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EIGHTEEN MEASURED SECTIONS OF THE LOWER TRIASSIC IVISHAK FORMATION IN THE SADLEROCHIT MOUNTAINS, NORTHEASTERN ALASKA

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INTRODUCTION

Eighteen stratigraphic sections of the Lower Triassic Ivishak Formation were measured in the Sadlerochit Mountains Northeastern Alaska (figure 1). The Ivishak Formation is the main producing formation at Prudhoe Bay. Its closest exposed equivalents are in the Sadlerochit Mountains. The purpose of this study is to provide a better understanding of the Ivishak Formation and its relationship to major hydrocarbon reservoirs. This study is part of the Alaska Division of Mining and Geology/ University of Alaska-Fairbanks Arctic National Wildlife Refuge research project.

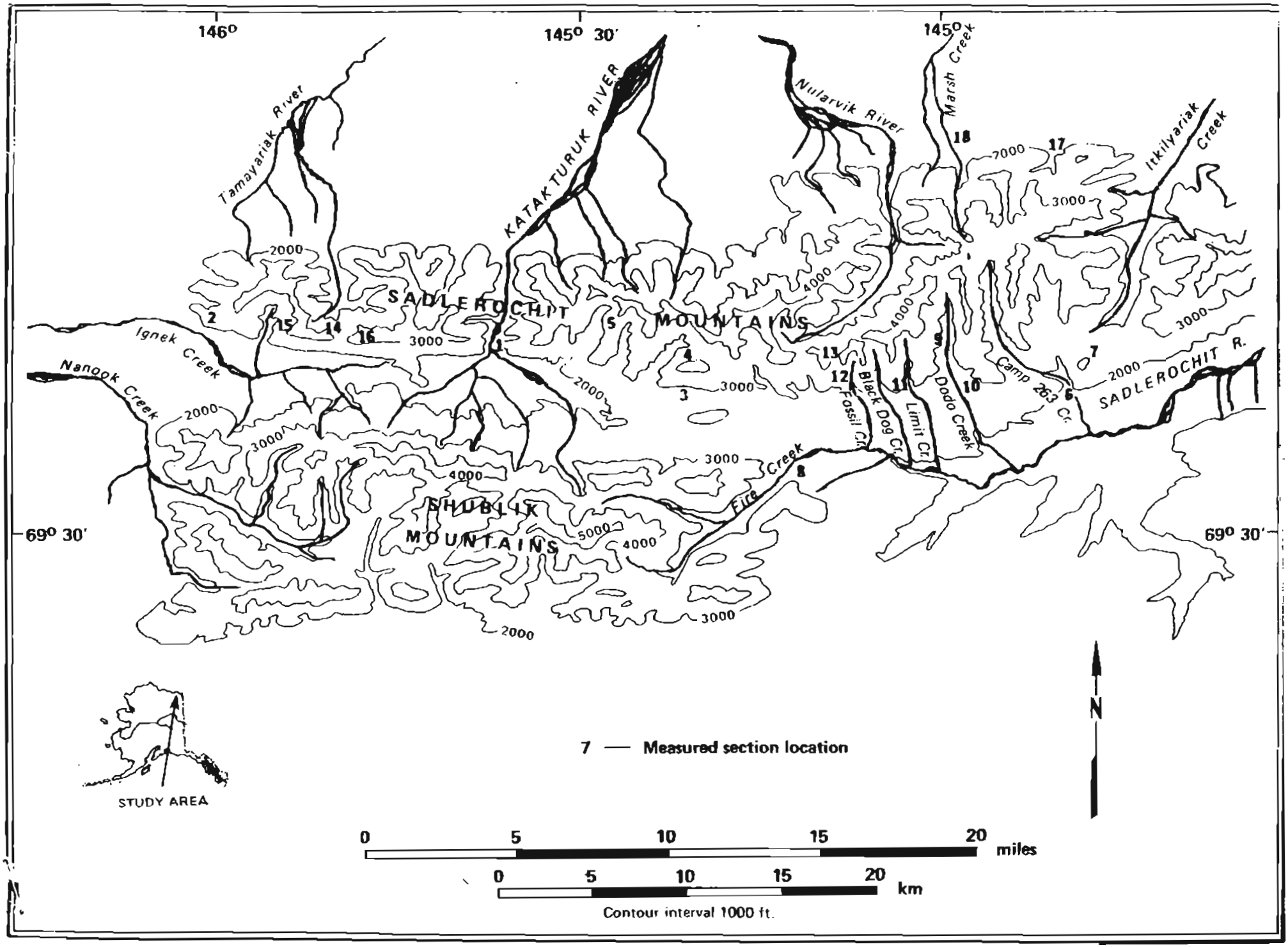
OBJECTIVES

The specific objectives of this study are:

