UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

EXPLANATION TO ACCOMPANY

RECONNAISSANCE GEOLOGIC MAP OF THE DE LONG MOUNTAINS A3, B3, AND PARTS OF A4, B4 QUADRANGLES, ALASKA

By

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EXPLANATION FOR DE LONG MOUNTAINS QUADRANGLE MAPS

INTRODUCTION TO DESCRIPTION OF MAP UNITS

This map is one of a series of three reconnaissance geologic maps of the southern De Long Mountains quadrangle (fig. 1). Because the geology in the three map areas is similar, a composite map explanation has been designed to facilitate their combined use and give a better perspective of the regional geology. There are some rock units and allochthons which do not occur on all three maps. For this reason, the explanation contains more rock units than occur on any one map. Rock units which appear on the accompanying map are indicated by an asterisk beside the map symbol in the explanation.

RELATIONS OF TECTONOSTRATIGRAPHIC AND LITHOSTRATIGRAPHIC UNITS

In Early Cretaceous time, the Brooks Range was created during an orogeny that produced numerous thrust faults with as much as tens of kilometers displacement. In areas where thrust faults are closely spaced, the structure is so complex that the terrane can be characterized as a "broken formation" (Hsu, 1968). The direction of thrust juxtaposition was such that upper thrust sheets traveled relatively northward over lower sheets. Displacement of rock units across some thrust faults is great enough to superimpose coeval rocks of different sedimentary facies so that rock units in one thrust sheet may be lithologically different from coeval rock units above and below. This is especially evident in Mississippian rocks which appear to have had more complex facies patterns in their original basins of deposition than younger rock units.

In order to describe our understanding of the complex stratigraphy and structure in the De Long Mountains quadrangle, most rock units on this map are grouped into the named sequences and the allochthons shown in figure 2. On this map, the word "sequence" is used as a stratigraphic term, meaning either a distinctive column of sedimentary rocks that were deposited contiguously or a group of associated and distinctive igneous rocks. Although the assignment of a rock unit to a particular sequence is usually based upon its lithology and stratigraphic relations, its structural position is also important. Thrust sheets that contain the same or similar sequences and occur in the same general structural level are herein grouped together into structural units called "allochthons". In contrast, most previous reports use terms such as "thrust tectonic unit", "structural sequence", or "thrust sequence", for both lithostratigraphic and tectonostratigraphic units. Table 1 compares the allochthons named on this map with analogous terminology used in other reports.

Various parts of the same sequence are commonly juxtaposed several times in adjacent thrust sheets. Faults that bound thrust sheets may occur at any horizon within a sequence, so that each thrust sheet usually contains only part of a complete sequence. Thrust faults that separate thrust sheets with different sequences are mapped as "intersequence thrust faults", and those that separate thrust sheets with the same sequence are mapped as "intrasequence thrust faults". Note that these are distinguished by different map symbols.

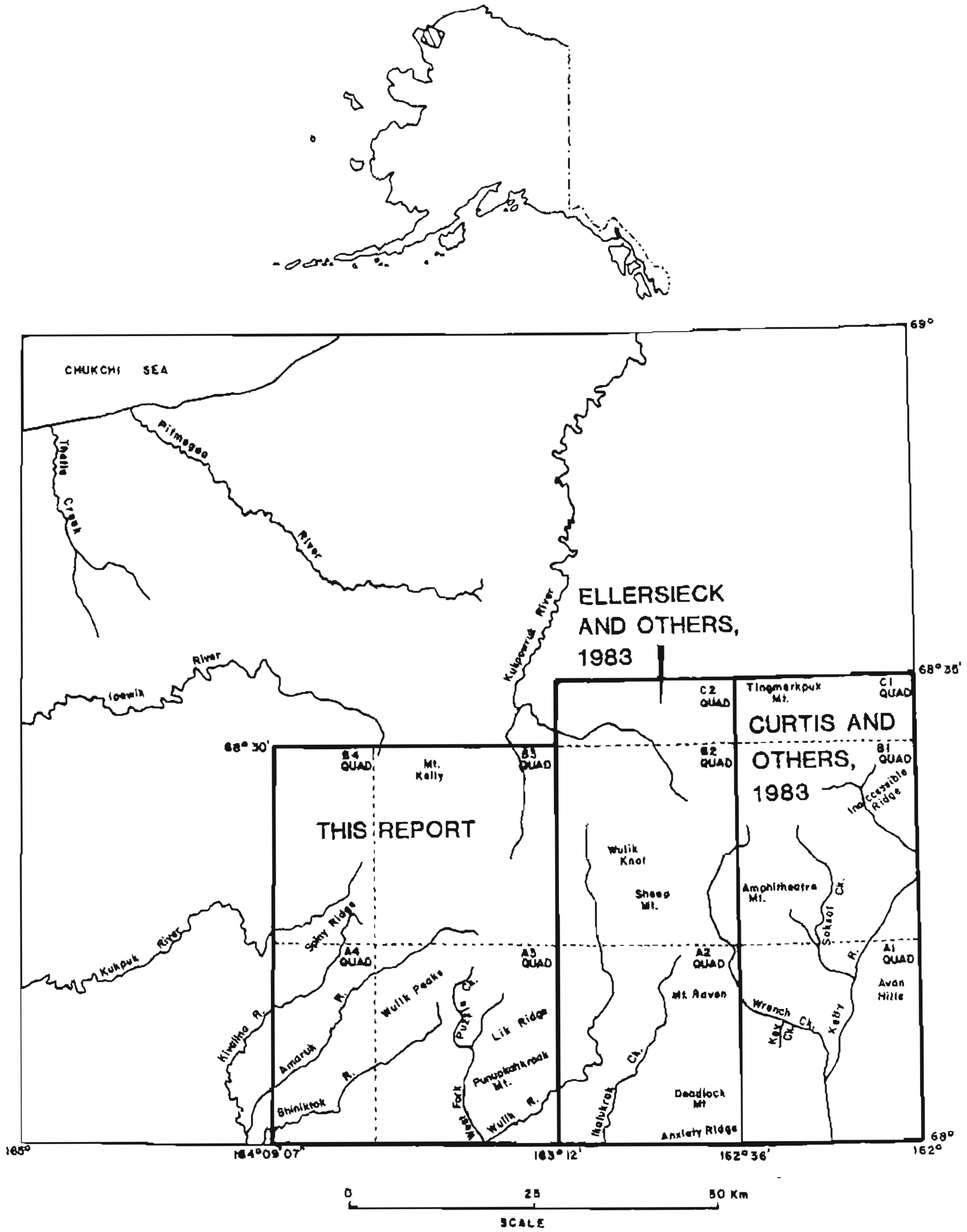


Figure 1.--Location of the De Long Mountains quadrangle, this map and the two adjacent maps of this series.

Table 1 --Comparison of allochthons in this report with equivalent structural units of other authors

This report	Curtis and others, 1982 ; Ellersieck and others, 1982 ; Mayfield and others, 1982	Ellersieck and others, 1979	Mayfield and others, 1979	Mull, 1979	Churkin and others, 1979	Mayfield and others, 1978a	Martin, 1970	Snelson and Tailleur, 1968; Tailleur, and Brosgè 1970	Tailleur and others, 1966
Misheguk Mountain allochthon	Misheguk Mountain allochthon	Misheguk Mountain thrust sequence	Misheguk Mountain thrust sequence	Misheguk sequence	Not distinguished	Misheguk Mountain thrust sequence	Ultrabasic pluton sequence	Misheguk thrust tectonic unit	Not distinguished
Copter Peak allochthon	Copter Peak allochthon	Copter Peak thrust sequence	Not distinguished	Misheguk sequence	Not distinguished	Misheguk Mountain thrust sequence	Ultrabasic pluton sequence	Misheguk thrust tectonic unit	Not distinguished
Nuka Ridge allochthon	Nuka Ridge allochthon	Nuka Ridge thrust sequence	Not distingusihed	Nuka sequence	Not distinguished	Nuka Ridge thrust sequence	Nuka Ridge sequence	Nuka Ridge thrust tectonic unit	Nuka Ridge sequence
Ipnavik River allochthon	Ipnavik River allochthon	Ipnavik River thrust sequence	Ipnavik River thrust sequence	Ipnavik sequence	Not distinguished	Ipnavik River thrust sequence	Ipnavik sequence	Ipnavik thrust tectonic unit	Ipnavik sequence
Kelly River allochthon	Kelly River allochthon	Kelly River thrust sequence	Kelly River thrust sequence	Kelly sequence	Not distinguished	Kelly River thrust sequence	De Long sequence	Kelly thrust tectonic unit	Not distinguished
Picnic Creek allochthon	Picnic Creek allochthon	Picnic Creek thrust sequence	Kuruk Creek thrust sequence	Not distinguished	Not distinguished	Northwestern Brooks Range thrust sequences	Not distinguished	Wulik thrust tectonic unit	Sequence at Kiligwa River (eastern facies)
Brooks Range allochthon	Brooks Range allochthon	Brooks Range thrust sequence	Brooks Range thrust sequence	Endicott sequence (eastern facies)	Kagvik structural sequence	{ Northwestern Brooks Range thrust sequences North Central Brooks Range thrust sequence (eastern facies)	{ Brooks Range sequence Ivotuk Hills sequence (eastern facies)	Foothills thrust tectonic unit	{ Foothills sequence Assemblages on Drenchwater Creek Sequence at Mount Bupto eastern facies)

Thrust sheets with the same sequence almost always occur in the same structural stacking position relative to thrust sheets with different sequences. This observation has permitted us to construct the generalized model, shown in figure 2, for the relationship between the various allochthons and sequences. This model shows the relative structural position of the allochthons and the sequence or sequences of rocks that occur within each allochthon. Postorogenic erosion removed large portions of the upper allochthons from the area, and some were probably never continuous across the quadrangle. The allochthons are usually in the form of large lens-shaped bodies or folded sheets from a few hundred meters to tens of kilometers across and from a few meters to a kilometer or more in thickness. In most vertical sections some of the allochthons are absent, and the sequences in others are internally repeated by intrasequence thrust faults.

In addition to the abrupt facies differences across intersequence thrust faults, there are also more gradual changes within the sedimentary rocks that make up certain allochthons. These changes are commonly most noticeable in the Mississippian and earliest Pennsylvanian rocks. Where a facies change in one or more rock units creates regionally significant differences in the stratigraphic column, two similar sequences that occur at the same structural level in different areas are named and described. In such cases, the similar sequences are presumed to have been deposited in contiguous areas and are grouped in the same allochthon. For example, the Amphitheatre and Kelly sequences are lithologically similar and occur at about the same structural level. For this reason, they were probably deposited side by side, and only a small amount of thrust juxtaposition is inferred to have occurred between them (see fig. 3 for location of sequences and allochthons). A similar relationship also probably exists for the Amaruk and Wulik sequences.

Map symbols for rock units contain numerical subscripts that identify the allochthon in which they occur. If individual map units are colored by the numbers, a tectonic map showing allochthons will result; if they are colored by the letter symbols, a map showing lithologic units will result.

Figure 4 shows the locations of foot traverses used in the compilation of this map. Not shown are the many observation points from a hovering helicopter and spot landing sites which were used for sketching geologic contacts.

ADOPTION OF THE IPEWIK FORMATION

In the Key Creek and Wulik sequences, there is a distinctive Jurassic and Early Cretaceous interval of rocks characterized by maroon or gray shale. Localized coquinoid limestone and sandstone also occur in the northern parts of the Key Creek sequence. These rocks were named the "Ipewik Formation" by Crane and Wiggins (1976). The formation was named for its type locality in the region of the Ipewik River, De Long Mountains quadrangle, Alaska, but was mispelled "Ipewick" in the published abstract. This formation name is adopted on this map, and the spelling is corrected to Ipewik to accurately reflect its geographic namesake. Due to structural complications and rapid facies changes, there is no single place where all lithologies in the formation are completely exposed. Well exposed reference sections exist at the following locations: Horseshoe Bend on the Ipewik River (lat 68°36.5' N., long 164°11.2' W.); 10 km west of Horseshoe Bend on the Ipewik River

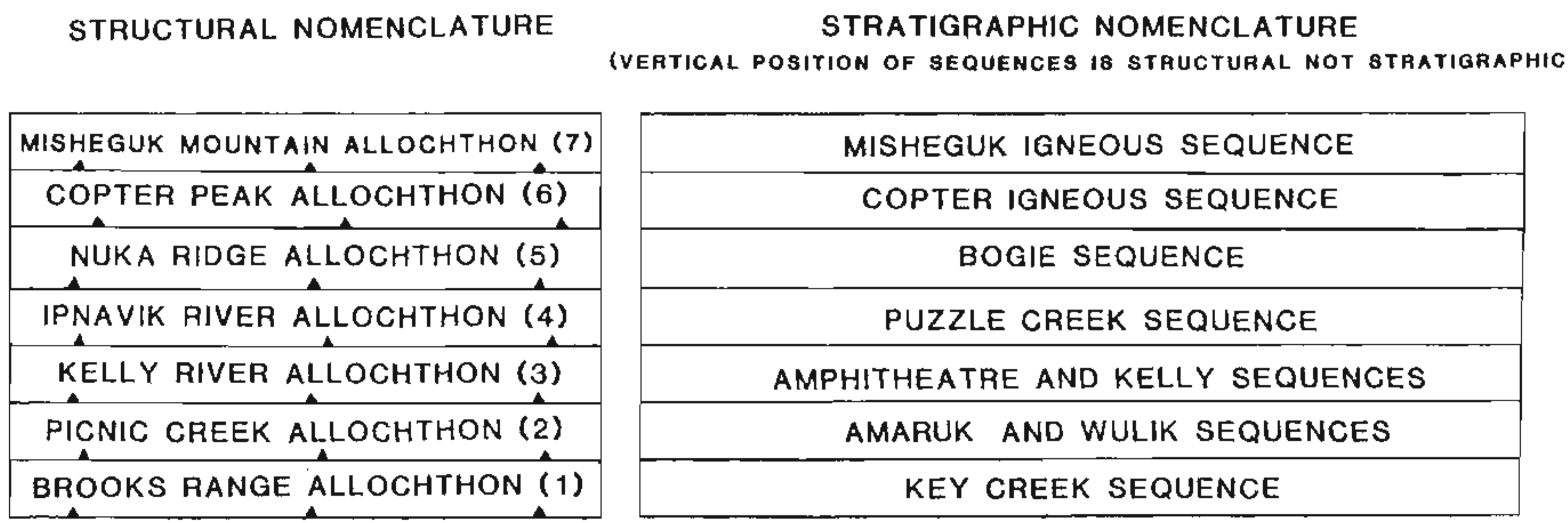


Figure 2.--Diagram showing the usual stacking position of structural units (allochthons 1 lowest and 7 highest) and stratigraphic units (sequences) in the southern part of the De Long Mountains quadrangle. Although the lowest thrust sheets of the Brooks Range allochthon are not exposed in the quadrangle, field relations from others areas indicate that the base is in fault contact with relatively autochthonous rocks (Mull and others, 1976; Mull and Tailleur, 1977).

