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MEASURED STRATIGRAPHIC SECTION OF THE "GILEAD CREEK SANDSTONE," NORTHEASTERN ALASKA

by
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CONTENTS

A) INTRODUCTION

The "Gilead Creek sandstone" (informal name, this report) is a sequence of Lower Cretaceous sandstone, siltstone and shale that crops out south of Gilead Creek, in the Sagavanirtok A-2 1:63,360 Quadrangle, northeastern Alaska. Our 2785-foot-thick measured section is located about 21 km southeast of the confluence of the Ivishak River and Gilead Creek (figure 1). The rocks are part of a faulted, broad southwest-plunging syncline. Lithologies are predominantly fine- to medium-grained sandstone, siltstone and shale. Regionally these rocks crop out along the "Shaviovik front," a northeast-southwest trending salient in the northeastern Brooks Range mountain front. This report presents preliminary results of Cretaceous stratigraphic studies of the Gilead Creek area. DGGS helicopter-supported field work was conducted during June and July 1989, and a preliminary geologic map is in preparation by Pessel and others.

A.1 PREVIOUS WORK AND NOMENCLATURE

Keller and others (1961) mapped the Gilead Creek area and mapped the "Gilead Creek sandstone" as the lower member of the Ignek Formation They also measured a section (# 8) at the same locality as ours, but measured southeast down the Kashivi stream valley to the contact with the Okpikruak formation. No fossils were reported in their measured section.

Leffingwell (1919) originally defined the Ignek formation as 2,500 feet of black shales with coal or "red beds" and subordinate sandstone members that probably overlies the Kingak Shale, and occurs at both ends and along the northern front of the Sadlerochit Mountains. Payne and others (1951) mapped these rocks as Nanushuk and Colville groups.

Gryc and Mangus (1947) and Keller and others (1961) included both Lower and Upper Cretaceous beds in the Ignek formation. Keller and others redefined Leffingwell's Ignek formation to include strata that from the Ivishak River to the Canning River and east, unconformably overlie the Okpikruak and Kingak Formations and underlie the Sagavanirktok Formation. They divided the Ignek formation into lower and upper members, and designated the sequence of sandstone and shale at Gilead Creek as part of the "Ignek formation, lower member".

Detterman and others (1975) abandoned the term "Ignek Formation" because some of the Ignek rocks closely resemble formations and members of the Nanushuk and Colville Groups that are present in the Umiat area of the east-central North Slope. They suggest that the Nanushuk and Colville Groups be extended into northeastern Alaska.

B) PRESENT STUDY

"The Gilead Creek sandstone" section was measured in June, 1989 by R.R. Reifenstuhl (DGGS) and T.J. Ryherd (Alaska Division of Oil and Gas) using a Jacob Staff, Brunton compass, and other field techniques; dip was averaged for every 100 feet of section. The section is located in the southeast quadrant of the Sagavanirtok A-2 1:63,360 Quadrangle (R18E, T3S, Section 23). The base of the section is at: $69^{o}10'23,"$ $147^{o}43'03,"$ and the top of the section is at: $69^{o}09'41,"$ $147^{o}48'05"$.

The base of this section, which is rubble-covered, lies in apparent thrust fault contact with the Jurassic and Cretaceous age Kingak Shale (figure 2). The section traverse heads southwest from the base to section-footage 1825 feet, where the section is offset one mile west (center, section 21) to a ridge at 2900 feet elevation. From this point the section was measured to the southwest.