To determine the lithostratigraphic, biostratigraphic and sedimentologic relations within the Ivishak Formation in the Sadlerochit Mountains through detailed measured section analysis.

To determine the nature of the Lower Cretaceous unconformity in relation to the Ivishak Formation on the northeast flank of the Sadlerochit Mountains.

To determine the depositional environment of the Ivishak Formation in the Sadlerochit Mountains.


146°
145° 30'
145°
Tamayariak River
KATAKTURUK RIVER
Niilarvik River
Marsh Creek
Itkilyariak Creek
SADLEROCHIT MOUNTAINS
SHUBLIK MOUNTAINS
Ignek Creek
Nanook Creek
Fossil Cr.
Black Dog Cr.
Limit Cr.
Dodo Creek
Camp 263 Cr.
SADLEROCHIT R.
Fire Creek
2000
3000
4000
5000
7000
69° 30'
STUDY AREA
7 — Measured section location
N
0 5 10 15 20 miles
0 5 10 15 20 km
Contour interval 1000 ft.

GEOLOGIC SETTING

The Sadlerochit Mountains form an east-west trending faulted anticline in the Arctic National Wildlife Refuge, northeastern Alaska (figure 2). The Permian to Triassic Sadlerochit Group, consisting of the Permian Echooka Formation and the Lower Triassic Ivishak Formation crop out, prominently along the southern and northeastern flanks of the Sadlerochit Mountains. This group forms a part of the Mississippian to Lower Cretaceous Ellesmerian sequence (figure 3). The Ellesmerian Sequence is believed to be derived from a northerly source in the area of the present Arctic Ocean. A variety of rock types including orthoquartzite, chert, siltstone, limestone, sandstone and shale make up the Sadlerochit Group (Detterman and others, 1975). Keller and others (a1961) designated the Ivishak as the upper member of the Sadlerochit Formation and established a type locality on the east side of Flood Creek. Detterman and others (1975) raised the Sadlerochit Formation to group status and the Ivishak member to formation rank.

The Ivishak Formation contains the Kavik, Ledge Sandstone, and the Fire Creek Siltstone Members (figure 4). The Kavik Member lies conformably on the Ikiakpauruak Member of the Echooka Group. Detterman and others (1975) have dated the Kavik on the basis of ammonite and pelecypod fauna of Early Triassic age (late Greiesbachian) and believe the Kavik probably represents the base of the Triassic system in

