UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

EXPLANATION TO ACCOMPANY

RECONNANISSANCE GEOLOGIC MAP OF THE NOATAK C5, D5, D6, and D7 QUADRANGLES, ALASKA

By

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Introduction

This map covers the northwestern part of the Noatak 1:250,000-scale quadrangle (fig. 1, sheet 1). The area has low topographic relief that largely consists of gently sloping hills separated by broad expanses of tundra growing on unconsolidated surficial materials. Elevations range from sea level up to 475 m (1,456 ft.) at Mount Jarvis. Study of bedrock geology is constrained by a scarcity of exposures in most areas. Most hill tops are rubble-covered, and there are only a few stream outcrops. As a result many of the stratigraphic and structural relationships between rock units are inferred from similar relationships previously determined in other areas of the western Brooks Range where the rocks are better exposed (Curtis and others, 1982, 1983; Ellersieck and others, 1982, 1983; and Mayfield and others, 1982, 1983a,b).

Field studies for this geologic map were carried out in June and July 1981. Additional data for the present compilation have come from other previous geologic studies in this part of the Noatak quadrangle. The first geologic studies in the area were by P. S. Smith who traversed along the Kivalina River in 1926. The results of this field work were reported by Smith and Mertie (1930). Outcrops of Pliocene to Pleistocene sediments near the mouth of the Kivalina River were described by Hopkins and MacNeil (1960) and McCulloch (1967). I. L. Tailleur compiled unpublished geologic maps from the area based on a series of helicopter landings and short traverses during 1964 and 1968. Fossil dates and descriptions of certain outcrops from these studies have added important details to this geologic map. Results of aeromagnetic surveys in the area have been reported by Andreasen (1960), Barnes (1966), and Decker and Karl (1977), and these studies have been helpful for locating probable mafic rocks in areas covered by unconsolidated materials. In the 1960's and 1970's the area was mapped by geologists from several oil companies and since 1975, by minerals exploration geologists. However, these maps and studies are generally not publically available except for a general description of the structure and stratigraphy of this region by Martin (1970). Fossil collections by geologists from private industry that were identified by USGS paleontologists are included in the table 1 on this map.

The bedrock in this map area is similar to that found elsewhere in the De Long and western Baird Mountains in which stacks of thrust sheets contain coeval successions of rocks with slightly different lithologic facies. The rocks within this thrust faulted area are assigned to one of several thrust-superimposed sequences. On this map, the word "sequence" is used as either a lithostratigraphic term for a distinctive succession of sedimentary rocks that are believed to have been deposited contiguously or for a group of associated and distinctive igneous rocks. It has been observed elsewhere in the De Long Mountains that thrust sheets with the same sequence almost always occur in the same relative structural positions. To provide a simple structural scheme for this large and complex region, multiple thrust sheets that contain the same or similar sequences are herein grouped together into structural units called "allochthons". For a more complete summary of the mapped distribution of sequences and allochthons in the western Brooks Range, see Mayfield and others (1983b).

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.

There are seven allochthons and nine sequences named on the correlation of map units (sheet 1). Each allochthon is numbered in succession with allochthon one (the Brooks Range allochthon) on the bottom and allochthon seven (the Misheguk Mountain allochthon) on the top. On this map, there is one sequence in each allochthon with the exception of allochthon three, the Kelly River allochthon. In the Kelly River allochthon, there are three sequences called the Amphitheatre, Kelly, and Eli sequences. The three sequences are inferred to be in thrust fault contact with the Amphitheatre sequence in the lowest structural position, the Kelly sequence in the middle, and the Eli sequence on top.

There are slight differences in Mississippian rock units in the three sequences of the Kelly River allochthon; however, the overall lithology of their stratigraphic sections is similar when compared with the sequences of other allochthons. The sequences of the Kelly River allochthon all contain a thick and prominent section of Mississippian limestone with gray to black chert nodules called the Kogruk Formation. This contrasts with sequences of other allochthons in which the Kogruk Formation is thin or absent. Within the Kelly River allochthon, the Amphitheatre sequence is distinguished by the black chert and shale that overlies the Kogruk Formation in most places and by the micritic limestone unit that underlies the Kogruk Formation. The Kelly sequence is distinguished by having a thick Kogruk Formation that overlies a buff-weathering shaly and sandy limestone called the Utukok Formation. The Eli sequence is distinguished by having less than one percent chert nodules in the Kogruk Formation and by thick quartzitic sandstone beds near the base of the Utukok Formation.

Regional studies of western Brooks Range geology (Tailleur and Brosgé 1970; Mayfield and others, 1983b) indicate that the period of thrust faulting began in Middle or Late Jurassic with the onset of the Brooks Range orogeny. Most thrusting had ceased by Albian time in the Early Cretaceous. It is likely that later folding occurred during a period of deformation that also affected the Lisburne Hills sometime between middle Cretaceous and early Tertiary time.

Based on study of overturned folds and on the most probable palinspastic restoration of the basins of deposition of the sedimentary rocks, we infer that lower thrust sheets moved south relative to upper thrust sheets by a process of underthrusting. Allochthon one is poorly exposed in the map area, and it is inferred to be allochthonous based on regional stratigraphic and structural relations farther to the east (Mull and others, 1976; Mull, 1982; Mayfield and others, 1983b). Minimum foreshortening between allochthon seven and allochthon one is measured in hundreds of kilometers. A more complete discussion of the stratigraphic and structural history of the De Long Mountains north of this map area is given in Curtis and others (1983); Ellersieck and others (1983); Mayfield and others (1983a,b).

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. A generalized allochthon map appears in figure 2, sheet 1.

The locations of foot traverses used in the compilation of this map appear on figure 3, sheet 1. Not shown are observation points from a hovering helicopter and spot landing sites which were used for sketching geologic contacts.

