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DETAILED STRATIGRAPHIC SECTIONS OF THE MISSISSIPPIAN ENDICOTT GROUP IN THE CENTRAL FRANKLIN AND EASTERN ROMANZOF MOUNTAINS, ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA

by

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INTRODUCTION

This report contains measured sections and preliminary environmental interpretations on the sedimentologic and stratigraphic evolution of the Mississippian Endicott Group in the Franklin and Romanzof Mountains, Arctic National Wildlife Refuge (Fig. 1). All data were collected during the 1988 field season. Measured sections and locations maps are included in the appendix at the end of this report. This project is part of an ongoing research effort in the Brooks Range by the Tectonics and Sedimentation Research Group at the University of Alaska-Fairbanks.

Reqional Perspective

In the northeastern Brooks Range, as in the subsurface at Endicott Field (and possibly in Umiat and Meade basins located to the west), the Endicott Group is autochthonous-to-parautochthonous and unconformably overlies pre-Upper Devonian basement rocks of the Franklinian Sequence (Nilsen, 1981; Moore and Nilsen, 1984; and Woidneck, et al, 1987). In the central and western Brooks Range the Endicott Group is present in three north-vergent thrust sheets, within which it rests conformably above carbonates of the Baird Group (Nilsen, 1981; Moore and Nilsen, 1984). The stratigraphy and sedimentology of this dominantly siliciclastic succession changes markedly between these three areas (Fig. 2). Relative to its occurrence in the

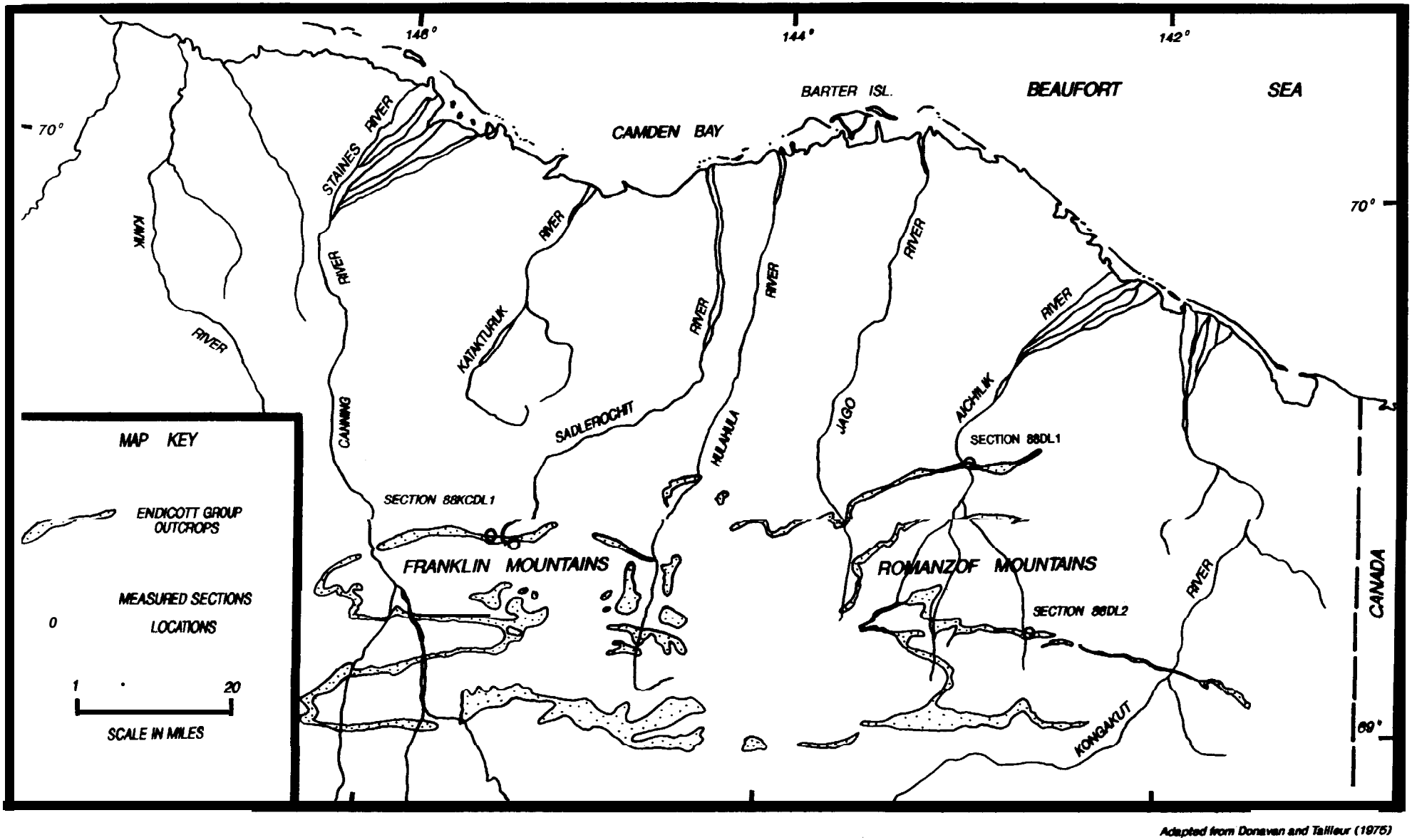

Figure 1 – Exposures of the Mississippian Endicott Group north of the continental divide in the Arctic National Wildlife Refuge, Alaska (measured sections shown with open circles).