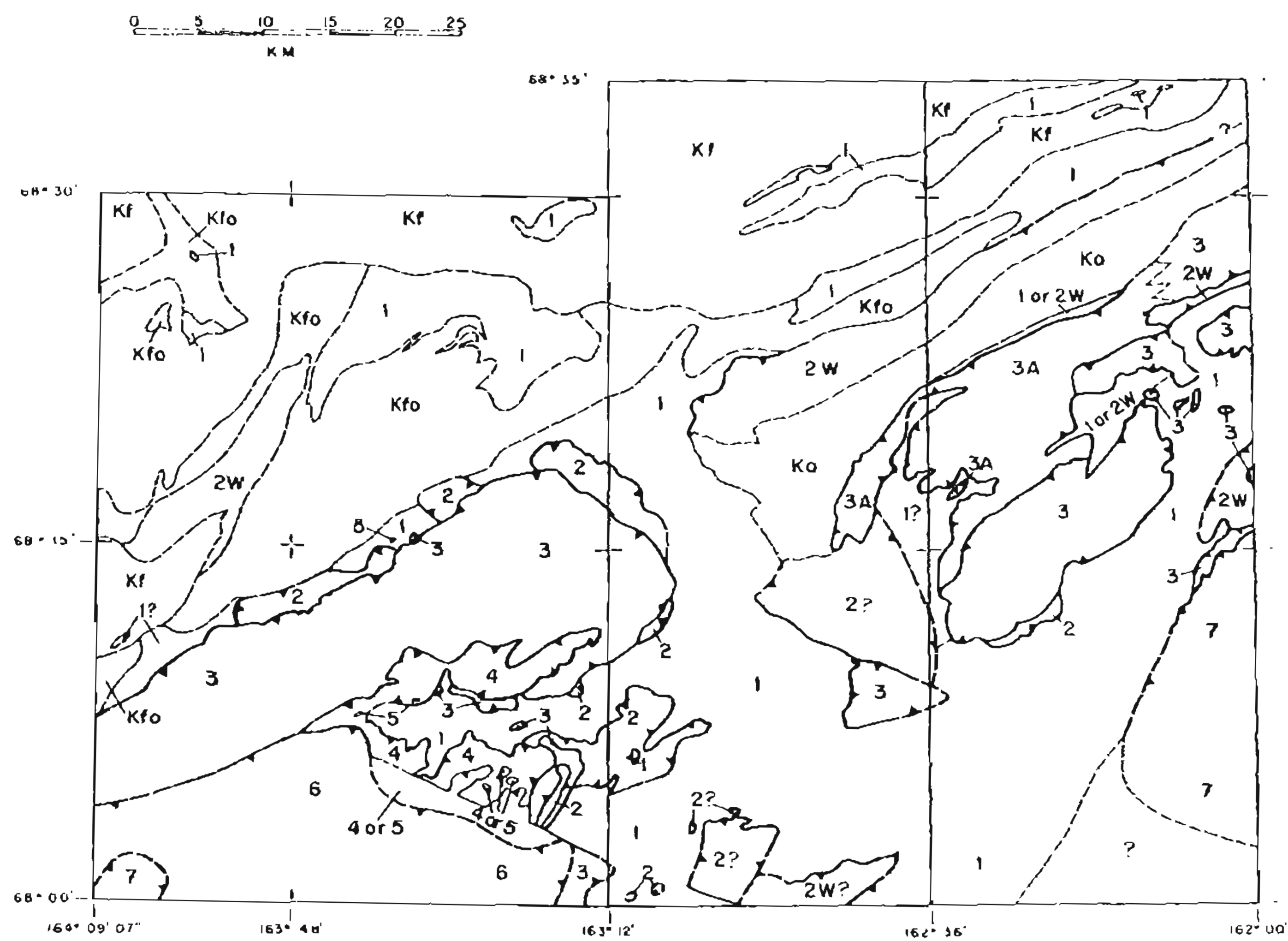


Figure 3.--Generalized allochthon and sequence map of south-central and southeastern De Long Mountains quadrangle. Symbols are: Kf - Fortress Mountain Formation, autochthonous; Kfo - Fortress Mountain Formation (autochthonous) and Okpikruak Formation (allochthonous), undivided; Ko - Okpikruak Formation, allochthon unknown; 1 - Brooks Range allochthon, Key Creek sequence; 2 - Picnic Creek allochthon, Amaruk sequence; 2W - Picnic Creek allochthon, Wulik sequence; 3 - Kelly River allochthon, Kelly sequence; 3A - Kelly River allochthon, Amphitheatre sequence; 4 - Ipnavik River allochthon, Puzzle Creek sequence; 5 - Nuka Ridge allochthon, Bogie sequence and (or) olistoliths of Bogie sequence within other allochthons; 6 - Copter Peak allochthon, Copter igneous sequence; 7 - Misheguk Mountain allochthon, Misheguk igneous sequence. Sawteeth on upper side of intersequence thrust faults. Dashed lines indicate boundaries with uncertain locations.

(lat 68°35.7' N., long 164°25.5' W.); upper Thetis Creek (lat 68°39' N., long 164°44.6' W.); upper Kukpowruk River (lat 68°29' N., long 162°42' W.); upper Kukpuk River (lat 68°25.1' N., long 163°33' W.).

A distinctive sandstone within the Ipewik Formation, named the Tingmerkpuk member by Crane and Wiggins (1976), is also adopted. Its type locality is at Tingmerkpuk Mountain (lat 68°33.7' N., long 162°27.6' W.).

CRITERIA USED TO DISTINGUISH SEQUENCES

The most important criteria used to distinguish one sequence from another are listed in Table 2. With the exception of the Bogie sequence, which contains the unique Nuka Formation (Tailleur and others, 1973), there is no single rock lithology that can be used by itself to distinguish a particular sedimentary sequence. The most common lithologic differences between sequences are found in middle and Late Mississippian rocks. However, lithologic differences in this time interval are not great enough to distinguish all sedimentary sequences. Thus, identification of some sequences also may require comparison of the lithologies of the older Mississippian and(or) Late Devonian rocks which underlie each particular set of Late Mississippian lithologies.

Late Mississippian (and Early Pennsylvanian?) rocks in all the sedimentary sequences are overlain by Pennsylvanian to Jurassic chert and shale of the Etivluk Group (Mull and others, 1982) and Early Cretaceous wacke and mudstone of the Okpikruak Formation. Generally, we have not seen enough lithologic variation in the Etivluk Group or Okpikruak Formation in the De Long Mountains quadrangle to make either of these two rock units useful for differentiating sequences. The Jurassic to Early Cretaceous Ipewik Formation is best exposed in structurally lower sequences such as the Key Creek and Wulik sequences. It is generally not useful for differentiating between these sequences except for the Tingmerkpuk Member of the Ipewik Formation which crops out in a narrow belt in the northern part of the Key Creek sequence and appears to be present in only the northernmost, and presumably lower thrust sheets of the Brooks Range allochthon.

UNCERTAIN RELATIONSHIPS BETWEEN ALLOCHTHONS AND SEQUENCES

A belt of Okpikruak Formation stretches from the Wulik River to the eastern edge of the De Long Mountains quadrangle through Sheep Mountain and the headwaters of the Kelly River. Bordering this large expanse of Okpikruak Formation are outcrops of Key Creek, Wulik, Amaruk, Amphitheatre, and Kelly sequences. Because we have no lithologic criteria for telling what sequence the Okpikruak Formation belongs to, we cannot be certain where intersequence faults may cut through the Okpikruak Formation. It is also possible that parts of the Okpikruak Formation may have been deposited shortly after the major faulting had already juxtaposed some allochthons, so that the intersequence faults could be buried under younger sediment. These uncertainties permit several interpretations of the structure along the carbonate front north of Inaccessible Ridge (fig. 1, De Long Mountains B1 quadrangle) and its southwestern extension, and under the Sheep Mountain trend of Okpikruak Formation.

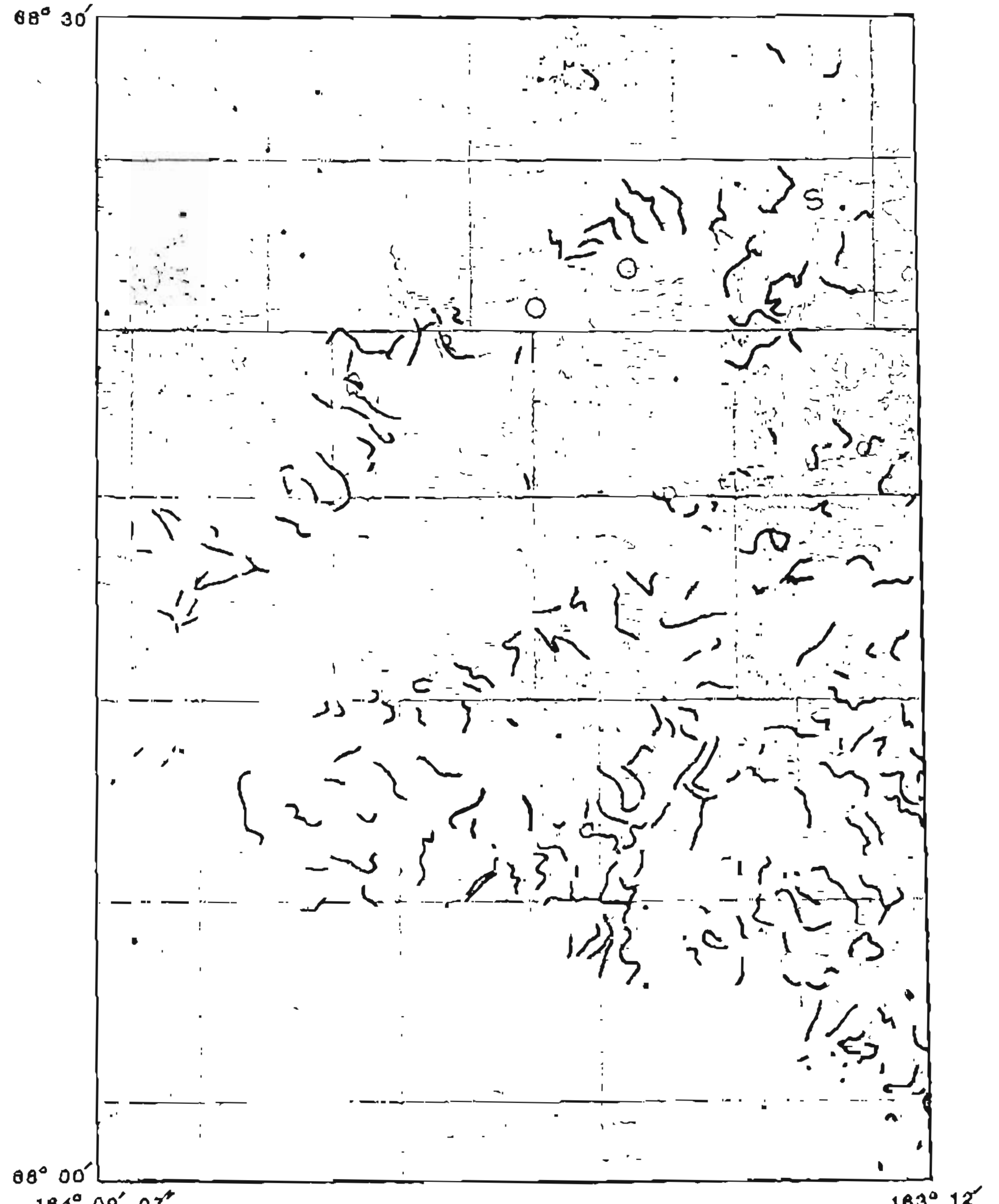


Figure 4.--Map showing locations of foot traverses used by the geologists who compiled this map

The cherty carbonate rocks of the Lisburne Group that crop out around Mount Raven, northeast of Punupkahkroak Mountain, and northwest of Anxiety Ridge (fig. 1) are currently mapped as part of the Amaruk sequence in allochthon two. There is some evidence from bedding atitudes along the lower Wulik River and upper Ikalukrok Creek that these rocks may be structurally below the Key Creek sequence, and therefore, they could belong to a separate, as yet unnamed, sequence. The upper part of the carbonate rocks contain post-Mississippian brachiopods near Mount Raven (fossil locality 50, De Long Mountains, B2 quadrangle), distinctly younger than any known carbonate rocks elsewhere in the Amaruk sequence. These outcrops are shown on the geology map and cross sections as part of allochthon two because they are lithologically most similar to the Amaruk sequence. They are queried as part of allochthon two on figure 3 to reflect our uncertainty about their structural position.

The Wulik sequence is differentiated from the Key Creek sequence mainly because of the presence of fine-grained Mississippian carbonate rocks which are well exposed in the Wulik Knot (De Long Mountains B2 quadrangle). There are no corresponding carbonates in the Key Creek sequence immediately north of the Wulik Knot. The Wulik sequence can be traced northeastward from the Wulik Knot into the De Long Mountains B1 and C1 quadrangles. In this direction the micritic limestone unit of the Wulik sequence (unit Mml_2) becomes thin and discontinuous, and the black chert and limestone unit (unit $\mathbb{P}Mcl_2$) becomes more carbonaceous and shaly, approaching Kuna Formation in lithology. It is possible that in the upper Kokolik River area (De Long Mountains C1 quadrangle) the Wulik and Key Creek sequences are merging into the same sequence by means of a gradual facies change.

One unresolved problem related to the Wulik sequence is the structural position of Anxiety Ridge (De Long Mountains A2 quadrangle), an anticline locally overturned to the north. Endicott Group rocks of the Key Creek sequence are thrust northward over the rocks of the southern side of the ridge. (This is best exposed in the Noatak quadrangle, south of the map area.) The combination of fine-grained black chert and limestone (unit $\mathbb{P}Mcl_2$) with Kuna Formation (unit $\mathbb{P}Mk_2$) resembles some of the thrust sheets that contain the Wulik sequence in the Wulik Knot and some of the thrust sheets that contain the Key Creek sequence along the west side of the upper Kelly River. Two structural possibilities, dependent upon whether Anxiety Ridge belongs to the Wulik sequence or to the Key Creek sequence, are shown on cross section B-B' for the De Long Mountains A2 map. One possibility is that Anxiety Ridge is part of the Picnic Creek allochthon which was first superposed over the Brooks Range allochthon that lies immediately north of Anxiety Ridge and then later was overridden from the south by a thrust sheet that contains rocks of another part of the Brooks Range allochthon. An alternative possibility is that Anxiety Ridge could be a thrust sheet in the Brooks Range allochthon that extends down dip to the north and contains a localized facies within the Key Creek sequence (shown in the alternative cross section).