Cross Sections

The cross sections for the geology map are necessarily speculative because there is a scarcity of rock outcrops by which to constrain them. Thrust faults and allochthon boundaries were projected to the subsurface and above the ground with the same structural style as exposed in more mountainous areas in the western Brooks Range where structure sections are based on more complete surface information.

The four sections (sections B-E) which cross the northwest part of the map area show the Amphitheatre and Kelly sequences as a complex series of intrasequence thrust sheets sandwiched between interallochthon thrust faults with much larger displacement distances. We would expect that similar structural complexity also occurs in this and other sequences elsewhere in the map area. To facilitate correlation between cross sections, major thrust sheets are labeled alphabetically. Thrust sheets in the Kelly sequence are labeled sheet A to F and those in the Amphitheatre sequence are labeled sheet S to Z.

The cross sections are not balanced, which means that if the thrust sheets were unstacked the cross-sectional lengths of the rock units at different stratigraphic levels shown on the sections would not be the same. To balance the sections would require fabricating even more complicated structure. The sections were left unbalanced because there are numerous plausible ways to explain currently known details of the surface geology. Thus, the sections are intended to show only generalized structural relations.

Fossil Table

Table 1 is a list of fossils that have been identified from the map area. Most fossils were collected in the summer of 1981, during fieldwork for this mapping project. However, they also include a few previously published and unpublished fossil collections dating back to 1926. Some collections were made by geologists from the petroleum industry and dated by U.S. Geological Survey paleontologists.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles.

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
1	81Ek69C	67°50'28"	164°20'52"	28583-PC	Early Mississippian (late Kinderhookian)	Mus_3	Conodonts ^{1}CAI=1^{1}/2	A. G. Harris
2	81Ek141C	67°57'21"	164°33'42"	--	Late Mississippian (Visean) Mamet Zones 14 & 15	PMn_5	Foraminifers	B. L. Mamet
2	81Ek141	67°57'21"	164°33'42"	--	Devonian to Permian	PMn_5	Conodonts ^{1}CAI=1	A. G. Harris
2	8-16-83J 8-16-83K	67°57'21"	164°33'42"	29233-PC 29234-PC	Latest Mississippian to earliest Pennsylvanian	PMn_5	Conodonts ^{1}CAI=1	A. G. Harris
2	^{2}27443-7	67°57'21"	164°33'42"	M1049-PC	Late Mississippian? and Permian?	PMn_5	Corals, brachiopods	A. K. Armstrong J. T. Dutro, Jr.
2	^{3}187-D6-175	67°57'21"	164°33'42"	--	Probably Late Mississippian	PMn_5	Corals	J. T. Dutro, Jr. W. J. Sando
3	81Ek149E	67°51'20"	164°32'39"	28588-PC	Early Mississippian (Kinderhookian)	Mu_3	Conodonts ^{1}CAI=1	A. G. Harris
4	81Md29C	67°57'36"	164°40'36"	28585-PC	Mississippian	Mko_3	Conodonts ^{1}CAI=1^{1}/2	A. G. Harris
5	81Md29H	67°56'57"	164°39'18"	28586-PC	Late Mississippian (late Meramecian to late Chesterian)	Mko_3	Conodonts ^{1}CAI=1	A. G. Harris
6	81Md9E	67°53'34"	164°55'54"	--	Mississippian to Permian	Mk_2	Conodonts ^{1}CAI=3	A. G. Harris

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
7	81Md57C	67°52'09"	164°45'33"	28368-PC	Late Mississippian (late Meramecian to early Chesterian)	$\mathbb{P}Mn_5$	Conodonts [1]CAI=2	A. G. Harris R. Lane
7	81Md57B	67°52'09"	164°45'33"	--	Late Mississippian (late Chesterian) Mamet zone 17	$\mathbb{P}Mn_5$	Foraminifers	B. L. Mamet
8	59AHp1092	67°48'57"	164°37'12"	19193-PC	Mississippian	Mko_3	Corals	Helen Duncan
9	[2]26446-1A [3]87-D6-72D	67°54'21"	164°53'18"	--	Late Mississippian (Meramecian)	Mko_2	Corals	A. K. Armstrong
10	81Md25C	68°00'05"	164°48'24"	M7590	Early Cretaceous (Berriasian)	Ko	Pelecypods Buchia Okensis	J. W. Miller
11	68ATr144	67°59'19"	164°33'54"	--	Early Cretaceous? (Valanginian?)	Ko_3	Pelecypod Buchia sp. juv.	D. L. Jones
12	[2]26455-1	67°57'05"	164°44'30"	--	Late Triassic (late Norian)	$J\mathbb{P}e$	Pelecypods	N. J. Silberling K. M. Nichols
13	[2]27440-1	67°57'03"	164°57'50"	--	Late Triassic (late Norian)	$J\mathbb{P}e_3$	Pelecypods	N. J. Silberling K. M. Nichols
14	[4]26AS2	67°51'20" approx. location	164°21'36"	--	Mississippian	Mko_3	Corals	G. H. Girty
15	[4]26As3	67°52'54" approx. location	164°25'05"	--	Mississippian	Mko_3?	brachiopods	G. H. Girty
16	[4]26As5	67°52'27" approx. location	164°14'48"	--	Mississippian	Mko_3	Corals, brachiopods	G. H. Girty

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued.

