MICROPALEO CONSULTANTS, INC.

PHILLIPS ALASKA (ARCO)

FIORD NO. 1

API #50-103-20162

SEC. 2, T12N/R5E UM

NORTH SLOPE, ALASKA

Prepared by:

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BIOSTRATIGRAPHY REPORT

Job No. 21-106 **February, 2002**

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Probable Maestrichtian

<u>1850-2150'</u>

Late Cretaceous
Campanian

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2150-3510'

Late Cretaceous
Turonian to Santonian

3510-3880'

Late Cretaceous
Probable Cenomanian

3880-6550'

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Early Cretaceous
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Discussion. Echooka Fm.

9898-10,250'T.D.

Early Permian
PE

Discussion. Youngest Lisburne Group. "Wahoo Fm."; Upper Limestone Unit.

FORAMINIFERA REPORT

Interpreted by

Michael B. Mickey

FORAMINIFERA SUMMARY

100-1450'?

Age.	Tertiary to Quaternary Undifferentiated
Environment.	Probable Nonmarine (Probable Alluvial Plain)

1450?-2150'

Age.	Late Cretaceous Campanian to Maestrichtian
Zone.	F-5
Environment.	Middle to Outer Neritic (Middle to Outer Shelf)

2150-3630'

Age.	Late Cretaceous Turonian to Santonian
Zone.	F-6
Environment.	Bathyal (Slope)

3630-3810'

Age.	Late Cretaceous Probable Cenomanian
Zone.	Probable F-8
Environment.	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)

3810-6510'

Age.	Early Cretaceous Middle to Late Albian
Zones.	F-10 to F-11
Environment.	Bathyal (Slope)

6510-6600'

Age.	Early Cretaceous Aptian to Early Albian
Zone.	F-11
Environment.	Probable Lower Bathyal - Distal (Probable Lower Slope & Base of Slope - Starved Basin)

6600-6720'

Age.	Early Cretaceous Barremian
Zone.	F-12
Environment.	Distal (Starved Basin)

6720-6900'

Age.	Early Cretaceous Hauterivian
Zone.	F-13a
Environment.	Middle Neritic (Middle Shelf)

6900-6990'

Age.	Early Cretaceous Valanginian
Zone.	F-13b
Environment.	Probable Middle Neritic (Probable Middle Shelf)

6990-7110'

Age.	Late Jurassic Kimmeridgian
Zone.	F-16a
Environment.	Upper Bathyal (Upper Slope)

7110-7750'

Age.	Late Jurassic Oxfordian
Zone.	F-16b
Environment.	Upper Bathyal (Upper Slope)

7750-7990'

Age.	Middle Jurassic Aalenian
Zone.	F-17
Environment.	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)

7990-8470'

Age.	Early Jurassic Toarcian
Zone.	F-18a
Environment.	Upper to Lower Bathyal - Some Distal (Upper to Lower Slope - Some Starved Basin)

8470-8710'

Age.	Early Jurassic Pliensbachian
Zone.	F-18b
Environment.	Middle to Lower Bathyal - Some Distal (Lower Slope to Base of Slope - Some Starved Basin)

8710-8920'

Age.	Late Triassic Norian
Zone.	F-19b
Environment.	Marginal Marine to Inner Neritic (Transitional to Inner Shelf)

8920-9790'

Age.	Early Triassic
Zone.	F-20a
Environment.	Probable Nonmarine to Marginal Marine (Probable Alluvial Plain to Transitional)
Discussion.	Sadlerochit Group. Fire Creek Siltstone tops at 8920 feet, Ivishak Fm. tops at 9010 feet and Kavik Fm. tops at 9610 feet.

9790-9910'

Age.	Probable Late Permian
Zone.	Probable F-20b
Environment.	Probable Nonmarine to Marginal Marine (Probable Alluvial Plain to Transitional)
Discussion.	Echooka Fm.

9910-10,250'T.D.

Age. Early Permian

Zone. F-21

Environment. Shoaling Shelf
(Bank)

Discussion. Youngest Lisburne Group. "Wahoo Fm."; Upper Limestone Unit.

