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# PRELIMINARY REPORT ON THE PALEOZOIC AND MESOZOIC SEDIMENTARY SEQUENCE ON ST. LAWRENCE ISLAND, ALASKA

By

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# PRELIMINARY REPORT ON THE PALEOZOIC AND MESOZOIC SEDIMENTARY SEQUENCE ON ST. LAWRENCE ISLAND, ALASKA

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Abstract.--Preliminary investigations in the eastern part of St. Lawrence Island indicate the presence of a heretofore unreported Paleozoic and Mesozoic sequence possibly as much as 8,000 feet thick. The oldest strata are represented by a thick sequence of Devonian dolomite and dolomitic limestone exposed along the Seknak River. The upper contact of this sequence is not exposed on the Seknak River but similar rocks on the Ongoveyuk River appear to be succeeded disconformably by at least 1,000 feet of Upper Mississippian limestone and cherty limestone. These rocks are in turn overlain disconformably by a 400-foot shaly sequence that is definitely of Middle and Late Triassic age in the upper part and probably of Early Triassic or Permian age in the lower part. The youngest sedimentary rocks appear to be a thick section of graywacke and mudstone along the Ongoveyuk River which tentatively has been assigned a Jurassic or Cretaceous age.

This Paleozoic and Mesozoic sequence shows strong lithologic and faunal similarities to coeval rocks in the western and central Brooks Range. In addition, counterparts of some of these Paleozoic and Mesozoic rocks appear to be present on the Seward and Chukotsky peninsulas.

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During the summer of 1968 the U.S. Geological Survey began reconnaissance mapping, stratigraphic studies, and geochemical sampling of the bedrock areas on St. Lawrence Island in the northern Bering Sea. These investigations are part of a broad program of onshore and offshore studies pointed toward assessing the mineral resources of the Bering Sea shelf (fig. 1). St. Lawrence Island by virtue of its unique

Figure 1 near here

geographic position serves as a valuable "window" to the subbottom geology of the shelf and is critical to the interpretation of marine geophysical data.

The purpose of this paper is to report briefly on a heretofore little known sequence of Paleozoic and Mesozoic rocks exposed in the eastern part of St. Lawrence Island. These rocks are of regional significance because they provide a stratigraphic tie between mainland Alaska and eastern Siberia and, hopefully, shed some light on the puzzling tectonic relationships between the North American and Asian land masses. In addition, they are of interest in the search for new sources of petroleum because they suggest that large parts of the Bering Sea shelf may be underlain by a thick section of Paleozoic carbonate rocks.

