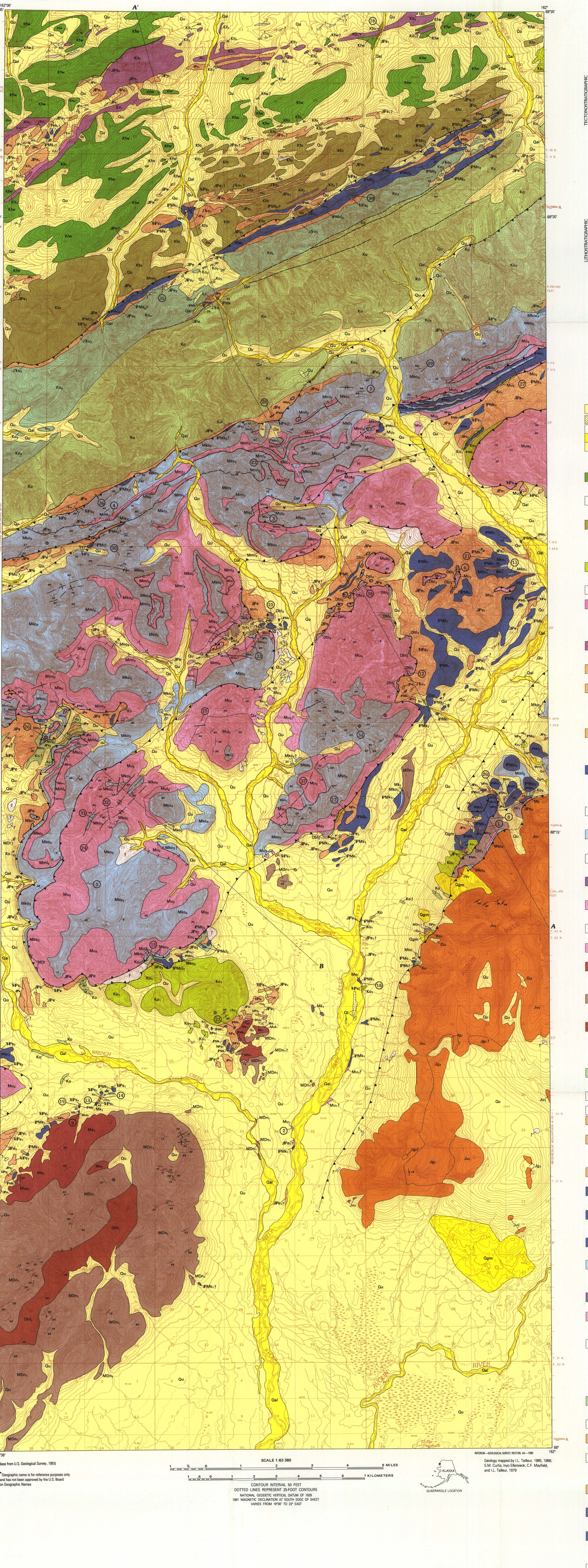

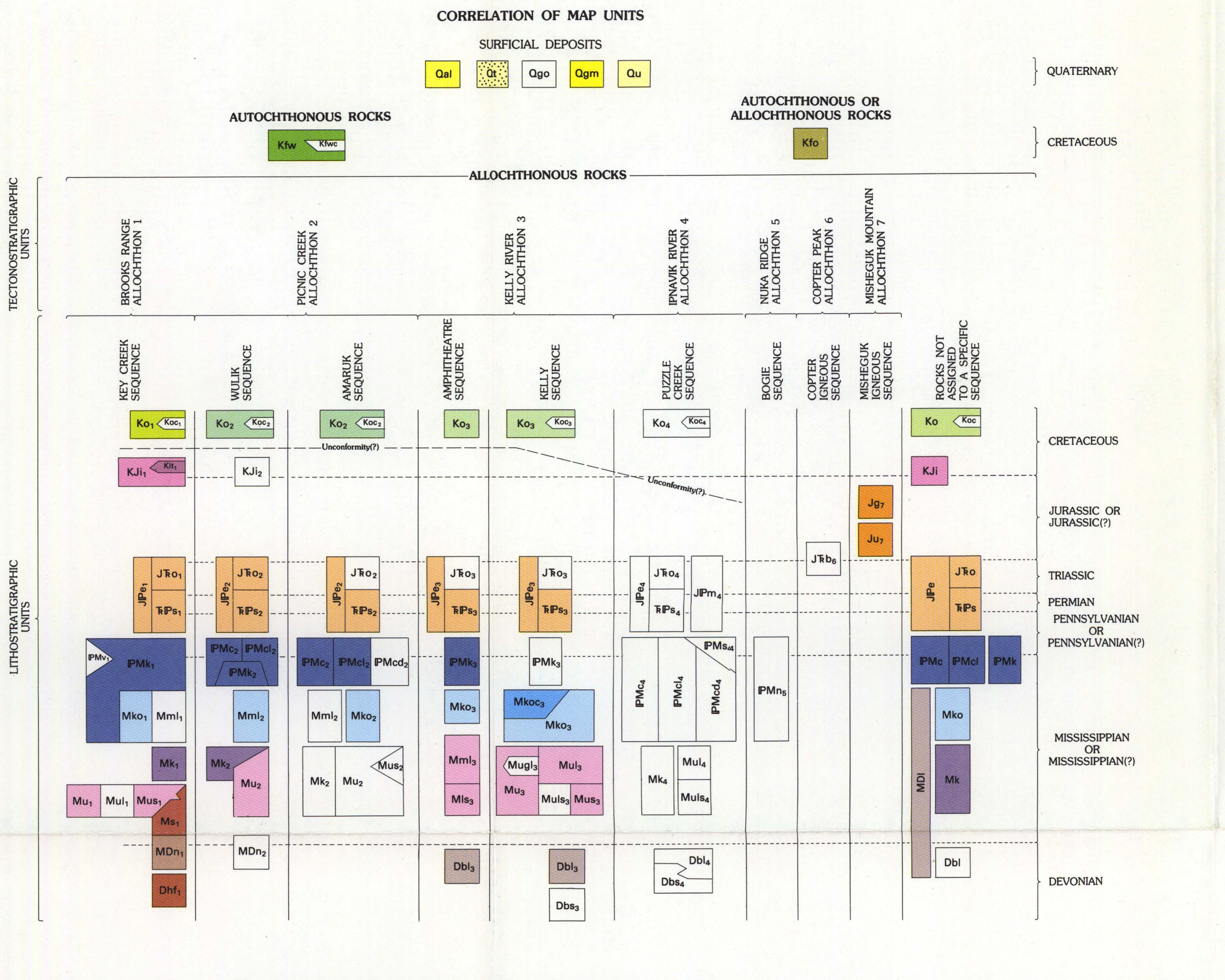

INTRODUCTION

This map is one of a series of three reconnaissance geologic maps of the southern De Long Mountains 1:250,000-scale quadrangle (fig. 1). Because the geology in all 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. Some rock units and allochthons do not occur on all three maps; therefore, the explanation contains more rock units than occur on any one map. In the description of map units and on the correlation chart, only the allochthons and rock units that appear on this map are colored.

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 of 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 north relative to the 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 that 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 both named sequences and allochthons (fig. 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, some previous reports use terms such as "thrust tectonic unit," "structural sequence," or "thrust sequence" for both lithostratigraphic and tectonostratigraphic units. Comparison of the named allochthons in this map with analogous terminology used in other reports is shown in table 1.

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 containing different sequences are mapped as "intersequence thrust faults," and thrust faults that separate thrust sheets containing the same sequence are mapped as "intrasequence thrust faults."

Thrust sheets containing a given sequence almost always occur in the same structural position relative to thrust sheets containing a different sequence. This observation has permitted us to construct the generalized model of the relations between the various allochthons and sequences (fig. 2). This model shows the relative structural positions of the allochthons and the sequence or sequences of rocks within each allochthon. Post-orogenic erosion removed large parts of the upper allochthons from the area, and some were probably never continuous across the quadrangle. The allochthons are usually made up of many large lens-shaped bodies or folded sheets a few hundred meters to tens of kilometers across and 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 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 adjacent to each other 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 adjacent to each other, and only a small amount of thrust juxtaposition is inferred between them (see fig. 3 for location of sequences and allochthons).