INTRODUCTION

Scope

Micropaleo Consultants, Inc. processed, picked and analyzed for Foraminifera 153 ditch samples and seven (7) conventional core samples from the Phillips Alaska (ARCO) Fiord No. 1 well. These samples covered the interval 100 to 10,250 feet total depth. This work was done as part of M.C.I. Job Number 21-106.

Procedures

Standard techniques were used to process the material. All samples were boiled in Quaternary-O and washed over 20 and 200 mesh screens. Frequency symbols correspond to the following numerical values: very rare (1), rare (2 - 4), frequent (5 - 25), common (26 - 100), abundant (101 - 999) and prolific (1000+). The picked foram slides and residues are reposited at the State of Alaska Geological Materials Center in Eagle River, Alaska.

Certain factors such as shelf widths, basin configuration and overall basin depths associated with Arctic Mesozoic basins are not completely understood at present. The paleoenvironments presented in this report reflect relative basinal position only and should not be tied to specific water depths. Generally, neritic corresponds to shelf or deltaic environments, while bathyal corresponds to slope or prodelta environments and bathyal (starved basin) corresponds to distal (far from the source) deposition. As an example, prodelta deposits could represent deposition as shallow as middle neritic or as deep as bathyal (slope) depending on the delta type and shelf width. With a narrow shelf, a river-dominated deltaic system could build across the shelf and the prodelta deposits would be in a bathyal (slope) depth. A tide-dominated deltaic system associated with a wide shelf could result in middle neritic prodelta deposition.

Format

A listing of the age, environment, fauna and occasional lithology comments for each biostratigraphic interval follows. A generalized summary of the well is presented in the Conclusions section at the end of the Foraminifera Report. A Foraminifera Distribution Chart (Figure F-1) and a High Resolution Biostratigraphy Plot (Figure B-1) containing foram diversity/abundance plots, a cumulative faunal plot and paleoenvironmental plot(s) are in pockets at the back of this report.

RESULTS

100-1450'?

Age.	Tertiary to Quaternary Undifferentiated
Environment.	Probable Nonmarine (Probable Alluvial Plain)
Fauna.	Barren of Foraminifera. Plant debris, calcispheres, coal, pyrite and rare of frequent tar.

1450?-2150'

Age.	Late Cretaceous Campanian to Maestrichtian
Zone.	F-5
Environment.	Middle to Outer Neritic (Middle to Outer Shelf)
Fauna.	*Eoeponidella linki, E. strombodes, Globulina inaequalis, Praebulimina seabeensis, P. venusae, Pullenia jarvisi, P. cretacea, Reticulophragmium amplectens, Anomalinoides talaria, A. pinguis, Trochammina ribstonensis, Caucasina vitrea, Neobulimina canadensis,* shell fragments, coal, pyrite and volcanic glass shards.

2150-3630'

Age. Late Cretaceous
Turonian to Santonian

Zone. F-6

Environment. Bathyal
(Slope)

Fauna. *Hippocrepina* sp., *Trochamminoides* sp. (small, thin), *Saccammina lathrami, Haplophragmoides excavata, Inoceramus* prisms, fish debris, shell fragments, megaspores, coal, paper shale, pyrite, frequent to common radiolaria and frequent bentonite between 2350 and 2640 feet.

3630-3810'

Age. Late Cretaceous
Probable Cenomanian

Zone. Probable F-8

Environment. Outer Neritic to Upper Bathyal
(Outer Shelf to Upper Slope)

Fauna. *Haplophragmoides excavata, Saccammina lathrami, Zonodiscus* sp. A, fish debris, *Inoceramus* prisms, megaspores and frequent to abundant paper shale.

Discussion. *Trochammina rutherfordi* found in 3810-3990' interval probably sloughed from this interval.

3810-6510'

Age. Early Cretaceous
Middle to Late Albian

Zones. F-10 to F-11

Environment. Bathyal
(Slope)

Fauna. *Haplophragmoides excavata, H. topagorukensis, H. collyra, Saccammina lathrami, Trochammina mcmurrayensis, T. rainwateri, Verneuilinoides borealis, Ammobaculites fragmentarius, Nodosaria flexocarinata, Saracenaria projectura*, fish debris, *Inoceramus* prisms, megaspores, *Ditrupa cornu*, bentonite, coal, pyrite, pyrite sticks and rare to frequent pyritized radiolaria.

