thick sequence of dominantly dolomitic rocks in the Katakturuk River canyon, the Katakturuk Dolomite. He informally subdivided the unit into nine members. During this study, the Katakturuk Dolomite was subdivided into thirteen informal mappable units in the Mt. Michelson C-4 quadrangle based on distinctive lithologies and weathering character. The sequence as recognized is at least 3,000 meter thick and appears to thicken to the east. The Katakturuk Dolomite section in this quadrangle does not appear to be repeated and generally strikes east-west and dips between 40 and 55 degrees to the south. Dutro (1970) suggested that the unit contained Devonian fossils in the Sadlerochit Mountains. However extensive sampling for conodonts and other forms in the Katakturuk Dolomite by Gus Armstrong and others of the USGS has not yielded any results. Recent work by Blodgett and Clough and others (unpublished) in the Shublik Mountains has resulted in the discovery of a mid Upper Cambrian through early Middle Devonian sequence of rocks that overlie rocks of the Katakturuk Dolomite. Therefore the Katakturuk Dolomite is now considered to be older than mid Upper Cambrian and probably is at least in part preCambrian.

### pCkus Upper Siliceous Dolomite

- -Uppermost part of the Katakturuk seen in the Sadlerochit Mountains.
- -Capped by Mississippian Lisburne Gp. and Endicott Gp at the preMississippian unconformity.
- -Consists of numerous, thick beds of very siliceous chert-rich dolomite; separated by recessive brown, gray or orange weathering dolomite.
- -Includes algal, laminated and cross-bedded horizons.
- -Little breccia
- -Siliceous zones are resistant, forming noses on ridges
- -About 170 meters exposed beneath the preMississippian unconformity

### pCkb Dolomite Breccia Unit

- -Mostly brecciated, thick to thin bedded dolomite.
- -Local brown chert beds to 1 meter thick occur in the upper part of the unit.
- -Breccias often have light colored, rounded to angular dolomite clasts to 4cm in diameter in a darker dolomite matrix.
- -Brecciated beds locally laced with siliceous webs, forming resistant ledges.
- -Unit weathers to mottled gray and creamy orange slopes.
- -Unit probably represent penecontemporaneous debris sheets and only minor later tectonic breccia
- -About 320 meters thick.

### pCkh Horsetooth Dolomite

- -Mostly brown or tan, fine-grained dolomite.
- -Thin breccia zones.
- -Much webwork quartz and horsetooth texture (quartz crystals filling voids).
- -Local black-weathering laminated to crossbedded dolomite.
- -About 75 to 100 meters thick.

pCkbk Black Laminated Dolomite

-Banded dark gray dolomite.
-Abundant large-scale crossbedding.
-Crossbedded intervals alternate with fine-grained brown dolomite, or beds of dolomite breccia.
-About 75 to 100 meters thick.

pCkp Pink Dolomite Unit

-Tan to pinkish gray-weathering dolomite.
-Massive to brecciated.
-Local thin, dark laminated horizons neat top of unit.
-Some horsetooth quartz veins and pods, with white or gray to pink quartz crystals fill voids.
-About 220 meters thick.

pCkuc Upper Gray Craggy Dolomite

-Resistant, dark gray, ridge-forming dolomite.
-Thick bedded.
-Coarsely crossbedded.
-Has numerous tabular clasts (rip ups ?) parallel to bedding.
-About 250 meters thick.
-Abundant algal mat hash, some crossbedding.

pCka Thin Bedded Algal Unit

-Recessive weathering, forms dark gray, shaly looking, soil zones.
-Laminated, algal horizons with paper-thin laminations.
-Thin bedded
-Some stromatolites in the lower part of the unit.
-About 150 meters thick.

pCklc Lower Gray Craggy Dolomite

-Thick-bedded, prominent ledge-forming dolomite.
-Characterized by coarse crossbeds, some fine algal horizons, and local upright stromatolite heads.
-Dark-gray to black weathering.
-About 220 meters thick.
-Crossbedding and parallel-bedded algal hash; commonly angular or rectangular shapes to 1cm across.

pCkbn Brown Weathering Dolomite

-Brown, laminated to massive dolomite
-Recessive weathering.
-Some horizons with ripups and crossbeds.
-About 100 meters thick.

pCkco Chert and Oolite Unit

-Thin to thick-bedded, medium gray weathering, dolomite.
-Numerous algal horizons, and stromatolites(?), ooids and gray chert beds in lower part of the unit.
-Some units are crossbedded.
-Forms blocky rubble.
-About 80 meters thick.