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
17	81Md21	67°51'57"	164°06'33"	--	Devonian	Db_3	Stromatoporoids	B. L. Mamet
18	81Md22A,B	67°52'24"	164°18'12"	--	Late Mississippian (Visean) Mamet zones 11 or 12	Mko_3	Foraminifers	B. L. Mamet
18	81Md22B	67°52'24"	164°18'12"	28817-PC	Mississippian	Mko_3	Brachiopods, corals	J. T. Dutro, Jr.
19	81Tr30B	67°53'46"	164°12'33"	--	Early Mississippian (middle Tournaisian) Mamet zone 7	MDl_3	Foraminifers	B. L. Mamet
19	81Tr30	67°53'46"	164°12'33"	28818-PC	Mississippian	MDl_3	Brachiopods, corals	J. T. Dutro, Jr.
20	81Md22C	67°52'29"	164°18'58"	--	Late Mississippian (Visean) Mamet zones 11 or 12	Mul_3	Foraminifers	B. L. Mamet
21	81Tr4E	67°53'21"	164°52'30"	--	Late Mississippian (Visean) Mamet zone 12	Mko_3	Foraminifers	B. L. Mamet
22	81Tr34A	67°55'24"	164°48'09"	--	Early Mississippian (Tournaisian) Mamet zone 9	Mu_3	Foraminifers	B. L. Mamet
23	81Tr34B	67°55'16"	164°48'09"	--	Late Mississippian (middle Visean) Mamet zone 12	Mul_3	Foraminifers	B. L. Mamet

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued.

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
24	81Tr34C	67°55'06"	164°48'32"	--	Late Mississippian (early Visean) Mamet zones 10 or 11	Mul_3	Foraminifers	B. L. Mamet
25	81Tr36E	67°54'30"	164°44'00"	--	Late Mississippian (early Visean) Mamet zone 11 or slightly younger	Mko_3	Foraminifers	B. L. Mamet
26	81Tr38B	67°55'48"	164°44'25"	--	Late Mississippian (middle Visean) Mamet zone 12	Mko_3	Foraminifers	B. L. Mamet
27	81Tr38C	67°55'45"	164°44'18"	--	Late Mississippian (Visean) Mamet zone 11 or slightly younger	Mko_3	Foraminifers	B. L. Mamet
28	81Tr39	67°55'30"	164°43'24"	--	Late Mississippian (Visean) Mamet zone 12	Mul_3	Foraminifers	B. L. Mamet
29	81Tr85A	67°59'36"	164°36'36"	--	Late Mississippian (Visean) Mamet zone 11 or slightly younger	Mul_3	Foraminifers	B. L. Mamet
30	81Tr88B	67°52'16"	164°47'38"	--	Late Devonian (latest Famennian) Mamet zone 4 or 5	Db_4	Foraminifers	B. L. Mamet

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued.

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
31	81Tr93A	67°48'57"	164°38'08"	--	Late Mississippian (early to middle Visean)	Mko_3	Foraminifers	B. L. Mamet
32	81Md29B	67°57'29"	164°40'54"	--	Late Mississippian (early to middle Visean)	Mko_3	Foraminifers	B. L. Mamet
33	81Md29G	67°57'06"	164°39'18"	--	Late Mississippian (early Visean or slightly younger)	Mu_3	Foraminifers	B. L. Mamet
34	81Md55C	67°59'30"	164°29'34"	--	Late Mississipian (early Visean) approx. Mamet zone 11	Mko_3	Foraminifers	B. L. Mamet
35	81Md55D	67°59'33"	164°29'38"	--	Late Mississippian (middle Visean) Mamet zone 12	Mul_3	Foraminifers	B. L. Mamet
36	81Md57D	67°52'26"	164°45'30"	--	Late Mississippian (late Visean) Mamet zones 14 to 15	Mkf_5	Foraminifers	B. L. Mamet
37	81Md60C	67°51'33"	164°38'30"	--	Early Mississippian (Tournaisian) Mamet zone ≤8	Mul_3	Foraminifers	B. L. Mamet
38	81Md60D	67°51'32"	164°37'30"	--	Early Mississippian (Tournaisian) Mamet zone ≤8	Mul_3	Foraminifers	B. L. Mamet

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
39	81Md61B	67°52'15"	164°34'02"	--	Early Mississippian (latest Tournaisian) Mamet zone 9	Mul_3	Foraminifers	B. L. Mamet
40	81Md61C	67°52'29"	164°34'02"	--	Late Mississippian (earliest Visean) Mamet zone 10	Mko_3	Foraminifers	B. L. Mamet
41	81Md61D	67°52'39"	164°33'48"	--	Late Mississippian (Visean)	Mko_3	Foraminifers	B. L. Mamet
42	81Md61E	67°52'51"	164°33'14"	--	Early Mississippian (early late Tournaisian) Mamet zone 8	Mul_3	Foraminifers	B. L. Mamet
43	81Md61F	67°52'55"	164°32'54"	--	Late Mississippian (early Visean)	Mko_3	Foraminifers	B. L. Mamet
44	81Tr27D	67°48'29"	164°02'39"	--	Late Devonian (probably Frasnian)	Db_3	Foraminifers	B. L. Mamet
45	81Ek150A	67°52'57"	164°28'20"	--	Late Mississippian (early Visean) Mamet zone 10 or slightly younger	Mko_3	Foraminifers	B. L. Mamet
46	81Tr36B	67°54'50"	164°45'28"	--	Late Mississipian (middle Visean)	Mko_3	Foraminifers	B. L. Mamet
47	81Tr2E	67°54'41"	164°54'01"	--	Late Mississippian (middle Visean) approx. Mamet zone 12	Mk_2	Foraminifers	B. L. Mamet

See footnotes at end of table.

Table 1.--Selected fossils from Noatak D5, D6, D7 quadrangles--Continued.

Map number	Field number	Latitude	Longitude	USGS collection number	Age	Map unit	Fossil type	Identified by
48	[2]26480	67°56'45"	164°53'00" 72F	187-D6-56-	Late Mississippian (probably Meramecian or early Chesterian)	PMc_3	Foraminifers	A. K. Armstrong
49	[2]27446-1	67°55'27"	164°51'21"	M1093	Late Mississippian (probably late Meramecian or early Chesterian)	PMc_2	Foraminifers	A. K. Armstrong
50	[2]26400-1	67°56'45"	164°38'54"	M1112	Late Mississippian (Meramecian) probably Mamet zones 14 or 15	Mko_3	Foraminifers	A. K. Armstrong
51	81Tr31	67°56'09"	164°04'03"	--	Probably Upper Devonian	Db	Algae, stromatoporoids	B. L. Mamet
52	--	67°49'00"	164°37'06"	--	Tertiary to Quaternary (late Pliocene to early Pleistocene)	QTc	[5]Pelecypods, gastropods, foraminifers, ostracods	F. S. MacNeil Ruth Todd I. G. Sohn

[1]Conodont color alteration index (CAI) is an estimate of maximum temperatures reached during diagenesis: CAI 1=60°C; CAI 1-1[1]/2=60-90°C; CAI 2=80-140°C; CAI 3=120-160°C (Harris and others, 1983).