6510-6600'

Age. Early Cretaceous
Aptian to Early Albian

Zone. F-11

Environment. Probable Lower Bathyal - Distal
(Probable Lower Slope & Base of Slope - Starved Basin)

Fauna. Barren of Foraminifera. Rare scattered pyritized radiolaria. Fish debris, pyrite and abundant paper shale.

6600-6720'

Age.	Early Cretaceous Barremian
Zone.	F-12
Environment.	Distal (Starved Basin)
Fauna.	Barren of Foraminifera. Rare scattered *Cenosphaera* spp. (pyritized), abundant paper shale and rare to frequent rounded frosted quartz floating sand grains.

6720-6900'

Age.	Early Cretaceous Hauterivian
Zone.	F-13a
Environment.	Middle Neritic (Middle Shelf)
Fauna.	Arenaceous spp. (large, coarse), *Ammobaculites erectus, A. reophacoides, Haplophragmoides coronis, H. duoflatis, Lenticulina muensteri, Trochammina squamata, Globulina canadensis, Gravellina* 1, *Pseudobolivina* sp., *Thuramminoides* sp., fish debris, pyrite and frequent to abundant rounded frosted quartz floating sand grains.

6900-6990'

Age. Early Cretaceous
Valanginian

Zone. F-13b

Environment. Probable Middle Neritic
(Probable Middle Shelf)

Fauna. *Ammobaculites alaskensis*, arenaceous spp. (large, coarse), *Gaudryina milleri, G. leffingwelli, Haplophragmoides canui, H. coronis, H. duoflatis, Trochammina elevata, Inoceramus* prisms, glauconite, pyrite and frequent to common rounded frosted quartz floating sand grains.

6990-7110'

Age. Late Jurassic
Kimmeridgian

Zone. F-16a

Environment. Upper Bathyal
(Upper Slope)

Fauna. *Marginulinopsis phragmites, Globulina topagorukensis, Lenticulina audax, Saracenaria topagorukensis, Ammodiscus asperus, Recurvoides turbinatus*, pyrite, frequent to common rounded frosted quartz floating sand grains, and abundant oil staining at 7050 to 7080 feet.

7110-7750'

Age. Late Jurassic
Oxfordian

Zone. F-16b

Environment. Upper Bathyal
(Upper Slope)

Fauna. *Ammobaculites alaskensis*, *A. vetusta*, arenaceous spp. (large, coarse), *Gaudryina milleri*, *G. tailleuri*, *G. leffingwelli*, *Haplophragmoides canui*, *H.* spp., *Globulina topagorukensis, Lenticulina audax, Saracenaria topagorukensis*, *Ammodiscus asperus*, *Recurvoides turbinatus*, *Marginulinopsis carievalensis*, *M. phragmites*, *M. bergquisti*, *Astacolus arietus*, *A. dubius*, *Lenticulina quenstedti*, *Trochammina instowensis*, *Tristix alcima, Rectoglandulina turbinata,* fish debris, *Inoceramus* prisms, glauconite, pyrite, pyrite sticks and rare to frequent rounded frosted quartz floating sand grains.

7750-7990'

Age. Middle Jurassic
Aalenian

Zone. F-17

Environment. Outer Neritic to Upper Bathyal
(Outer Shelf to Upper Slope)

Fauna. *Astacolus calliopsis, Eoguttulina metensis, Lenticulina audax, Haplophragmoides* spp., *Trochamminoides* sp. (small, thin), *Recurvoides turbinatus, Cenosphaera* spp. (pyritized) and frequent to common *Tasmanites*.

7990-8470'

Age. Early Jurassic
Toarcian

Zone. F-18a

Environment. Upper to Lower Bathyal - Some Distal
(Upper to Lower Slope - Some Starved Basin)

Fauna. Rare scattered *Trochamminoides* sp. (small, thin) and *Bathysiphon anomalocoelia*, frequent to common *Cenosphaera* spp. (pyritized) and abundant paper shale below 8170 feet.