The Puzzle Creek sequence has been included in the Ipnavik River allochthon on figure 2 and in table 1 because it occupies the same structural level, and it is lithologically similar to other sequences in the Ipnavik River allochthon further east. However, the Puzzle Creek sequence is also lithologically similar to the Amaruk sequence of the Picnic Creek allochthon (see fig. 3 for locations), and it is possible that the Puzzle Creek and

Table 2.--*Important criteria used to distinguish sequences*

Sequence	Approximate age of diagnostic lithologies	Description of diagnostic lithologies in sequences
Misheguk igneous sequence	Jurassic	1. The only sequence composed of gabbro and peridotite
Copter igneous sequence	Jurassic? and Triassic	1. The only sequence that contains pillow basalt
Bogie sequence	Carboniferous	1. The only sequence that contains the Nuka Fm.
Puzzle Creek sequence	Early Pennsylvanian? to middle Mississippian	1. Relatively thick black chert and(or) black chert and limestone or dolomite (thickness generally greater than 100 m). Underlain by:
	middle to Early Mississippian	2. Kayak Shale and Utukok Fm.
	Late and Middle Devonian	3. Base of section is Baird Group limestone
Kelly sequence	Late to middle Mississippian	1. A thick section of Kogruk Fm. (thickness generally greater than 300 m). Underlain by:
	middle and Early Mississippian	2. Thick section of Utukok Fm. (thickness generally greater then 500 m)
	Late Devonian	3. Base of section is Baird Group limestone
Amphitheatre sequence	Late Mississippian	1. A thick section of Kogruk Fm. (thickness generally greater than 500 m). Underlain by:
	Late to Early Mississippian	2. A thick section of micritic limestone (thickness generally greater than 200 m)
Amaruk sequence	Early Pennsylvanian? to middle Mississippian	1. Relatively thick black chert and(or) black chert and carbonate (thickness up to 200 m). Underlain by:
	middle Mississippian	2. Relatively thin and discontinuous Kogruk Fm. (thickness less than 20 m). Underlain by:
	middle to Early Mississippian	3. Base of section is Kayak Shale and(or) Utukok Fm.
Wulik sequence	Early Pennsylvanian? to Late Mississippian	1. Relatively thick black chert and(or) black chert and limestone (thickness generally greater than 75 m). Underlain by:
	Late to middle Mississippian	2. Thin and discontinuous Kuna Fm. is generally less than 30 m thick. Underlain by:
	middle Mississippian	3. Thin to thick section of micritic limestone (thickness up to 80 m)
Key Creek sequence	Early Pennsylvanian to middle Mississippian	1. Relatively thick shaly Kuna Fm. (thickness approx. 50 m). Bedded black chert on top of Kuna Fm. is generally less than 15 m thick. Underlain by:
	middle Mississippian	2. Relatively thin and discontinuous Kogruk Fm. (thickness less than 30 m) or micritic limestone (thickness less than 30 m
	Early Mississippian? to Late Devonian	3. Base is thick section of Late Devonian sandstone and shale of the Kanayut Conglomerate, Noatak Sandstone, and Hunt Fork Shale (thickness at least 600 m)

Amaruk sequences are parts of the same sequence which have been thrust into two structural levels, one above and one below the Kelly River allochthon. The Devonian shale and limestone of the Baird Group within the Puzzle Creek sequence are similar to Devonian rocks in allochthons above the Kelly River allochthon in the Misheguk Mountain quadrangle (Ellersieck and others, 1982), leading us to believe that the Puzzle Creek sequence is part of the Ipnavik River allochthon rather than the Picnic Creek allochthon.

The Nuka Ridge allochthon is represented by only three isolated outcrops of the Nuka Formation, one located north and other two located south of the Wulik Peaks (De Long Mountains A3 and B3 quadrangles, fig. 1 and 3). Some or all of these outcrops may be olistoliths, because they are small, isolated, and largely surrounded by Cretaceous wacke and conglomerate which may be part of lower sequences. If this interpretation is correct, then these outcrops are fragments of a thrust sheet of Nuka Ridge allochthon that once overlaid part of the southern De Long Mountains quadrangle, and they slid into a Cretaceous basin deposited on structurally lower thrust sheets. More extensive outcrops of the Nuka Ridge allochthon are exposed in the Noatak quadrangle south of the map area.

We believe the Permian age, based on brachiopod identifications, for the upper part of the Nuka Formation is suspect. Both conodont and foraminifer ages from this unit are consistently Late Mississippian and possibly Early Pennsylvanian. The base of the Etivluk Group which directly overlies the Nuka Formation has not yet been dated by well preserved index fossils. B. K. Holdworth (written commun., 1980) has observed radiolarian fossils from chert of the Etivluk Group lying above the Nuka Formation at Nuka Ridge (Misheguk Mountain quadrangle) and finds specimens which are similar to *Albaillella pennata* s.s. of earliest Pennsylvanian age. Unfortunately, these specimens were not well enough preserved for definitive determination. In structurally lower sequences, the base of the Etivluk Group has been dated by radiolarians and conodonts as Early or Middle Pennsylvanian. We see no evidence, either from fossils or from correlation of chert lithologies, that the base of the Etivluk Group should be greatly diachronous. Therefore, we regard the age of the Nuka as Early Pennsylvanian(?) and Late Mississippian.

The contact between the Copter Peak allochthon and the Misheguk Mountain allochthon is not exposed in the De Long Mountains quadrangle. We infer that the Misheguk Mountain allochthon is on top, because this is the case in the Misheguk Mountain quadrangle to the east and in the Noatak quadrangle to the south.

SUMMARY OF GEOLOGIC HISTORY

Restoration of stratigraphic sequences to their relative positions before the large thrust dislocations that occurred during the Brooks Range orogeny is critical to understanding the geologic history of the De Long Mountains. We believe that the simplest and most reasonable reconstruction requires a consistent unstacking of thrust sheets, with higher sheets restored to the south relative to lower sheets (Tailleur and Brosgé, 1970; Martin, 1970) This important premise is based on:

1) our interpretation of the probable facies patterns in pre-Cretaceous rocks, and
2) the consistent northward vergence of visible structures in the De Long Mountains and Misheguk Mountain quadrangles.

Figure 5 shows a palinspastic diagram of the sequences, based on the interpretations above. North and south as labeled on the diagram refer to present-day directions. This orientation does not take into account the possible rotation of the entire Arctic Alaskan plate due to rifting in the Canada Basin (Tailleur and Snelson, 1969; Tailleur, 1973), or possible crustal bending about the Chukchi syntaxis (Tailleur, 1973; Patton and Tailleur, 1977). The scale is purposely vague. The original north-south width of sequences is difficult to determine because of many factors. Erosion during the Brooks Range orogeny removed an undetermined amount of the northern edges of the thrust sheets. Erosion after, and possibly during, the orogeny also stripped away an undetermined width of the thrust sheets over the core of the Baird Mountains. The amount of shortening caused by folding and thrust faulting within allochthons is not accurately known, although in a few areas it is undoubtedly substantial. The continuity of allochthons in the subsurface, or in their projection above the present surface, is difficult to estimate. In all cases, we have tried to make our estimates as conservative as possible, so that the north-south width of the sequences shown in figure 5 is a minimum amount.

During the Middle and Late Devonian and Early Mississippian, two partly coeval groups of sedimentary rocks were deposited on a continental platform with unknown dimensions (Tailleur and others, 1967). The southern part of the platform contained the Baird Group, composed of clean, biohermal limestone in the Kelly sequence and interbedded limestone, dolomite, calc-siltstone, and shale in the sequences south of the Kelly. Conodont ages from the Baird Group range from Middle to Late Devonian (Famennian). Foraminifera ages indicate that the top of the Baird Group is Mamet zone 6 (B. L. Mamet, written commun., 1981) which is latest Devonian or earliest Mississippian in age. On the continental platform north of the Baird Group, in the Wulik and Key Creek sequences, the Endicott Group of clastic rocks was deposited in an intracratonic basin during the Late Devonian and Early Mississippian. The lower part of the Endicott Group is the Hunt Fork Shale. Above this is the Noatak Sandstone and Kanayut Conglomerate, composed of shallow-marine and paralic sandstone with some shale and conglomerate (Tailleur and others, 1967; Nilsen, 1981).

Throughout the Mississippian, sedimentation over the platform was complex. The lower part of the Mississippian in all sequences is characterized by intergradational limey siltstone, limestone, sandstone, and shale. We have mapped the facies that contains mostly sandy limestone as Utukok Formation, the facies with mostly shale as Kayak Shale, and a mostly fine-grained, thin-bedded limestone as "micritic limestone".

During middle and Late Mississippian and possibly Pennsylvanian time, a complex series of submarine rises and troughs developed on the platform. The different sedimentary facies in these areas are an important key for differentiating stratigraphic sequences. The most prominent rise was in the Kelly sequence, where up to 650 m of cherty carbonate rocks, the Kogruk Formation, was deposited. Tongues of Kogruk extended to the north into the

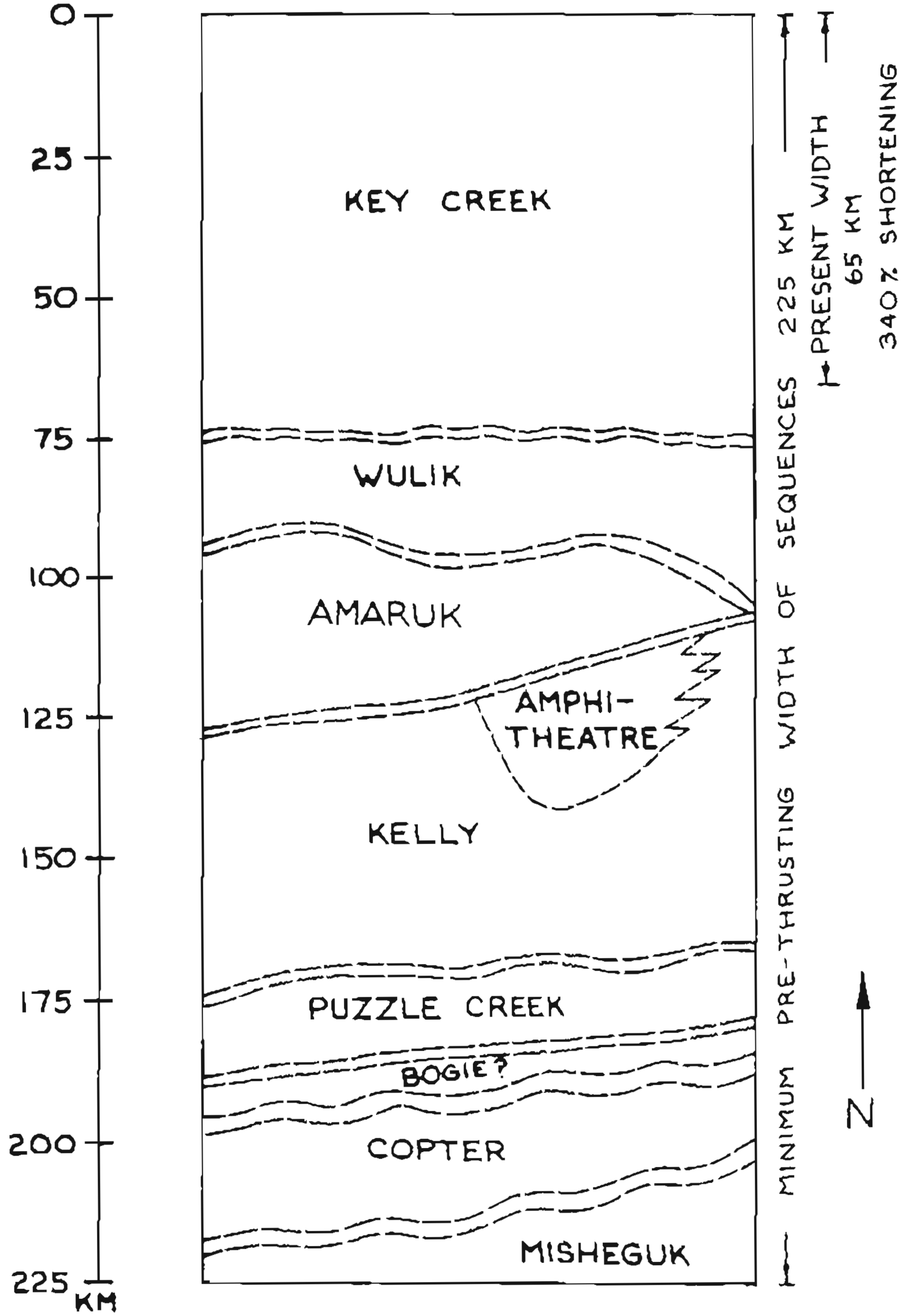


Figure 5.--Generalized palinspastic map of sequences exposed in the south central and southeastern De Long Mountains quadrangle, prior to Mesozoic thrust faulting. Inferred direction of thrust transport is along a north-south line. The width of sequences is based on outcrops within the map area only, and does not take into account extent of some sequences south of the De Long Mountains quadrangle. See text for more complete explanation.

Wulik sequence and discontinuously into the Key Creek sequence. North and south of the Kelly sequence, interbedded chert and carbonate sediments were deposited in broad troughs in the areas of the Puzzle Creek, Amaruk, and Wulik sequences. North of the Kelly sequence carbonate rocks, a euxinic basin developed in which the Kuna Formation (Mull and others, 1982) was deposited. The Kuna Formation is predominantly black shale, with lesser amounts of radiolarian chert, limestone, and dolomite. Some of the carbonate beds are detrital, but in at least one locality, there are corals in growth position in a clean limestone interbedded with black shale, suggesting that at least some of the Kuna was not deposited in deep water. The Kuna Formation is best developed in the Key Creek sequence, but is also present in the Wulik sequence, and some thin tongues probably overlie the Mississippian carbonate rocks in parts of the Amphitheatre and Kelly sequences. A similar black shale (unit PMs$_4$) is also present at the top of the Mississippian black chert and dolomite unit (unit PMcd$_4$) in the Puzzle Creek sequence.

The Nuka Formation is unique among the Carboniferous sedimentary rocks in the western Brooks Range in that it contains abundant feldspar grains in sandy limestone. Coeval units in structurally lower allochthons, which formed a belt hundreds of kilometers wide north of the Nuka Formation at this time, contain very little sand-size silicate debris, and almost no feldspar. The source area for the arkose in the Nuka has not been found, but it was probably to the south. The structural position of the Bogie sequence and the arkosic limestone and sandstone in the Nuka Formation are best explained if the Nuka was deposited on the south edge of the Mississippian and Pennsylvanian basin. The depositional environment of the Nuka Formation may have been shallow banks with clastic sources in land to the south. It is possible that the granitic source for the arkose began to rift away from the Arctic Alaska platform during the Pennsylvanian(?), which left the Bogie and other sequences mapped in the De Long Mountains quadrangle on a southward-facing continental margin.

The close of the carbonate and shale cycle of sedimentation over the entire platform began in the Pennsylvanian and was marked by deposition of radiolarian chert and siliceous shale of the Etivluk Group. In areas where the Kuna Formation was deposited, this change is gradational. We have chosen the boundary between Kuna Formation and Etivluk Group as the distinctive horizon that is marked by a change from black chert of the Kuna Formation to red, green, and gray chert of the Etivluk Group, possibly reflecting a change in the oxidation potential of the seawater at this time. In some exposures of this horizon, there are yellow or orange clay layers, a few centimeters thick, which may be bentonite.

Where limestone or interbedded limestone and chert underlie the Etivluk Group, the contact is sharp, although there is commonly an increase in the percentage of chert in the upper 100 m of some of the underlying chert-carbonate units and the Kogruk Formation. This cherty interval is partly correlative with the Tupik Formation which has been differentiated in areas to the east of the map area (Sable and Dutro, 1961; Curtis and others, 1982). The contact of the Nuka Formation and Etivluk Group is not exposed in the De Long Mountains quadrangle, but farther east the contact is sharp in places and possibly gradational in others (Tailleur and others, 1973). There is no compelling evidence from any of the sequences that the Etivluk Group was deposited on a major unconformity. However, it is possible that future detailed paleontological sampling may substantiate local disconformities at the top of the Kogruk and (or) Nuka Formations.