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

[3]Collected by geologists from Mobile Oil Corporation

[4]Fossils previously reported by Smith and Mertie (1930)

[5]Fossils previously reported by Hopkins and MacNeil (1960) and McCulloch (1967)

DESCRIPTION OF MAP UNITS
Surficial Deposits

Qat ACTIVE ALLUVIAL DEPOSITS AND TERRACE DEPOSITS, UNDIVIDED (Quaternary)--Locally divided into:

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

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

Qb BEACH DEPOSITS (Quaternary)--Pebbly sand and gravel deposits along the present coastline and small dune deposits in the back beach area. Includes some ancient beach terrace deposits as much as two km from the present coast.

Qg GLACIAL DEPOSITS (Quaternary)--Sand and gravel deposits in the upper part of the Kivalina River. Includes outwash and possibly some morainal deposits.

Qu SURFICIAL DEPOSITS, UNDIVIDED (Quaternary)--Unconsolidated clay, silt, sand, and gravel. Includes tundra, soil, lacustrine, alluvial, colluvial, and glacial deposits.

QTc MARINE CLAY (Quaternary and/or Tertiary)--Unconsolidated black organic clay, pebbly clay, and silty sand. Thickness is 3 to 5 m. Marine fossils include pelecypods, gastropods, foraminifers, and ostracods of probable late Pliocene or early Pleistocene age at fossil locality 52. Unconformably overlies Mississippian limestone at only mapped outcrop on north side of Kivalina Lagoon.

Autochthonous Rocks

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

Kf FORTRESS MOUNTAIN FORMATION (Cretaceous)--Greenish gray, calcareous, micaceous wacke. Exposed at rubbly outcrops in the northwestern part of the map area. Contains the Albian pelecypods Inoceramus anglicus and Aucellina dowlingi in the foothills north of the map area.

Allochthonous Rocks
Brooks Range allochthon
Key Creek sequence

Named for characteristic exposures along Key Creek (lat 68°08' N., long 162°29' W.), De Long Mountains A1 quadrangle (Curtis and others, 1983). Letter symbols for map units in this sequence include the subscript number 1 to signify that they are part of the Brooks Range allochthon.

PMk_1 KUNA FORMATION (Pennsylvanian and Mississippian)--Black carbonaceous shale with interbedded black chert. Contains a few dark gray, fine-grained limestone interbeds. Shale commonly has a bluish-silver sheen on weathering. Age inferred from stratigraphic correlation with similar beds that contain conodonts, radiolarians, and brachiopods found elsewhere in the De Long Mountains. Mapped in only two areas: near the coast between the lower Asikpak and Kivalina Rivers, and in the southeastern part of the map. Base is gradational into the Endicott Group.

MDe_1 ENDICOTT GROUP, UNDIVIDED (Mississippian and Devonian)--Brown- and reddish brown-weathering siltstone and sandstone and gray shale. Age inferred from lithologic correlation with beds that contain conodonts, plant fragments, and brachiopods found elsewhere in the Mulgrave Hills (fig. 1) and De Long Mountains. Mapped in a few low rubbly hills in the southeastern part of the map. Base is not exposed.

Picnic Creek allochthon
Amaruk sequence

Named for characteristic exposures along the upper tributaries of the Amaruk River (lat 68°14' N., long 163°38' W.), De Long Mountains B3 quadrangle (Mayfield and others, 1983a). Letter symbols for map units in this sequence include the subscript number 2 to signify that they are part of the Picnic Creek allochthon.

Ko_2 OKPIKRUAK FORMATION (Cretaceous)--Interbedded gray to brown, fine- to medium-grained wacke and gray mudstone. Early Cretaceous age inferred from stratigraphic correlation with similar beds that contain the pelecypod Buchia in this unit in adjacent sequences. Regionally is inferred to have an unconformity at base in some places; in other places base may be conformable on shale at top of the Etivluk Group.

$J\mathcal{P}e_2$ ETIVLUK GROUP (Jurassic to Pennsylvanian)--Mostly gray radiolarian chert with minor amounts of siliceous shale; weathers to shades of brown, yellow, gray, green, and maroon. Age inferred from stratigraphic correlation with similar beds in the De Long Mountains that contain Carboniferous to early Mesozoic radiolarians and conodonts and near the top, the Triassic pelecypod Monotis. Depositional thickness is estimated to be approximately 110 m. Base is probably gradational into black chert unit. Locally distinguished as:

$\mathcal{TP}s_2$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon and olive gray argillite and chert. Mapped in only one outcrop east of upper Okpiksugruk Creek. Base is probably gradational into black chert unit.

$\mathcal{P}Mc_2$ BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded black chert locally interbedded with light gray-weathering limestone. Contains Late Mississippian foraminifers in limestone beds at fossil locality 49. Base is gradational into the Kogruk Formation or conformable on the Kayak Shale.

Mko_2 KOGRUK FORMATION (Mississippian)--Well-bedded, medium-grained limestone with subordinate black nodular chert. Contains Meramecian corals at fossil locality 9. Commonly contains crinoids. Depositional thickness estimated to be 0 to 30 m. Base appears to be conformable on the Kayak Shale.