8470-8710'

Age. Early Jurassic
Pliensbachian

Zone. F-18b

Environment. Middle to Lower Bathyal - Some Distal
(Lower Slope to Base of Slope - Some Starved Basin)

Fauna. *Trochamminoides* sp. (small, thin), *T.* sp. (medium, thin), *Ammobaculites* sp. (small, nodose chambers) and abundant paper shale.

8710-8920'

Age. Late Triassic
Norian

Zone. F-19b

Environment. Marginal Marine to Inner Neritic
(Transitional to Inner Shelf)

Fauna. *Astacolus connudatus, Nodosaria larina*, echinoid spines, ostracods (medium-large, smooth), *Monotis/Halobia* fragments and frequent to common dark gray sand-size phosphatic? pebbles below 8830 feet.

<u>8920-9790'</u>

<u>Age.</u>	Early Triassic
<u>Zone.</u>	F-20a
<u>Environment.</u>	Probable Nonmarine to Marginal Marine (Probable Alluvial Plain to Transitional)
<u>Fauna.</u>	Barren of Foraminifera. Rare to frequent pyrite, frequent white triplitic chert and common paper shale below 9610 feet.
<u>Discussion.</u>	Sadlerochit Group. Fire Creek Siltstone tops at 8920 feet, Ivishak Fm. tops at 9010 feet and Kavik Fm. tops at 9610 feet.

<u>9790-9910'</u>

<u>Age.</u>	Probable Late Permian
<u>Zone.</u>	Probable F-20b
<u>Environment.</u>	Probable Nonmarine to Marginal Marine (Probable Alluvial Plain to Transitional)
<u>Fauna.</u>	Barren of Foraminifera. Glauconite and pyrite.
<u>Discussion.</u>	Echooka Fm.

9910-10,250'T.D.

Age. Early Permian

Zone. F-21

Environment. Shoaling Shelf
(Bank)

Fauna. *Earlandia elegans, Trepeilopsis* sp., *Eoschubertella yukonensis, Eostaffella radiata, Pseudoglomospira* sp., archaediscids, *Globivalvulina bulloides, Millerella pressa, Monotaxinoides multivolutus, Protonodosaria* sp., *Volvotextularia mississippiana, Zellerina designata, Biseriella parva, Profusulinella* sp., *Paleotextularia* ss., *Priscella prisca, Globoendothyra* sp., *Tetrataxis angusta*, glomospirids (thick walled), *Asphaltina* sp., *Stylocodium* sp., *Paleoaplysina* sp., *Mitcheldeania* sp., ostracods, birds eyes and rare to frequent oolites and ooids.

Discussion. Youngest Lisburne Group. "Wahoo Fm."; Upper Limestone Unit.

CONCLUSIONS

The Phillips Alaska (ARCO) Fiord No. 1 well penetrated the following biostratigraphic sequence based on foraminiferal analysis:

- 1350+ feet (100-1450') of undifferentiated Tertiary to Quaternary age (Middle to Late Brookian) nonmarine clastic deposition.

- 2180 feet (1450-3630') of Turonian to Maestrichtian age (Early Brookian) upward shallowing slope foresets and shelf topsets.

- 3270 feet (3630-6900') of Hauterivian to probable Cenomanian age (Early Brookian & Beaufortian - Rift Sequence) middle to outer shelf topsets, slope foresets and base of slope bottomsets.

- 1810 feet (6900-8710') of Pliensbachian to Valanginian age (Beaufortian - Incipient Rift Sequence) probable middle shelf to base of slope sedimentation.

- 1200 feet (8710-9910') of probable Late Permian to Late Triassic (Norian) age (Late Ellesmerian) nonmarine, marginal marine and inner shelf deposition.

- 340+ feet (9910-10,250'T.D.) of Early Permian age (Early Ellesmerian) shoaling shelf (bank) carbonates.