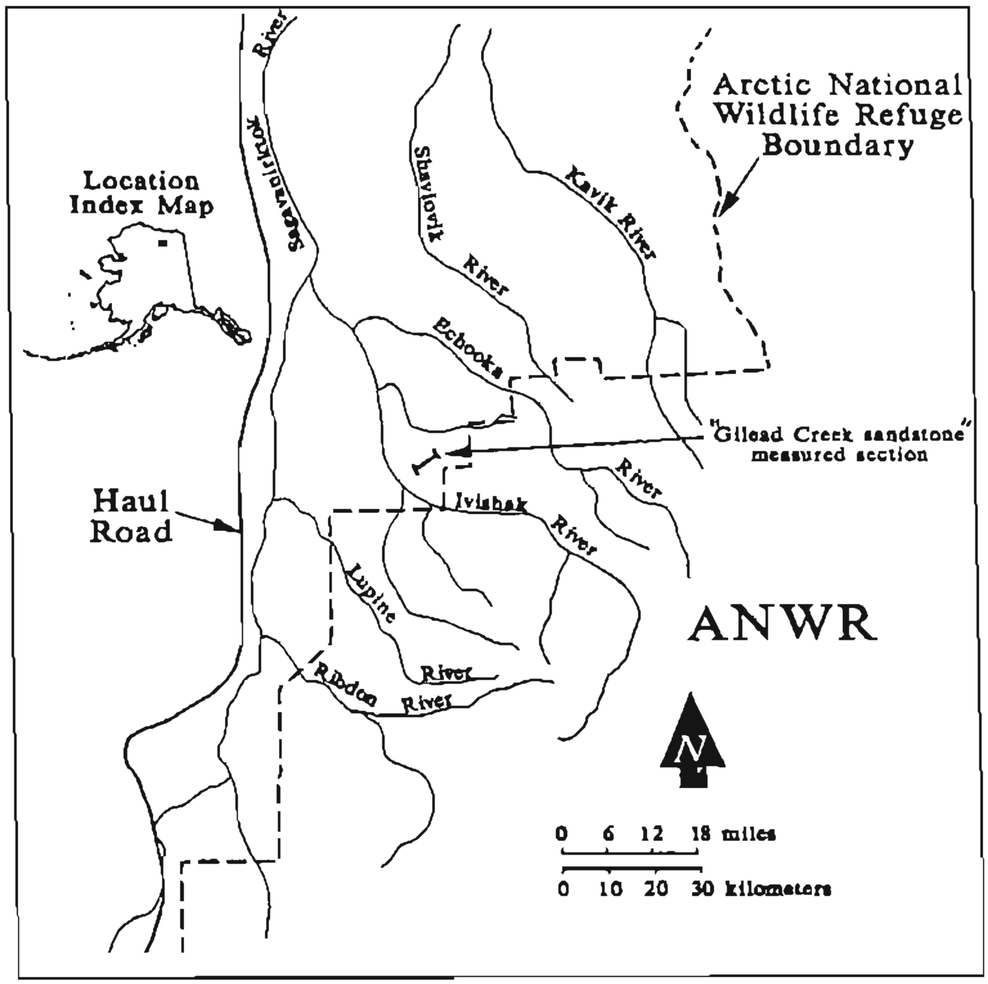

Figure 1. "Gilead Creek sandstone" measured section location map.