Mk_2 KAYAK SHALE (Mississippian)--Gray shale with subordinate amounts of interbedded rusty-weathering silty limestone, and siltstone. Contains imprecisely dated Mississippian to Permian conodonts at fossil locality 6 and Late Mississippian foraminifers near the top at fossil locality 47. Locally includes:

Mks_2 Sandstone member (Mississippian)--Interbedded siltstone, shale, and fine-grained quartzite, locally calcareous. Weathers light brown or reddish brown. Contains a few crinoid impressions. Base not exposed.

Kelly River allochthon
Amphitheatre sequence

Named for exposures around Amphitheatre Mountain (lat 68°19' N., long 162°34' W.). De Long Mountains B1 quadrangle (Curtis and others, 1983). 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 and Eli sequences is shown on figure 2 (sheet 1).

Ko_3 OKPIKRUAK FORMATION (Cretaceous)--Interbedded fine- to medium-grained lithic wacke and mudstone. Early Cretaceous age inferred from regional stratigraphic correlations. Mapped at only a few places near Kisemaraktuk Mountain. Some of the Okpikruak Formation in the northwestern part of the map probably is part of this sequence. Regionally is inferred to have an unconformity at base in some places and in other places base may be conformable on shale at top of the Etivluk Group.

$J\mathbb{P}e_3$ ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray radiolarian chert with minor amounts of siliceous shale; weathers to shades of brown, yellow, gray, green, and maroon. Includes the Siksikpuk and Otuk Formations. Contains the Late Triassic pelecypod Monotis at fossil locality 13. Depositional thickness is estimated to be approximately 110 m. Locally divided into:

$J\mathfrak{R}o_3$ 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 Monotis. Radiolarian fossils are common in chert. Top is probably Early or Middle Jurassic based on regional stratigraphic correlations. Base is probably gradational into the Siksikpuk Formation.

$\mathfrak{R}\mathbb{P}s_3$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Gray, olive-gray, and maroon siliceous shale and radiolarian chert. Age inferred from stratigraphic correlation with similar beds in the De Long Mountains. Base is probably conformable on black chert and shale unit or cherty parts of the Kogruk Formation.

$\mathbb{P}Mc_3$ BLACK CHERT AND SHALE (Pennsylvanian? and Mississippian)--Black to dark gray chert overlying a thin discontinuous zone of black carbonaceous, siliceous shale. Also includes subordinate amounts of interbedded limestone. Limestone beds contain Late Mississippian foraminifers at fossil locality 48. Possible Pennsylvanian age at top inferred from regional correlation with similar beds in the Kuna Formation. Appears to be laterally gradational into cherty limestone member of the Kogruk Formation. Base is gradational into the Kogruk Formation.

Mko_3 KOGRUK FORMATION (Mississippian)--Light gray-weathering, medium-to fine-grained limestone and dolomite with up to 25 percent black chert nodules and lenses. Higher proportions of chert and silicified carbonate occur near top. Commonly contains crinoids. Late

Mississippian age inferred from correlation with similar beds in the Kogruk Formation in the Kelly sequence. Depositional thickness estimated to be 50 to 200 m. Base is gradational into micritic limestone. Top part is locally distinguished as:

$Mkoc_3$ Cherty limestone member (Mississippian)--Medium- to fine-grained, light gray limestone and dolomite interbedded with 25 to 50 percent black chert nodules and lenses. Carbonate and chert beds are commonly silicified to gray quartz and chalcedony. Possibly correlates with the Tupik Formation as mapped in the Misheguk Mountain quadrangle (Curtis and others, 1982) and probably grades laterally into black chert and shale unit (PMc_3) in this sequence.

Mml_3 MICRITIC LIMESTONE (Mississippian)--Gray to dark gray, fine-grained limestone. Weathers light gray to buff in color and breaks into platy to flaggy fragments on talus slopes. Contains a few black chert nodules near the top and subordinate interbedded calcareous dark gray shale in the lower part. Mid-Mississippian age inferred from stratigraphic correlation with lithologically similar but more fossiliferous beds near Amphitheatre Mountain, De Long Mountains B1 quadrangle (Curtis and others, 1983). Basal contact is a thrust fault.

Kelly sequence

Named for characteristic exposures along the Kelly River (lat 68°16' N., long 162°15' W.), De Long Mountains B1 quadrangle (Curtis and others, 1983). 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 and Eli sequences is shown in figure 2 (sheet 1).

Ko_3 OKPIKRUAK FORMATION (Cretaceous)--Interbedded fine- to medium-grained greenish gray lithic wacke and gray mudstone. Contains the pelecypod Buchia of probable Early Cretaceous age at fossil locality 11. Regionally has an unconformity at base in some places; in other places base may be conformable on shale at top of the Etivluk Group.

$J\,Pe_3$ ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, olive gray, and maroon radiolarian chert with minor amounts of siliceous shale. Weathers to shades of brown, yellow, gray, green, and maroon. Includes the Siksikpuk and Otuk Formations. Age inferred from regional stratigraphic correlations with similar rocks of this unit elsewhere that contain radiolarian and conodont fossils. Depositional thickness estimated to be approximately 110 m. Locally divided into:

$JTr\,o_3$ OTUK FORMATION (Jurassic and Triassic)--Gray chert; weathers brown and cream-colored. Mapped in only one small rubbly zone northeast of Okpiksugruk Creek.

$TrPs_3$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon and gray chert. Mapped in only one small rubbly outcrop in the valley southeast of the Siaktak Hills. Age inferred from regional lithologic correlations. Not known if base is conformable or disconformable on the Kogruk Formation.

Mko_3 KOGRUK FORMATION (Mississippian)--Light gray, medium- to coarse-grained limestone. Generally contains less than ten percent black and gray chert nodules. Limestone commonly has silicified zones of gray quartz and chalcedony. Contains Late Mississippian brachiopods, corals, crinoids, conodonts, and foraminifers. Foraminifers appear to range from Mamet zone 12 near the bottom to at least as young as Mamet zone 14 or 15 higher in the section. Depositional thickness estimated to be approximately 100 to 250 m. Base is gradational into the Utukok Formation.