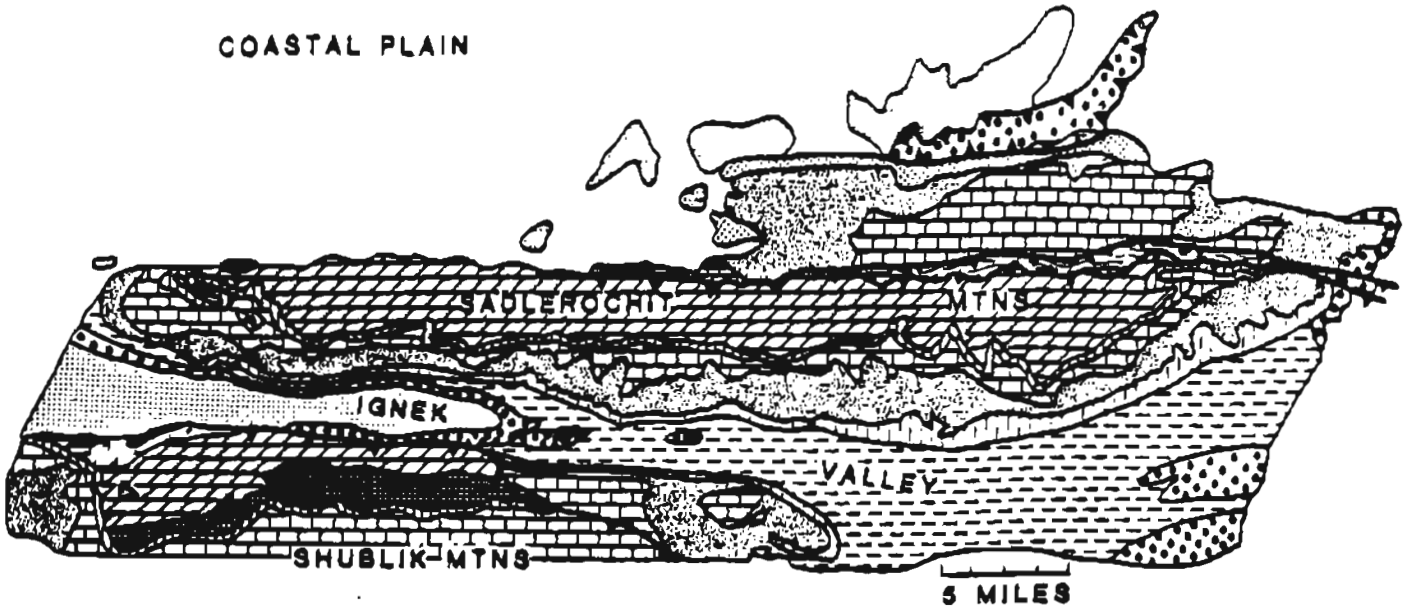
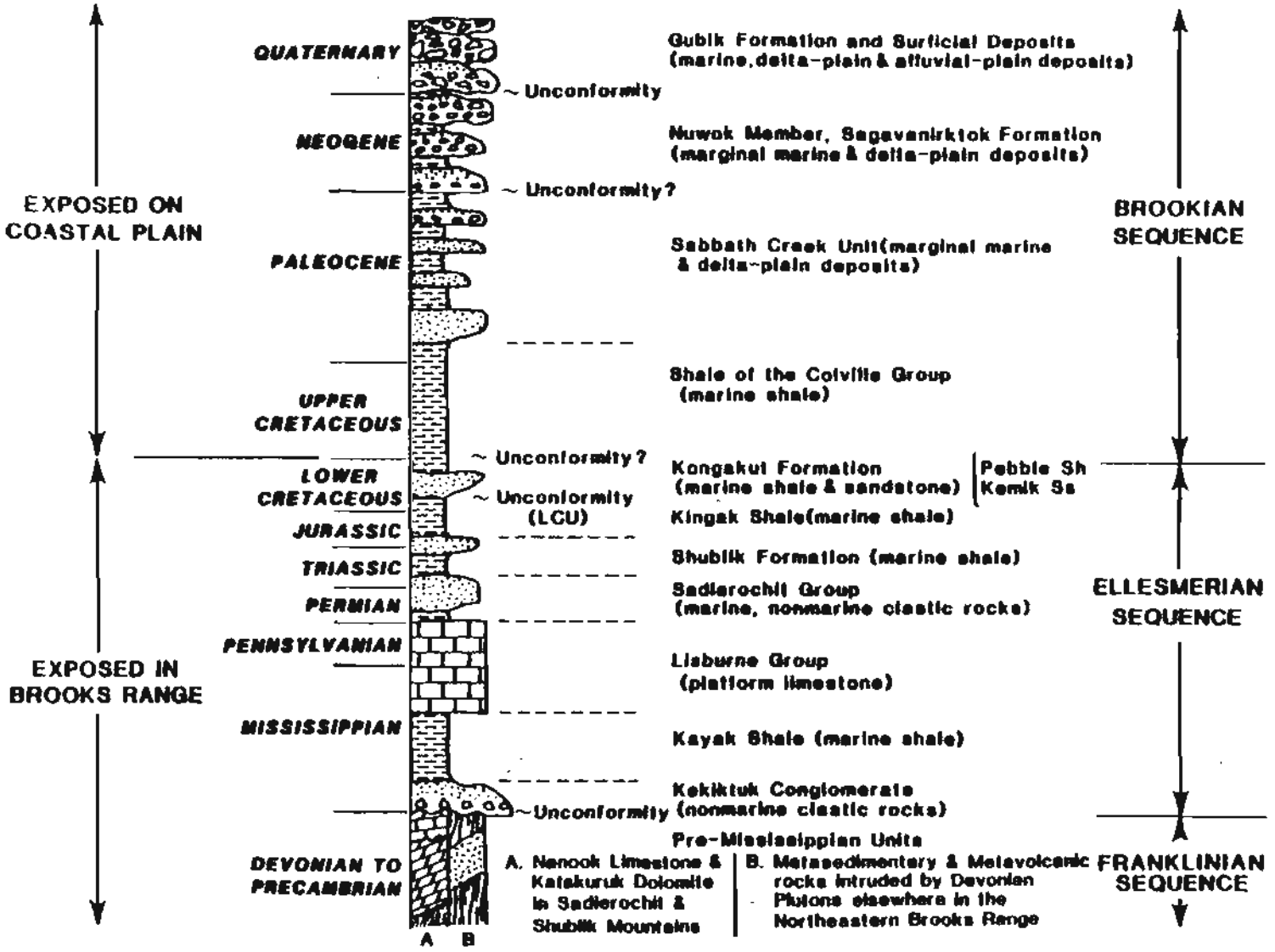