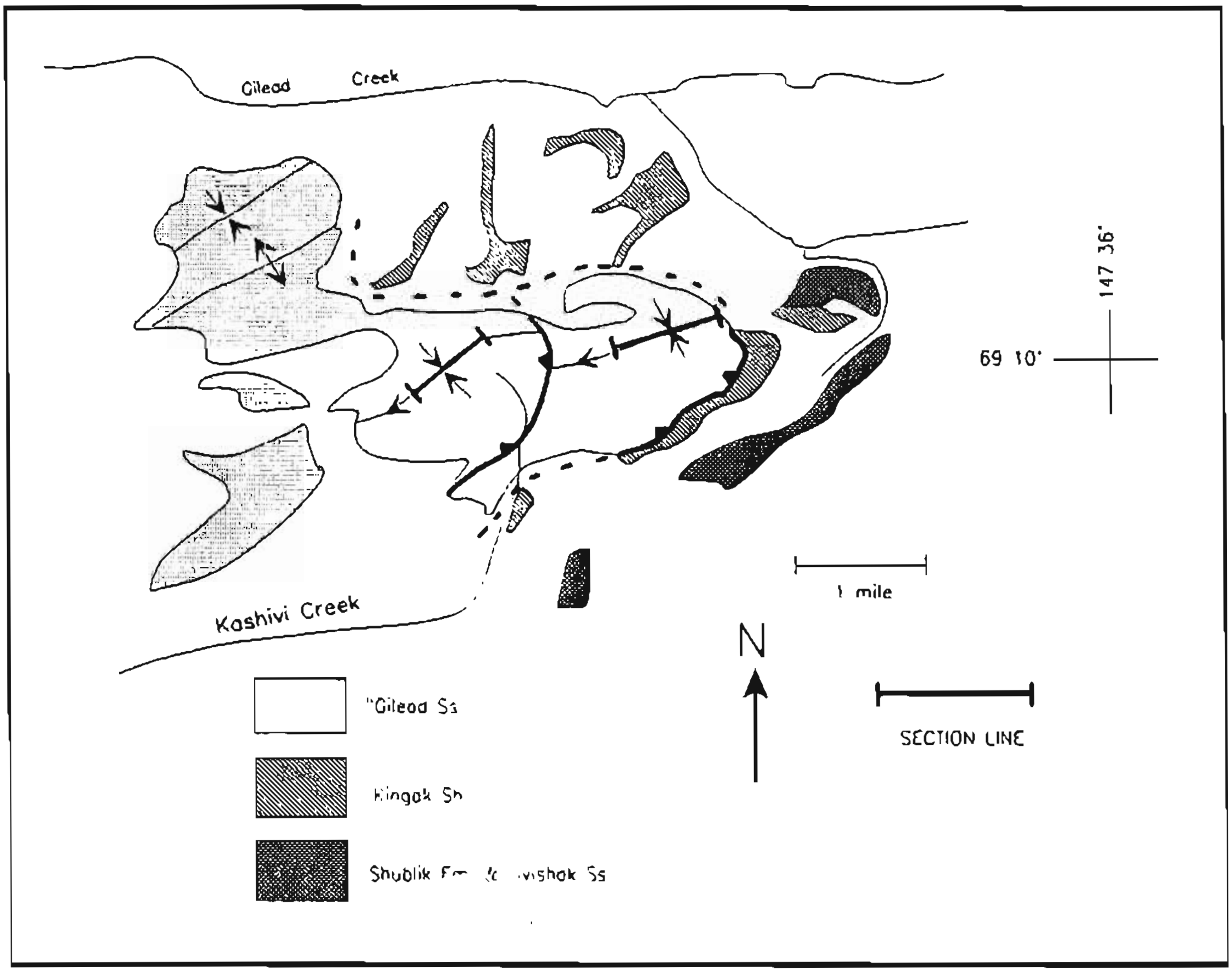

Figure 2 "Gilead Creek Ss" section location and generalized geologic map

B.1 LITHOLOGY

"The Gilead Creek sandstone" consists predominantly of sandstone with lesser siltstone and shale. The sandstone is a dark-gray, and medium-gray, dark-gray and orange-brown-weathering, fine to coarse-grained, subangular, moderately sorted litharenite. The finer grained sandstones range from fine- and very-fine-grained sand, to silt-sized grains. However, the coarser grained sandstone is far more abundant. Siltstone is a minor component (< 5 percent) but may be more abundant in the rubble- and vegetation-covered zones. Siltstone is a gradational phase between the top of sandstone beds and the overlying thin shale horizons. Shale (typically < 5 cm thick in outcrop) is very dark gray to black and locally contains carbonaceous plant fragments and coalified material. The sandstone-to-shale ratio (ss/sh) is greater than 10/1. Sandstone forms the resistant outcrop ridges in the Gilead Creek area whereas the shale-rich sequences underlie the recessive-weathering, rubble- and vegetation-covered zones. Consequently, sandstone appears to be the dominant rock type in outcrop.

Matrix and cement in this litharenite consist of $\leq$ 10 percent clay and iron oxide, however carbonate cement may locally comprise 10 percent of the rock. The carbonate appears to be preferentially concentrated in broadly cross bedded zones. Porosity and permeability is estimated to be low in most of the sandstone.

Thin section analysis indicate that the sandstone grains consist of: 50% quartz, 30% chert, 10% metamorphic rock fragments, 2% plagioclase feldspar, 2% limonitic-weathered clasts, 1% white mica, and 3% carbonaceous material locally. In one carbonate-rich section chert grains are replaced by microcrystalline carbonate.

B.2 PALYNOLOGY, THERMAL ALTERATION INDEX AND VITRINITE REFLECTANCE

Palynology analyses by Bujak and Davies Group, Calgary, Alberta, Canada (unpublished report no. 890030/1, September, 1989) provides palynological zonation, Thermal Alteration Index (TAI), thermal reflectance equivalent (R_O), and paleoenvironmental interpretation (appendix 1). Three palynology samples are dated as Late Jurassic to Early Cretaceous, and probable Early Cretaceous, and are interpreted as non-marine to paralic.

Six "Gilead Creek sandstone" samples yield TAI values ranging from 2 to 3-, and six Kingak Shale samples yield values ranging from 3 to 4-. Table 1 lists TAI values, vitrinite reflectance equivalents, and kerogen maturity used in this report.