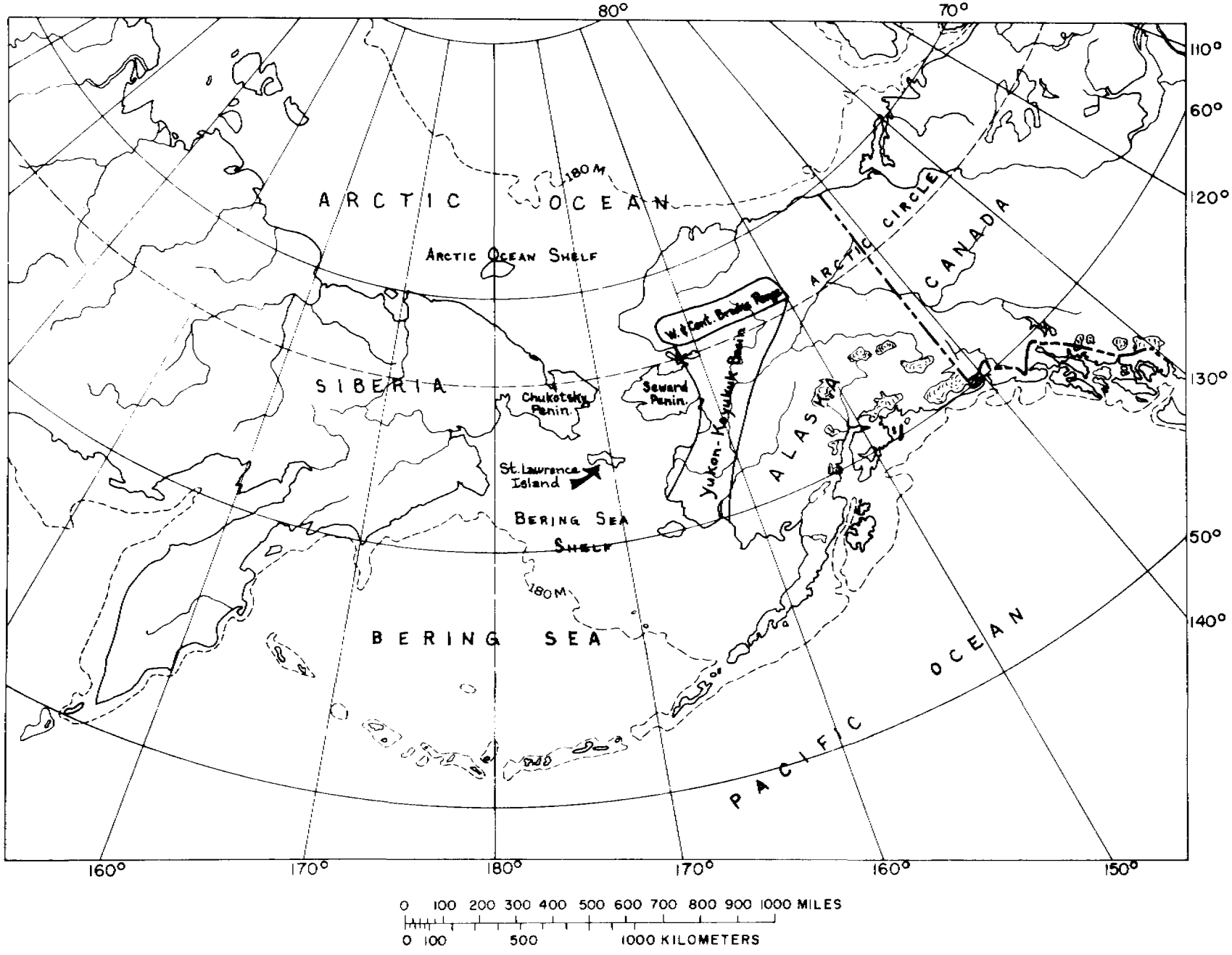


Figure 1. Index map showing St. Lawrence Island and shelf areas of the Bering Sea and Arctic Ocean.

The stratigraphic data presented in this report are based on three weeks of fieldwork during July 1968. Inasmuch as only a small portion of the eastern part of the island has been critically examined thus far, these data should be regarded as preliminary and tentative.

Very little published information on the geology of St. Lawrence Island is available. Previous investigations were confined to exploratory surveys along the coast (Dawson, 1894; Emerson, 1904; Collier, 1906) and to an unpublished terrain study prepared by the U.S. Geological Survey (Muller, 1959) for the Army Corps of Engineers. Aside from a brief mention of the Triassic strata (Martin, 1926) no information has been published about the Paleozoic and Mesozoic sedimentary rocks.

## GEOLOGIC SETTING

The eastern part of St. Lawrence Island is a broad, wave-cut, bedrock platform now elevated from a few feet to nearly 100 feet above sea level (fig. 2). The surface of the platform is dotted with

Figure 2 near here

countless small, shallow lakes and blanketed by a thin veneer of water-soaked mossy turf and peat. Several isolated groups of talus-covered hills, which are bounded by ancient sea cliffs and probably represent former islands, rise 1,000 to 2,000 feet above the surface of the platform.