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 lithology that can be used by itself to distinguish a particular sedimentary sequence. The most distinctive lithologic differences between sequences are usually found in middle and Upper Mississippian rocks. However, lithologic differences in this interval are not great enough to distinguish all sedimentary sequences. Thus, identification of some sequences also may require comparison of the lithologies of the Upper Devonian and (or) older Mississippian rocks that underlie each particular set of Upper Mississippian lithologies.

Upper Mississippian (and Lower 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 wacke and mudstone of the Lower Cretaceous Okpikruak Formation. Generally, we have not seen enough systematic 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.

UNCERTAIN RELATIONS BETWEEN ALLOCHTHONS AND SEQUENCES

A belt of the Okpikruak Formation stretches from the Wulik River to the eastern edge of the De Long Mountains quadrangle through Sheep Mountain (De Long Mountains B–2 quadrangle) and the headwaters of the Kelly River (De Long Mountains B–1 quadrangle). Bordering this large expanse of the Okpikruak Formation are outcrops of the Key Creek, Wulik, Amaruk, Amphitheatre, and Kelly sequences. Because we are not able to determine to which sequence the Okpikruak Formation belongs on the basis of its lithology, 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 sedimentary rocks. These uncertainties permit several interpretations of the structure along the carbonate front north of Inaccessible Ridge and its southwestern extension (De Long Mountains B–1 and B–2 quadrangles) and under the Sheep Mountain trend of the Okpikruak Formation.

Some of the thrust sheets mapped as part of the Picnic Creek allochthon may instead belong to a sequence associated with the Brooks Range allochthon. These rocks were assigned to the Amaruk and Wulik sequences on the basis of Carboniferous strata that are similar to black bedded chert and cherty limestones in the Amaruk and Wulik sequences. However, there is structural and stratigraphic evidence that these rocks may be structurally beneath the Key Creek sequence (Moore and others, 1986). Moore and others name these rocks the Wolverine Creek allochthon and suggest a correlation with the Ivotuk sequence of the Brooks Range allochthon (Mayfield and others, 1983).

The upper part of the carbonate rocks near Mount Raven (De Long Mountains A–2 quadrangle) contains post-Mississippian brachiopods (fossil loc. 50, De Long Mountains B–2 quadrangle), which are distinctly younger than any known carbonate rocks elsewhere in the Picnic Creek allochthon. The Otuk Formation, which is stratigraphically above the Carboniferous cherty limestones at Mount Raven, contains a shale member and an upper limey chert member that are more commonly developed in sequences in the Brooks Range allochthon than in other, structurally higher, allochthons. This combination of characteristics suggests that the thrust sheets near Mount Raven are stratigraphically unlike the rest of the Amaruk sequence, and may instead be part of the Wolverine Creek allochthon of Moore and others, 1986.

On the Wulik River near where it crosses the western boundary of the De Long Mountains A–2 quadrangle, a thrust fault is shown dipping north, thrusting Carboniferous limestone and chert ($\mathbb{P}Mcl_2$) over the Etivluk Group and Okpikruak Formation on the south side of the fault. This contact may instead be a partially disrupted normal stratigraphic contact dipping south, putting unit $\mathbb{P}Mcl_2$ structurally beneath, rather than above, the Key Creek sequence. If that is the case, there should be another, unmapped south-dipping intersequence fault between the Wulik River and Ikalukrok Creek that brings the Key Creek sequence over the plate containing unit $\mathbb{P}Mcl_2$. The unit $\mathbb{P}Mcl_2$ in this plate would belong to the Wolverine Creek allochthon instead of belonging to the Picnic Creek allochthon.

In the north fork of Ferric Creek (De Long Mountains A–3 quadrangle), Carboniferous chert and limestone ($\mathbb{P}Mcl_2$) in the thrust sheet discussed above are mapped as thrust over micritic limestone (Mml_1) and Kuna Formation ($\mathbb{P}mk_1$) of the Key Creek sequence on the west. This may instead be a thrust fault dipping west, extending down Ferric Creek to the east side of the Ferric Creek prospect.