B.3 SEDIMENTOLOGY

The "Gilead Creek sandstone" sandstone is non-channelized and typically is massive with minor parallel-bedded exposures. Local examples of wavy lamination (upper flow regime?), hummocky cross stratification, climbing ripples, grading, and trough cross stratification are present. Loadcasts and groove casts are locally abundant. Medium- and coarse-grained sand is locally erosive into the underlying, finer grained beds. Zones of carbonate-cemented, medium and coarse-grained sandstone occur in trough cross stratified beds. The carbonate appears to be preferentially concentrated in these broadly cross bedded zones.

Sandstone beds are typically medium-bedded, 1 to 20 cm thick. However, resistant thick-bedded units of featureless, medium and coarse sandstone (> 50 cm thick) are also common. These featureless, massive sandstones appear to be the result of amalgamation rather than bioturbation because no convincing evidence for bioturbation was found. Interbeds range from fine and very fine sandstone to siltstone and locally shale. The transition from coarser to finer grained beds is gradational. In some exposures, 3 cm to 30 cm-thick beds grade from basal very-coarse-grained carbonaceous sand to medium and fine sand, to silt and shale. Locally, groove casts are erosive into lower beds. Bedding plane-parallel laminations, graded bedding and shale rip-ups suggest event-type deposition.

TAI	SPORE COLOR	R_o% EQUIVALENT	AMORPHOUS KEROGEN	HERBACEOUS/ WOODY KEROGEN
2	Orange-brown	0.6%	Mature	Immature
2 to 2+	Brown-orange	0.7%	Peak maturity	Onset of maturity
2+	Light brown	0.9%	Peak maturity	Onset of maturity
2+ to 3-	Light brown-brown	1.0%	Highly mature	Peak maturity
3-	Brown	1.1%	Highly mature	Peak maturity
3- to 3	Medium brown	1.2%	Highly mature	Peak maturity
3	Brown/dark brown	1.5%	Overmature	Peak maturity
3+	Dark brown	2.0%	Overmature	Highly mature

Table 1. Thermal Alteration Index (TAI) scale used in the present study.
Bujak Davies Group Unpublished Report No. 890030/1, September, 1989, Calgary, Alberta.
R_o% = vitrinite reflectance.

B.4 DEPOSITIONAL ENVIRONMENT MODELS

The depositional environment for the "Gilead Creek sandstone" is equivocal. Based on the observed sedimentary features the favored interpretations are: (1) turbidite deposits, and (2) shelf deposits. However, these interpretations need not be mutually exclusive. Many of the depositional features suggest event-type processes. These processes bear heavily on any interpretation.

The majority of field data favors event-type deposition by turbidity currents. This process is consistent with graded bedding, local 1 to 5 cm thick Bouma sequences, flute casts, amalgamation of sandstone beds, and shale rip-ups. However, distinctive but enigmatic climbing ripples and hummocky(?) cross stratification are also present. Climbing ripples in very fine to coarse sand are in beds that are typically 3 to 4 cm thick, and locally are 15 to 20 cm thick. Trough cross stratification zones appear to pinch and swell and range from 20 to 50 cm thick. Individual beds are typically in the 1 to 3 cm range. Climbing ripples and trough cross stratification are features more commonly attributed to shallow-water environments, rather than classic turbidites. The ambiguous nature of sedimentary features in the "Gilead Creek sandstone" results in the seemingly conflicting interpretations of the deposition environment. Additional field studies of the depositional environment of the "Gilead Creek sandstone" are planned.

B.5 ROCKS BELOW MEASURED SECTION

The Kingak Shale, of Jurassic to Neocomian age, underlies the "Gilead Creek sandstone" in apparent thrust fault-contact (figure 2). Quartz crystals to 1.5 cm long in open fractures, abundant slickensides, and local brecciation occur in several localities at the top of the Kingak Shale and suggests that the overlying "Gilead Creek sandstone" package is in fault contact with the Kingak Shale.

The Kingak Shale consists of black, and orange-brown-weathered soft clay-shale; it is exposed only locally as rubble-crop. Concretions to 15 cm in diameter are abundant in float. Iron-stained, very-fine-grained sandstone float also occurs locally. No megafossils were found in the Kingak Shale in this study. A black shale from the top of the Kingak Shale yielded a single poorly preserved specimen of *Pareodinia ceratophora* of probable Jurassic age and suggests a paralic to marginally marine depositional environment (Bujak and Davies, 1989; appendix 1).

Two additional palynology samples from the Kingak Shale in the Gilead Creek area yield age calls of Jurassic, and possible Bathonian (Middle Jurassic). Three samples were of indeterminate age. Thermal alteration index (TAI) values in the six samples of the Kingak Shale range from 3 to 4- (appendix 1).