pCkl Laminated Brown Dolomite Unit

-Fine, planer laminations on a mm scale.
-About 15 meters thick.

pCkc Cobweb Dolomite

-Gray dolomite, locally orange-weathering.
-Distinguished by dense network or "web" of white or tan quartz veinlets.
-Overlain by brown laminated dolomite.
-Algal mats and chert concentrations prevalent in lower part of the unit.

pCkv Variegated Dolomite

-Alternating gray to light tan dolomite beds.
-cryptalgal textures and some chert in the upper part of this unit.
-Includes a thin bed of black shale and brown calcareous siltstone.
-Some thicker beds contain web-like quartz veinlets.

pCkz Zebra Dolomite

-Brownish-gray dolomite with white chert/quartz segregations parallel to bedding.
-Possibly replaced evaporite horizons.
-White quartz/chert segregations .8 cm to 1.2 cm thick, separated by 2.5 cm to 5 cm of dolomite.
-Conformably overlies Spire Unit and underlies Variegated Unit.
-Weathered surfaces appear vuggy.
-Unit forms rounded, craggy outcrops.
-Locally brecciated.
-At least 100 meters thick.

pCks Spire Dolomite

-Massive, thick bedded dolomite.
-Unlayered in appearance from a distance.
-Some fine quartz webwork.
-Weathers to spires and tors on ridgelines and cliffs.
-Faintly laminated locally.
-at least 375 meters thick.

## NERUOKPUK FORMATION

Leffingwell (1919) described a sequence of pre-Carboniferous quartzite schists and quartz mica schists that outcrop near Lake Peters and called the sequence the Neruokpuk Schist. Later, Gryc and Mangus (1947), Wittington and Sable (1948), and Payne (1951) all referred to this sequence as the Neruokpuk Formation. The formation is composed chiefly of slightly to moderately metamorphosed sedimentary, volcanisedimentary and volcanic rocks that lie below the preMississippian unconformity in northeastern Alaska. Dutro and others (1972) described the significance of Cambrian fossils in the Neruokpuk Formation and also subdivided the unit into at least six mappable members. During the current study, rocks assigned to the Neruokpuk Formation have been subdivided into the following map units based on the mappability of the unit and also on the dominant rock type(s) in the unit.

**pCn Neruokpuk Formation (undifferentiated)**

- -Crops out in the central Sadlerochit Mountains
- -Thrust fault contact with overlying Katakturuk Dolomite unit.
- -Fault contact with Lisburne limestones.
- -Polyformed unit, locally isoclinally folded with well defined axial plane cleavage as the dominant fabric.
- -Lithologies include: quartzite, fine-grained metasedimentary rocks (locally phyllitic and schistose) and argillaceous dolomite.

**pCnq** Quartzite and Argillite

- -Brown and tan-weathering quartzite and shale.
- -Unit varies from fine to coarse-grained, from white to reddish-brown and locally to dark greenish-gray.
- -interbedded shale intervals are dark gray, green and black,thin to thick bedded, and sheared locally.
- -Isoclinal folding is the predominant structural style in the shale and argillite intervals.

**pCnd** Argillaceous Dolomite

- -Light- to dark- gray and black, thin laminated to massive, dolomite.
- -Dolomites are predominantly boundstones and packstones.
- -Contains stromatolites and pisoliths.
- -Thin laminated, argillaceous dolomite and argillite layers are isoclinally folded, and have well developed axial plane cleavage foliation.

**pCng** Mafic Volcanic Flows

- -Dark maroon to black and green, fine- to coarse- grained, andesite or basalt.
- -Occurs as recognizable flow units locally.
- -Volcanics contain chlorite, calcite and zeolite(?) vesicle fillings.
- -Vesicles vary from less than 1mm to 5mm in diameter.
- -Orange to brown weathering.
- -Similar to volcanic rocks in the Shublik Mountains.
- -Basal contact in the central Sadlerochit Mountains is a thrust fault.
- -Upper contact is a disconformity with units of the Katakturuk Dolomite, and with the Lisburne limestone.
- -Plagioclase microlite swallow-tail terminations and plagioclase crystal clots suggest volcanic origin.

pCns Slate

-Dark red, black, and green slate.
-Well-developed slaty cleavage.
-Tightly folded and contorted with pencil cleavage and rodding structure developed.
-Occurs within quartzite (pCnq) and best exposed in upper Marsh Creek near Mt. Weller.
-Total thickness approximately 22 meters.

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