Mu_3 UTUKOK FORMATION (Mississippian)--Upper part contains light gray- to buff-weathering limestone; commonly blocky-weathering on talus slopes. Lower part contains sandy limestone, calcareous siltstone, shale, and fine-grained sandstone; commonly weathers recessive. Contains Early to Late Mississippian foraminifers of Mamet zones 9 to 12. Common megafossils are crinoids and brachiopods. Basal contact is poorly exposed and thought to be a thrust fault. Upper part is mapped locally as:

Mul_3 Buff limestone member (Mississippian)--Buff- to light gray-weathering, medium-grained limestone interbedded with minor amounts of sandy limestone and calcareous shaly layers. Appears to contain more fine clastic impurities than the overlying Kogruk Formation. Contains Late Mississippian foraminifers that range from Mamet zones 10 or 11 to zone 12. Gradational at base into sandier parts of the Utukok Formation.

Eli sequence

Named for characteristic exposures in the drainages of the Eli River (lat 67°38'30" N., long 162°0-5' W.), Noatak C1 quadrangle. Map units in this sequence include the subscript number 3 in their map symbols to signify that they belong to the Kelly River allochthon. Location of the area where the Eli sequence occurs relative to the Amphitheatre and Kelly sequences is shown in figure 2 (sheet 1).

MDl_3 LIMESTONE AND DOLOMITE, UNDIVIDED (Mississippian and/or Devonian)--Light gray-weathering carbonate that is either part of the Kogruk Formation or the Baird Group. Mapped in rubble-covered hills in the area of the lower Kivalina and Wulik River drainages. Most outcrops have not been sampled or visited. Contains Early Mississippian foraminifers of Mamet zone 7 and Mississippian corals and brachiopods at fossil locality 19.

Mko_3 KOGRUK FORMATION (Mississippian)--Light gray-weathering, medium-grained limestone; locally has a few black chert nodules in upper part and a few thin stringers of silicified limestone elsewhere in the section. Medium-bedded; weathers to blocky talus slopes. Difficult to distinguish on a lithologic basis from limestone in the Baird Group in many places. Common megafossils are crinoids, brachiopods, and corals. Contains Late Mississippian foraminifers that range in age from Mamet zone 10 to 12. Base is gradational into the Utukok Formation.

Mu_3 UTUKOK FORMATION (Mississippian)--Buff-weathering limestone, sandy limestone, and fine-grained calcareous quartzite. Contains Early Mississippian conodonts and Early to Late Mississippian foraminifers. Base seems to be conformable on limestone and dolomite of the Baird Group. In most places divided into:

Mul_3 Buff limestone member (Mississippian)--Buff and light gray-weathering, medium-grained limestone. Contains brachiopods, crinoids, and a few colonial corals. Contains Early and Late Mississippian foraminifers of Mamet zones 8 to 12. Probably conformable on or interfingers with the sandstone member.

Mus_3 Sandstone member (Mississippian)--Gray to light brown, fine-grained quartzite with minor amounts of interbedded sandy limestone. Sandier beds commonly covered by black lichens. Contains Early Mississipian (Late Kinderhookian) conodonts collected from interbedded limestone at fossil locality 1.

Db_3 BAIRD GROUP (Devonian)--Light to dark gray-weathering, medium- to fine-grained limestone and dolomite; massive to thick bedded in most places. Contains Late Devonian (probably Frasnian) foraminifers at fossil locality 44. Mostly occurs in low rubble-covered hills between the lower Kivalina and Wulik Rivers. Base is not exposed.

Ipnavik River allochthon
Ipnavik sequence

Named for characteristic exposures along the Ipnavik River (late 68°39' N., long 157°10' W.), Howard Pass quadrangle (Tailleur and others, 1966). Map units in this sequence include the subscript number 4 in their map symbols to signify that they belong to the Ipnavik River allochthon.

$J\mathbb{P}m_4$ MAFIC SILLS AND DIKES (Jurassic? to Pennsylvanian)--Fine- to coarse-grained diabase mainly composed of plagioclase and augite. Age inferred from regional correlations in the Misheguk Mountain and Howard Pass quadrangles where diabase of this sequence appears to have intruded chert of the Etivluk Group. It is uncertain that this rock unit is as young as upper part of the Etivluk Group.

$J\mathbb{P}e_4$ ETIVLUK GROUP (Jurassic to Pennsylvanian)--Maroon, green, and gray radiolarian chert interbedded with minor amounts of siliceous shale. Mapped in only a few low rubbly outcrops northwest of Mount Jarvis. Age inferred from regional stratigraphic correlations with similar rocks of this unit that contain radiolarian and conodont fossils. Depositional thickness estimated to be approximately 110 m. Base is gradational into black chert unit. Locally mapped as:

$\mathbb{R}\mathbb{P}s_4$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon and gray siliceous argillite. Mapped in only one place north of Mount Jarvis.

$\mathbb{P}Mc_4$ BLACK CHERT (Pennsylvanian? and Mississippian)--Well-bedded radiolarian chert with a few shale partings. Commonly bleached white and recrystallized by intrusions of mafic dikes and sills. Age inferred from regional correlation with similar beds in the Ipnavik sequence in the Misheguk Mountain quadrangle (Ellersieck and others, 1982). Poorly exposed in low rubble-covered hills northwest of Mount Jarvis and near the mouth of the Asikpak River. Locally mapped as:

$\mathbb{P}Mrc_4$ Recrystallized black chert (Pennsylvanian? and Mississippian)--Dark gray to light gray-weathering chalcedony and quartz. Inferred to be recrystallized chert because in some places relict bedding is similar to that found elsewhere in black chert unit ($\mathbb{P}Mc_4$). Origin of recrystallization is uncertain but may be related to diabase intrusions in this sequence. Mostly mapped in a few places in upper tributaries and near mouth of the Asikpak River.