PALYNOLOGY REPORT

Interpreted by:

Hideyo Haga

PALYNOLOGY SUMMARY

100-550'

Age.	Tertiary - Quaternary Undifferentiated
Environment.	Nonmarine

550-1550'

Age.	Tertiary Paleocene
Zone.	P-T10
Environment.	Nonmarine to Marginal Marine

1550-1850'

Age.	Late Cretaceous Probable Maestrichtian
Zone.	Probable P-T11 and marginal marine equivalent
Environment.	Marginal Marine

1850-2050'

Age.	Late Cretaceous Campanian
Zone.	P-T12 and marginal marine equivalent
Environment.	Marginal Marine

2050-2820'

Age.	Late Cretaceous Santonian - Campanian
Zone.	P-M14
Environment.	Marine

2820-3360'

Age.	Late Cretaceous Turonian - Coniacian
Zone.	P-M15
Environment.	Marine

<u>3360-3990'</u>

<u>Age.</u>	Probable Late Cretaceous Probable Cenomanian
<u>Zone.</u>	Probable P-M16
<u>Environment.</u>	Marine

<u>3990-6600'</u>

<u>Age.</u>	Early Cretaceous Middle - Late Albian
<u>Zone.</u>	P-M17
<u>Environment.</u>	Marine

<u>6600-6720'</u>

<u>Age.</u>	Early Cretaceous Barremian - Early Albian
<u>Zone.</u>	P-M18a
<u>Environment.</u>	Marine

<u>6720-6907'C</u>

<u>Age.</u>	Early Cretaceous Hauterivian
<u>Zone.</u>	P-M19
<u>Environment.</u>	Marine

<u>6907C-7020'</u>

<u>Age.</u>	Early Cretaceous Possible Valanginian
<u>Zone.</u>	P-M20?
<u>Environment.</u>	Marginal Marine to Marine
<u>Remarks.</u>	Evidence for P-M20 zonule is weak.

<u>7020-7810'</u>

<u>Age.</u>	Late Jurassic Oxfordian
<u>Zone.</u>	P-M22
<u>Environment.</u>	Marine
<u>Remarks.</u>	The top part of this interval may include some Kimmeridgian age strata Reworked Paleozoic spores are abundant through this interval.

7810-8710'

Age.	Early - Middle Jurassic Undifferentiated
Zones.	P-M24? to P-M23
Environment.	Marine
Remarks.	The top of zonule P-M24 is tentatively placed at 8410 feet.

8710-8920'

Age.	Late Triassic - Early Jurassic Undifferentiated
Zones.	P-T15 and/or P-M24
Environment.	Marine
Remarks.	Relatively poor palynomorph recoveries in this interval. Consistent Triassic evidence appears below 8800 feet. The presence of some Norian age strata is suggested by the occurrence of a dinocyst marker recorded as a sloughed specimen below this interval.

8920-9790'

Age.	Early Triassic Undifferentiated
Zone.	P-T16
Environment.	Marine

9790-10,250'T.D.

Age.	Permian (Possible Early Permian) Undifferentiated
Zone.	P-T18
Environment.	Marine?
Remarks.	Evidence of Permian age strata is sparse.

INTRODUCTION

Purpose and Scope

Micropaleo Consultants, Inc. (M.C.I.) conducted palynological analyses on a total of 160 samples from the Phillips Alaska (ARCO) Fiord No. 1 well. The samples consisted of 153 ditch cutting composites and seven (7) core samples taken between 100 feet and the total depth of 10,250 feet.

The maturation analyses included 39 Thermal Alteration Index (T.A.I.) and 11 vitrinite reflectance (V.R.) samples.

Based on the palynomorph assemblages observed, an age and generalized environment of deposition were interpreted for each palynostratigraphic subdivision. The environments, as interpreted from the palynological preparations, are simply categorized as nonmarine, marginal marine or marine. The categories are based on the absence or presence and diversity of microplankton cysts.

Procedures

The sample material was obtained from the State of Alaska, Department of Natural Resources, Geological Materials Center in Eagle Creek, Alaska. All processed material is on reposit at that facility.

The samples were processed with standard palynologic techniques using hydrochloric acid, hydrofluoric acid and nitric acid treatments. The resultant kerogen residues were further concentrated by heavy liquid separation, sonification and a sieving/panning technique. Each sample slide has a mount of two coverslips. One slip contains the greater than 20 micron fraction and the second slip contains the 10-20 micron fraction.

The kerogen concentrates for the maturation analyses omitted the nitric acid chemical treatment and the sonification procedure.

As each sample was examined, an estimate of abundance for each palynomorph taxon was recorded in a microcomputer. These data form the basic elements of the species distribution chart.