central Brooks Range and the north slope subsurface, the Endicott Group in the northeastern Brooks Range is poorly understood.

Information on the relationships between the various Endicott Group sequences is critical to our understanding of the Devonian and Mississippian depositional and tectonic evolution of northern Alaska, and the circum-Arctic region. A detailed analysis of the Endicott Group in northeastern Alaska will aid in determining these relationships.

PURPOSE AND OBJECTIVES

The purpose of this study is to gain a better understanding of the stratigraphy, sedimentology, paleogeography, and tectonic setting of the Endicott Group in northeastern Alaska. The objectives are:

1.) To determine the sedimentologic and structural nature of the pre-Mississippian unconformity, its relationship to the Kekiktuk Conglomerate and the structural evolution of the Franklin and Romanzof Mountains.

2.) To perform a petrofacies analysis of the framework constituents to determine their provenance.

3.) To carry out a detailed facies analysis of the Endicott Group, with emphasis on the internal geometry and lateral variations within the Kekiktuk Conglomerate, and the sandstones and bioclastic/biohermal limestones of the Kayak Shale. The facies analysis will also include characterizing the nature of the transition between the Kekiktuk

Conglomerate and the Kayak Shale, and the Kayak Shale and the Alapah Limestone (Lisburne Group).

4.) To determine the depositional environments recorded in the Endicott Group.

5.) To reconstruct the paleogeography of northeastern Alaska during Endicott time.

REGIONAL GEOLOGIC SETTING

The Endicott Group in the northeastern Brooks Range crops out along the northern and southern flanks; of several regional anticlinoria, which extend approximately from the Canning River eastward to the Canadian border and beyond (Bader and Bird, 1986). Extensive exposures of the complexly deformed and metamorphozed sediments and igneous rocks of the Franklinian Sequence occur within the core zones of these anticlinoria (Mull, 1982). The Endicott Group forms the base of the Ellesmerian Sequence in this region, and rests with distinct angular discordance above the metasediments and igneous rocks of the Franklinian Sequence (pre-Upper Devonian basement). Regional studies of the northeastern Brooks Range indicate that the pre-Upper Devonian basement rocks were deformed by thrust faulting during a Middle Paleozoic orogeny (Mull, 1982). Pre-Upper Devonian rocks were subsequently thrust northward during the Cretaceous Brookian Orogeny to form large duplex structures (W. K. Wallace, oral commun., October and November 1988).

A limited body of literature exists on the geology of the northeastern Brooks Range, however, several informative papers are available for more detailed disscussions of regional geology: Bird and Bader (1987); Bird and Molenar; Bowsher and Dutro (1957); Brosge, et al. (1962); Reed (1968); Sable (1977). Nilsen (1981) and Moore and Nilsen (1984) provide an excellent general regional prospective of the Endicott Group in northern Alaska. Melvin (1987a and 1987b) and Woidneck and others (1987) provide useful discussions of the depositional environments, petrography, and reservoir characteristics of the Kekiktuk Formation in the subsurface at Endicott Field.

STRATIGRAPHY

Excellent exposures of the Endicott Group occur along Straight Creek (Lat. 69 deg. 18 min. N and Long. 145 deg. 31 min. W) and on the east side of a large cirque-basin, located at the headwaters of the third major drainage west of Whistler Creek (Lat. 69 deg. 17 min. N and Long. 145 deg. 15 min. W), both in the Franklin Mountains (figure 1). Several partial sections of the Endicott Group containing portions of the Kekiktuk Conglomerate and Kayak Shale occur along a tributary to Leffingwell Fork in the Romanzof Mountains (Lat. 69 deg. 11 min. N and Long. 142 deg. 39.5 W).

Kekiktuk Conglomerate

The Kekiktuk Conglomerate west of Lake Peters consists of a 59-to-79 meter thick, fining upward succession of polymictic, chert and quartz-pebble conglomerate and medium- to very coarse-grained sandstone (measured sections 88KCDL1 and 88KCDL2). Minor amounts of platy, black slate and gray-black carbonate clasts occur mixed in with the chert and quartz. The lower 40-to-45 meters is distinctly fluvial and contains multiple fining and coarsening upward cycles from 7-to-15 meters thick. Each cycle consists of an erosional lower contact which is overlain by a massive-to cross-stratified, multiply-erosional channel-fill succession. Individual channel-fills consist of imbricated, granule-to pebble conglomerate that generally fines upward to medium-to very coarse-grained sandstone. Near the tops of fining upward cycles, individual channel-fills grade upward from coarse-to very coarse-grained to medium-grained sandstone. Individual channel-fills range from < 0.5 meter to approximately 1.0 meter in thickness.