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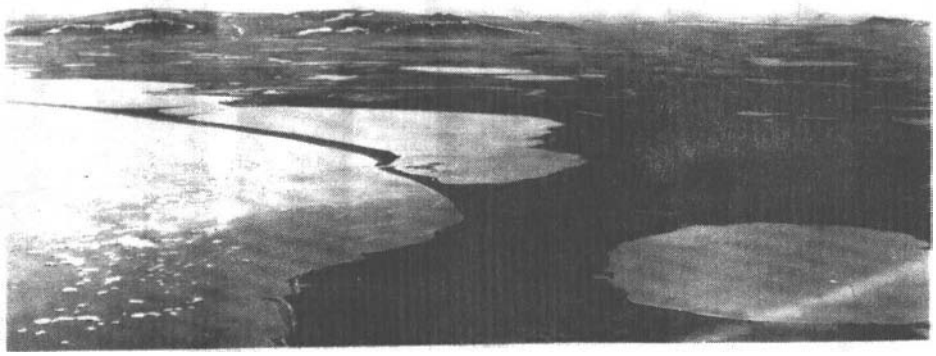

A. View of eastern part of St. Lawrence Island from north coast showing wave-cut platform carved across folded Paleozoic and Mesozoic sediments. Hills in background composed chiefly of granitic intrusives. (Photo by U. S. Navy)

B. Incised tributary of Ongoveyuk River with cutbank exposures of Mississippian and Triassic strata in foreground and middle distance and Jurassic-Cretaceous (?) strata in background. (Photo by T. P. Miller)

FIGURE 2

The Paleozoic and Mesozoic strata are sparsely exposed along small drainages which are incised as much as 30 feet into the platform (fig. 2). The best exposures of these rocks are found along the Ongoveyuk, Seknak, and Maknek Rivers and their tributaries (fig. 3). However,

Figure 3 near here

even along these drainages the exposures are discontinuous and the bedrock is largely reduced to frost-riven talus.

Bedding attitudes where discernible indicate that the Paleozoic and Mesozoic strata are everywhere highly folded with dips locally as high as 90°. The gross distribution of the rock units suggests that these strata have a north to northeast regional strike and a west to northwest regional dip. Examination of aerial photos reveals that all the bedrock units are cut by two sets of lineaments trending approximately N. 50° E. and N. 25° W.

Granitic intrusives and volcanic rocks of late Mesozoic and Cenozoic age, which underlie all the hilly areas as well as large parts of the wave-cut platform, have thermally altered broad areas of the surrounding sedimentary rocks. In addition, all the sedimentary rock units are pervasively intruded by a variety of felsic and mafic sills and dikes.