Figure 2. GENERALIZED GEOLOGIC MAP OF THE SADLEROCHIT AND NORTHERN SHUBLIK MOUNTAINS (MODIFIED FROM REISER, 1970)

EXPLANATION

Kc	Tertiary to Upper Cretaceous Colville Group
KpK	Lower Cretaceous Pebble Shale Unit and Kemik Sandstone
KpKt	Lower Cretaceous Pebble Shale Unit and Thin Kemik Sandstone Unconformably over Sadlerochit Group (NE Sadlerochit Mtns.)
KJk	Lower Cretaceous to Jurassic Kingak Shale
Ŧs	Triassic Shublik Formation
ŦPs	Lower Triassic to Permian Sadlerochit Group
ĪPMl	Pennsylvanian to Mississippian Lisburne Group
Mk	Mississippian Kayak Shale and Kekiktuk Conglomerate
D€n	Devonian to Cambrian Nanook Limestone
p€k	Precambrian (?) Katakturuk Dolomite
p€u	Precambrian (?) Phyllite, Quartzite, and Calcilutite
pMv	Pre-Mississippian Mafic Extrusive and Intrusive Rocks

Figure 3. **GENERALIZED STRATIGRAPHY OF NORTHEASTERN BROOKS RANGE AND ARCTIC COASTAL PLAIN**



northeastern Alaska. Fossils of Late Permian age (late Guadalupian) are found in beds directly underlying the Kavik Member. Detterman and others (1975) suggest this could represent a short hiatus between the Ivishak and Echooka Formations.

The Ledge Sandstone Member is thickest in the Sadlerochit Mountains, Shublik Mountains and in the northern Brooks Range and is equivalent to the Ivishak Sandstone, a main producing unit at Prudhoe Bay (Jones and Speers, 1976). Ammonites found within the Ledge Sandstone Member indicate a middle Early Triassic (Smithian) age (Detterman and others, 1975).

The uppermost member of the Ivishak Formation, the Fire Creek Siltstone, overlies the Ledge Sandstone Member conformably. It conformably underlies the Shublik Formation in the northeast exposures and underlies the Shublik Formation unconformably in the Brooks Range to the south. Based on ammonite fossils Detterman and others (1975) date the Fire Creek Siltstone as being middle early Triassic (Smithian)