The top-most portions of many sandstone beds show evidence of extensive bioturbation and, near the top of the fluvial sequence, megaripples are preserved on some exhumed bedding surfaces. The bases of many individual channel-fill sequences cut into gray-black, organic-rich, argillaceous silty-to fine-grained sandstones lo-to-60 cm thick. These finer-grained lithologies contain abundant broken and carbonized plant fossils, show extensive bioturbation, and often exhibit flaser bedding. Similar fine-grained deposits

are observed as mud drapes overlying the tops of some channel-fill sequences. Cycle thicknesses range from five to 17 meters. These are interpreted to be either abandoned channel fill, slack water, or flood-plain deposits.

The upper-most 19-to-34 meters of the Kekiktuk Conglomerate consists of multiply-erosional channel-fill successions, as in the lower Kekiktuk (sections 88KCDL1 and 2). However, they are restricted to the lower-most beds, and are composed of medium-to very coarse-grained sandstone, and grade upward near the top of the Kekiktuk into extensively bioturbated, medium-bedded, fine-to coarse-grained chert-quartzose sandstone. Many of the finer-grained uppermost beds are trough cross-stratified with internal ripple-drift cross-laminae. Gray-black mudstone interstratified with the finer-grained sandstones become more abundant near the top of this interval. Plant fossils progressively decrease in abundance upward in this interval.

East of Lake Peters, in the eastern Romanzof Mountains north of Bathtub Ridge, the basal portion of the Kekiktuk Conglomerate exhibits greater grain-size variability. In a disrupted section located immediatetly east of Leffingwell Fork, on the west bank of an unnamed tributary (section 88DL2 at Lat. 69 deg. 11 min. N and Long. 142 deg. 39.5 min. W), the basal beds of the Kekiktuk consist of polymictic, granule-to pebble-conglomerate, which grade upward into medium-to coarse-grained sandstone; whereas exposures of the lower-most beds of the Kekiktuk immediately west of the Aichilik River consist of polymictic, cobble conglomerate,

containing clasts as large as 30 centimeters.

The contact between the Kekiktuk Conglomerate and the Kayak Shale has not been precisely defined as yet, due to the interfingering nature of the two formations. We propose herein that the contact be placed at the base of the first prominent occurrence of shale, siltstone, or mudstone occurring above the uppermost interval of the Kekiktuk Conglomerate that is laterally continuous at outcrop scale.

Kayak Shale

The upper beds of the Kekiktuk Conglomerate interfinger with organic-rich shale, siltstone, and quartzarenite of the Kayak Shale (section 88KCDL1). Measured thicknesses of the Kayak Shale west of Lake Peters range from 151-to-162 meters. These estimates may exaggerate the true stratigraphic thickness of the Kayak Shale, since in this region (as elsewhere) it serves as a detachment horizon along which there may have been structural thickening (Wallace, personal commun., October 1988). Additional work is necessary to address the degree of structural thickening in this area.

The lower third (40-to-70 meters) of the Kayak Shale consists of siltstone and silty-shale, interrupted by several laterally continuous, coarse-grained intervals (sections 88KCDL1 and 2). The coarse-grained intervals consist of medium-to very coarse-grained, quartzose sandstone and chert-quartz granule-conglomerate that range from l-to-16 meters in thickness. Internally, the coarser

grained beds are trough cross-stratified, contain ripple-drift lamination, are extensivley bioturbated near their tops, and contain strongly undulatory bedding surfaces. Some of the thicker coarse-grained units contain large-scale lateral accretion surfaces (epsilon cross bedding).

The upper two-thirds (80-to-125 meters) of the Kayak Shale consists predominantly of gray-black, organic-rich, siltstone and shale, with occassional interbeds of bioclastic limestone (sections 88KCDL1 and 2). The bioclastic beds are composed of normally graded, broken and abraded crinoid and brachiopod fragments (0.1-1.0 centimeter thick in section 88KCDL1, Franklin Mountains; and 10-to-100 centimeters thick southeast of section 88DL2, Romanzof Mountains) that appear to have been deposited from episodic, waning-flow events. The Kayak Shale becomes increasingly calcareous upsection and, in sections 88KCDL1 and 2, is abruptly overlain by the Alapah Limestone (Lisburne Group).