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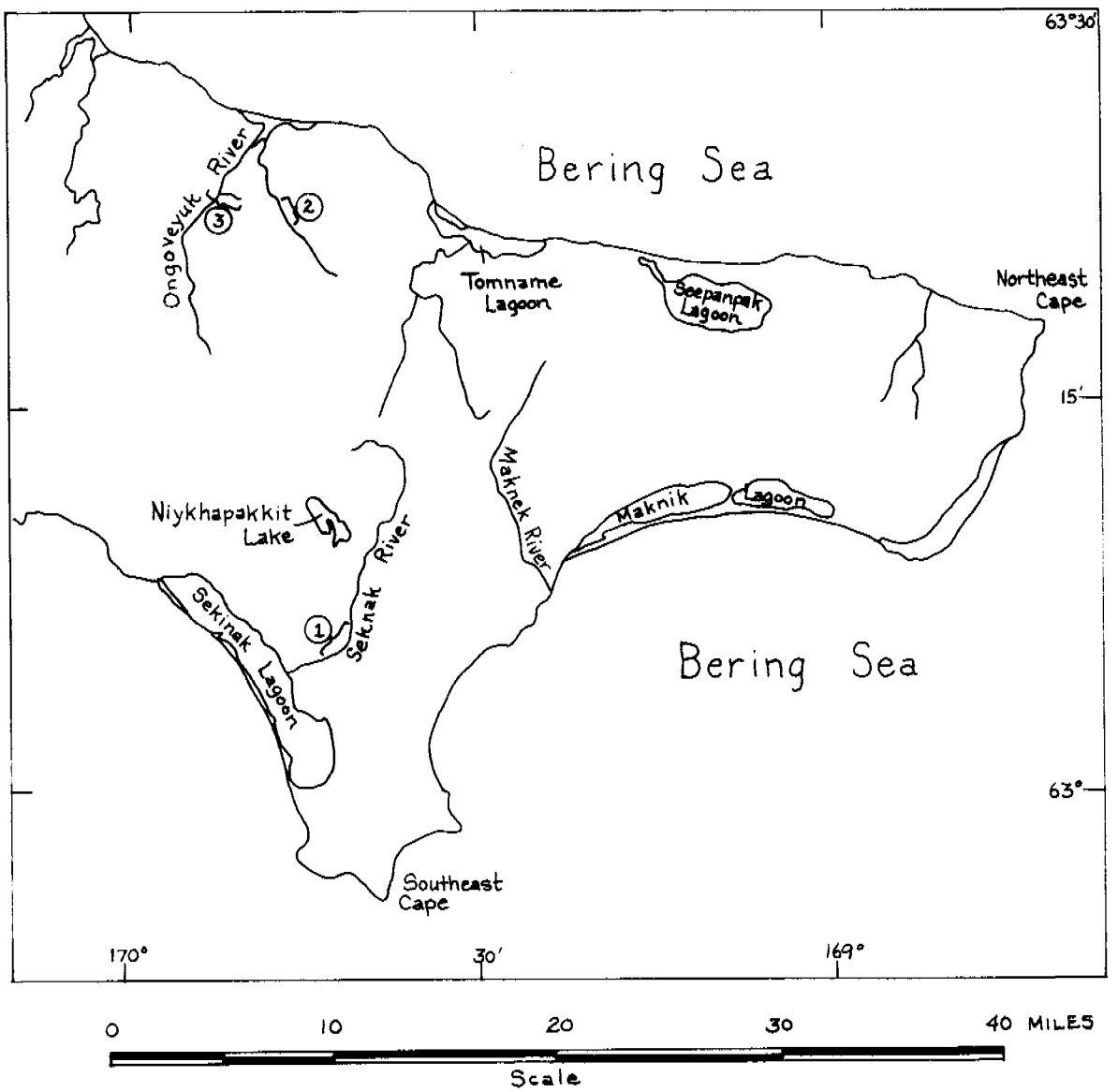


Figure 3. Map of eastern St. Lawrence Island showing location of Paleozoic and Mesozoic sections (see Figure 4 ).

## DEVONIAN

The oldest rocks recognized in the eastern part of St. Lawrence Island comprise a thick sequence of dolomites and dolomitic limestones of probable Devonian age. These rocks are widely exposed along the Seknak and Maknek Rivers on the south side of the island and in a small area along the Ongoveyuk River on the north side of the island.

The bulk of the exposed sequence (fig. 4) is composed of medium-

Figure 4 near here

gray to brown, laminated, locally brecciated dolomite and dolomitic limestone which contain poorly preserved Amphipora(?). In the upper part these beds grade into dark-gray to black, fine-grained, thin-bedded dolomite with abundant Amphipora(?) and corals. A few thin beds of black chert and black silty dolomite are intercalated near the top of the sequence.

The sequence is best exposed along the lower Seknak River (fig. 3) in a series of discontinuous cutbanks. The beds strike uniformly north-northwest and dip on the average of 30° NE. Judging from the width of outcrop, the sequence may be as much as 4,000 feet thick. The top of the sequence is not exposed on the Seknak River. However, on the Ongoveyuk River dark thin-bedded dolomites similar to those in the upper part of the Seknak River section are succeeded by cherty and sandy limestones of Late Mississippian age.