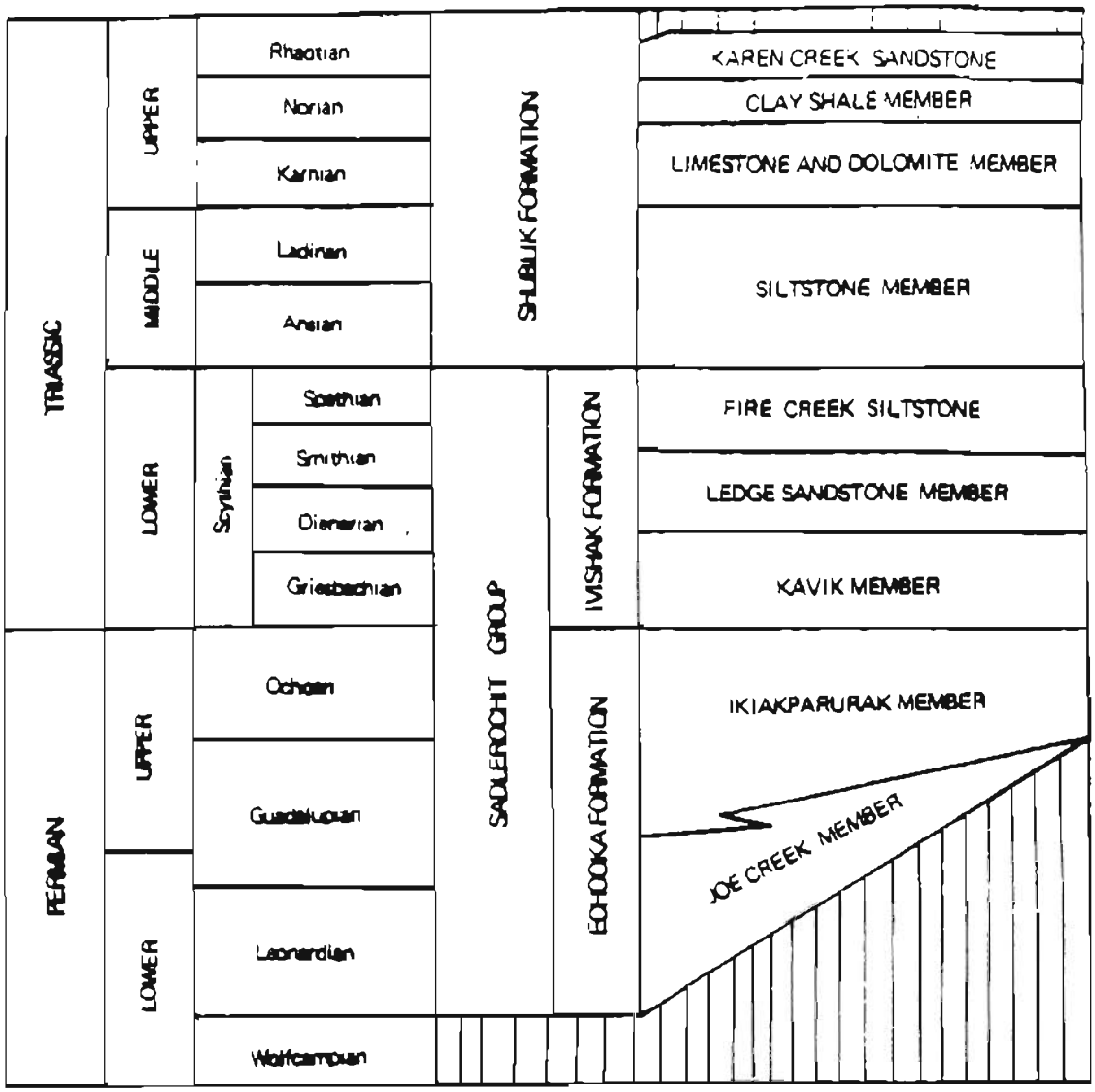


Figure 4. Permian-Triassic statigraphy in northeastern Alaska after Detterman and others, 1975.

STRATIGRAPHY

KAVIK MEMBER

Good exposures of the Kavik member are rare due to the talus covering of the Ledge Sandstone member. The Kavik member is well exposed in three localities (figure 1), the East Fork of Marsh Creek (Stratigraphic Section 86NH17, 82 m thick), the West Fork of Marsh Creek (Stratigraphic Section 86NH18, 16 m thick), and Dodo Creek (Stratigraphic Section 86NH09, 50 m thick).

The Kavik Member consists of interbedded siltstone and shale defining respectively resistant and recessive intervals. Slightly thicker bedded nodular siltstone beds define packages of interbedded siltstone and shale. Packages decrease in thickness up section from 1.2 m to 80 cm as shale intervals thin up section.