ENVIRONMENTAL INTERPRETATION

The Endicott Group records a major transition from terrigenous clastic to carbonate depositional environments. The Kekiktuk Conglomerate represents depostion in braided, fluvial and deltaic systems. Retrograding environments gradually drowned the Kekiktuk dispersal system and initiated deposition of the Kayak Shale. The Kayak Shale represents an extensive suite of lagoonal, tidal and storm-dominated inner shelf environments. The uppermost beds in

the Kayak Shale consist of bioclastic and biohermal silty limestone. These record the final transition from terrigenous clastic deposition to deposition of the major carbonate platform of the Lisburne Group.

ACKNOWLEDGMENTS

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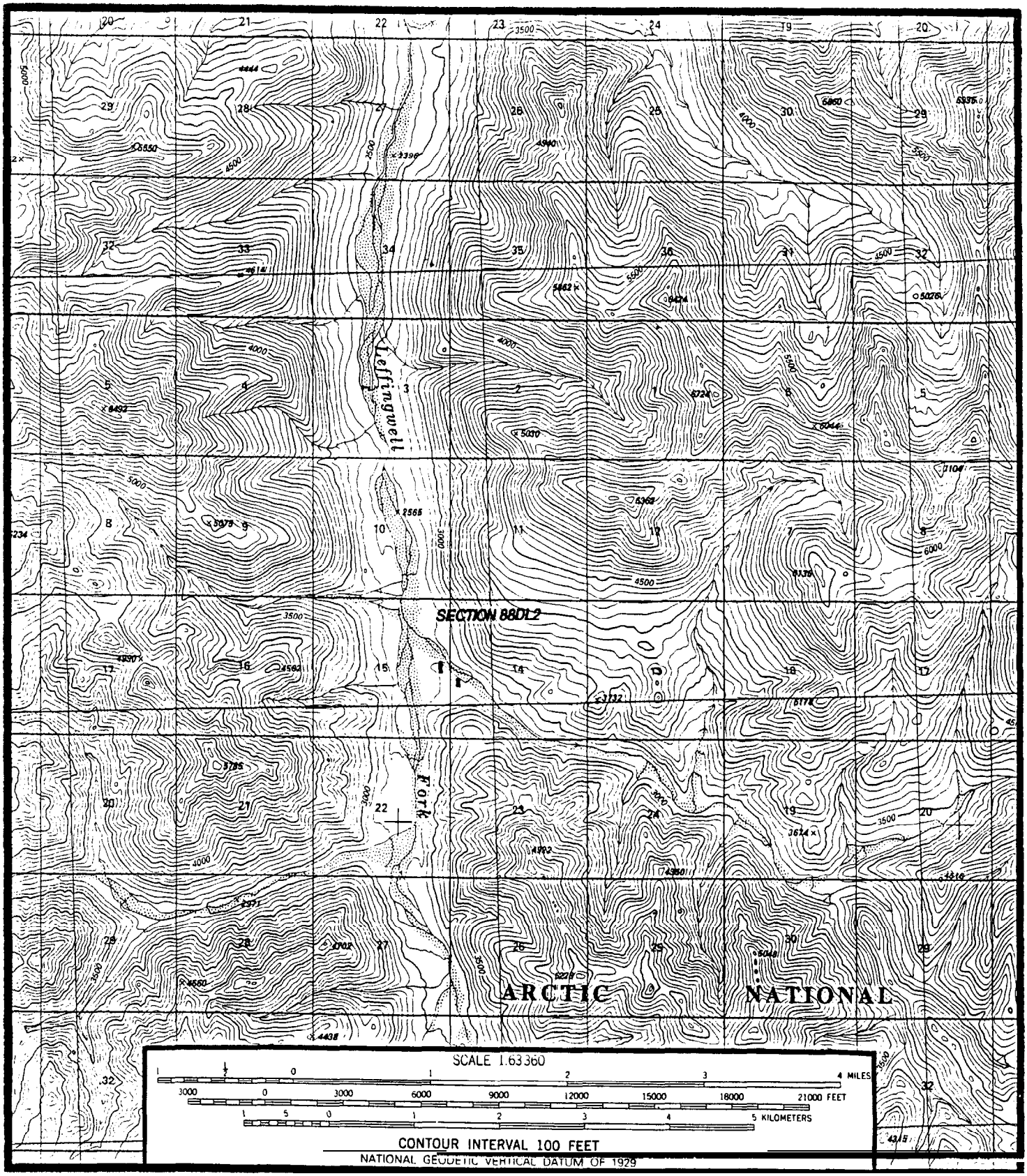
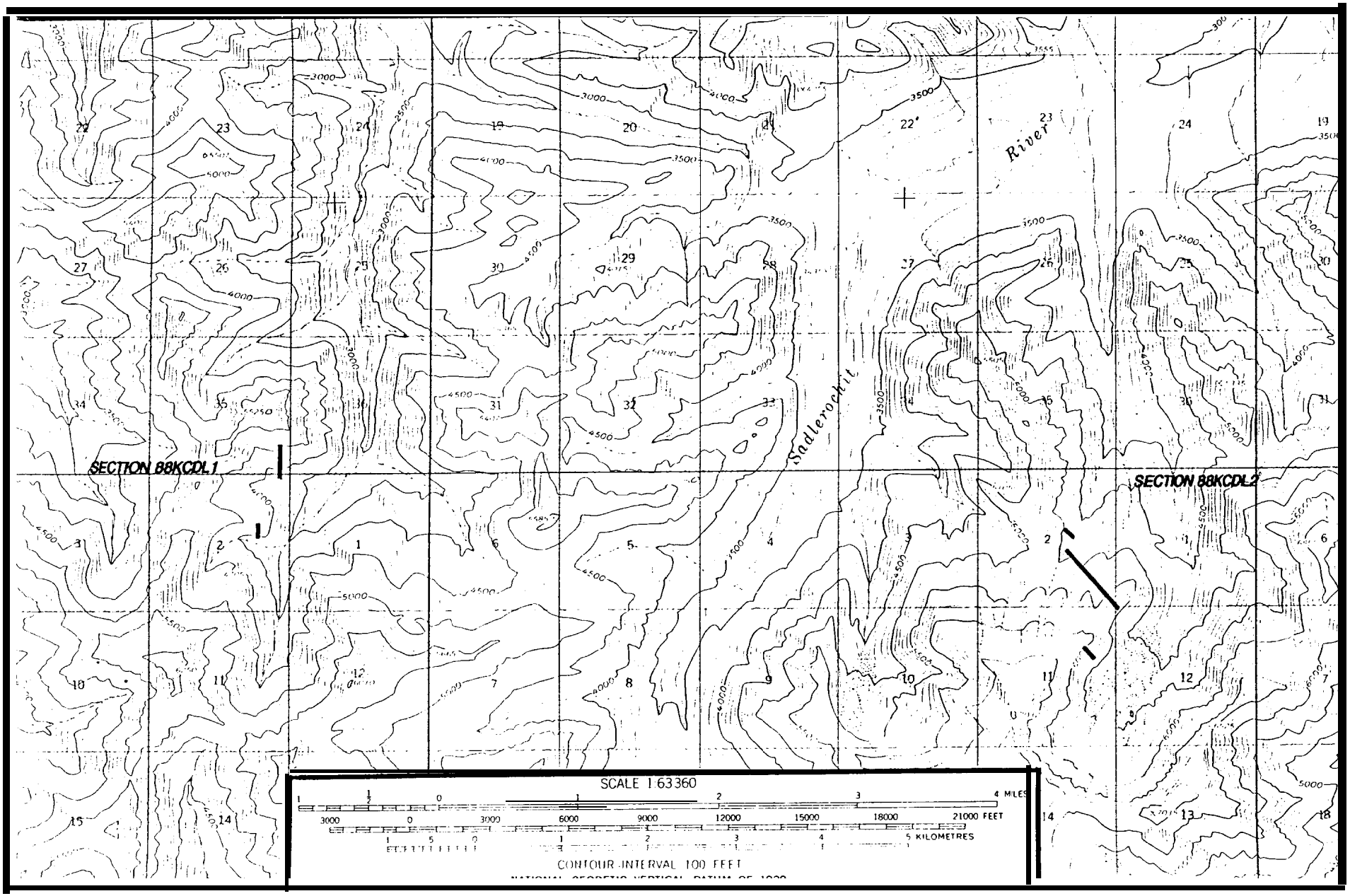