Deposition of the Etivluk Group continued until at least Early or Middle Jurassic time. In the northern sequences (fig. 5), lithographic limestone, packed with the pelecypod Monotis, was deposited in the limestone member of the Otuk Formation of the Etivluk Group during Late Triassic time; most of this limestone was subsequently silicified. In the northern part of the Key Creek sequence, the calcareous Monotis interval is overlain by 5 to 10 m of dark chert and paper shale that resembles the Early to Middle Jurassic Blankenship Member of the Otuk Formation (Mull and others, 1982). Early Jurassic radiolarians also have been identified from near the top of the Etivluk Group in the Puzzle Creek sequence at Punupkahkroak Mountain (De Long Mountains A3 quadrangle).

Pillow basalts and flows of the Copter igneous sequence are not well exposed in the map area, but are similar to the Copter igneous sequence in the Misheguk Mountain quadrangle where radiolarians from cherts intercalated with pillows have been correlated with radiolarians from the Norian part of the Otuk Formation. The higher structural position of the Copter igneous sequence suggests that it was erupted south of the coeval rocks of the Etivluk Group. The basement onto which the Copter basalts were erupted is not known; blocks of Devonian limestone are commonly associated with the Copter igneous sequence and may be parts of this basement, but whether the contacts are mainly stratigraphic, intrusive, or tectonic has not been determined.

In the Late Jurassic and Early Cretaceous a major change in sedimentation occurred as the old continental shelf was broken up into large allochthonous sheets. This tectonism, which began the Brooks Range orogeny, most likely progressed from south to north as thrust sheets of southern origin overrode shelf rocks to the north, which were in turn thrust still farther north. The orogeny probably began at the southern edge of the Arctic Alaska plate when the Misheguk Mountain allochthon overthrust the Copter igneous sequence. Structurally lower thrust faults then developed beneath the Copter igneous sequence, creating the Copter Peak allochthon. Both allochthons then moved relatively northward over the sedimentary sequences on the old shelf. The leading edges of the allochthons were exposed to erosion and began to shed clastic debris north of the developing mountain range.

The petrology of the mafic and ultramafic rocks that make up the Misheguk Mountain allochthon is typical of the lower parts of many ophiolites, indicating that this allochthon is probably a remnant of oceanic crust which lay south of the Arctic Alaska continental plate before the Brooks Range orogeny (Patton and others, 1977). The basalts and oceanic sediment which may have been atop the gabbro and peridotite have been eroded away and are no longer preserved in the quadrangle.

The mechanism of the thrusting is uncertain. We believe the best conceptual explanation is that the Arctic Alaska plate, on which the Brooks Range sedimentary sequences were deposited, was subducted toward the (present) south, and the allochthonous sedimentary sequences were detached from the upper layers of the subducted plate. In this model, the several hundred kilometers of crust on which the sedimentary sequences were deposited are no longer near the Earth's surface. The suture between the Arctic Alaska plate and the southern oceanic(?) plate is now south of the Baird Mountains. Remnants of the suture plane also may occur at the base of the gently folded ophiolite klippen, mapped as the Misheguk Mountain allochthon.

In the northern sequences, which were probably relatively stable during the early parts of the Brooks Range orogeny, the Jurassic and Early Cretaceous Ipewik Formation appears to lay conformably on the Etivluk Group. Some thin tongues of the Ipewik Formation possibly extended as far south as the Amphitheatre sequence. The lower part of the Ipewik Formation is commonly present in the Wulik sequence in places where it has not been removed by erosion at the sub-Okpikruak unconformity, and the upper part of the Ipewik Formation is best developed in the northern parts of the Key Creek sequence. Coquina beds composed of the pelecypod Buchia, and the clean, well-sorted sandstone of the Tingmerkpuk Member of the Ipewik Formation may indicate that the water depth was shoaling toward the northern limits of the presently mapped Key Creek sequence in Valanginian time.

The Early Cretaceous Okpikruak Formation was deposited in a foredeep on the north side of the ancestral Brooks Range during the Brooks Range orogeny. The Okpikruak is mostly graywacke and shale, with some conglomerate locally. Features characteristic of turbidity-current deposition are common. Conglomerate clasts are composed of chert of the Etivluk Group, chert and limestone of the Lisburne Group, arkose of the Nuka Formation, limestone of the Baird Group, and gabbro or diabase derived from the known allochthons. There are also many clasts of volcanic and plutonic igneous rocks which have not been recognized within any of the allochthons currently present in the De Long Mountains. Their source is problematical; they may have been derived from the Copter Igneous sequence, the upper parts of the Misheguk igneous sequence, or from allochthons structurally above the Misheguk Mountain allochthon which now have been entirely removed by erosion (Mayfield and others, 1978b).

The base of the Okpikruak Formation is an unconformity in most places, although there may have been continuous deposition in the northern areas where it sits on Ipewik Formation. It is evident from the map pattern that the Okpikruak truncates older units, in some places resting directly on Devonian rocks, but the angularity of truncation is relatively gradual. Depositional contacts between the Okpikruak and older units seem to be concordant on the scale of an outcrop. If any folding preceded deposition of the Okpikruak, it must have been relatively gentle.

Olistoliths from structurally higher thrust sheets slumped into the foredeep and were incorporated in Okpikruak sedimentary materials deposited atop lower stratigraphic sequences (Mull, 1979). The olistoliths are commonly blocks of limestone of the Baird Group or Kogruk Formation, chert of the Etivluk Group, and arkose of the Nuka Formation. In some cases they are surrounded by isolated areas of conglomerate that probably represent submarine channel deposits. Isolated blocks of older, more competent rocks completely surrounded by graywacke and shale of the Okpikruak Formation are common in many areas. Distinguishing olistoliths from tectonically incorporated blocks is difficult in most of these cases.

As the thrust sheets moved northward relative to the rocks under them, they overrode parts of the Okpikruak Formation that were deposited earliest, but the Okpikruak continued to be deposited on sequences farther to the north. Thus the depocenter of the Early Cretaceous foredeep migrated northward with time (Snelson and Tailleur, 1968). There is some fossil evidence to support this conclusion even though the early orogenic clastic sediments are poorly dated by sparse occurrences of the pelecypod, Buchia. In the more northerly (structurally lowest) thrust sheets that are made up of the Key Creek sequence along the Kukpowruk River (De Long Mountains B2 quadrangle), the base of the orogenic flyschoid sediments, mapped here as the Fortress Mountain Formation, is younger than the well dated Early Cretaceous (Valangian) beds of the Tingmerkpuk Member of the Ipewik Formation (Crane and Wiggins, 1976) on which it was deposited. The Ipewik Formation contains the pelecypod Buchia Sublaevis of Valanginian age. Near the mountain front 22 km to the southwest in a structurally higher thrust sheet of the Key Creek sequence (fossil locality 9, De Long Mountains B3 quadrangle), the orogenic flyschoid sediments, mapped here as the Okpikruak Formation, are at least as old as Berriasian age, because they contain the pelecypod, Buchia Okensis. In a structurally higher thrust sheet which is part of either the Kelly River, Ipnavik River, or Nuka Ridge allochthon, Curtis and others (1982, fossil locality 48) report a Late Jurassic (Tithonian) pelecypod, Buchia Fischeriana, from orogenic flyschoid sediments, mapped as wacke and mudstone, in outcrops along the lower Kugururok River in the Misheguk Mountain quadrangle. This fossil evidence shows that the age of the base of the Okpikruak Formation and other related orogenic clastic beds are older in structurally higher sequences than they are in lower sequences. Such a diachronous relationship supports the concept of northward prograding flyschoid deposition beginning at least as early as Tithonian in higher sequences and beginning as late as the Valanginian in the structurally lowest part of the lowest sequence.

The stacked allochthons that are mapped in the De Long Mountains quadrangle may have been thrust over the south edge of the sequence of rocks present in the subsurface of the North Slope. The evidence for the allochthonous nature of the Brooks Range allochthon, the lowest exposed in the map area, is based on field relationships along the north side of the Baird and Schwatka Mountains east of the map area (Mull and others, 1976). None of the North Slope sequence is exposed in the De Long Mountains, but it may underlie the entire area at several kilometers depth.

With the waning of the large-scale thrusting during middle Cretaceous time, the foredeep north of the mountain range continued to fill with sediment. The Fortress Mountain Formation, of late Early Cretaceous age, was derived from the Brooks Range and deposited on the northern part of the Okpikruak Formation and the Ipewik Formation. The character of the graywacke and shale of the southern part of the Fortress Mountain Formation is so similar to the graywacke and shale of the Okpikruak Formation that the southern limit of its extent is not easily differentiated from the Okpikruak. North-south compression in the Late Cretaceous and early Tertiary caused folds with east-west trends and some minor thrust faulting in the Fortress Mountain Formation, and also created broad folds in the stacked allochthons. The De Long Mountains probably remained a topographic high since Fortress Mountain time, because no rocks younger than Early Cretaceous have been found within this area.

FOSSIL TABLE

Table 3 is a list of the fossils which have been identified from the De Long Mountains A3, B3, and parts of A4 and B4 quadrangles. Most fossils were collected in the summer of 1979 during fieldwork for this mapping project. However, they also include previously unpublished fossil collections dating back to the 1950's. Some collections were made by geologists from the petroleum industry and dated by U.S. Geological Survey paleontologists.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
1	68ATr193	68°07'33"	163°39'33"	--	Devonian or older	Dbl_4	Stromatoporoids?	A. K. Armstrong
2	63ATr206	68°20'42"	163°51'54"	21421-PC	Late Mississippian to possibly Early Pennsylvanian	$\mathbb{P}Mk_2$	Brachiopods, gastropods	E. L. Yochelson
3	26AS19	68°15'33"	163°54'52"	13716	Early Cretaceous	Ko	Pelecypods	J. B. Reeside, Jr.
4	79Ek280C	68°15'21"	163°36'00"	--	[1]Probably Permian	$\mathbb{P}Mn_5$	Bryozoans, brachiopods, fish fragments	J. T. Dutro, Jr.
5	[2]AF491	68°15'18"	163°35'54"	M2477	Probably Late Jurassic	Ko	Pelecypods	D. L. Jones
6	[2]AE2421	68°10'02"	163°22'24"	M2484	Late Jurassic to Early Cretaceous	Ko	Pelecypods	D. L. Jones
7	[2]AF477	68°19'31"	163°15'48"	M2474	Early Cretaceous (Valanginian)	Ko_1	Pelecypods	D. L. Jones
8	[2]AF464	68°24'51"	163°27"06"	M2475	Probably Early Cretaceous	Ko_1?	Pelecypods	D. L. Jones

See footnote at end of table

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
9	[2]AF480	68°19'57"	163°17'54"	M2473	Early Cretaceous (Berriasian)	Ko_1	Pelecypods	D. L. Jones
10	[2]AF2422	68°09'50"	163°23'42"	M2483	Late Jurassic to Early Cretaceous	Ko	Pelecypods	D. L. Jones
11	[2]AF536	68°12'54"	163°51'06"	M2478	Early Cretaceous (Valanginian)	Kfo	Pelecypods	D. L. Jones
12	55ATr76 55ATr77	68°07'18"	163°13'54"	--	Early Mississippian	Mu_1	Corals, bryozoans, brachiopods	J. T. Dutro, Jr.
13	55ATr80	68°06'30"	163°15'10"	--	Late Mississippian	Mko_3	Corals brachiopods	J. T. Dutro, Jr.
14	63ATr225	68°18'30"	163°52'48"	--	Late Mississippian	$ℙMk_2$	Cephalopods	M. Gordon, Jr.
15	[3]26377	68°01'09"	163°12'18"	9150-SD	Devonian to Silurian	Dbl_3	Corals	W. A. Oliver, Jr.
16	[3]26378	68°00'18"	163°15'06"	9169-SD	Devonian to Silurian	Dbl_3	Corals	W. A. Oliver, Jr.

See footnotes at end of table.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangle--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
17	[3]26540	68°00'54"	163°14'30"	9170-SD	Devonian to Silurian	Dbl_3	Corals	W. A. Oliver, Jr.
18	79Cx127G	68°08'39"	163°38'36"	--	Early Mississippian [4]CAI=2½-3	Mk_4	Conodonts, crinoids, corals	A. G. Harris J. T. Dutro, Jr.
19	79Md86B	68°06'00"	163°36'20"	10167-SD	Late Devonian (Frasnian) [4]CAI=2½-3	Dbs_4	Conodonts	A. G. Harris
20	79Tr142	68°00'20"	163°15'18"	27595-PC	Late Mississippian (late Meramecian to Chesterian) [4]CAI=2½	Mko_3	Conodonts	A. G. Harris
20	79Tr142C	68°00'20	163°15'18"	--	Mississippian (Visean)	Mko_3	Foraminifera	B. L. Mamet
21	79Tr144	68°08'22"	163°25'54"	27596-PC	Early Mississippian (Kinderhookian) [4]CAI=2½-3	MD1	Conodonts	A. G. Harris

See footnotes at end of table.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangle--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
22	79Cx125H1	68°07'57"	163°38'42"	--	Early Pennsylvanian (early-middle Morrowan) [4]CAI=2½-3	ℙMn$_5$	Conodonts	A. G. Harris
23	79Md107C	68°24'26"	163°31'48"	--	Early Triassic (latest Spathian) [4]CAI=2	J₸o$_1$	Conodonts	B. R. Wardlaw
24	79Ek175C	68°06'06"	163°34'18"	27553-PC	Early Mississippian (late Kinderhookian) [4]CAI=3	Mul$_4$	Conodonts	A. G. Harris
25	79Ek180C	68°10'35"	163°34'28"	--	Middle Devonian to middle Mississippian (middle Osagian) [4]CAI=3	Muls$_4$	Conodonts	A. G. Harris
26	79Ek189C2	68°22'00"	163°22'15"	27555-PC	Middle to Late Mississippian (middle Osagian to middle Chesterian) [4]CAI=2½-3	ℙMk$_1$	Conodonts	A. G. Harris

See footnote at end of table.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4 and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
27	79Md115 E,F	68°10'36"	163°24'33"	10150-SD	Late Devonian (Famennian) [4]CAI=3	Dbl_4	Conodonts	A. G. Harris
28	79Md116B	68°10'15"	163°26'06"	--	Middle Devonian to Early Mississippian (middle Osagian) [4]CAI=3-4	Dbs_4	Conodonts	A. G. Harris
29	79Md146D	68°18'20"	163°19'27"	27556-PC	Late Mississippian (probably late Meramecian) [4]CAI=3	Mko_3	Conodonts	A. G. Harris
30	79Md171A	68°08'03"	163°41'30"	10151-SD	Latest Early to Middle Devonian [4]CAI=3	Dbs_4	Conodonts	A. G. Harris
31	79Md171D	68°07'49"	163°43'06"	27559-PC	Early Mississippian (late Kinderhookian) [4]CAI=2½-3	Mk_4	Conodonts	A. G. Harris

See footnote at end of table.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4 and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S collection number	Age	Map unit	Fossil type	Identified by
32	79Md180	68°06'15"	164°06'20"	27567-PC	Mississippian (late Osagian to early Chesterian) [4]CAI=1½-2	Mko_3	Conodonts	A. G. Harris
33	79Cx227-Om	68°07'45"	163°33'06"	--	Latest Devonian (late Famennian) to Late Mississippian (early Meramecian) [4]CAI=3-4	Mk_1	Conodonts	A. G. Harris
34	73ATr135.3	68°10'20"	163°12'36"	1138	Late Mississippian (Meramecian)	Mko_3	Foraminifera, corals, algae	A. K. Armstrong
35	73ATr137	68°00'45"	163°13'12"	1137	Mississippian (Osagian?)	Mko_3	Corals, foraminifera, algae	A. K. Armstrong
36	68ATr162	68°00'50"	163°12'42"	--	Late Mississippian (possibly late Meramecian)	Mko_3	Foraminifera	A. K. Armstrong