B.6 REGIONAL CORRELATION

Possible correlations for the Lower Cretaceous "Gilead Creek sandstone" include (1) the Albian to Cenomanian Nanushuk Group, (2) the early Albian Torok Formation, (3) early Albian Fortress Mountain Formation, and (4) the early Albian Bathtub Graywacke. Present data are inadequate for correlation with confidence

Field mapping indicates that the "Gilead Creek sandstone" lies above the Kingak Shale in apparent thrust fault contact. The amount of movement on this detachment surface is not known but direction of transport is probably to the north. The apparent allochthonous or parallochthonous relationship of the "Gilead Creek sandstone" with the underlying rock units complicates correlations.

Correlation of the "Gilead Creek sandstone" will require more geologic details including: tighter age control, provenance, depositional environment, structure, and tectonic history. Continuing DGGS studies are outlined below.

C) FUTURE STUDY

C.1 ADDITIONAL PALYNOLOGY AND FORAMINIFERA ANALYSIS

Samples from the Gilead Creek area will be re-analyzed for palynology and foraminifera by Micropaleo Consultants, Inc., to achieve better age- and paleoenvironment-control. Foraminifera analysis may yield important age control on samples that have produced typically wide-ranging age calls from palynology.

C.2 DETAILED FIELD WORK

Plans for the 1990 field season include more detailed geologic mapping in the Gilead Creek area and additional detailed section measuring. These studies will help to further constrain the depositional environment for the "Gilead Creek sandstone" and provide details for regional correlations and age control.

C.3 PETROGRAPHIC PROVENANCE STUDY

Petrography on thirty thin sections will yield information on provenance, maximum and modal grain size, sorting, rounding, and types of grain contacts. Details will be summarized on ternary diagrams illustrating sandstone type and provenance fields.

C.4 VITRINITE REFLECTANCE ANALYSIS

Shale and organic-rich sandstone samples from the "Gilead Creek sandstone" will be analyzed for vitrinite reflectance, total organic carbon and thermal maturity through a cooperative agreement with the U.S. Geological Survey laboratory.

C.5 THERMAL UPLIFT HISTORY

Thermal uplift history of "Gilead Creek sandstone" samples is underway by Paul O'Sullivan of Latrobe University, Victoria, Australia using apatite fission track analysis. These data will be issued as a DGGS publication when they become available.

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APPENDIX 1

PALYNOLGICAL ANALYSIS* OF SAMPLES FROM THE GILEAD CREEK AREA

SAMPLE 89RR20-500

Sample from "Gilead Creek sandstone" measured section

Zone Indeterminate (Indeterminate age)

Miospores

Osmundacidites wellmanii
Sellaginellaites perinatus

Assemblage Characteristics

black coaly material (Abundant)
woody and root fragments (Abundant)
oxidized kerogen

Paleoenvironment: Indeterminate

Comments: The highly oxidized kerogen is contaminated with woody and root fragments as well as modern algae and miospores, suggests that most palynomorphs in this sample represent a weathering or soil zone. The in situ assemblage has very poor preservation so that the palynomorphs are difficult to identify.

TAI: 3-

SAMPLE 89RR20-1826

Sample from "Gilead Creek sandstone" measured section

Zone Indeterminate (Indeterminate age)

Assemblage Characteristics

black coaly material (Dominant)

Paleoenvironment: Indeterminate

Comments: The kerogen is oxidized and possibly represents a weathered rock.

TAI: 3-

*BY BUJAK DAVIES GROUP REPORT NO. 890030/1, SEPTEMBER, 1989, CALGARY, ALBERTA, CANADA
Ages are assigned according to the concurrent ranges of the marker species, indicated by (+).

SAMPLE 89RR20-2722

Sample from "Gilead Creek sandstone" measured section

Zone indeterminate (Late Jurassic to Early Cretaceous)

Miospores

Cedripites canadensis

Assemblage Characteristics

black coaly material (Dominant)
woody kerogen (Abundant)

Paleoenvironment: Non-marine to Paralic

Comments: The assemblage contains only rare long-ranging Late Jurassic to Early Cretaceous gymnospermous pollen.

TAI: 2

SAMPLE 89RR70A

Sample from "Gilead Creek sandstone" Kishivi Creek

Zone indeterminate (Indeterminate age)

Miospores

Lycopodiumsporites annotinioides (Rare)

Assemblage Characteristics

black coaly material (Abundant)
wood and root fragments (Dominant)
fungal hyphae and spores (Rare)

Paleoenvironment: Indeterminate

Comments: The presence of wood and root fragments with fungal hyphae and spores suggests that this sample represents a weathered or soil zone.

