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USGS/HUSKY - NPRA

WALAKPA NO. 2

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NORTH SLOPE, ALASKA

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BIOSTRATIGRAPHY REPORT

Job No. 22-113 **June, 2003**

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Discussion. Black basement argillite.

FORAMINIFERA REPORT

Interpreted by

Michael B. Mickey

FORAMINIFERA SUMMARY

130-2230'

Age.	Early Cretaceous Probable Albian	
Zones.	Probable F-9 to F-11	
Environment.	130-1060':	Nonmarine to Middle Neritic (Alluvial Plain to Middle Shelf)
	1060-1870':	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)
	1870-2260':	Middle to Lower Bathyal (Middle to Lower Slope)

2230-2260'

Age.	Early Cretaceous Barremian
Zone.	F-12
Environment.	Middle to Lower Bathyal (Middle to Lower Slope)

2260-2530'

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

2530-2650'

Age.	Early Cretaceous Valanginian
Zone.	F-13b
Environment.	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)

2650-2984'C

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

2987C-3250'

Age.	Middle Jurassic Aalenian	
Zone.	F-17	
Environment.	2987C-3040':	Middle to Outer Neritic (Middle to Outer Shelf)
	3040-3250':	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)

3250-3570'

Age.	Early Jurassic Toarcian	
Zone.	F-18a	
Environment.	Upper to Middle Bathyal (Upper to Middle Slope)	

3570-3990'

Age.	Early Jurassic Pliensbachian	
Zone.	F-18b	
Environment.	3570-3729'C:	Upper to Middle Bathyal (Upper to Middle Slope)
	3732C-3990':	Middle to Outer Neritic (Middle to Outer Shelf)

3990-4290'

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

4290-4360'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Discussion.	Black argillite.

INTRODUCTION

Scope

Data from 199 Foraminifera samples from the USGS/Husky Walakpa No. 2 well were incorporated into this report. These consisted of 142 ditch, 51 conventional core and 6 sidewall core samples covering the interval 130 to 4360 feet total depth. This work was done as part of M.C.I. Job Number 22-113.

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

130-2230'

Age. Early Cretaceous
Probable Albian

Zones. Probable F-9 to F-11

Environment.
130-1060': Nonmarine to Middle Neritic (Alluvial Plain to Middle Shelf)
1060-1870': Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)
1870-2260': Middle to Lower Bathyal (Middle to Lower Slope)

Fauna. *Haplophragmoides topagorukensis, H. excavatus, Saccammina lathrami, Bathysiphon vitta, Gaudryina nanushukensis, Textularia topagorukensis, Lenticulina macrodisca, Inoceramus* prisms, megaspores, shell fragments, pelmatozoan fragments, pyrite sticks, pyrite, with frequent to common pyritized radiolaria below 1060 feet.

2230-2260'

Age. Early Cretaceous
Barremian

Zone. F-12

Environment. Middle to Lower Bathyal
(Middle to Lower Slope)

Fauna. Arenaceous spp. (large, coarse), *Haplophragmoides duoflatis, Marginulinopsis cephalotes* and frequent rounded frosted quartz floating sand grains.

2260-2530'

Age. Early Cretaceous
Hauterivian

Zone. F-13a

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

Fauna. *Trochammina squamata, Gavelinella stictata, Rectoglandulina humilis, Miliammina awunensis, Gaudryina tailleuri, Haplophragmoides duoflatis,* arenaceous spp. (large, coarse), *Ammobaculites reophacoides, Saracenaria projectura, Thuramminoides* spp., *Bathysiphon scintillata*, *Trochamminoides* spp., *Lenticulina muensteri*, pyrite and frequent to common rounded frosted quartz floating sand grains.

2530-2650'

Age.	Early Cretaceous Valanginian
Zone.	F-13b
Environment.	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)
Fauna.	*Haplophragmoides goodenoughensis, H. duoflatis, H. inflatigrandis, H. coronis, Bathysiphon scintillata,* arenaceous spp. (large, coarse), *Trochamminoides* spp., *Gaudryina tailleuri, G. milleri, Ammodiscus* sp. (small, thin), *Conorboides umiatensis, Reophax tundraensis, Lenticulina* sp. (raised sutures), *Glomospirella arctica, G.* sp. S, *Ammobaculites reophacoides, Oolina apiculata,* rounded frosted quartz floating sand grains, and rare scattered glauconite in core samples.