See footnote at end of table.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4 and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
37	26505	68°04'06"	163°12'36"	M1115	Mississippian	Mul$_1$	Foraminifera	A. K. Armstrong
38	79EK173D	68°07'28"	163°33'46"	--	Mississippian to Early Pennsylvanian	JPe$_1$	Radiolaria	B. L. Murchey
39	79Md162C	68°12'58"	163°43'48"	--	Mesozoic	TRPs$_2$	Radiolaria	B. L. Murchey
40	79Ek193C	68°24'22"	163°23'48"	--	Mesozoic	JTRo$_1$	Radiolaria	B. L. Murchey
41	79Ek193D	68°24'30"	163°23'24"	--	Mesozoic	JTRo$_1$	Radiolaria	B. L. Murchey
42	79Ek194D	68°25'22"	163°31'00"	--	Mesozoic	TRPs$_1$	Radiolaria	B. L. Murchey
43	79Cm0 to 79Cm13	68°06'42"	163°21'28"	--	Late Triassic (early to middle Karnian) at bottom of section; Early Jurassic (late Pliensbachian or Taorcian) at top	JTRo$_4$	Radiolaria	C. D. Blome

Table 3.--Selected fossils from De Long Mountains A3. B3. amd parts pf A4. amd B4 quadrangles--Continued

Map number	...Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
44	79Md122C	68°13'32"	163°20'40"	--	Late Mississippian (early late Visean) Mamet zones 14-15	$Mkoc_3$	Foraminifera	B. L. Mamet
45	79Ek179B	68°08'30"	163°33'20"	--	Late Mississippian (early late Visean) Mamet zones 14-15	PMn_5	Foraminifera	B. L. Mamet
45	79Ek179A 79Ek179C	68°08'30"	163°33'20"	28381-PC 28382-PC	[1]Probably Permian	PMn_5	Brachiopods	J. T. Dutro, Jr.
46	79Tr16A 79Tr16B	68°01'36"	163°14'48"	--	Late Mississippian (Visean) Mamet zone 11 or younger	Mko_3	Foraminifera	B. L. Mamet
47	79Tr24E2	68°03'36"	163°20'04"	--	Late Mississippian (Visean) Mamet zone 11 or younger	Mko	Foraminifera	B. L. Mamet
48	79Tr69A	68°07'06"	163°38'24"	--	Late Devonian	Dbl_4	Foraminifera	B. L. Mamet

See footnote at end of table

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
49	79Tr71A 79Tr71B 79Tr71C	68°11'10"	163°30'54"	--	Late Mississippian (middle Visean) approximately Mamet zone 12	Mko_3	Foraminifera	B. L. Mamet
50	79Tr95D 79Tr95E	68°11'18"	163°29'10"	--	Late Mississippian (middle Visean) approximately Mamet zone 12	Mul_3	Foraminifera	B. L. Mamet
51	79Tr104D	68°10'55"	163°12'24"	--	Late Mississippian (middle Visean) Mamet zone 12 or younger	Mko_3	Foraminifera	B. L. Mamet
52	79Tr105E	68°10'24"	163°12'06"	--	Latest Devonian to earliest Mississippian Mamet zone 6	MDl	Foraminifera	B. L. Mamet
53	79Tr119A	68°12'18"	163°13'30"	--	Mississippian (latest Tournaisian) Mamet zone 9 or younger	Mul_3	Foraminifera	B. L. Mamet

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
54	79Tr119B 79Tr119C	68°12'06"	163°13'36"	--	Late Mississippian (Visean) Mamet zone 12	Mu_3	Foraminifera	B. L. Mamet
55	79Tr119F	68°11'45"	163°12'54"	--	Late Mississippian (Visean) Mamet zone 12 or younger	Mul_3	Foraminifera	B. L. Mamet
56	79Tr122D 79Tr122F 79Tr122G	68°19'20"	163°17'06"	--	Late Mississippian (Visean) Mamet zone 11 or younger	Mko_2	Foraminifera	B. L. Mamet
57	79Tr126E	68°13'38"	163°27'36"	--	Late Mississippian (Visean) Mamet zones 14-15	$Mkoc_3$	Foraminifera	B. L. Mamet
58	79Tr127B	68°13'58"	163°26'22"	--	Late Mississippian (Visean) approximately Mamet zones 11-12	$Mugl_3$	Foraminifera	B. L. Mamet
59	79Tr128A	68°12'46"	163°25'17"	--	Late Mississippian (Visean) approximately Mamet zones 11-12	Mko_3	Foraminifera	B. L. Mamet

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
60	79Tr128B	68°12'46"	163°25'48"	--	Late Mississippian (Visean) approximately Mamet zones 11-12	Mu_3	Foraminifera	B. L. Mamet
61	79Tr129C	68°12'09"	163°27'57"	--	Late Mississippian (Visean) Mamet zone 12	$Mugl_3$	Foraminifera	B. L. Mamet
62	79Tr129D	68°12'15"	163°28'28"	--	Late Mississippian (Visean) Mamet zone 12	Mu_3	Foraminifera	B. L. Mamet
63	79Tr135B	68°11'38"	163°30'48"	--	Mississippian (Visean)	Mko_3	Foraminifera	B. L. Mamet
64	79Tr135C	68°11'42"	163°30'42"	--	Late Mississippian (Visean) approximately Mamet zone 12	Mko_3/ Mu_3 contact	Foraminifera	B. L. Mamet
65	79Tr135G	68°12'22"	163°30'47"	--	Late Mississippian (Visean) approximately Mamet zone 11	$Mugl_3$	Foraminifera	B. L. Mamet
66	79Tr148B	68°15'17"	163°33'10"	--	Mississippian (Visean)	Mko3	Foraminifera	B. L. Mamet

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
67	79Tr149A	68°09'31"	163°50'06"	--	Late Mississippian (Visean) Mamet zones 12-13	Mko_3/ Mul_3 contact	Foraminifera	B. L. Mamet
68	79Tr23	68°03'10"	163°20'42"	10471-SD	Middle Devonian	Dbl	Brachiopods	J. T. Dutro, Jr.
69	79Tr67A	68°07'02"	163°32'28"	10473-SD	Devonian?	Dbl_4	Corals	J. T. Dutro, Jr.
70	79Tr72E	68°10'33"	163°32'18"	28374-PC	Early Mississippian (probably Osagian)	$Muls_4$	Brachiopods	J. T. Dutro, Jr.
71	79Tr122G	68°19'21"	163°17'24"	28376-PC	Mississippian (late Osagian to early Meramecian	Mko_2/ Mu_2 contact	Bryozoans	J. T. Dutro, Jr.
71	79Tr122H	68°19'21"	163°17'24"	28377-PC	Mississippian (possibly Osagian)	Mu_2	Gastropods	J. T. Dutro, Jr.
72	79Ek174	68°05'47"	163°35'48"	10475-SD	Probably Devonian	Dbl	Corals	J. T. Dutro, Jr.

Table 3.--Selected fossils from De Long Mountains A3, B3, and parts of A4, and B4 quadrangles--Continued

Map number	Field number	Latitude	Longitude	U.S.G.S. collection number	Age	Map unit	Fossil type	Identified by
73	79Ek175E	68°05'33"	163°35'12"	10476-SD	Probably Middle Devonian (Givetian)	Dbl	Brachiopods	J. T. Dutro, Jr.
74	79Cx24B	68°09'06"	163°20'12"	28385-PC	Late Mississippian (late Meramecian to Chesterian)	Mko_3	Brachiopods	J. T. Dutro, Jr.
75	79Ek16C	68°01'45"	163°12'18"	10474-SD	Late Devonian (Famennian)	Dbl_3	Brachiopods, corals	J. T. Dutro, Jr.

[1]The Nuka Formation has fossil ages from brachiopods that are younger than those ages determined by conodonts foraminifers. See description of map units.

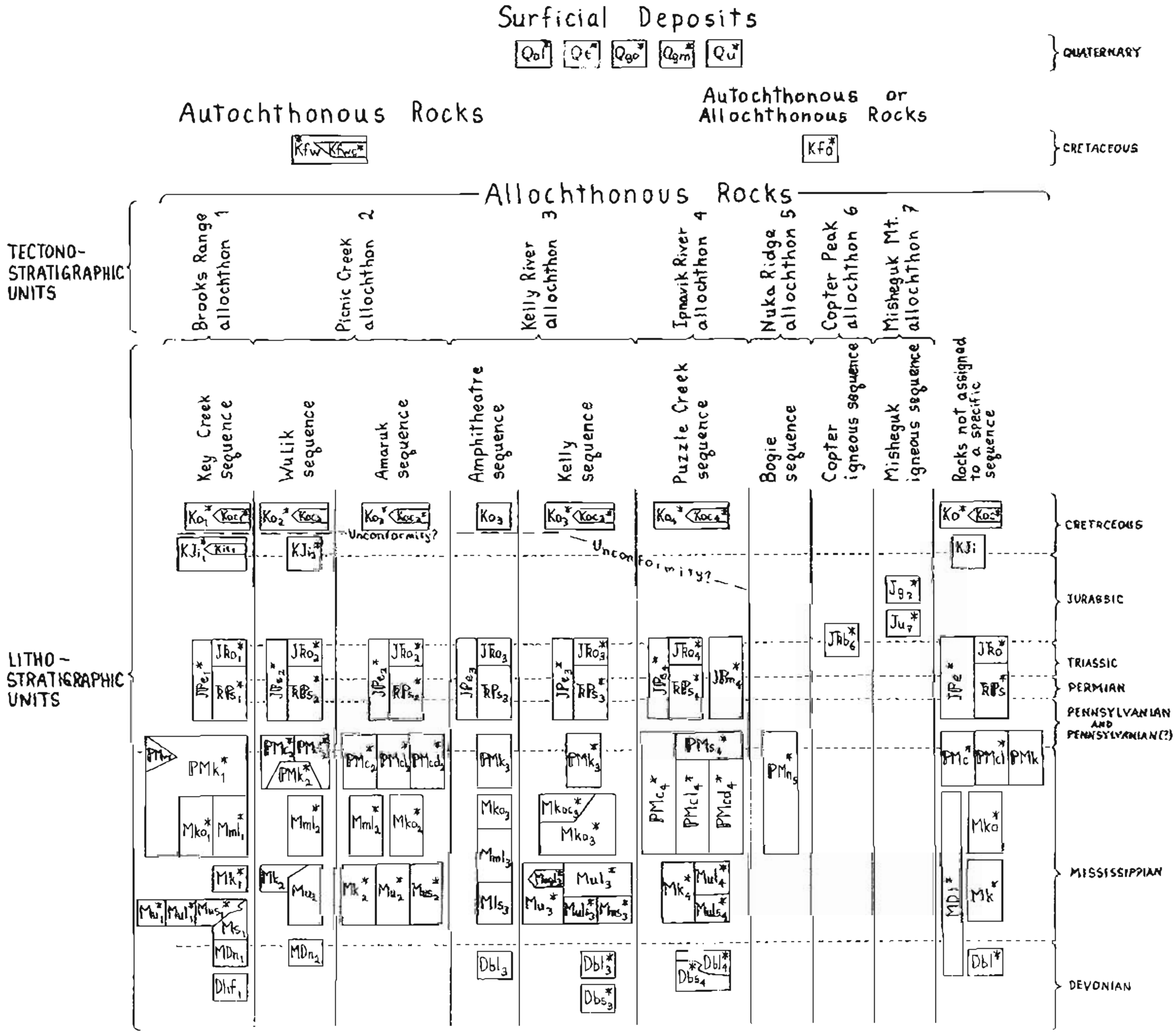
[2]Collected by geologists from British Petroleum Company.

[3]Collected by geologists from Standard Oil Company of California.

[4]Conodont color alteration index ((CAI) estimated maximum temperatures reached during diagenesis): CAI=1½-2 (50°-100°C); CAI=2 (60°-140°C); CAI=2½ (80°-15°C; CAI=2½-3 (100°-160°C); CAI=3 (120°-160°C); CAI=4 (120°-200°C)

CORRELATION OF MAP UNITS

(asterisks identify map units in the De Long Mountains A3, B3, and parts of A4, B4 quadrangles)



DESCRIPTION OF MAP UNITS IN THE DE LONG MOUNTAINS QUADRANGLE

(Asterisk identifies map units exposed in this map area)

Surficial Deposits

Qal* ACTIVE ALLUVIAL DEPOSITS (Quaternary)--Unconsolidated silt, sand, and gravel which is actively reworked during stream floods. Surfaces marked by sparse vegetation in most places

Qt* TERRACE DEPOSITS (Quaternary)--Inactive alluvial deposits composed of silt, sand, and gravel at or above present high water stage. Surface covered by stable vegetation

Qgo* GLACIAL OUTWASH DEPOSITS (Quaternary)

Qgm* GLACIAL MORAINE DEPOSITS (Quaternary)

Qu* SURFICIAL DEPOSITS, UNDIVIDED (Quaternary)--Includes alluvium, colluvium, lacustrine, and glacial deposits

Autochthonous Rocks

(Rocks which have undergone minor thrust displacement relative to the older rocks under them.)

FORTRESS MOUNTAIN FORMATION (Cretaceous)--Exposed in northern part of map in foothills of De Long Mountains. Variable thickness which is probably more than 1 km in some places at northern edge of map. Divided into:

Kfw* Wacke and mudstone member (Cretaceous)--Commonly more than 50 percent fine- to medium-grained wacke which is usually calcareous, well-bedded, and locally conglomeratic. Some wacke beds have numerous shale chips. Commonly weathers a medium- to light-brown color on hill slopes where some soil and rock fragments have encrustations of caliche. Contains Albian pelecypod, Inoceramus. Base rests on either Valanginian part of Ipewik Formation in northern part of map area or Okpikruak Formation in more southerly exposures.