TAI: possibly 3-

SAMPLE 89MR13C

Top (?) of "Gilead Creek sandstone" (?)

Zone indeterminate (Barremian to Albian)

Microplankton

Achomosphaera sp. indet. (Rare)
Astrocysta cretacea (+) (Rare)
Cleistosphaeridium sp. indet. (Common)
Cribroperidinium sp. indet.
Kleithriasphaeridium loffrense (+)
Muderongia simplex simplex (+) (Questionably present)
Pterodinium aliferum (+) (Questionably present)
Spiniferites ramosus ramosus

Miospores

Alisporites grandis
Araucariacites australis
Cedripites canadensis (+) (Rare)
Laevigatosporites ovatus
Podocarpidites granulosus

Assemblage Characteristics

black coaly material (Abundant)

Paleoenvironment: A marginally marine depositional environment is indicated by an assemblage of dinoflagellates with low diversity and low abundances.

Comments: The assemblage mostly contains long-ranging Early Cretaceous species.

TAI: 2

SAMPLE 89IM36

Sample from "Gilead Creek sandstone"

Zone of indeterminate age

Assemblage Characteristics

black coaly material (Abundant)
wood kerogen (Common)

Paleoenvironment: Indeterminate

Comment: No palynomorphs were observed in this sample.

TAI: 3-

SAMPLE 89MR8C

Sample from Kingak Shale

Zone indeterminate (indeterminate age)

Miospores

Lycopodiumsporites annotinoides

Assemblage Characteristics

abundant black coaly material

Paleoenvironment: Indeterminate

Comments: The highly corroded and thermally altered kerogen is contaminated with rare modern spores.

TAI: 3

SAMPLE 89IM37

Sample from Kishivi Creek below fault zone

Zone Indeterminate (Indeterminate age)

Miospores

Lycopodiumsporites annotiniodes (Rare, probably modern contaminants)

Assemblage Characteristics

black coaly material (Dominant)

Paleoenvironment: Indeterminate

Comments: No in situ palynomorphs were observed in this sample. The modern spores have a TAI of 1 and are considered to be contaminants, and the in situ kerogen is thermally corroded.

TAI: 3-

SAMPLE 89PE34

Sample from Kingak Shale

possible Kylindrocysta sp.C zone (possible Bathonian = Middle Jurassic)

Microplakton

Kylidracysta sp. indet. (Questionably present)

Miospores

Alisporites bilateralis
Carollina sp. indet. (Rare)
Deltiodospora hallii

Assemblage Characteristics

black coaly material (common)

Paleoenvironment: A paralic to inner neritic depositional environment is suggested if the identification of the dinoflagellate *Kylindracysta* sp. is correct.

Comments: Positive identifications are inhibited by the high thermal alteration, oxidized kerogen, and poor preservation.

TAI: 3+

SAMPLE 89IM38

Sample from Kingak Shale, Kishivi Creek

Zone indeterminate (indeterminate age)

Assemblage Characteristics

black coaly material (Dominant)

Paleoenvironment: indeterminate

Comments: No palynomorphs were observed in this sample.

TAI: 4-

SAMPLE 89RR19A

Sample from Kingak Shale

Zone indeterminate (probably Jurassic)

Microplankton

Pareodinia ceratophora (+)

Miospores

Alisporites bilateralis (Rare)
Corollina sp. indet. (+) (Common)

Assemblage Characteristics

black coaly material (Abundant)
poor preservation
thermally corroded

Paleoenvironment: A paralic to marginally marine depositional environment is suggested by the single, poorly preserved specimen of *Pareodinia ceratophora*

TAI: 3+

SAMPLE 89MR16C

Sample from Kingak Shale

Zone indeterminate (Jurassic)

Miospores

Acanthotriletes varispinosus
Carollina sp. indet. (+) (Abundant)

Assemblage Characteristics

black coaly material (Dominant); thermally corroded

Paleoenvironment: A non-marine to paralic depositional environment is indicated by the high dominance gymnospermous assemblage and the absence of dinoflagellates.

Comments: Palynomorphs in this sample have high thermal alteration and are very difficult to identify. Assemblages dominated by *Carollina* are generally Jurassic but they are rarely found in Early Cretaceous in the Alaskan North Slope region.

TAI: 3+