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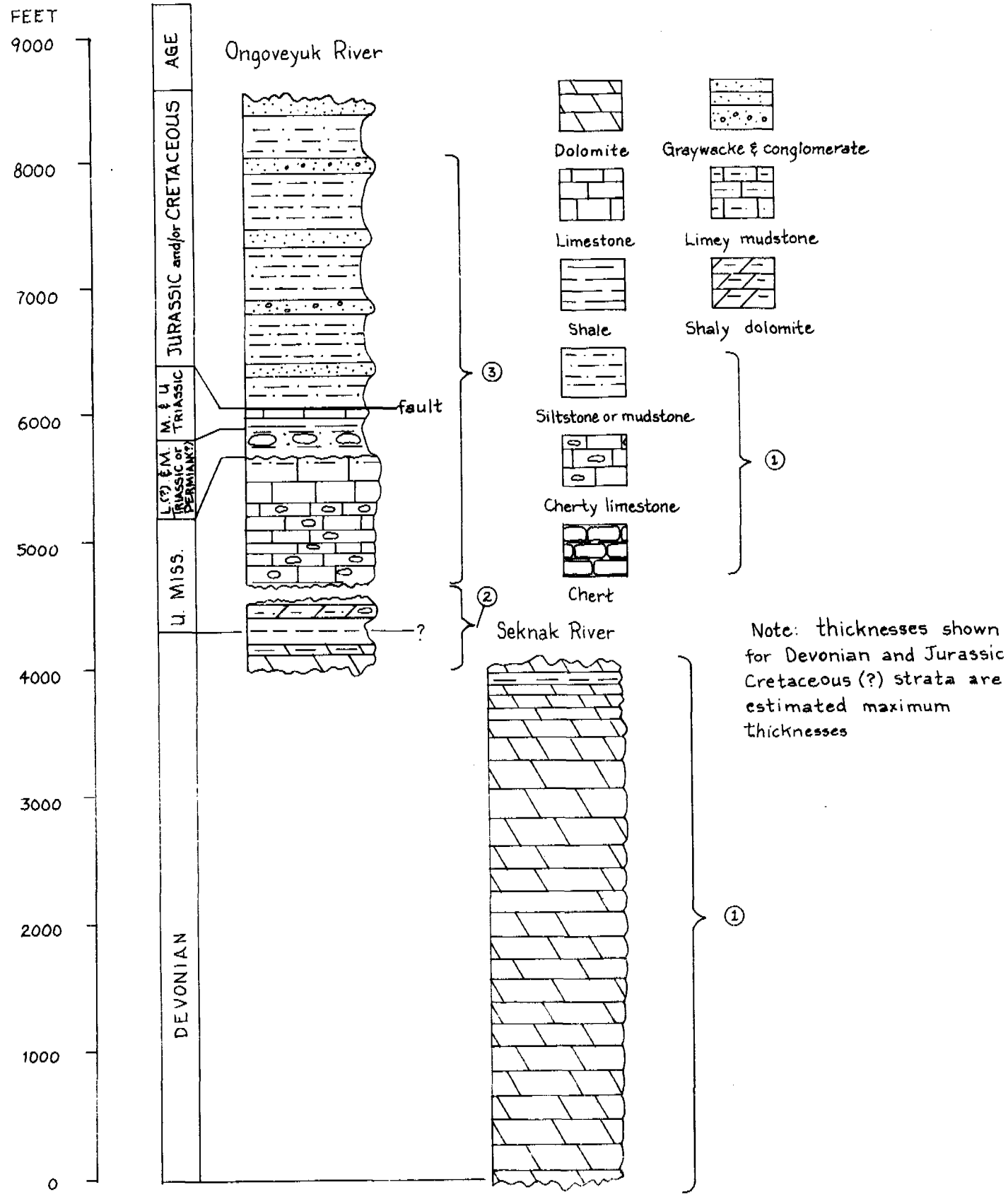


Figure 4. Generalized columnar section of Paleozoic and Mesozoic sedimentary rock, eastern St. Lawrence Island (see Figure 3 for location of sections).

Five collections of stromatoporoids and corals from the Seknak River sequence were examined by W. A. Oliver, Jr. (personal commun., 1968), who reports that they represent the stromatoporoid genus Amphipora(?) and tabulate corals including Favosites and thamnoporoid forms. He states that a Devonian age is strongly suggested, possibly Givetian or Frasnian, although these fossil groups range earlier into the Silurian.

## MISSISSIPPIAN

Strata of Mississippian age are widely distributed along the Ongoveyuk River in the northern part of the island and occur in scattered rubble patches around the shores of Niykhapakhit Lake in the central part of the island. These rocks can be divided informally into two members (fig. 4): a thin-bedded dark-colored cherty member below; and a thick-bedded light-colored limestone member above. The lower member, about 600 feet thick, contains abundant dark-gray chert nodules--as much as 35 percent to 40 percent in the upper 50 feet and 5 percent to 20 percent in the lower part. The upper member, about 350 feet thick, is nearly chert-free and is composed chiefly of light- to medium-gray, medium to coarsely bioclastic limestone. Lime mudstone comprises about 30 percent of the top 50 feet of the member.