Kfwc* Wacke and conglomerate member (Cretaceous)--Brown-weathering, gray and gray-green wacke and granule- to pebble-wacke conglomerate interbedded with subordinate siltstone and mudstone. Texturally and compositionally immature with clasts of quartz, limestone, chert, diabase, and shale. Mapped only at Mount Kelly, De Long Mountains B3 quadrangle

Autochthonous or Allochthonous Rocks

Kfo* FORTRESS MOUNTAIN AND OKPIKRUAK FORMATIONS, UNDIVIDED (Cretaceous)--Interbedded wacke and mudstone. Age based on Early Cretaceous palynomorphs and pelecypods

Allochthonous Rocks

Brooks Range allochthon

Key Creek sequence

Named for characteristic exposures along Key Creek (lat 68°8' N., long 162°29' W.), De Long Mountains A1 quadrangle. Letter symbols for map units in this sequence include the subscript number 1 to signify that they are part of the Brooks Range allochthon

Ko_1* OKPIKRUAK FORMATION (Cretaceous)--Interbedded gray mudstone and fine- to medium-grained wacke. Contains Early Cretaceous pelecypods Buchia Sublaevis and Buchia Okensis. Locally contains blocks of older rocks which are possible olistoliths from higher allochthons. Exposed thickness varies from 0 to more than 300 m. Depositional thickness is probably variable. In some areas base may be gradational into Ipewik Formation; in other areas it is an unconformity. Locally includes:

Koc_1* Conglomerate member (Cretaceous)--Wacke conglomerate with rounded boulders and pebbles that consist of chert, limestone, granite, dacite, diabase, and gabbro. Deposited sporadically with thickness that ranges from 0 to approximately 30 m

KJi_1* IPEWIK FORMATION (Cretaceous and Jurassic)--Maroon and gray shale, coquinoid limestone, siltstone, and clean quartz sandstone. Shale locally contains sparse well-rounded pebbles that consist of quartz, chert, gabbro, and granite. Shale contains local light-weathering clay beds (bentonite?), and at one location on a tributary of upper Kukpuk River (shown by a note on De Long Mountains B3 quadrangle), there are volcanic rocks of intermediate composition. Variable thickness from 0-50 m. Early Cretaceous pelecypod Buchia Sublaevis commonly occurs in limestone coquina beds and concretions in upper part. Basal contact appears to be conformable on Otuk Formation but fossil evidence does not preclude a disconformity. Locally includes:

Kit_1 Tingmerkpuk Member (Cretaceous)--Fine- to medium-grained clean quartz sandstone. Massive to thick-bedded. Locally interbedded with red shale that has concretions and shell beds with Early Cretaceous (Valanginian) pelecypod Buchia Sublaevis. Thickness approximately 0-50 m

$J\!P e_1$* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray chert with minor amounts of shale; weathers brown, yellow, gray, green, and maroon. Includes Siksikpuk and Otuk Formations. Contains Pennsylvanian to Triassic radiolarians; in upper part, Late Triassic pelecypod Monotis is common

JTRo$_1$* OTUK FORMATION (Jurassic and Triassic)--Light-gray to dark-gray chert with thin siliceous shale partings. Upper part weathers to cream-colored or light-brown and green bed surfaces and contains a few siliceous limestone beds that contain Late Triassic pelecypod *Monotis*. Middle part is well-bedded gray, brown, or dark-gray chert with rarely preserved Triassic pelecypod *Halobia* in shaly layers. Lower part, which is locally absent, is gray shale with a few carbonate beds that contain Early Triassic conodonts. Chert also contains numerous Mesozoic radiolarians. Top is probably Jurassic based on stratigraphic correlation with similar chert beds that contain identified radiolarians from Puzzle Creek sequence (De Long Mountains A3 quadrangle) and pelecypods from Howard Pass quadrangle (Mull and others, 1982). Depositional thickness is approximately 30-50 m. Base appears to be gradational into the Siksikpuk Formation

TRℙs$_1$* SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Gray chert and gray, olive-gray, and maroon siliceous shale. Middle part of unit is mostly shale which grades both up and down into well-bedded chert with thin siliceous shale partings. Mammillary bedding structures locally common especially near base. Bottom of section contains indefinitely dated Late Mississippian to Early Pennsylvanian radiolarians. Top of section is difficult to precisely determine in outcrop but appears to contain Mesozoic radiolarians. Depositional thickness is approximately 40-80 m. Base appears to be gradational into Kuna Formation, and in places the gradational zone contains yellow-weathering clay beds (bentonite?)

ℙMk$_1$* KUNA FORMATION (Pennsylvanian and Mississippian)--Black carbonaceous shale with subordinate interbedded black chert, except in top 10 m where chert predominates. Contains a few dark-gray, fine-grained limestone interbeds. There are a few beds of calcareous granule sandstone west of Wulik River. Shale surfaces commonly acquire a bluish-silver sheen on weathering. Lower part contains Osagian to Chesterian conodonts and probable early Meramecian brachiopods. Upper part contains Late Mississippian to Early or Middle Pennsylvanian radiolarians. Limestone contains rare corals. Depositional thickness is approximately 40-70 m. Basal contact is either sharp on Kogruk Formation or gradational into micritic limestone unit or Kayak Shale

ℙMv$_1$ INTERMEDIATE TO MAFIC VOLCANIC ROCKS (Pennsylvanian or Mississippian)--May include hypabyssal intrusive rock. Andesite or basalt composed of plagioclase, augite, biotite, apatite, and ilmenite(?) which is partly altered to chlorite, kaolinite, calcite, and leucoxene. Only found in small outcrops near Deadlock Mountain and east of middle part of Wulik River (De Long Mountains A2 quadrangle). In uncertain stratigraphic position but probably interfingers with upper part of the Kuna Formation

Mko$_1$* KOGRUK FORMATION (Mississippian)--Gray medium-grained limestone with up to 25 percent black chert nodules and lenses, locally dolomitic. Contains crinoids and brachiopods which have not been studied in detail. Middle to Late Mississippian age based on stratigraphic position between Kuna Formation and Kayak Shale. Outcrops appear to be discontinuous, with depositional thickness from 0-20 m. Base is gradational into Kayak Shale

Mml_1* MICRITIC LIMESTONE (Mississippian)--Dark-gray, light-weathering, thin-bedded limestone with subordinate interbedded black shale. Middle to Late Mississippian age based on stratigraphic position between Kuna Formation and Kayak Shale south of lower part of Puzzle Creek, De Long Mountains A3 quadrangle. Probably laterally gradational into Kogruk Formation. Depositional thickness is approximately 0-30 m. Base is gradational into Kayak Shale

Mk_1* KAYAK SHALE (Mississippian)--Black to dark-gray shale with interbedded rusty-weathering fossiliferous limestone and pyritic ironstone concretions. Locally contains a few siltstone and sandstone beds. Common fossils include probable Early Mississippian crinoids, brachiopods, bryozoa, and conodonts. Depositional thickness is approximately 10-40 m. Base is gradational into Utukok Formation

Mu_1* UTUKOK FORMATION (Mississippian)--Buff-weathering, light-gray coarse-grained limestone with interbedded clean, fine-grained quartz sandstone, siltstone, and shale. Locally contains numerous Early Mississippian crinoid, bryozoan, coral, and brachiopod fossils. Exposed only in De Long Mountains A1, A2, and A3 quadrangles. Intertongues with top of red-brown siltstone unit in De Long Mountains A1 quadrangle. Locally includes:

Mul_1* Limestone and shale member (Mississippian)--Consists of 75 percent buff-weathering limestone interbedded with 25 percent gray calcareous shale. Contains numerous Mississippian crinoid, brachiopod, gastropod,and coral fossils, and upper part has Late Mississippian foraminifers of Mamet zone 11 or younger. Exposed thickness of 100-300 m may be, in part, structurally repeated. Basal contact is not exposed

Mus_1* Sandstone member (Mississippian)--Buff-weathering, fine- to medium-grained clean quartz sandstone interbedded with sandy limestone and subordinate gray shale. Common fossils are crinoids and brachiopods which have not been studied in detail. Mapped only in De Long Mountains A1, A2, and A3 quadrangles. Exposed thickness is less than 40 m; basal contact is a thrust fault

Ms_1 RED-BROWN SILTSTONE (Mississippian)--Mostly reddish brown-weathering siltstone, locally calcareous, with subordinate amounts of sandstone and shale. Ironstone concretions are locally abundant in shaly intervals. Cross-beds and ripple marks are common features in sandy beds. Common fossils include crinoids, brachiopods, and gastropods, which have not been studied in detail. Contains Early Mississippian conodonts in equivalent beds in Noatak quadrangle (A. G. Harris, personal communication, 1982). Exposed thickness is 0-200 m. Base is gradational into light-brown-weathering, thicker-bedded Noatak Sandstone and Kanayut Conglomerate, undivided

MDn_1 NOATAK SANDSTONE AND KANAYUT CONGLOMERATE, UNDIVIDED (Mississippian and Devonian)--Mostly light-brown to reddish-brown-weathering, well-indurated, fine- to coarse-grained sandstone with interbeds of conglomerate, siltstone, and maroon or gray shale. Sandstone is locally calcareous. Exposed thickness is probably greater than 300 m. Base is gradational into Hunt Fork Shale

Dhf_1 HUNT FORK SHALE (Devonian)--Shale, slate, and phyllite with lesser amounts of interbedded siltstone and sandstone. Mapped only in southern part of De Long Mountains A1 and A2 quadrangles. Thickness is greater than 300 m. Base is not exposed in map area

Picnic Creek allochthon

Wulik sequence

Named for characteristic exposures along the tributaries of the upper part of the Wulik River (lat 68°21' N., long 163° W.), De Long Mountains B2 quadrangle. Letter symbols for map units in this sequence include the subscript number 2 to signify that they are part of the Picnic Creek allochthon. Location of the area where the Wulik sequence occurs relative to the Amaruk sequence is shown in figure 4.

Ko_2* OKPIKRUAK FORMATION (Cretaceous)--Interbedded brown-weathering, fine-to medium-grained wacke and gray mudstone. Contains Early Cretaceous pelecypod Buchia Sublaevis. Locally contains blocks of older rocks which are possible olistoliths from higher allochthons. Exposed thickness varies from 0 to more than 700 m. Depositional thickness is probably variable. In some areas base may be gradational into Ipewik Formation; in other areas, it is an unconformity. Locally includes:

Koc_2 Conglomerate member (Cretaceous)--Wacke conglomerate with rounded boulders and pebbles of chert, limestone, granite, dacite, diabase, and gabbro. Deposited sporadically with thickness from 0 to approximately 20 m

KJi_2* IPEWIK FORMATION (Cretaceous and Jurassic)--Maroon or gray shale. Depositional thickness is from 0-10 m. Basal contact appears to be conformable on Otuk Formation

$J\mathbb{P}e_2$* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray chert with minor amounts of shale; weathers to shades of brown, yellow, gray, green, and maroon. Includes Siksikpuk and Otuk Formations. Chert contains numerous late Paleozoic and Mesozoic radiolarians and upper part contains Late Triassic pelecypod Monotis

$J\overline{R}o_2$* OTUK FORMATION (Jurassic and Triassic)--Light-gray to dark-gray chert with thin siliceous shale partings. Upper part contains Triassic pelecypod Monotis, weathers to cream-colored or light-brown and green bed surfaces, and commonly contains a few carbonate beds. Chert contains Triassic radiolarians. Top is probably Jurassic based on stratigraphic correlation with similar chert beds that contain identified radiolarians from Puzzle Creek sequence (De Long Mountains A3 quadrangle) and pelecypods from Howard Pass quadrangle (Mull and others, 1982). Depositional thickness is approximately 30-50 m. Base is probably gradational into Siksikpuk Formation

$\overline{R}\mathbb{P}s_2$* SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Gray and maroon chert and siliceous shale. Chert contains radiolarians which have not been studied in detail in this sequence. Age based on stratigraphic correlation with this unit in Key Creek sequence. Depositional thickness is approximately 40-60 m. Basal contact appears to be sharp and conformable on black chert unit or black chert and limestone unit

IPMc$_2$* BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded black chert with a few siliceous black shale partings. Local white-weathering rind on bed surfaces. Chert contains radiolarians which have not been studied in detail. Age based on stratigraphic correlation with top of Kuna Formation in Key Creek sequence. Depositional thickness varies from 0-50 m. Basal contact is sharp on micritic limestone unit, or is gradational into Kuna Formation

IPMcl$_2$* BLACK CHERT AND LIMESTONE (Pennsylvanian? and Mississippian)--Approximately equal amounts of interbedded black chert and micritic limestone. Locally may have a few dolomitic beds. Sparse fossils in limestone include crinoids, bryozoa, and Late Mississippian brachiopods. Age of upper part based on stratigraphic correlation with black chert and limestone unit in the Amaruk sequence. Depositional thickness varies from 0-200 m. Base is gradational into Kuna Formation or micritic limestone unit

IPMk$_2$* KUNA FORMATION (Pennsylvanian? and Mississippian)--Black carbonaceous shale with subordinate black chert beds. Locally contains numerous thin beds of micritic limestone. Lower part contains middle Osagian conodonts and upper part contains indefinitely dated Late Mississippian to Early Pennsylvanian brachiopods and gastropods. Depositional thickness varies from 0-35 m. Base is gradational into micritic limestone unit or Kayak Shale

Mml$_2$* MICRITIC LIMESTONE (Mississippian)--Dark-gray, fine-grained limestone; weathers light-gray. Beds from 0.5-5 cm thick commonly weather flaggy to platy. Locally contains a few beds of medium-grained crinoidal limestone with black chert nodules that probably is a thin tongue of Kogruk Formation (not distinguished as a discrete map unit in this sequence). Contains Late Mississippian (Meramecian) foraminifers and indefinitely dated Late Osagian to Early Chesterian conodonts. Megafossils include Late Mississippian brachiopods. Depositional thickness varies from 0-80 m. Base is gradational into Kayak Shale or Utukok Formation

Mk$_2$ KAYAK SHALE (Mississippian)--Gray fissile shale with interbedded light-gray-to buff-weathering limestone and local rusty-weathering ironstone concretions. Local bioclastic limestone beds contain abundant crinoid buttons. Exposed thickness is 5-40 m and may be locally absent south of Inaccessible Ridge (De Long Mountains B1 quadrangle). Base is probably conformable on Utukok Formation

Mu$_2$ UTUKOK FORMATION (Mississippian)--Interbedded sandy limestone and calcareous sandstone. Contains crinoid and brachiopod fossils which have not been studied in detail. Early Mississippian age based on stratigraphic correlation with Utukok Formation in Amaruk and Kelly sequences. Stratigraphic relation to Kayak Shale is uncertain but is probably both laterally and vertically intergradational. Exposed thickness is approximately 30 m with a thrust fault at base south of Inaccessible Ridge (De Long Mountains B1 quadrangle). Locally absent at Anxiety Ridge (De Long Mountains A2 quadrangle)

MDn_2 NOATAK SANDSTONE (Mississippian and Devonian)--Calcareous, medium-brown to buff-weathering, well-indurated, fine- to medium-grained sandstone and siltstone. Contains a few ironstone concretions with abundant siltstone beds in upper part. Mapped only on Anxiety Ridge (De Long Mountains A2 quadrangle) and east of map area in Misheguk Mountain quadrangle (Curtis and others, 1982). Exposed thickness is about 50 m and base is not exposed

Picnic Creek allochthon

Amaruk sequence

Named for characteristic exposures along the upper tributaries of the Amaruk River (lat 68°14'30" N., long 162°38' W.), De Long Mountains B2 quadrangle. Letter symbols for map units in this sequence include the subscript number 2 to signify that they are part of the Picnic Creek allochthon. Location of the area where the Amaruk sequence occurs relative to the Wulik sequence is shown on figure 4.