Report Format

The following Results section gives the age, environment of deposition and significant palynomorphs for each palynological subdivision. This is an expansion of the brief Summary at the beginning of the report. After the Results, some generalized interpretations are outlined in the Conclusions section. The last section of the report consists of the Kerogen Maturation analyses.

A Palynomorph Distribution Chart (Figure P-1) is located in a pocket. This chart records the occurrence and abundance of individual taxa in each sample. Included on this chart are the diversity and abundance curves for spore-pollen and microplankton cysts.

High Resolution Biostratigraphy Plots - Foraminifera/Palynomorphs (Figure B-1) is also provided. Additional palynology parameters are shown in the form of a cumulative plot that illustrates the relative abundance of nonmarine, marine and miscellaneous palynomorph constituents.

RESULTS

100-550'

Age. Tertiary - Quaternary
Undifferentiated

Environment. Nonmarine

Palynomorphs. This interval recovered a sparse nondescript Tertiary spore-pollen assemblage. The assemblage includes *Alnipollenites, Laevigatosporites* and undifferentiated bisaccates.

The few microplankton recorded are reworked Cretaceous species.

550-1550'

Age. Tertiary
Paleocene

Zone. P-T10

Environment. Nonmarine to Marginal Marine

Palynomorphs. The Paleocene section is marked by the appearance of the pollen *Paraalnipollenites confusus*.

The lower part of this interval recorded occurrences of *Micrhystridium* spp. which indicates some minor marine influences at the site of deposition.

1550-1850'

Age. Late Cretaceous
Probable Maestrichtian

Zone. Probable P-T11 and marginal marine equivalent

Environment. Marginal Marine

Palynomorphs. The Maestrichtian section is tentatively separated based on the presence of the pollen species *Aquilapollenites magnus* in a sample within this interval.

The dinocyst assemblage includes species of *Chatangiella, Isabelidinium* and *Laciniadinium biconiculum*.

Discussion. The diversity/abundance and cumulative palynomorph plots depict the increase in marine influences beginning in this interval (Figures P-1 and B-1).

1850-2050'

Age. Late Cretaceous
Campanian

Zone. P-T12 and marginal marine equivalent

Environment. Marginal Marine

Palynomorphs. The overall assemblage in this interval is similar to the interval above. The important addition is the appearance of the Campanian marker pollen *Aquilapollenites trialatus*.

2050-2820'

Age.	Late Cretaceous Santonian to Campanian
Zone.	P-M14
Environment.	Marine
Palynomorphs.	The spore-pollen fraction is relatively unimportant in this interval. The dinocyst species increase in diversity with the appearance of many species of *Chatangiella*. The significant species of the group is *Chatangiella ditissima*.

2820-3360'

Age.	Late Cretaceous Turonian to Coniacian
Zone.	P-M15
Environment.	Marine
Palynomorphs.	This interval is marked by the occurrences of the dinocyst *Isabelidinium globosum*.

3360-3990'

Age.	Probable Late Cretaceous Probable Cenomanian
Zone.	Probable P-M16
Environment.	Marine
Palynomorphs.	The dinocyst species *Endoceratium* cf. *E. dettmanniae* is the basis for the tentative age assignment of Cenomanian. This species has an age range that extends into the Albian.

3990-6600'

Age.	Early Cretaceous Middle to Late Albian
Zone.	P-M17
Environment.	Marine
Palynomorphs.	The Albian section is separated by the appearance of a few dinocyst marker species. These forms include *Luxadinium propatulum, Ovoidinium verrucosum* and *Spinidinium vestitum.*
Discussion.	The consistent occurrence of *Spinidinium vestitum* tops at 5910 feet. This datum may be a useful correlative horizon to other wells in the region.

6600-6720'

Age.	Early Cretaceous Barremian to Early Albian
Zone.	P-M18a
Environment.	Marine
Palynomorphs.	The increased abundance of *Oligosphaeridium complex* and the appearance of *Fromea amphora*, *Gardodinium trabeculosum*, *Micrhystridium* sp. A and *Senoniasphaera microreticulata* define this interval.