Mk_4 KAYAK SHALE (Mississippian)--Dark gray shale with interbedded rusty-weathering calcareous concretions. Mapped only in one small rubble zone northwest of Mount Jarvis. Age inferred from correlation with similar beds in this unit mapped elsewhere in the De Long Mountains (Ellersieck and others, 1982; Mayfield and others, 1982).

Db_4 BAIRD GROUP LIMESTONE (Devonian)--Blocky-weathering, massive light gray, medium- to fine-grained limestone. Contains Late Devonian (latest Famennian) foraminifers at fossil locality 30. Mapped only at two small outcrops northwest of mouth of the Asikpak River. Base is not exposed.

Nuka Ridge allochthon
Bogie sequence

Named for characteristic exposures along Bogie Creek near Nuka Ridge (lat 68°38' N., long 159°15' W.), Misheguk Mountain quadrangle (Mayfield and others, 1982). Map units in this sequence include the subscript number 5 in their map symbols to signify that they are part of the Nuka Ridge allochthon.

Ko_5 OKPIKRUAK FORMATION (Cretaceous)--Interbedded gray mudstone and greenish gray medium- to fine-grained lithic wacke. Age is Early Cretaceous inferred from regional stratigraphic correlation but lower part may be Middle or Late Jurassic. Regionally has an unconformity at base in some places; in other places base may be conformable on shale at top of the Etivluk Group.

$J\mathcal{P}e_5$ ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, greenish gray, and maroon radiolarian chert with minor amounts of interbedded siliceous shale. Weathers light brown and cream-colored in upper part. Includes the Siksikpuk and Otuk Formations. Age inferred from regional stratigraphic correlations with similar rocks of this unit elsewhere that contain radiolarian and conodont fossils. Depositional thickness estimated to be approximately 110 m. Locally divided into:

$J\mathcal{R}\,o_5$ OTUK FORMATION (Jurassic and Triassic)--Gray radiolarian chert; weathers brown with some light cream-colored beds. Contains the Late Triassic pelecypod Monotis. Mapped in only one small outcrop south of lower part of the Asikpak River.

$\mathcal{R}\mathcal{P}s_5$ SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon siliceous shale and radiolarian chert. Mapped in only one small rubbly outcrop east of lower Okpiksugruk Creek. Age inferred from regional stratigraphic correlations. Base appears to be conformable on the Nuka Formation.

$\mathcal{P}Mn_5$ NUKA FORMATION (Pennsylvanian? and Mississippian)--Light gray to maroon, medium- to coarse-grained arkose, calcareous arkose, and coarse-grained limestone. Locally contains red beds, glauconitic sandstone, and gray shale. Crinoids and brachiopods are conspicuous fossils. Contains Late Mississippian foraminifers of Mamet zone 17 at fossil locality 7 near mouth of the Asikpak River. Depositional thickness probably less than 40 m at outcrops on the lower Asikpak River.

Mk_5 KAYAK SHALE (Mississippian)--Gray shale interbedded with 1-4 cm beds of encrinitic, orange-weathering limestone beds. Mapped at one small outcrop along Tulukak Creek, a tributary of the upper Kivalina River. Divided into an upper feldspathic sandstone member and a lower limestone and shale member at outcrops along the lower Asikpak River.

Mkf_5 Feldspathic sandstone member (Mississippian)--Brown-weathering, feldspathic, calcareous sandstone interbedded with gray shale and a few thin limestone beds. Contains Late Mississippian foraminifers of Mamet zone 14 or 15 at fossil locality 36. Base is gradational into limestone and shale member.

Mkl_5 Limestone and shale member (Mississippian)--Brown-weathering thin-bedded silty limestone interbedded with gray calcareous shale. Base is not exposed at only outcrop along the lower Asikpak River.

Copter Peak allochthon
Copter igneous sequence

Named for characteristic exposures at Copter Peak (lat 68°30' N., long 161°18' W.), Misheguk Mountain quadrangle (Curtis and others, 1982). Letter symbols for the map unit in this sequence include the subscript number 6 to signify that it is part of the Copter Peak allochthon.

JTr b_6 BASALT (Jurassic? and Triassic)--Brown-weathering basalt and diabase; locally has pillow structures. Triassic age inferred from lithologic correlation with similar rocks in the Misheguk Mountain quadrangle that contain intercalated Triassic chert that was dated by radiolarian fossils. Jurassic(?) age is based on possibility that gabbroic rocks of Jurassic age, similar to those in the Misheguk igneous sequence, may have been the source for some of the basalt. Basal contact is inferred to be an interallochthon thrust fault.

Misheguk Mountain allochthon
Misheguk igneous sequence

Named for characteristic exposures at Misheguk Mountain (lat 68°15' N., long 161°05' W.), Misheguk Mountain quadrangle (Ellersieck and others, 1982). Letter symbols for the map unit in this sequence include the subscript number 7 to signify that they are part of the Misheguk Mountain allochthon.

Ju_7 ULTRAMAFIC ROCKS (Jurassic)--Serpentinite and partly serpentinized peridotite. Mapped only in a few exposures east of the upper Kivalina River. Age inferred from 160-170 m.y. potassium argon dates from gabbro that are associated with similar peridotite in the Misheguk igneous complex located in the De Long Mountains northeast of the map area (Ellersieck and others, 1982). Thought to be the lower part of an ophiolite sequence (Patton and others, 1977).

Rocks not assigned to a specific sequence

Ko OKPIKRUAK FORMATION (Cretaceous)--Interbedded gray mudstone and greenish gray lithic wacke. Contains Early Cretaceous pelecypod Buchia Okensis of Berriasian age a short distance north of the map area at fossil locality 10. Locally includes:

Koc Conglomerate member (Cretaceous)--Wacke conglomerate with rounded cobbles and pebbles of lithic clasts that consist of chert, limestone, and diabase. Mapped in only two outcrops, one near the sea coast in the northwest part of the map and the other north of the mouth of the Asikpak River.