Ko_2* OKPIKRUAK FORMATION (Cretaceous)--Interbedded gray-brown, fine- to medium-grained wacke and gray mudstone. Early Cretaceous age based on stratigraphic correlation with similar beds that contain the pelecypod *Buchia Sublaevis* in this unit in adjacent sequences. Locally contains blocks of older rocks which are possible olistoliths from higher allochthons. Exposed thickness varies from 0 to more than 1200 m. Depositional thickness is probably variable. Has a possible unconformity at base. Locally includes:

Koc_2* Conglomerate member (Cretaceous)--Wacke-matrix conglomerate with rounded boulders and pebbles of chert, limestone, granite, dacite, and diabase. Deposited sporadically with thickness that varies from 0 to approximately 20 m

$J\mathbb{P}e_2$* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray chert with minor amounts of shale; weathers to shades of brown, yellow, gray, green, and maroon. Includes Siksikpuk and Otuk Formations. Chert contains late Paleozoic and early Mesozoic radiolarians and, in upper part, Late Triassic pelecypod *Monotis*

$JTRo_2$* OTUK FORMATION (Jurassic and Triassic)--Light- to dark-gray chert with thin siliceous shale partings. Upper part contains cream-colored bed surfaces and Late Triassic pelecypod *Monotis*. Lower part, which is seldom exposed, is mostly shale with a few limestone beds that contain Early Triassic conodonts. Triassic radiolarians are common in chert. Top is probably Jurassic on basis of stratigraphic correlation with similar chert beds that contain identified radiolarians from Puzzle Creek sequence (De Long Mountains A3 quadrangle) and brachiopods and pelecypods from Howard Pass quadrangle (Mull and others, 1982). Depositional thickness is about 30-50 m. Base is probably gradational into Siksikpuk Formation

$TR\mathbb{P}s_2$* SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Olive-gray and maroon chert and siliceous shale. Chert contains radiolarians which have not been studied in detail in this sequence. Age based on stratigraphic correlation with this unit in Key Creek sequence. Depositional thickness is about 40-80 m. Basal contact is probably conformable on black chert unit, black chert and limestone unit, or black chert and dolomite unit

PMc_2* BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded black chert with a few black shale partings and less than 10 percent gray or brown-weathering carbonate beds. Probably laterally gradational into black chert and limestone unit or black chert and dolomite unit. Age based on stratigraphic correlation with black chert and limestone unit and Kuna Formation of Key Creek sequence. Depositional thickness is 0-60 m. Sharp basal contact on sandstone member of Utukok Formation

$PMcl_2$* BLACK CHERT AND LIMESTONE (Pennsylvanian and Mississippian)--Approximately equal amounts of interbedded black chert and fine-grained gray limestone. In some areas limestone beds are pervasively silicified. Limestone contains sparse crinoids and brachiopods. Top contains brachiopods of probable Pennsylvanian or Permian age near Mt. Raven (De Long Mountains A2 quadrangle). Lower part contains Late Mississippian corals and foraminifers. Laterally gradational into black chert unit and black chert and dolomite unit. Depositional thickness is about 70-200 m. Base is gradational into Kogruk Formation or sharp on Kayak Shale or Utukok Formation

$PMcd_2$* BLACK CHERT AND DOLOMITE (Pennsylvanian? and Mississippian)--Approximately equal amounts of interbedded black chert and fine-grained, gray- or brown-weathering dolomite. Laterally gradational into black chert unit and black chert and limestone unit. Depositional thickness is about 50-150 m. Base is either gradational into Kogruk Formation or is sharp on Utukok Formation and Kayak Shale

Mml_2* MICRITIC LIMESTONE (Mississippian)--Dark-gray, fine-grained limestone; weathers light-gray with flaggy to platy beds. Only exposure recognized in this sequence is northeast of Wulik Peaks (De Long Mountains B3 quadrangle). Exposed thickness varies from 0-10 m; depositional contact on Kayak Shale or Utukok Formation is not exposed but is inferred from a similar stratigraphic relationship in Wulik sequence

Mko_2* KOGRUK FORMATION (Mississippian)--Well-bedded, medium-grained limestone with less than 20 percent black nodular chert. Contains foraminifers of Mamet zone 11 or slightly younger. Base is middle Mississippian (late Osagian to early Meramecian) based on identification of bryozoans. Commonly contains crinoids. Depositional thickness varies from 0-20 m. Base is gradational into Utukok Formation

Mk_2* KAYAK SHALE (Mississippian)--Gray fissile shale with subordinate amounts of interbedded rusty or buff-weathering limestone. Common fossils include crinoids and brachiopods. Probably laterally gradational into Utukok Formation. Exposed thickness varies from about 0-30 m; basal contact is a thrust fault

Mu_2* UTUKOK FORMATION (Mississippian)--Approximately 60-70 percent buff-weathering limestone or sandy limestone and 30-40 percent interbedded shale. Contains Early Mississippian ostracodes and conodonts. Common megafossils are crinoids, brachiopods, and Early Mississippian gastropods. Probably laterally gradational into Kayak Shale. Exposed thickness is less than 30 m; basal contact is a thrust fault. Locally includes:

Mus_2* Sandstone member (Mississippian)--Buff-weathering, fine- to medium-grained clean quartz sandstone interbedded with sandy limestone and subordinate gray shale. Common fossils are crinoids and brachiopods which have not been studied in detail in this sequence. One locality in De Long Mountains A2 quadrangle has Early Mississippian foraminifers of Mamet zone 8 or older. Only mapped west of Wulik River in De Long Mountains A2, B2, and B3 quadrangles. Exposed thickness is less than 50 m; basal contact is a thrust fault

Kelly River allochthon

Amphitheatre sequence

Named for characteristic exposures around Amphitheatre Mountain (lat 68°19' N., long 162°34' W.), De Long Mountains B1 quadrangle. Letter symbols for map units in this sequence include the subscript number 3 to signify that they are part of the Kelly River allochthon. Location of the area where the Amphitheatre sequence occurs relative to the Kelly sequence is shown in figure 4.

Ko_3 OKPIKRUAK FORMATION (Cretaceous)--Interbedded fine- to medium-grained lithic wacke and mudstone. Early Cretaceous age based on regional stratigraphic correlations. Exposed thickness varies from 0 to more than 300 m. Depositional thickness is probably variable. Mapped west of upper Wrench Creek and in upper Kelly River drainage, De Long Mountains B1 and B2 quadrangles. Has a probable unconformity at base

JPe_3 ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray chert with minor amounts of shale; weathers to shades of brown, yellow, gray, green, and maroon. Includes Siksikpuk and Otuk Formations. Chert contains late Paleozoic radiolarians and in upper part, Late Triassic pelecypod <u>Monotis</u> in cream-colored beds

$J\mathrm{TR}o_3$ OTUK FORMATION (Jurassic and Triassic)--Gray to dark-gray, well-bedded chert with siliceous shale partings. Contains a few interbedded siliceous limestone beds near top. Weathers to brown, green, yellow, and cream-colored bed surfaces. Cream-colored zone near top contains Late Triassic pelecypod <u>Monotis</u>. Chert beds contain radiolarians. Top is probably Jurassic based on stratigraphic correlation with similar chert beds that contain identified radiolarians from Puzzle Creek sequence (De Long Mountains A3 quadrangle) and pelecypods from Howard Pass quadrangle (Mull and others, 1982). Depositional thickness is about 30-50 m. Base is probably gradational into Siksikpuk Formation

$\mathrm{TR}Ps_3$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Gray, radiolarian chert and gray, olive-gray, and maroon siliceous shale. Age based on stratigraphic correlation with this unit in other sequences. Depositional thickness is approximately 40-60 m. Basal contact is sharp and probably conformable on a thin tongue of Kuna Formation or Kogruk Formation

PMk_3 KUNA FORMATION (Pennsylvanian? and Mississippian)--Black, carbonaceous, calcareous shale with subordinate interbedded fine-grained limestone. Age based on stratigraphic correlation with Kuna Formation in structurally lower sequences. Poorly exposed; thickness varies from 0-15 m. Basal contact seems to be conformable on Kogruk Formation

Mko_3 KOGRUK FORMATION (Mississippian)--Light-gray-weathering, medium-grained limestone with up to 25 percent black chert nodules and lenses. Common fossils are Late Mississippian corals, crinoids, brachiopods, and foraminifers of Mamet zone 11 or younger (Armstrong and Mamet, 1977). Depositional thickness is greater than 600 m. Base is gradational into micritic limestone unit

Mml_3 MICRITIC LIMESTONE (Mississippian)--Gray to dark-gray, fine-grained limestone. Weathers light-gray to buff in color and platy to flaggy on talus slopes. Locally contains medium- to coarse-grained crinoidal limestone beds near top that resemble buff limestone member of Utukok Formation of Kelly sequence. Upper half locally contains Late Mississippian (probably early Meramecian) brachiopods, pelecypods, horn corals, and crinoids, and Late Mississippian foraminifers of Mamet zone 11 or younger. Exposed thickness is approximately 130-200 m; depositional contact on Baird Group limestone is not exposed and is inferred from regional stratigraphic relationships. Locally, lower part is mapped as:

Mls_3 Shale and micritic limestone member (Mississippian)--Mostly gray to black carbonaceous shale with from 20-40 percent interbedded micritic limestone. Probably laterally gradational into Utukok Formation of Kelly sequence

BAIRD GROUP--Consists of:

Dbl_3 LIMESTONE (Devonian)--Light-gray, medium- to coarse-grained. Occurs as isolated blocks along thrust faults at base of micritic limestone unit along upper part of Saksot Creek (De Long Mountains B1 quadrangle). Contains indefinitely dated Middle Devonian to Early Mississippian conodonts. Age based on correlation with similar limestone thrust slices at base of Kelly sequence that are Middle and Late Devonian in age. Exposed thickness is up to about 25 m; basal contact is a thrust fault

Kelly River allochthon

Kelly sequence

Named for characteristic exposures along the Kelly River (lat 68°16' N., long 162°15' W.), De Long Mountains B1 quadrangle. Letter symbols for map units in this sequence include the subscript number 3 in their map symbols to signify that they are part of the Kelly River allochthon. Location of the area where the Kelly sequence occurs relative to the Amphitheatre sequence is shown in figure 4.

Ko_3* OKPIKRUAK FORMATION (Cretaceous)--Interbedded fine- to medium-grained lithic wacke and mudstone with local wacke conglomerate. Contains Early Cretaceous pelecypods *Buchia Sublaevis* and *Buchia Crassicolis Solida* in this sequence east of the map area (Curtis and others, 1982). Locally contains blocks of older rocks which may be olistoliths from higher allochthons. Lower part may be Late Jurassic. Exposed thickness varies from 0-300 m. Depositional thickness is probably variable. Has a probable unconformity at base. Locally includes:

Koc_3* Conglomerate member (Cretaceous)--Wacke conglomerate with rounded cobbles and pebbles of chert, limestone, granite, and basalt. Deposited sporadically with thickness that varies from 0 to approximately 20 m

JPe_3* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, black, brown, or maroon, radiolarian chert with siliceous shale partings. Includes Siksikpuk and Otuk Formations

$JTRo_3$* OTUK FORMATION (Jurassic and Triassic)--Gray or maroon, well-bedded chert with siliceous shale partings. Cream-colored zone near top has a few limestone beds and contains Late Triassic pelecypod *Monotis*. Lower part of section has 5-m zone of black chert with shale partings that contain Middle or Late Triassic pelecypod *Halobia*. Chert contains Triassic radiolarians. Top is probably Jurassic based on stratigraphic correlation with similar chert beds that contain identified radiolarians from Puzzle Creek sequence (De Long Mountains A3 quadrangle) and pelecypods from Howard Pass quadrangle (Mull and others, 1982). Depositional thickness about 30-50 m. Base is gradational into Siksikpuk Formation

$TRPs_3$* SIKSIKSUK FORMATION (Triassic to Pennsylvanian)--Gray, olive-gray, and maroon radiolarian chert and siliceous shale. Age based on stratigraphic correlation with this unit in other sequences. Depositional thickness is approximately 10-40 m. Sharp basal contact, a possible disconformity, on cherty limestone member of Kogruk Formation or a thin discontinuous tongue of Kuna Formation

PMk_3* KUNA FORMATION (Pennsylvanian? and Mississippian)--Black chert and carbonaceous shale, thin and discontinuous. Mapped only at two small areas along east side of upper part of West Fork of Wulik River, De Long Mountains A3 quadrangle. Age based on stratigraphic correlation with the Kuna Formation in lower sequences. Exposed thickness is about 10 m

Mko_3* KOGRUK FORMATION (Mississippian)--Light-gray limestone which in most places has less than 25 percent black chert nodules and lenses. Locally contains subordinate thin zones of dark-gray, micritic carbonate with lenses of black chert. Common megafossils are middle and Late Mississippian corals, crinoids, and brachiopods. Conodont identifications range from Early Mississippian (possibly as old as late Osagian) to Late Mississippian (Chesterian) in age. Foraminifers are Late Mississippian, and range from approximately Mamet zone 11 or slightly younger to zones 14 or 15 (Armstrong and Mamet, 1977). Basal contact with Utukok Formation in Wulik Peaks area appears to be Mamet zone 12. Depositional thickness varies from about 200-600 m. Base is gradational into Utukok Formation. Locally, upper part mapped as:

$Mkoc_3$* Cherty limestone member (Mississippian)--Consists of medium-grained limestone with 25-50 percent black chert lenses and beds. Mapped only at top of the Kogruk Formation in Wulik Peaks area, De Long Mountains A3, A4, and B3 quadrangles. Probably grades laterally into Tupik Formation as mapped in Misheguk Mountain quadrangle (Curtis and others, 1982b, Sable and Dutro, 1961). Locally contains crinoids but otherwise is sparsely fossiliferous. Late Mississippian age (Mamet zones 14 to 15) based on collections of foraminifers from De Long Mountains A3 quadrangle. Depositional thickness is approximately 30-75 m. Base is gradational into less cherty limestone of the Kogruk Formation

Mu_3* UTUKOK FORMATION (Mississippian)--Buff-weathering limestone, sandy limestone, and fine-grained sandstone. Interbedded gray shale may comprise up to 50 percent in lower part west of Wulik River. Early Mississippian fossils are abundant and include brachiopods, corals, bryozoans, gastropods, crinoids, and pelecypods. Foraminifer ages range from Early Mississippian, Mamet zone 7 or slightly older, to Late Mississippian, approximately Mamet zone 12. Exposed thickness is up to about 1,000 m; depositional contact on limestone of the Baird Group is not exposed and is inferred from regional stratigraphic relationships. Locally, divided into:

$Mugl_3$* Light-gray limestone member (Mississippian)--Medium- to thick-bedded, medium-grained limestone mapped locally in Wulik Peaks area (De Long Mountains A3 and B3 quadrangles). Resembles Kogruk Formation but does not have black chert. Foraminifer ages are Mamet zones 11 or 12. Depositional thickness is approximately 20 m

Mul_3* Buff limestone member (Mississippian)--Buff-weathering limestone interbedded with subordinate sandy limestone and shale. Depositional thickness is about 200-500 m, and base is gradational into limestone and shale member or sandstone member

Mus_3* Sandstone member (Mississippian)--Interbedded buff-weathering, fine-grained sandstone, calcareous sandstone, sandy limestone and shale. Mostly mapped in De Long Mountains A1 and B1 quadrangles but also occurs at base of high ridge west of lower Amaruk River (De Long Mountains A4 quadrangle). Depositional thickness approximately 200-400 m. Basal contact is commonly a thrust fault

$Muls_3$* Limestone and shale member (Mississippian)--Approximately equal amounts of interbedded buff-limestone and gray silty shale. May contain a few calcareous sandstone beds. Only mapped west of Wulik River. Exposed thickness is approximately 200 m. Basal contact is not exposed

BAIRD GROUP--Divided into:

Dbl_3* LIMESTONE (Devonian)--Light-gray, medium- to coarse-grained. Occurs as isolated blocks along thrust faults at base of Utukok Formation in mountains east and west of Kelly River (De Long Mountains A1 and B1 quadrangles); also occurs near south edge of De Long Mountains A2 and A3 quadrangles. Contains indefinitely dated Silurian to Devonian corals and stromatoporoids, and Middle to Late Devonian brachiopods and conodonts. Exposed thickness is 0-70 m. Basal contact is a thrust fault

Dbs_3* LIMESTONE AND SHALE (Devonian)--Gray shale interbedded with light-gray- to buff-weathering limestone. Most limestone is fine-grained and weathers to platy and flaggy fragments. Shale is locally carbonaceous. Mapped only above a thrust fault on east side of Punupkahkroak Mountain, De Long Mountains A3 quadrangle. Age uncertain and based on lithologic similarity to shale and limestone unit in Puzzle Creek sequence

Ipnavik River allochthon

Puzzle Creek sequence

Named for characteristic exposures in the hills around the upper part of Puzzle Creek (lat 68°10' N., long 163°33' W.), De Long Mountains A3 quadrangle. Letter symbols for map units in this sequence include the subscript number 4 to signify that they are part of the Ipnavik River allochthon.