Topographic map showing the location of section 88DL2 in the Romanzof Mountains, north of Bathtub Ridge (Demarcation Point Quadrangle).



Topographic map showing the location of sections 88KCDL1 and 88KCDL2 in the central Franklin Mountains, west of Lake Peters (Mt. Michelson Quadrangle).

SECTION KEY

Ripple-drift cross lamination 

Planar cross stratification 

Trough cross stratification 

Mutually erosive channels 

Lateral accretion surfaces 

Vertical burrows

Plant fragments 

Log imprints 

Rootlets 

Echinoderm fragments 

Brachiopod fragments 

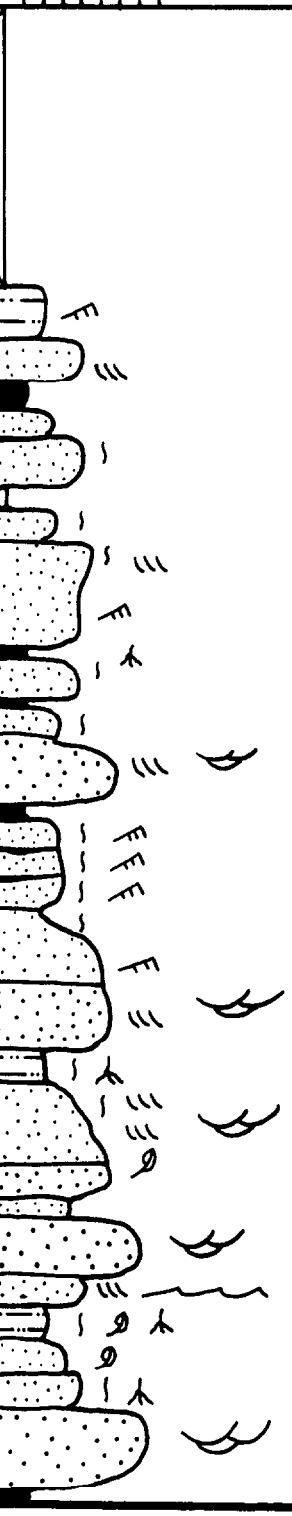
Key to symbols used in measured sections.

SECTION # 88KCDL1

MISSISSIPPIAN ENDICOTT GROUP

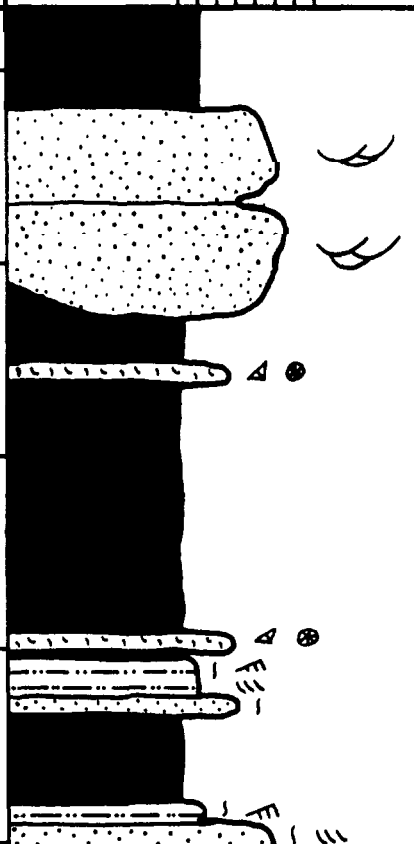
FRANKLIN MOUNTAINS

GROUP	FORMATION	THICKNESS (Meters)	GRAPHIC COLUMN	LITHOLOGIC DESCRIPTION
ENDICOTT GROUP	KAYAK SHALE	70		Covered interval.
	KEKIKTUK CONGLOMERATE	60		Salt and pepper colored, thin-to medium-bedded, litharenite, dark gray siltstone, and minor gray-black shale. Sandstones are locally channnelized and some contain lateral accretion surfaces.
		50		
		40		
		30		Tan-brown, polymictic, grain-supported, conglomerate and litharenite, with minor gray-black siltstone and silty shale.
		20		
		10		