6720-6907'C

Age.	Early Cretaceous Hauterivian
Zone.	P-M19
Environment.	Marine
Palynomorphs.	The Hauterivian interval is marked by a diverse dinocyst assemblage. This assemblage includes the species *Florentinia cooksoniae*, *Imbatodinium micropodum*, *Oligosphaeridium complex* (thick-wall) and *Tubotuberella uncinatum*.

6907C-7020'

Age. Early Cretaceous
Possible Valanginian

Zone. P-M20?

Environment. Marginal Marine to Marine

Palynomorphs. The tentative Valanginian age assignment is based mainly on the appearance of *Tubotuberella apatela*. The usual marker species, *Gochteodinia villosa*, for this zonule was not present in the well.

Discussion. Palynomorph evidence for the Valanginian age is considered to be weak.

The consistent occurrences of reworked Mississippian and Devonian age spores begin in this interval.

7020-7810'

Age.	Late Jurassic Oxfordian
Zone.	P-M22
Environment.	Marine
Palynomorphs.	The Oxfordian interval is marked by a diverse dinocyst assemblage. This assemblage includes the forms *Chytroeisphaeridia pericompsa, C. "verrucosa", Endoscrinium galeritum, Gonyaulacysta cladophora* and *Nannoceratopsis pellucida*.
Discussion.	The most abundant and diverse Oxfordian dinocyst assemblage appears to begin at about 7110 feet. The less developed dinocyst assemblage at the uppermost part of the interval, between 7020 feet and 7110 feet, may be of Early Kimmeridgian age. The datum for the species *Chytroeisphaeridia "verrucosa"* appears to be at 7400 feet. This datum has been recorded in other wells of the region. The Oxfordian section contains the most diverse and abundant reworked Paleozoic spore assemblage of the well.

7810-8710'

Age.	Early to Middle Jurassic Undifferentiated
Zones.	P-M24? to P-M23
Environment.	Marine
Palynomorphs.	The Early - Middle Jurassic interval is marked by the dinocyst forms *Fromea elongata* and *Nannoceratopsis gracilis*. Other less frequent markers include *Parvocysta cracens, P. nasuta* and *Phallocysta minuta*.
Discussion.	Based on the forms recovered, the P-M23 assemblage appears to range in age from Toarcian to Aalenian. A decrease in dinocyst occurrences below 8410 feet suggests the top of zonule P-M24 may occur at that depth.

8710-8920'

Age.	Late Triassic to Early Jurassic Undifferentiated
Zones.	P-T15 and/or P-M24
Environment.	Marine
Palynomorphs.	The upper part of this interval produced relatively poor palynomorph recoveries. The assemblage consisted mainly of bisaccate pollen and Tasmanaceae.

The lower part of the interval (below 8800 feet) is marked by the appearances of striated bisaccate pollen. These forms include *Striatites richteri*, *Lueckisporites* and *Taeniaesporites*.

No dinocyst evidence for any Late Triassic Shublik Formation strata was seen within this interval. However, a Norian age dinocyst was recorded as a sloughed specimen in a ditch sample within the Permian section below and indicates the presence of some Shublik strata in this well.

8920-9790'

Age. Early Triassic
Undifferentiated

Zone. P-T16

Environment. Marine

Palynomorphs. The assemblage from this section is similar to the above except for an apparent increase in spore-pollen frequencies. In addition, the forms *Lundbladispora* and *Crustaesporites* are present.

9790-10,250'T.D.

Age. Permian (Possible Early Permian)
Undifferentiated

Zone. P-T18

Environment. Marine?

Palynomorphs. The spore-pollen assemblage of this interval includes the same forms as seen above along with fairly consistent occurrences of *Dulhuntyispora minuta* and *Klausipollenites staplinii*. Single occurrences of *Potonieisporites* and *Vittatina* were also recorded.

Discussion. Evidence for Permian age strata is sparse. The presence of *Potonieisporites*, which has an age range from Pennsylvanian to Early Permian, and *Vittatina* is the basis for a tentative Early Permian age.

CONCLUSIONS

Palynological analysis of the Phillips Alaska (ARCO) Fiord No. 1 well provides the following generalized palynostratigraphic succession:

- Nonmarine and marginal marine Tertiary strata occur from 100 feet to 1550 feet.