The total thickness of the Mississippian sequence in the Ongoveyuk River area probably does not exceed 1,500 feet. Nearly 1,000 feet of section, including the upper contact, is almost completely exposed on a small tributary of the Ongoveyuk River (fig. 3). The lower contact is not exposed at this locality, but on the east fork of the Ongoveyuk River fossiliferous cherty and sandy limestones of Late Mississippian age are separated by only a narrow covered interval from dolomites of probable Devonian age (figs. 3 and 4).

Fossils of Late Mississippian age were found at several levels in the sequence. Among the more significant forms are Gigantoproductus brachiopods that occur about 100 feet above the base of the upper member. This interval correlates in a general way with the Gigantoproductus Zone in the upper part of the Alapah Limestone of the central Brooks Range sequence (Bowsher and Dutro, 1957, p. 5-6; Yochelson and Dutro, 1960, fig. 24).



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Three collections near the base of the sequence contain many specimens of what is probably a new species of Rugosochonetes, together with a rich endothyroid microfauna of Viséan age, according to A. K. Armstrong (written commun., 1966). An assemblage from the lower 200 feet of the sequence (corals identified by W. J. Sando, written commun., 1968) includes:

Caninia sp.

Syringopora (Kuiechowpora) cf. S. virginica Butts

Zaphrentis sp. (large)

echinoderm debris, indet.

ramose bryozoans, indet.

Anthracospirifer sp.

productoid fragment, indet.

Sando states that the corals "...indicate a possible early Chester age, although a late Meramec age cannot be ruled out."

Another collection from an indeterminate level in the sequence contains Ekvasophyllum? sp. that suggests to Sando (written commun., 1968) either an early or middle Meramec age. A lithostrotionoid coral collected as float by T. P. Miller in 1966 was identified as Lithostrotionella aff. L. mclareni Sutherland by Armstrong (written commun., 1966) who suggested that it indicates a Meramec age. Similar corals occur in the lower part of the Alapah Limestone in the central Brooks Range, together with Meramec age endothyroids and brachiopods, according to Armstrong.



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Thus, the faunal evidence indicates that the sequence is approximately correlative to the Alapah Limestone, with an age range from early Meramec through possible early Chester. More detailed studies of the foraminifera are now in progress. Hopefully, these will establish more precise ages and correlations.

## TRIASSIC

The Mississippian strata on the Ongoveyuk River are overlain by a 400-foot section of siltstone, shale, dark chert, and limestone that contains Triassic fossils in the upper part. Similar rocks also were found at scattered localities along the streams that drain into Tomname Lagoon. Triassic fossils also have been identified (unpublished notes, E. H. Muller and others, 1948-1949) in float from the northwestern part of the island but the presence of Triassic bedrock in this part of the island has not been established.

The upper 170 feet of the Ongoveyuk River section (fig. 4) is chiefly black shale, dark-gray to tan-weathering, thin-bedded limestone, and dark chert. Flat clams identified as Daonella, Halobia, and Monotis by N. J. Silberling (personal commun., 1968) occur in vertical sequence and indicate a condensed section including beds of Ladinian, Karnian, and Norian age. The lithologic and faunal character of these beds is remarkably similar to the upper part of the Shublik Formation (Limestone and Chert Members) in the Brooks Range of northern Alaska (Patton and Tailleur, 1964) (fig. 5).