Spiny Ridge (De Long Mountains B–4 quadrangle) is another area where the rocks may belong to either the Picnic Creek allochthon or to a local facies within the Brooks Range allochthon. The rocks at Spiny Ridge were differentiated from the Key Creek sequence because they include Carboniferous chert and limestone ($\mathbb{P}Mcl_2$) and bedded black chert ($\mathbb{P}Mc_2$) similar to the stratigraphic sequence at Wulik Knot (De Long Mountains B–2 quadrangle), whereas the Mississippian strata of the Key Creek sequence exposed in the Sooner River area (De Long Mountains B–3 quadrangle) east of Spiny Ridge consists entirely of the shaly Kuna Formation ($\mathbb{P}Mk_1$). Cross section *C–C′*, De Long Mountains A–4 and B–4 quadrangles, does not attempt to interpret the structural relation of Spiny Ridge to the Amaruk and Key Creek sequences that are exposed on the northwestern side of the Wulik Peaks south of Spiny Ridge.

The Wulik sequence is differentiated from the Key Creek sequence mainly because of fine-grained Mississippian carbonate rocks that are well exposed in the Wulik Knot (De Long Mountains B–2 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 B–1 and C–1 quadrangles. In this direction the micritic limestone unit (Mml_2) of the Wulik sequence becomes thin and discontinuous, and the black chert and limestone unit ($\mathbb{P}Mcl_2$) becomes more carbonaceous and shaly, approaching the lithology of the Kuna Formation. The geologic map of the southwestern Misheguk Mountain quadrangle (Curtis and others, 1984) interprets the rocks along strike to the northeast as belonging to the Key Creek sequence of the Brooks Range allochthon. We are not sure whether this reflects a misinterpretation of the rocks in the Misheguk Mountain quadrangle, a facies change within the Wulik sequence, or additional structural complications.

Anxiety Ridge (De Long Moutains A–2 quadrangle) is an anticline locally overturned to the north. It was assigned to the Wulik sequence because it contains the combination of fine-grained black chert and limestone ($\mathbb{P}Mcl_2$) and the Kuna Formation ($\mathbb{P}Mk_2$), similar to some of the thrust sheets in the Wulik Knot. It is possible that the rocks of Anxiety Ridge may have been deposited close to the rocks belonging to the Wolverine Creek allochthon mentioned above, rather than with rocks of the Wulik sequence. Two structural interpretations, dependent upon whether Anxiety Ridge belongs to the Wulik sequence of the Picnic Creek allochthon, or to the Wolverine Creek allochthon, are shown on cross section *B–B′* for the De Long Mountains A–2 map. One possibility is that Anxiety Ridge is part of the Picnic Creek allochthon that was first thrust over the Brooks Range allochthon that lies immediately north of Anxiety Ridge, and then later was overridden from the south by a thrust sheet from the Brooks Range allochthon that contains sandstones of the Endicott Group. The thrust sheets of the Endicott Group are best exposed in the Noatak quadrangle immediately south of the map area. Another possibility, shown in the alternative part of cross section *B–B′*, is that Anxiety Ridge could be a thrust sheet within the Brooks Range allochthon that extends down dip to the north and underlies the Key Creek sequence rocks exposed near the Red Dog zinc-lead-silver deposit.

The Nuka Ridge allochthon is represented by only three isolated outcrops of the Nuka Formation, one north and the other two south of the Wulik Peaks (De Long Mountains A–3 and B–3 quadrangles, figs. 1 and 3). Some or all of these outcrops may be olistoliths because they are small, islolated from other Paleozoic sedimentary rocks, and largely surrounded by Cretaceous wacke and conglomerate that may have been deposited on lower sequences. If these exposures of Nuka Formation are olistoliths, they slid into a Cretaceous basin on structurally lower thrust sheets from a thrust sheet of Nuka Formation that once overlaid part of the southern De Long Mountains quadrangle. The Nuka Ridge allochthon is exposed in the Noatak quadrangle, south of the map area, in its normal structural position above the Ipnavik River allochthon.

We believe that the previously accepted Permian age for the upper part of the Nuka Formation, which is based on brachiopod identifications, is suspect. Conodont and foraminifer ages from this unit are consistently Late Mississippian and 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. Holdsworth (written commun., 1980) has observed radiolarian specimens from chert of the Etivluk Group above the Nuka Formation at Nuka Ridge (Misheguk Mountain quadrangle) that are similar to *Albaillella pennata* s.s. of earliest Pennsylvanian age. However, these specimens were not preserved well enough 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 chert lithologies, that the base of the Etivluk Group should be greatly diachronous. Therefore, we regard the age of the Nuka as Late Mississippian and Early Pennsylvanian(?).