J Pe ETIVLUK GROUP (Jurassic to Pennsylvanian)--Gray, olive gray, and maroon radiolarian chert with siliceous shale partings; weathers to shades of brown, green, cream-colored, gray, black, and maroon. Age inferred from regional stratigraphic correlations with similar rocks of this unit elsewhere that contain pelecypod, radiolarian, and conodont fossils; see description of this unit in allochthon two. Includes the Otuk and Siksikpuk Formations.

JTr o OTUK FORMATION (Jurassic and Triassic)--Gray to dark gray, radiolarian chert with siliceous shale partings; weathers gray, green, brown, and cream-colored. Contains Late Triassic pelecypod Monotis. Mapped northwest of Kisemaraktuk Mountain; probably belongs to allochthon one, two, or three.

TrPs SIKSIKPUK FORMATION (Triassic to Pennsylvanian)--Maroon and gray radiolarian chert and siliceous shale. Mapped only west of Kisemaraktuk Mountain; probably belongs to the Amaruk or Amphitheatre sequences.

PMc BLACK CHERT (Pennsylvanian? and Mississippian)--Mapped only in a few outcrops west of Kisemaraktuk Mountain. Probably belongs to either the Amaruk sequence or the Amphitheatre sequence.

PMk KUNA FORMATION (Pennsylvanian and Mississippian)--Black carbonaceous shale that has a bluish-silver sheen on weathering. Mapped only in one place west of Kisemaraktuk Mountain; probably belongs to either the Amaruk sequence or the Amphitheatre sequence.

Mu? UTUKOK FORMATION? (Mississippian?)--Calcareous sandstone, shale, and limestone. Appears to be baked by the adjacent mafic igneous rock. Probably is part of the Utukok Formation of the Kelly sequence or a calcareous part of the sandstone member of the Kayak Shale in the Amaruk sequence. Mapped in only one place in a valley five km southwest of Kisemaraktuk Mountain.

BAIRD GROUP--divided into:

Db LIMESTONE (Devonian)--Fine- to coarse-grained, light- to dark gray-weathering, massive- to thick-bedded limestone. Largest exposure, located at Mount Jarvis, was previously mapped as Carboniferous in age from reconnaissance study by Smith and Mertie (1930) on basis of

doubtful Mississippian fossils from this mountain. These rocks are here inferred to be part of the Baird Group on the basis of lithologic correlation with similar fossiliferous beds mapped elsewhere in sequences of allochthons four and five. Contains probable Upper Devonian alga Tharama sp. at fossil locality 51.

Dbs SHALY LIMESTONE (Devonian)--Gray to buff-weathering, thin-bedded shale and fine-grained limestone. Mapped in two recessive zones north of Mount Jarvis.

mi MAFIC BASALTIC ROCKS (Cenozoic to Paleozoic)--Mapped at two locations, both with uncertain stratigraphic and structural relations. At one exposure located in northwest part of the map surrounded by Okpikruak Formation, basalt is composed of altered and partly vesicular(?) mafic volcanic rocks. Age and contact relations are uncertain. Another group of exposures is located north of Mount Jarvis and consists of a series of outcrops with brown-weathering basalt and diabase that may be parts of allochthons four, five and(or) six.

MzPzi MAFIC TO INTERMEDIATE PLUTONIC ROCKS (Mesozoic and/or Paleozoic)--Mapped at two outcrops. One is composed of a coarse-grained gabbroic rock located in a valley about five km southwest of Kisemaraktuk Mountain. Consists of plagioclase with minor augite and brown hornblende. Minor quartz in exsolution textures with plagioclase. The other outcrop makes up a small steep-sided hill south of Kisemaraktuk Mountain. Consists of medium- to coarse-grained diorite and quartz-diorite composed of plagioclase and quartz with lesser amounts of brown hornblende and biotite. Quartz-plagioclase exsolution textures are common. Age of both outcrops is tentative and is based on similarity with intermediate plutonic rocks in the Copter igneous sequence and on similarity with igneous cobbles collected from Early Cretaceous conglomerate in the Okpikruak Formation that are Jurassic in age (Mayfield and others, 1978).

MzPzm METAMORPHIC ROCK (Mesozoic and/or Paleozoic)--Includes fine-grained quartz-sericite schist interpreted to be metachert(?) and amphibole-epidote-plagioclase schist interpreted to be metabasite. Metamorphism probably occurred during Late Jurassic and(or) Early Cretaceous at base of Misheguk Mountain allochthon during ophiolite obduction. Mapped only at two small outcrops along Kisimilat Creek north of Mount Jarvis.

Pzs FELDSPATHIC SANDSTONE (Paleozoic)--Fine-grained, light brown-weathering, calcareous sandstone composed of quartz, plagioclase, and potassium feldspar. May correlate with the feldspathic sandstone member of the Kayak Shale in the Bogie sequence. Age is probably either Devonian or Mississippian. Mapped at two small outcrops, one at the base of a small hill of diorite south of Kisemaraktuk Mountain and the other north of Mount Jarvis.

Explanation of map symbols

CONTACT--Dashed where approximately located

HIGH-ANGLE FAULT--Dashed where inferred, short dashed where concealed; queried where doubtful; U=upthrown side; D=downthrown side

INTERSEQUENCE THRUST FAULT--Dashed where approximately located; dotted where concealed; sawteeth on upper plate; queried where extension of fault is doubtful; queried and dashed or dotted where existence of fault is doubtful. Half arrows show relative motion on cross section

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

OVERTURNED INTRASEQUENCE THRUST FAULT--Dotted where concealed

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

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

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
- Foliation in metamorphic rocks

QUERIED OUTCROPS--Plotted from aerial photographs and not investigated in the field. Identity of rocks making outcrop not known

FOSSIL LOCATIONS--Listed on table 1

Mml_3?
$Mko_{2?}$

ROCK SYMBOL--Queried where rock unit is doubtful; subscript number queried where the assigned allochthon is doubtful

P

PINGOS OR PINGO-LIKE STRUCTURES

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