MISSISSIPPIAN ENDICOTT GROUP

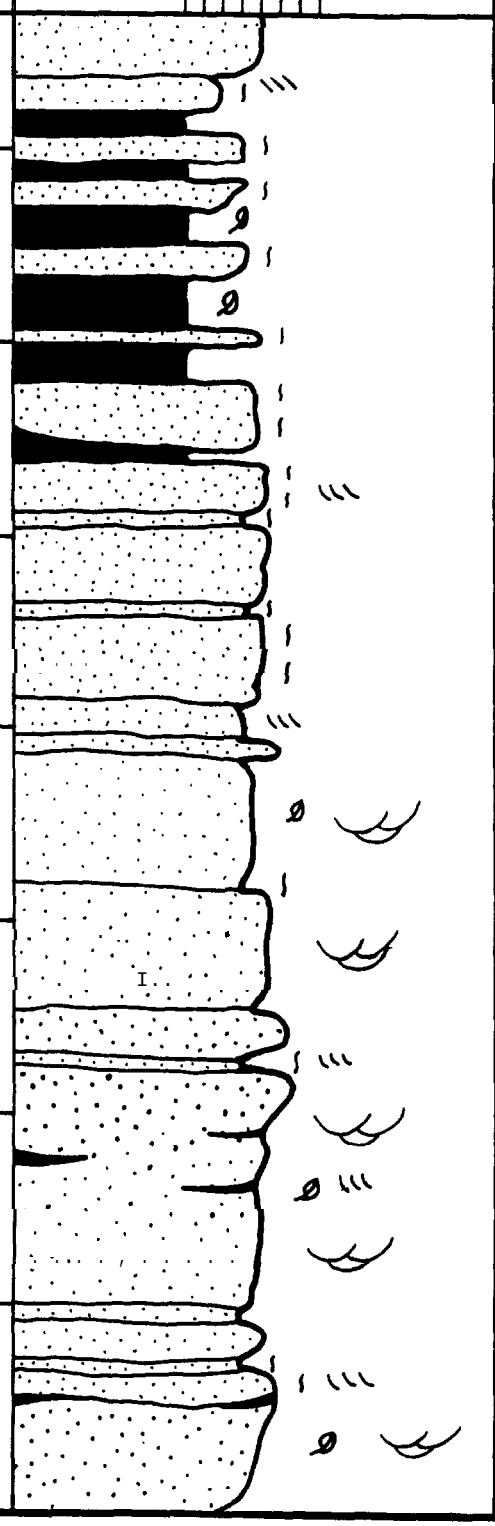
FRANKLIN MOUNTAINS

GROUP	FORMATION	THICKNESS (Meters)	GRAPHIC COLUMN	LITHOLOGIC DESCRIPTION
ENDICOTT GROUP	KAYAK SHALE	150–140		Gray-black, fissile shale, with occassional thinly laminated-to thinly bedded, tightly folded, red-brown siltstone (46 meters): passes upsection into gray-black, calcareous siltstone (29 meters).
		140–130		Tan-brown colored, polymictic, chert and quartz-pebble conglomerate, passing upsection into medium-grained, quartz arenites.
		130–120		Gray-black, shaly siltstone, with interbedded, laterally continuous and normally graded lamina of arenaceous bioclastic limestone.
		120–110		Gray-black, organic-rich, shaly siltstone, with inter-stratified, medium bedded, tan-brown colored, medium- to coarse-grained, quartz arenite, and minor dark gray, silty, fine-to medium-grained litharenite. Litharenite has distinctive rusty-brown, iron-oxide stains on weathered surfaces, which arcassociated with vertical burrows.
		110–80		Covered interval.

SECTION # 88KCDL2

MISSISSIPPIAN **ENDICOTT GROUP**

FRANKLIN MOUNTAINS



LITHOLOGIC DESCRIPTION

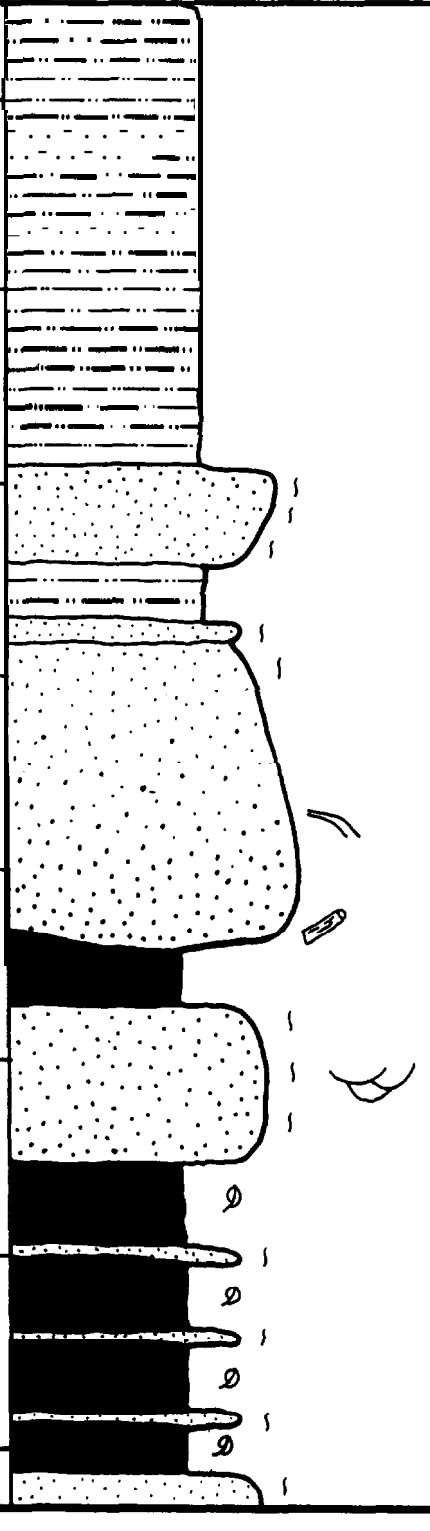
Black, organic-rich sandy and silty shale, with irregularly interbedded, massive, bioturbated litharenite

Orange-brown, medium-bedded, massive, bioturbated, polymictic conglomerate and litharenite. Vertical burrows visible on most bedding surfaces and are surrounded by iron-oxide stains. **Megaripples** visible on many bedding surfaces.

Tan-brown colored, polymictic, grain-supported conglomerate and litharenite, with minor gray-black siltstone and silty shale.