- Marginal marine and marine strata of Campanian and Maestrichtian age are identified from 1550 feet to 2050 feet.

- Marine Santonian - Campanian age strata occur between 2050 feet and 2820 feet.

- Marine strata of Turonian - Coniacian age occur from 2820 feet to 3360 feet.

- Marine strata of probable Cenomanian age are interpreted to be present from 3360 feet to 3990 feet.

- Marine strata of Middle - Late Albian age are present from 3990 feet to 6600 feet.

- Marine Barremian - Early Albian age strata are identified between 6600 feet and 6720 feet.

- Marine Hauterivian age strata occur from 6720 feet to 6907C feet.

- Marginal marine to marine strata of possible Valanginian age are seen between 6907C feet and 7020 feet.

- Marine Jurassic strata occur between 7020 feet and 8710 feet. This section includes two intervals of Jurassic strata ranging from Early to Late Jurassic.

- Marine strata of Late Triassic to Early - Middle Jurassic ages occur from 8710 feet to 8920 feet. The Jurassic strata may be as young as Toarcian - Aalenian. Evidence was also recorded to suggest the presence within this interval of some Norian age strata.

- Marine strata of Early Triassic age are present from 8920 feet to 9790 feet.

- The bottom interval, from 9790 feet to the total depth of 10,250 feet, consists of Permian (possible Early Permian) age strata.

KEROGEN MATURATION REPORT

Interpreted by:

Hideyo Haga

KEROGEN MATURATION
(T.A.I. - VITRINITE REFLECTANCE)

The maturation levels of kerogen residues from the Phillips Alaska (ARCO) Fiord No. 1 well were determined by visual estimates (Thermal Alteration Index or T.A.I.) and by Vitrinite Reflectance (V.R.) measurements. A chart correlating the two analytical techniques and their relationship to hydrocarbon generation is given in Figure 1.

An unoxidized fraction of selected kerogen samples was used to make the T.A.I. slides and V.R. resin mounts. The V.R. resin "plugs" were cut and polished in preparation for the reflectance measurements.

Thermal Alteration Index

Thirty-nine (39) T.A.I. samples were prepared and analyzed. The sample spacing is at about 300 feet except for the selected core samples.

The T.A.I. and percentage estimates for the major organic constituents are presented in Table I. The constituent classification scheme used here is very generalized, but the terminology employed may be equated to the following categories:

- Amorphous = Alginite = Type I
- Herbaceous = Exinite = Type II
- Woody = Vitrinite = Type III
- Fusinitic = Inertnite = Type IV

The T.A.I. estimates suggest that the well is within the immature/mature transitional level for organic maturation down to about 9700 feet. Below 9700 feet the mature level of alteration is attained within the Early Triassic and Permian age strata.

The organic constituents indicate that an abundance in oil-prone material begins in the Santonian - Campanian section at about 2000 feet to 2600 feet. This amorphous and herbaceous organic material reappears in significant amounts within the probable Cenomanian strata at about 3500 feet, and continues at 50 percent or greater concentrations down to 9500 feet. Below 9500 feet, in the Early Triassic and Permian strata, the gas-prone material dominates.

Vitrinite Reflectance

A Leitz MPV-II photometer system and Leitz Orthoplan microscope were used to make the V.R. measurements. This equipment was integrated with a desktop computer for data recording and manipulation.

The V.R. measurements and histogram plots for 11 samples are given in the Appendix. One of the average values is questioned due to the sparse measurements obtained. Although more V.R. "plugs" were made for analysis, some of the samples yielded insufficient organics or vitrinite fragments and were deemed not suitable for obtaining valid measurements.

The average V.R. (R_o) values of the measured samples are also included in Table I. Figure 2 displays the average V.R. for each sample in a semi-log plot. This plot shows a generally slow increase in maturation with increased depth, but the mature level for oil generation is not reached until the Early Triassic section.

REFERENCE

Heroux, Y., Chagnou, A. and Bertrand, R., 1979. Compilation and correlation of major thermal maturation indicators: Bull. Am. Assoc. Petr. Geol., 63: pp. 2128-2144.

APPENDIX

VITRINITE REFLECTANCE DATA