Ko$_4$* OKPIKRUAK FORMATION (Cretaceous)--Interbedded fine- to medium-grained lithic wacke and mudstone with local wacke conglomerate. Upper part is probably Early Cretaceous based on stratigraphic correlation with fossiliferous parts of the Okpikruak Formation in other sequences. Lower part may be Late Jurassic. Locally contains blocks of older rocks which are possible olistoliths from higher allochthons. Exposed thickness varies from 0 to more than 200 m. Depositional thickness is probably variable. Has a probable unconformity at base. Locally includes:

Koc$_4$* Conglomerate member (Cretaceous)--Wacke conglomerate with rounded to angular cobbles and pebbles that consist of chert, limestone, granite, and basalt. Deposited sporadically with thickness that varies from 0 to approximately 50 m

Jℙe$_4$* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, black, brown, and maroon, radiolarian chert with siliceous shale partings. Includes Siksikpuk and Otuk Formations.

JTRo$_4$* OTUK FORMATION (Jurassic and Triassic)--Light- to dark-gray chert with thin siliceous shale partings. Upper part has cream-colored rind on bed surfaces and Late Triassic pelecypod *Monotis*. Radiolarians range from Triassic to as young as Early Jurassic (Toarcian to late Pliensbachian). Depositional thickness is approximately 30-50 m. Base is gradational into Siksikpuk Formation

TRℙs$_4$* SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Olive-gray and maroon, radiolarian chert and siliceous shale. Age based on stratigraphic correlation with this unit in other sequences. Exposed thickness varies from about 20-60 m. Base is probably conformable on black chert unit, black chert and limestone unit, or black chert and dolomite unit

Jℙm$_4$* MAFIC SILLS AND DIKES (Jurassic to Pennsylvanian)--Mostly consists of diabase composed of plagioclase and augite. Intrudes black chert and Baird Group limestone in southern part of DeLong Mountains A3 quadrangle

ℙMc$_4$* BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded, black chert with a few black shale partings and less than 10 percent gray- or brown-weathering carbonate beds. Probably vertically and laterally gradational into black chert and limestone unit, black chert and dolomite unit, or black shale unit. Age based on stratigraphic correlation with black chert and black chert and limestone units in Nachralik Pass and Ipnavik sequences in south-central Misheguk Mountain quadrangle (Ellersieck and others, 1982) which contain indefinitely dated Late Mississippian to Pennsylvanian radiolarians and Late Mississippian foraminifers. Depositional thickness varies from 0 to approximately 70 m. Base is gradational into black chert and limestone unit on Punupkahkroak Mountain (De Long Mountains A3 quadrangle)

ℙMs$_4$* BLACK SHALE (Pennsylvanian? and Mississippian)--Black carbonaceous shale with a few interbedded black siliceous shale, chert, and thin, fine-grained, dark-gray limestone or dolomite beds. Local small calcareous concretions. Probably laterally gradational into black chert unit. Depositional thickness is approximately 0 to 10 m and is locally thickened by folding. Base is gradational into black chert and limestone unit or black chert and dolomite unit

ℙMcl$_4$* BLACK CHERT AND LIMESTONE (Pennsylvanian? and Mississippian)--Approximately equal amounts of interbedded black chert and fine-grained limestone. Probably laterally gradational into black chert and black chert and dolomite unit. Maximum exposed thickness is about 70 m. Sharp basal contact on Kayak Shale

ℙMcd$_4$* BLACK CHERT AND DOLOMITE (Pennsylvanian? and Mississippian)--Approximately equal amounts of interbedded black chert and gray or brown-weathering dolomite. Probably laterally gradational into black chert and black chert and limestone units. Maximum exposed thickness is approximately 100 m. Sharp basal contact with either Kayak Shale or buff limestone member of Utukok Formation

Mk$_4$* KAYAK SHALE (Mississippian)--Black fissile shale with interbedded orange-weathering limestone, siltstone, and ironstone concretions. Probably interfingers with Utukok Formation. Limestone contains Early Mississippian corals and conodonts. Maximum exposed thickness is about 30 m; depositional contact on Baird Group limestone is not exposed but is inferred from regional stratigraphic relationships

UTUKOK FORMATION--Divided into:

Mul$_4$* Buff limestone member (Mississippian)--Predominately limestone with a few interlayered sandstone beds. Contains Early Mississippian conodonts. Thickness is about 100 m. Base is gradational into limestone and shale member

Muls$_4$* Limestone and shale member (Mississippian)--Interbedded buff-weathering silty limestone and gray shale. Probably laterally gradational into Kayak Shale. Contains Early Mississippian (probably Osagian) brachiopods. Exposed thickness is about 100 m; depositional contact on Baird Group limestone is not exposed but is inferred from regional stratigraphic relationships

BAIRD GROUP--Divided into:

Dbl$_4$* LIMESTONE (Devonian)--Massive- to thin-bedded, light-gray medium- to coarse-grained; weathers blocky to flaggy. Sparse fossils include stromatoporoids, corals, and Late Devonian (Famennian) conodonts. Seems to overlie or, in part, interfinger with shale and limestone unit. Maximum exposed thickness is up to about 200 m. Basal contact is commonly a thrust fault

Dbs_4* SHALE AND LIMESTONE (Devonian)--Interbedded light silvery-gray shale and light-gray limestone. Locally has a few thin sandstone beds. Limestone is mostly fine-grained and weathers light-gray with flaggy to platy beds, but locally may be medium-grained and weathers buff-colored and medium-bedded. Shale is commonly well-indurated and in some places has slaty cleavage. Youngest conodont age is Late Devonian (Frasnian), and oldest age is Early to Middle Devonian. Megafossils include brachiopods and crinoids which have not been studied in detail. Maximum exposed thickness is up to about 500 m; basal contact is a thrust fault

Nuka Ridge allochthon

Bogie sequence

Named for characteristic exposures along upper Bogie Creek and Nuka Ridge (lat 68°38' N., long 159°15' W.), Misheguk Mountain quadrangle. Letter symbols for the map unit in this sequence include the subscript number 5 to signify that it is part of the Nuka Ridge allochthon. The position of outcrops of this sequence leads us to believe that some, if not all, of the mapped occurrences are olistoliths and are at a lower structural level than most other occurrences of the Nuka Ridge allochthon in the western Brooks Range.

PMn_5* NUKA FORMATION (Pennsylvanian? and Mississippian)--Light-gray- to buff-weathering, coarse-grained arkose, limestone, arkosic limestone, and glauconitic calcareous sandstone. Mapped at three small isolated occurrences: one in the stream bed of Puzzle Creek, another about 4 km to the west (De Long Mountains A3 quadrangle), and the third along Olistopuk Creek (De Long Mountains B3 quadrangle). Each occurrence is associated with Cretaceous conglomerate and may be an olistolith. Locally contains Early Pennsylvanian conodonts, and Late Mississippian foraminifers. Megafossils include brachiopods of possible Permian age. The upper part of the Nuka has previously been dated on the basis of brachiopod identifications as Permian in age (Tailleur and others, 1973). However, recent collections of conodonts from the top beds at Nuka Ridge (east of map area) indicate its age is not older than Early Pennsylvanian (A.G. Harris, written commun., 1982). Late Mississippian foraminifers and conodonts occur in the Nuka from a wide area of the western Brooks Range. The age of the Nuka is therefore considered to be Early Pennsylvanian(?) and Late Mississippian

Copter Peak allochthon

Copter igneous sequence

Named for characteristic exposures at Copter Peak (lat 68°30' N., long 161°18' W.), Misheguk Mountain quadrangle. Letter symbols for the map unit in this sequence include the subscript number 6 to signify that they are part of the Copter Peak allochthon.

$J\bar{R}b_6$* BASALT (Jurassic? and Triassic)--Locally has pillow structures. Poorly exposed in southern part of De Long Mountains A3 and A4 quadrangles. Basal contact is a thrust fault. Triassic age based on lithologic correlation with similar rocks in Misheguk Mountain quadrangle that contain intercalated Triassic chert that has been dated by radiolarian fossils. Jurassic(?) age is based on the possibility that gabbroic rocks of Jurassic age, similar to those exposed in the Misheguk igneous sequence, may have been the source for some of the basalt

Misheguk Mountain allochthon

Misheguk igneous sequence

Named for characteristic exposures at Misheguk Mountain (lat 68°15' N., long 161°5' W.), Misheguk Mountain quadrangle. Letter symbols for map units in this sequence include the subscript number 7 to signify that they are part of the Misheguk Mountain allochthon.

Jg_7* GABBRO (Jurassic)--Medium- to coarse-grained. Predominant minerals are plagioclase, clinopyroxene, orthopyroxene, hornblende, and olivine. Locally banded with plagioclase- and pyroxene-rich layers, and locally includes small dikes of peridotite, pyroxenite, and hornblende-plagioclase pegmatite. Age based on potassium-argon dates on hornblende from similar rocks in Misheguk Mountain quadrangle (Patton, and others, 1977). Mapped only in southeast part of De Long Mountains A1 quadrangle and southern part of De Long Mountains A4 quadrangle

Ju_7* ULTRAMAFIC ROCKS (Jurassic)--Predominantly orange-weathering peridotite and partly serpentinized dunite with minor amounts of pyroxenite in small dikes. Basal contact is a thrust fault. Mapped only in De Long Mountains A1 and A4 quadrangles

Rocks not assigned to a specific thrust sequence

Ko* OKPIKRUAK FORMATION (Cretaceous)--Greenish-gray, lithic wacke and gray mudstone. Contains Early Cretaceous pelecypod <u>Buchia</u>. In some areas where this unit was deposited upon Kelly or Puzzle Creek sequences lower part may be Late Jurassic. Locally includes:

Koc* Conglomerate member (Cretaceous)--Wacke conglomerate with rounded cobbles and pebbles that consist of chert, limestone, granite and mafic igneous rocks

KJi IPEWIK FORMATION (Cretaceous and Jurassic)--Thin-bedded maroon or gray shale. Depositional thickness varies from 0-10 m. Mapped at mountain front east of upper Saksot Creek and along upper Kelly River (De Long Mountains B1 quadrangle). Base appears to be conformable on Otuk Formation

JPe* ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, radiolarian chert with siliceous shale partings. Includes Siksikpuk and Otuk Formations

JTRo* OTUK FORMATION (Jurassic and Triassic)--Light-gray to dark-gray, radiolarian chert with thin siliceous shale partings. Upper part weathers to cream-colored or light-brown and green bed surfaces

TRPs* SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon and gray radiolarian chert and siliceous shale. Chert contains radiolarians

PMc* BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded black radiolarian chert with a few black siliceous shale partings

PMcl* BLACK CHERT AND LIMESTONE (Pennsylvanian? and Mississippian)--Occurs as isolated olistoliths(?) and (or) thrust slices in Okpikruak Formation in De Long Mountains A3 and B2 quadrangles

PMk KUNA FORMATION (Pennsylvanian and Mississippian)--Black carbonaceous shale and subordinate black chert. Contains a few thin, fine-grained limestone beds. Age is based on correlation with Kuna Formation in Key Creek sequence. Contains Late Mississippian foraminifers and pelecypods on north side of Inaccessible Ridge (De Long Mountains B1 quadrangle)

Mko* KOGRUK FORMATION (Mississippian)--Light-gray limestone with black chert nodules and lenses. Crops out as a thrust block on west edge of Avan ultramafic complex (De Long Mountains A1 quadrangle) and as olistoliths in Okpikruak Formation (De Long Mountains A3 and B2 quadrangles)

Mk* KAYAK SHALE (Mississippian)--Dark-gray shale with a few interbeds of rusty-weathering limestone and ironstone concretions. Occurs in small isolated outcrops on west edge of Avan ultramafic complex (De Long Mountains A1 quadrangle) and north of Punupkahkroak Mountain (De Long Mountains A3 quadrangle)

MDl* LIMESTONE WITH UNCERTAIN STRATIGRAPHIC AFFINITIES (Mississippian or Devonian)--Light-gray-weathering, medium- to thick-bedded limestone. Locally includes a few dark-gray chert nodules. Outcrops may be thrust slivers and (or) olistoliths. May locally include parts of the Kogruk Formation or Limestone of the Baird Group

BAIRD GROUP--Consists of:

Dbl* LIMESTONE (Devonian)--Massive- to thick-bedded, light-gray. Age based on lithologic correlation with nearby Devonian limestone. Crops out southeast and northwest of lower part of Wulik River, De Long Mountains A3 quadrangle. Thrust slivers and (or) olistoliths locally may belong to Kelly, Puzzle Creek, Bogie, or Bastille (Curtis and others, 1982; Ellersieck and others, 1982) sequences. Large thrust sheets made up of this unit on mountain tops in southern part of De Long A2 and A3 quadrangles probably belong to Ipnavik River or Nuka Ridge allochthons. Exposed thickness is up to 200 m

Explanation of map symbols

CONTACT--Dashed where approximately located; queried where doubtful

HIGH-ANGLE FAULT--Dotted where concealed; queried where extension of fault is doubtful

THRUST FAULT BETWEEN ALLOCHTHONS (intersequence thrust fault)--Dashed were approximately located; dotted where concealed; sawteeth on upper plate; queried where extension of fault is doubtful; queried and dashed where existence of fault is doubtful. Half arrows show relative motion on cross section. Where thrust faults can be inferred to occur near outcrop boundaries a thrust fault symbol is shown next to Quaternary sediments. In such cases the bedrock is not thrust over the Quaternary deposits but is thrust over bedrock that occurs under a thin cover of unconsolidated sediment

THRUST FAULT WITHIN AN ALLOCHTHON (intrasequence thrust fault)--Dashed where approximately located; dotted where concealed; sawteeth on upper plate; queried where extension of fault is doubtful; queried and dashed where existence of fault is doubtful

ANTICLINE--Showing trace of axial plane and plunge of axis; dashed where approximately located

OVERTURNED ANTICLINE--Showing trace of axial plane and plunge of axis; dashed where approximately located

SYNCLINE--Showing trace of axial plane and plunge of axis; dashed where approximately located

OVERTURNED SYNCLINE--Showing trace of axial plane and plunge of axis; dashed where approximately located

STRIKE AND DIP OF BEDS OR LAYERS:

- Horizontal
- Inclined
- Approximate inclined
- Vertical
- Overturned
- Layers in igneous rocks

QUERIED OUTCROPS--Plotted from aerial photographs and not investigated in the field

FOSSIL LOCATIONS--Listed on table 3

Zinc-lead-silver prospects

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