The purplish-black shale weathers green-yellow to orange and contains abundant disseminated pyrite. Silt content increases up section. The shale of the Kavik Member at the East and West Forks of Marsh Creek contains a significantly higher percentage of silt than the finer grained fissile shale of the Dodo Creek section.

Siltstone intervals consist of thin to medium beds of dark purple-black thinly laminated siltstone and iron stained orange nodular siltstone. Iron nodular siltstone dominates siltstone intervals at Dodo Creek. Siltstone beds contain planar laminations in the middle of the section. Higher

angle crossbeds occur in the upper portion of the section. Grain size increases up section.

The upper Kavik is transitional into the lower Ledge Sandstone. In the Marsh Creek sections, the transitional interval consists of interbedded siltstone, sandstone and shale. Medium to thick bedded sandstone beds increase in frequency and thickness up section. Siltstone beds decrease in frequency and become sandier up section. Shale intervals gradationally thin and decrease in frequency up section. The top of the transitional interval at the West Fork of Marsh Creek contains a small channelized sandstone bed below the upper most deposition of Kavik siltstone.

LEDGE SANDSTONE MEMBER

The Ledge Sandstone consists of a thick succession (90 m) of very fine grained to fine grained light blue-gray pure quartz arenite. On the south flank of the Sadlerochit Mountains the Ledge Sandstone crops out as prominent questas. Grain size coarsens to the north on the East and West Forks of Marsh Creek (Stratigraphic Sections 86NH17 and 86NH18). No significant grain size change occurs at Fire Creek (Stratigraphic Section 86NH08) in the Shublik Mountains. The Ledge is divided into a lower, middle, and upper unit.

The lower Ledge Sandstone contains a 10 m sucession of silty to very fine grained light to medium gray quartz

arenite. Medium to thick beds show a general thickening up section. A distinctive hematite stain and spheroidal weathering is present throughout this interval. Finer grained beds contain planar laminations. Siltstone and shale rip up clasts along with fossil fragments form discrete thin intervals. Minor cross cutting channels 3 m wide and 1 to 2 m high are apparent in the western and northern Sadlerochits. No lag deposits are included within these channels. Some bedding surfaces are bioturbated. Rippled surfaces are also apparent.

The middle Ledge unit is made up of an extremely thick 30 to 70 m succession of light blue gray very fine to fine grained pure quartz arenite. An upward thickening then fining interval defines the middle Ledge unit. Several smaller thickening then thinning subintervals, 10 to 20 thick, are present within this interval. Coarsening and fining can respectively accompany thickening and thinning. Bedding remains thick to extremely thick 50 cm to 3 m throughout. Beds thicken and thin laterally. Near Window Creek (stratigraphic section 86NH15, 86NH14, and 86NH16) beds thicken to 2 m and thin to 50 cm laterally over eight meters. Thicker bedded intervals contain small poorly sorted interbeds of coarser grained (medium to pebble sized) sand and chert. These discontinuous interbeds are generally less than 3 m long and from 2 to 5 cm thick. They can fine upwards. Abundant weathered medium grained pyrite is disseminated through out this unit. Low angle crossbeds are

abundant. Trough and higher angle crossbeds are occasionally evident. Most bedding planes contain ripples. Extremely rare shale or clay drapes separate a few sandstone beds in some sections. This interval contains a thick conglomerate unit on the East and West Fork of Marsh Creek. On the East Fork of Marsh Creek (stratigraphic section 86NH17) the conglomerate unit is located within the middle of this interval. On the West Fork of Marsh Creek it lies directly below the Lower Cretaceous unconformity and the overlying Lower Cretaceous Kemik Sandstone.

The upper Ledge sandstone is present throughout the south flank of the Sadlerochit Mountains. It is absent on the north flank of the Sadlerochits. The upper Ledge is made up of an 5 to 20 m succession of thick to medium bedded very fine to fine grained light gray blue quartz arenite. Abundant medium to coarse grained weathered pyrite grains are evenly distributed. Extremely regular thick beds fine subtlety up section. Rare rippled bedding surfaces and low angle crossbeds are present. This unit defers only from the middle Ledge unit by its regular and thinner bedding. The upper Ledge unit is transitional into the lower Fire Creek Siltstone.