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 the higher sheets restored to the south relative to the 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 structures in the De Long Mountains and Misheguk Mountain quadrangles.

A palinspastic reconstruction of the sequences, based on the interpretations above, is shown in figure 5. North and south as labeled on the diagram refers 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 original north-south extent of sequences is difficult to determine because of many factors, so the scale is only approximate. Erosion during the Brooks Range orogeny removed an undetermined amount of the northen edges of the thrust sheets. Erosion after, and possibly during, the orogeny also stripped away an undetermined width of the thrust sheets south of the map area. 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 Middle and Late Devonian and Early Mississippian time, two partly coeval groups of sedimentary rocks were deposited in the Arctic Alaska sedimentary basin (Tailleur and Brosgé, 1970), the dimensions of which are unknown due to the compression that disrupted its southern part in the Brooks Range orogeny. The southern part of the basin contained the Baird Group (Tailleur and others, 1967), which is composed of clean, biohermal limestones of the Kelly sequence. Fossil ages from the Baird Group range from Cambrian to Late Devonian (Famennian). Foraminifers from the uppermost part of the Baird Group belong to Mamet zone 6 (B.L. Mamet, written commun., 1981) and are latest Devonian or earliest Mississippian in age. In the De Long Mountains quadrangle, fossils older than Devonian have not been collected from the Baird Group. 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 Late Devonian and Early Mississippian time. The lower part of the Endicott Group consists of the Hunt Fork Shale. Above this is the Noatak Sandstone and Kanayut Conglomerate, which are composed of shallow-marine and paralic sandstone and 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, and shale. We have mapped the facies that contains mostly sandy limestone as the Utukok Formation, the facies containing mostly shale as the Kayak Shale, and a mostly fine-grained, thin-bedded limestone as the micritic limestone unit.

During middle and Late Mississippian and Pennsylvanian time, a complex series of submarine rises and troughs developed in the Arctic Alaska basin. The different sedimentary facies of this age are an important key for differentiating stratigraphic sequences. The most prominent rise was in the Kelly sequence where as much as 650 m of cherty carbonate sediments belonging to Mississippian Kogruk Formation were deposited. Tongues of the Kogruk extended to the north into the 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 of carbonate rocks, a euxinic basin developed in which the Mississippian and Pennsylvanian Kuna Formation (Mull and others, 1982) was deposited. The Kuna Formation is predominantly black shale, with lesser amounts of radiolarian chert, limestone, and dolomite. The Kuna Formation is best developed in the Key Creek sequence, but it is also present in the Wulik sequence, and some thin tongues of the Kuna Formation probably overlie the Mississippian carbonate rocks in parts of the Amphitheatre and Kelly sequences. A similar black shale unit is also present at the top of the Mississippian and Pennsylvanian black chert and dolomite unit ($\mathbb{P}Mcd_4$) in the Puzzle Creek sequence. The northern and eastern limits of the Kuna Formation intertongue with and grade into Lisburne Group limestone of the Ivotuk sequence in the Howard Pass quadrangle (Mayfield and others, 1988). Outcrops in the De Long Mountains quadrangle that may be a western equivalent of the Ivotuk sequence, the Wolverine Creek allochthon (Moore and others, 1986) are discussed in the previous section.

The Nuka Formation is unique among the Carboniferous sedimentary rocks in the western Brooks Range because it contains abundant feldspar grains in sandy limestones. 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 no feldspar. The source area for the arkose in the Nuka has not been found, but it was probably to the south of the Arctic Alaska basin. 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 areas to the south. It is possible that the granitic source for the arkose began to rift away from the Arctic Alaska platform during Pennsylvanian(?) time, which left the Bogie and other sedimentary sequences 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 the Kuna Formation and Etivluk Group as the distinctive horizon that is marked by a change from the black cherts of the Kuna Formation to the red, green, and gray cherts of the Etivluk Group, possibly reflecting a change in the oxidation potential of the seawater at this time. In some exposures of this horizon, yellow or orange clay layers, a few centimeters thick, may be bentonite.