MISSISSIPPIAN **ENDICOTT GROUP**

FRANKLIN **MOUNTAINS**

GROUP	FORMATION	THICKNESS (Meters)	GRAPHIC COLUMN	LITHOLOGIC DESCRIPTION
			SAND CONG: CLAY SILT Fn Md Cs Gm Peb Cob	
ENDICOTT GRO 4	KAYAK SHALE	150		Gray-black, **siltstone,** appears bioturbated (inferred **fro** talus) .
		140		
		130		
		120		Tan-brown-to **orange-brown, polymictic** gonglomerate to litharenite, with minor silty, fine-grained sandstone.
		110		Black, **silty** shale
		100		Orange-brown, **massive,** bioturbated, litharenfte.
		90		Black, organic-rich, silty shale, **occassionally** interbedded **with** massive, **bioturbated, litharenite.**
		80		

MISSISSIPPIAN ENDICOTT GROUP

FRANKLIN MOUNTAINS

GROUP	FORMATION	THICKNESS (Meters)	GRAPHIC COLUMN	LITHOLOGIC DESCRIPTION
LISBURNE GROUP	ALAPAH LIMESTONE			
ENDICOTT GROUP	SHALE	210		Calcareous siltstone
		200		
		190		Black, **fissile,** silty shale.
		180		
	KAYAK	170		Dark red-brown, fine-grained sandstone. Unit contains small-scale overturned folds near top.
		160		

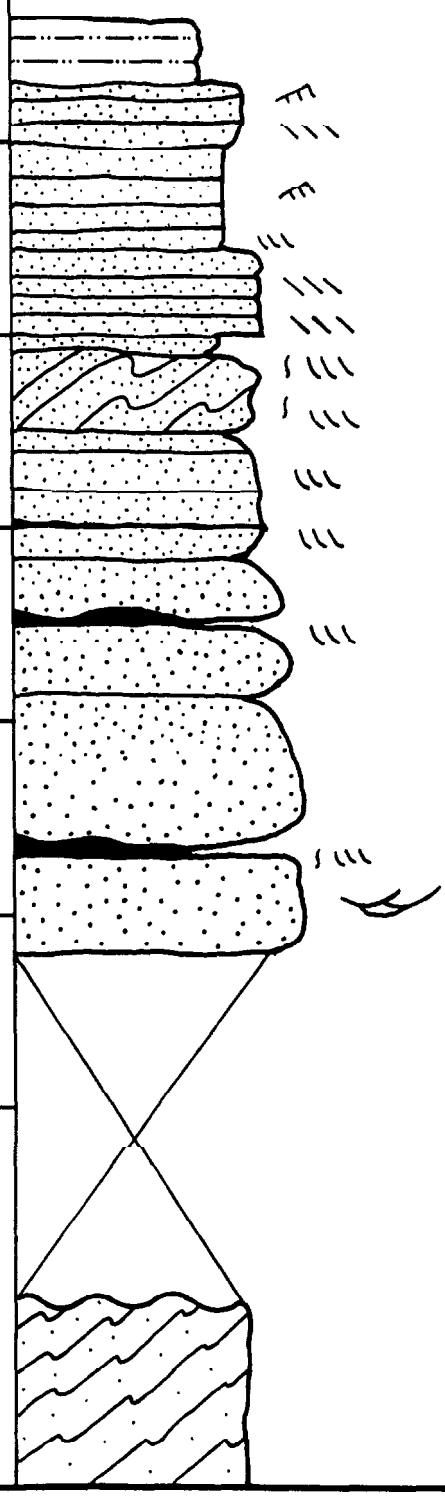
SAND CONG

CLAY SILT Fn Md Cs Gm Peb Cob

SECTION # 88DL2

MISSISSIPPIAN ENDICOTT GROUP

ROMANZOF MOUNTAINS

GROUP	FORMATION	THICKNESS (Meters)	GRAPHIC COLUMN (CLAY SILT Fn Md Cs Gn Peb Cob SAND CONG)	LITHOLOGIC DESCRIPTION
ENDICOTT GROUP	KEKIKTUK CONGLOMERATE	60		Gray-black, faintly laminated, **arenaceous** siltstone.
				Dark gray, thin-to medium-bedded, lithic **wacke.** In the middle **of** this interval beds are wavy and overlain by mud.
		50		Purple-gray, medium-bedded, sub-litharenite. Trough **cross-stratification** in **sets** 15-30 cm thick.
				Light **gray,** medium-bedded, litharenite. Bedding is disrupted **and** fractured, with **some fracture surfaces** containing **slickenside** striae. **Numerous quartz veins** cut through the zone oblique to bedding.
		40		**Light gray,** medium-bedded, **litharenite. Trough cross-**stratification in sets 15-20 cm thick.
		30		Light gray, polymictic, matrix supported conglomerate **and** litharenite, **with** minor **gray-black, burrowed** siltstone.
		20		Light Gray, **polymictic,** matrix supported conglomerate and litharenite, arranged in **10-15 cm** thick **fining** Upward cycles ; **top** of interval overlain by **black,** organic-rich, bioturbated silty shale.
		10		Covered interval.
	PRE-MISS. BASEMENT			