Figure 5 near here



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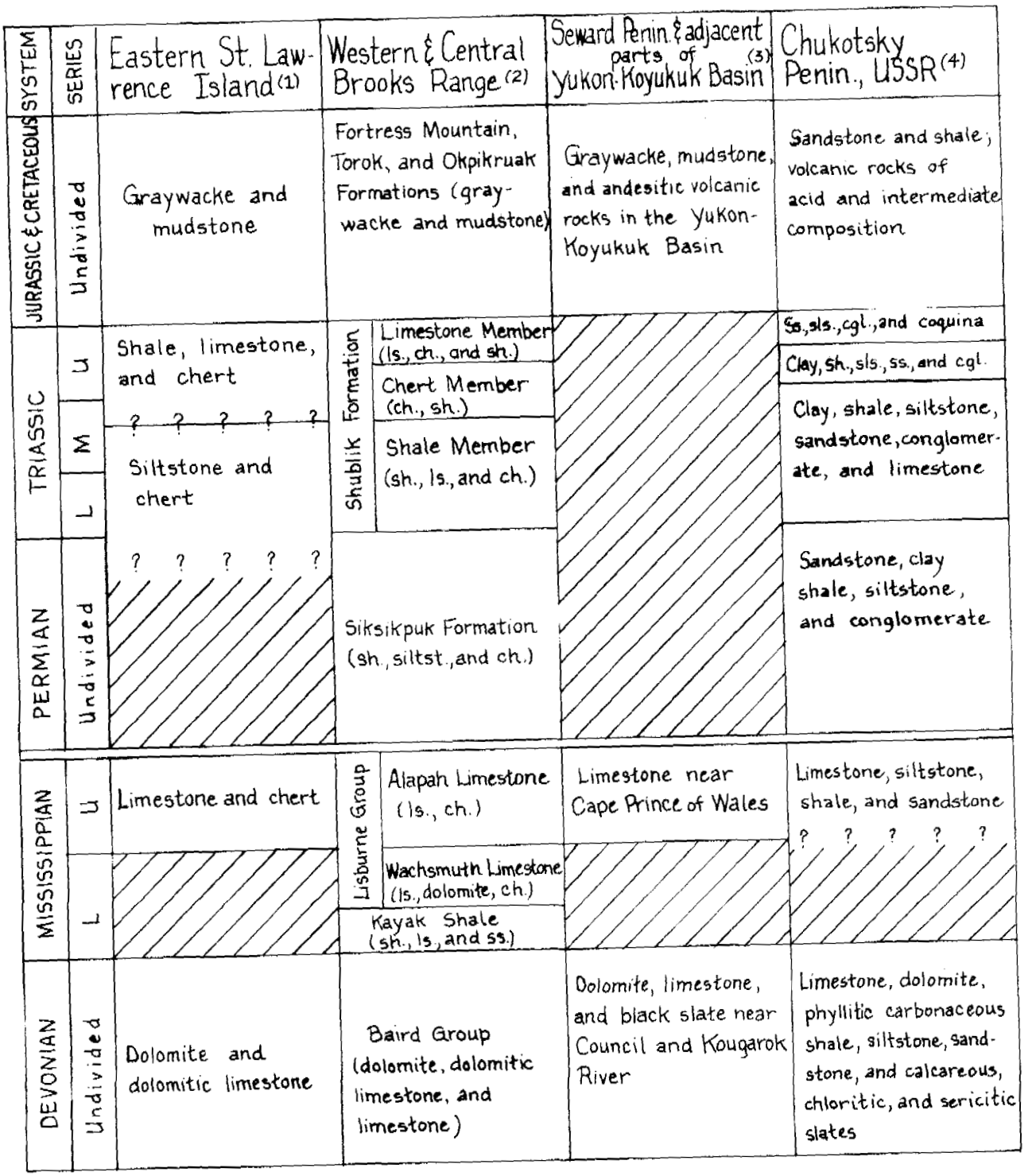


Source data: (1) This report.
(2) Patton and Tailleur, 1964; Bowsher and Dutro, 1957; Tailleur and others, 1967.
(3) Patton, 1967; Steidtmann and Cathcart, 1922; Gryc and others, 1967.
(4) Sachs and Strelkov, 1961; Markov and Tkachenko, 1961; Krasny, 1964.

Figure 5 Suggested correlation of Paleozoic and Mesozoic sequences of eastern St. Lawrence Island, Western Alaska, and Chukotsky Peninsula (USSR).