Where limestone or interbedded limestone and chert underlies 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 that has been differentiated in areas to the east of the map area (Sable and Dutro, 1961; Curtis and others, 1984). 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). No compelling evidence from any of the sedimentary sequences shows 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 Middle Jurassic time. In the northern sequences (fig. 5), lithographic limestone, packed with 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 Lower and Middle Jurassic Blankenship Member of the Otuk Formation (Mull and others, 1982). Early Jurassic radiolarians also have been identified near the top of the Etivluk Group in the Puzzle Creek sequence at Punupkahkroak Mountain (De Long Mountains A–3 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 Upper Triassic (Norian) part of the Otuk Formation. The higher structural position of the Copter igneous sequence suggests that it was originally south of the coeval part of the Etivluk Group. The basement onto which Copter basalts were erupted is not known; blocks of Devonian limestone are commonly associated with the Copter igneous sequence and may be part of this basement, but whether the contacts are mainly stratigraphic, intrusive, or tectonic has not been determined.

In Late Jurassic and Early Cretaceous time 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, 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 south 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 (Patton and others, 1977; Zimmerman and others, 1981), indicating that this allochthon is probably a remnant of oceanic crust that lay south of the Arctic Alaska continental plate before the Brooks Range orogeny. The basalts and oceanic sediment that may have been on top 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 explanation is that the Arctic Alaska plate, on which the Brooks Range sedimentary sequences were deposited, was subducted toward the (present) south, and allochthonous sedimentary sequences were detached from the upper layers of the subducted plate. In this model, the several hundred kilometers of lower crust on which the sedimentary sequences were deposited are no longer exposed in the De Long Mountains. 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 be at the base of the gently folded ophiolitic 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 Lower Cretaceous Ipewik unit appear to lie conformably on the Etivluk Group. Some thin tongues of the Ipewik unit possibly extended as far south as the Amphitheatre sequence. The lower part of the Ipewik unit 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 unit is best developed in the northern parts of the Key Creek sequence. Coquina beds composed of the pelecypod *Buchia*, and the clean, well-sorted quartzitic sandstone of the Tingmerkpuk subunit of the Ipewik unit may indicate that the water depth was shoaling toward the northern limits of the presently mapped Key Creek sequence during Valanginian time.

The Lower 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 and contains local conglomerate. 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. Also, many clasts of volcanic and plutonic igneous rocks are present that 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 part of the Misheguk igneous sequence, or from allochthons structurally above the Misheguk Mountain allochthon that 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 the Ipewik unit. It is evident from the map pattern that the Okpikruak truncates older units, and in some places rests 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 the deposition of the Okpikruak, it probably was relatively gentle.

Olistoliths from structurally higher thrust sheets slumped into the foredeep and were incorporated in the 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 conglomerate that probably represents submarine channel deposits. Isolated blocks of older, more competent rocks completely surrounded by graywacke and shale of the Okipikruak 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 earlier, 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). Some fossil evidence supports 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 B–2 quadrangle), the base of the orogenic flyschoid sediments, mapped here as the Fortress Mountain Formation, is younger than the well-dated Lower Cretaceous (Valanginian) beds of the Tingmerkpuk subunit of the Ipewik unit (Crane and Wiggins, 1976) on which it was deposited. 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 B–3 quadrangle), the orogenic flyschoid sediments, mapped here as the Okpikruak Formation, are at least as old as Berriasian, because they contain the pelecypod *Buchia okensis*. In a structurally higher thrust sheet that is part of either the Kelly River, Ipnavik River, or Nuka Ridge allochthon, Curtis and others (1984, fossil locality 48) report a Late Jurassic (Tithonian) pelecypod *Buchia fischeriana*, from orogenic flyschoid sediments, mapped as wacke and mudstone, in the Misheguk Mountain quadrangle. This fossil evidence shows that the age of the base of the Okpikruak Formation and related orogenic clastic rocks is older in structurally higher sequences than it is in lower sequences. Such a diachronous relation supports the concept of northward-prograding flyschoid deposition beginning at least as early as Tithonian in higher sequences and beginning as late as Valanginian in the northern part of the structurally 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 relations along the north side of the Baird and Schwatka Mountains east of the map area (Mull and others, 1976). The North Slope sequence is not 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 mid-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 Ipewik unit. 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 its southern 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 have probably remained a topographic high since Fortress Mountain time, because no rocks younger than Early Cretaceous have been found within this area.

RECONNAISSANCE GEOLOGIC MAP OF THE DE LONG MOUNTAINS A–1 AND B–1 QUADRANGLES AND PART OF THE C–1 QUADRANGLE, ALASKA

By
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1990

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