FIRE CREEK SILTSTONE MEMBER

The Fire Creek Siltstone forms a thin secondary questa unit on top of the main Ledge questa unit on the south flank of the Sadlerochit Mountains. To the south at Fire Creek

(stratigraphic section 86NH08) in the Shublik Mountains, the Fire Creek Member forms a thick succession of sandstone, siltstone and shale. The member is absent on the north flank of the Sadlerochit Mountains.

On the south flank of the Sadlerochit Mountains, the Ledge Sandstone is transitional into the Fire Creek Siltstone. Very fine to fine grained, light gray quartz arenites in the lower member and orange brown silty sandstone in the upper part of the member alternate with covered recessive possibly shaley intervals. At the base of the Fire Creek a thin shaley interval is overlain by thick quartz arenite marker bed containing U shaped burrows. This marker bed is evident at Katakturuk Canyon, Fire Creek, and Fossil Creek (stratigraphic sections 86NH01, 86NH08, and 86NH12). This thin questa unit shows a general thick to medium bedding thinning upward. Beds can pinch and swell laterally. Crossbeds and ripples are sometimes evident. Upper beds show spheroidal weathering. A thin covered interval separates the Fire Creek from the overlying Shublik Formation.

To the south at Fire Creek, Shublik Mountains (stratigraphic section 86NH08), the Fire Creek becomes substantially thicker and more diverse. The base of the member consists of thick to medium, very fine to fine grained quartz arenite beds. Beds contain U shaped burrows, bioturbated tops, and low to medium angle crossbeds. These beds are abruptly overlain by a medium bedded chert

conglomerate. The middle Fire Creek Member is composed of interbedded silty sandstone and shale. Sandstone dominated intervals fine upward into shale dominated intervals. Red-dull brown thick bedded silty sandstone and siltstone make up sandstone dominated intervals. Bedding thickens and thins laterally. Beds show spheroidal weathering. Siltstone and shale rip up clasts are contained within some sandstone beds. Ripple marks and tool marks can also be present. Bedding planes are usually defined by thin shale beds. Shale dominated intervals are defined by alternating shale and thin bedded silty quartz arenite to siltstone. In the upper Fire Creek sandstone intervals dominate. Thin shale intervals are only present near the base of the interval. Sandstone and siltstone bedding decreases in thickness up section. Medium sandstone beds are overlain abruptly by conglomerate of the Shublik Formation.

INTERPRETATION

LOWER CRETACEOUS UNFORMITY

On the East and West Fork of Marsh Creek the Ledge Sandstone Member is overlain unconformably by the Lower Cretaceous Kemik Sandstone. On the East Fork of Marsh Creek (stratigraphic section 86NH17) part of the Ledge Member and the Fire Creek Member are missing. This demonstrates pre-early Cretaceous erosion or nondeposition of these units. On the West Fork of Marsh Creek (stratigraphic section

86NH18) additional strata is also missing making this section substantially thinner. This indicates that the Lower Cretaceous unconformity is located in a lower stratigraphic position at the West Fork of Marsh Creek.

DEPOSITIONAL ENVIRONMENT

The thick succession of alternating siltstone and shale of the Kavik Member indicates open marine deposition. Punctuated siltstone beds point to periodic influxes of silt into a quiet open marine environment. Kavik deposition occured at depths beneath storm wave base. The general upward coarsening within the Kavik represents a gradually shallowing depositional environment into the overlying Ledge Sandstone Member.

The Ledge Sandstone is made up of a thick succession of regularly bedded pure quartz arenite. The member is also characterized by abundant rippled surfaces and low angle crossbeds. The Ledge represents reworked sediments deposited in and inner shelf to near shore environment. Pronounced thickening then thinning intervals mark pulses within an aggradational sequence. Deposition occured over a relatively short period of geologic time.

The Fire Creek Siltstone Member includes intimately interbedded sandstone, siltstone and shale. General bedding features along with rip up clasts and tool marks indicate storm deposition within a inner to middle shelf environment.

The Ivishak Formation represents a progradational-aggradational-retrogradational sequence within the shallow marine environment. Subtle shallowing up of the Kavik Member into the lower Ledge Sandstone records a progradational phase. The middle and upper Ledge unit represents aggradational deposition within the near shore environment. Retrogradational conditions are evident in the deepening of the Fire Creek Member.

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