The lower 225 feet of the Ongoveyuk River section is mostly thin-bedded chert and dark siltstone. These beds have yielded no fossils but their lithologic character suggests a possible correlation with either the Shale Member (Early? and Middle Triassic) of the Shublik Formation or the Siksikpuk Formation (Permian?) (fig. 5).

## JURASSIC-CRETACEOUS(?)

The youngest Mesozoic strata appear to be a thick sequence of graywacke and mudstone which tentatively is assigned a Jurassic or Cretaceous age. These rocks are extensively exposed along the middle course of the Ongoveyuk River and also occur in scattered patches of rubble along the streams that drain into Tomname Lagoon. As yet, however, they have not been identified elsewhere on the eastern part of the island.

Gross structural relationships clearly suggest that these graywacke and mudstone strata immediately overlie the Triassic beds, although the exposed contact on the Ongoveyuk River is complicated by faulting. The upper contact is not exposed, but it appears that these strata dip northwestward beneath the Cenozoic(?) volcanic rocks which crop out along the lower Ongoveyuk River.

No fossils have been found in the graywacke and mudstone beds and their tentative age assignment is based on: 1) their apparent stratigraphic position above the Triassic strata and below the Cenozoic(?) volcanic rocks, and 2) the widespread occurrence of graywacke and mudstone of Jurassic and Cretaceous age in adjacent parts of mainland Alaska.



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The graywacke, which comprises 15 percent to 25 percent of this unit, is typically a dark-greenish-gray, well-indurated, poorly sorted, fine-grained, muddy sandstone that locally displays sole markings, graded bedding, and other features characteristic of turbidites. Thin intraformational polymict granule-pebble conglomerate and shale chip conglomerate are sparsely distributed through the unit. Both the graywacke and the mudstone are heavily sheared, in places so intensely that individual graywacke layers have been broken into disconnected, randomly oriented, slickensided blocks which are enveloped in a mudstone paste.

Accurate thickness measurements of this unit are not possible owing to local structural complications and incomplete exposures. Judging from the width of outcrop and the regional dip of the strata the unit may be as much as 2,500 feet thick.

## CORRELATIONS

As indicated in figure 5, the Paleozoic and Mesozoic strata on eastern St. Lawrence Island show a marked resemblance to coeval rocks in the western and central Brooks Range. In addition, counterparts of some of the Paleozoic and Mesozoic strata appear to be present on the Seward and Chukotsky peninsulas.

Devonian rocks are widely distributed in the Brooks Range and include substantial thicknesses of dolomite and limestone which bear a characteristic stromatoporoid and coral fauna (Tailleur and others, 1967). Similar carbonate rocks, of probable Devonian age, are reported on the Seward Peninsula ~~(Smith, 1939)~~ Gryc and others, 1967 but few details of their stratigraphy are known.



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Upper Mississippian limestone and cherty limestone beds with a coral and brachiopod fauna identical to that found on St. Lawrence Island are extensively exposed in the western and central Brooks Range (Dutro and Bowsher, 1957; Sable and Dutro, 1961). Coral-bearing limestone of probable Late Mississippian age has also been recognized in a small exposure near Cape Prince of Wales at the extreme western end of the Seward Peninsula (Steidtmann and Cathcart, 1922).

The Upper and Middle Triassic strata on St. Lawrence Island closely resemble the upper part of the Shublik Formation in the western Brooks Range and the shaly beds underlying these fossiliferous strata may be correlative with the lower part (Lower? and Middle Triassic) of the Shublik Formation or with the Siksikpuk Formation (Permian?). Triassic strata were thought to be present in the western Seward Peninsula but recent investigations in this area by C. L. Sainsbury (personal commun., 1969) indicate that most, if not all, of the rocks previously mapped as Triassic (Dutro and Payne, 1957) are pre-Ordovician in age.

Graywacke and mudstone strata of Jurassic and Cretaceous age similar to those found on St. Lawrence Island are widely distributed in western and northern Alaska. Rocks of this character comprise nearly all of the Cretaceous strata of the Yukon-Koyukuk basin (Gates, Grantz, and Patton, 1968) and all of the Jurassic and Early Cretaceous beds of the western and central Brooks Range.

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