2650-2984'C

Age.	Late Jurassic Oxfordian
Zone.	F-16b
Environment.	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)
Fauna.	*Marginulina utricula, Ammodiscus cheradospirus, A. asperus, Recurvoides turbinatus, Trochammina instowensis, T. kumaensis, T. gryci, T. canningensis, Saracenaria* cf. *navicula, S. oxfordiana, Globulina topagorukensis, Lenticulina audax, L. volgensis, L. wisniowskii, L. toarcense, Haplophragmoides* spp., *H. canui*, arenaceous spp. (large, coarse), *Marginulinopsis phragmites, Frondicularia lustrata, Ammobaculites alaskensis, A. barrowensis, Rectoglandulina turbinata, Textularia areoplecta, Glomospira perplexa, Tristix* cf. *alcima, Vaginulina sherborni, Vaginulinopsis matutina, Citharina fallax*, ostracods, pelmatozoan fragments, *Inoceramus* prisms, pyrite, and rare to common glauconite below 2800 feet.

2987C-3250'

Age.	Middle Jurassic Aalenian	
Zone.	F-17	
Environment.	2987C-3040':	Middle to Outer Neritic (Middle to Outer Shelf)
	3040-3250':	Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)
Fauna.	*Ammodiscus siliceus, A. cheradospirus, A. asperus, Ammobaculites alaskensis, Haplophragmoides* spp., *Reophax liasica, Bathysiphon anomalocoelia, Dentalina tenuistriata, Lenticulina excavata, L. audax, Astacolus pediacus, Trochamminoides* spp., *Nodosaria mitis, Gaudryina topagorukensis, Inoceramus* prisms, pyrite, pyrite sticks and rare to common scattered glauconite.	

3250-3570'

Age. Early Jurassic
Toarcian

Zone. F-18a

Environment. Upper to Middle Bathyal
(Upper to Middle Slope)

Fauna. *Triplasia kingakensis, Ammodiscus orbis, A. siliceus, Bathysiphon anomalocoelia, Lenticulina audax, Ammobaculites alaskensis, A. barrowensis, Haplophragmoides* spp., *H. canui, Trochamminoides* spp., *Saccammina* sp., *Trochammina canningensis, Lituotuba irregularis*, ostracods, *Inoceramus* prisms, gastropods (pyrite casts), pelecypods (pyrite casts), pyrite, pyrite sticks and frequent pyritized radiolaria.

3570-3990'

Age. Early Jurassic
Pliensbachian

Zone. F-18b

Environment. 3570-3729'C: Upper to Middle Bathyal
(Upper to Middle Slope)
3732C-3990': Middle to Outer Neritic
(Middle to Outer Shelf)

Fauna. *Bathysiphon anomalocoelia, Reophax metensis, R. densa, R. liasica, R. suevica, Trochammina gryci, Haplophragmoides* spp., *Trochamminoides* spp., *Ammobaculites alaskensis, A.* cf. *sthenarus, A.* cf. *vetusta, Ammodiscus siliceus*, pyrite, rare glauconite and rare to frequent scattered pyritized radiolaria.

3990-4290'

Age.	Late Triassic Norian
Zone.	F-19b
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)
Fauna.	*Lingulina alaskensis, Nodosaria larina, N. shublikensis, Astacolus connudatus, Pseudoglandulina simpsonensis, Gaudryina adoxa, Sagoplecta incrassata*, ostracods (medium, smooth), echinoid spines, glauconite, pyrite, frequent to abundant *Monotis/Halobia* shell fragments above 4170 feet, and frequent to common sand-size black phosphate? pebbles between 4110 and 4170 feet.

4290-4360'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of indigenous Foraminifera.
Discussion.	Black argillite.

CONCLUSIONS

The USGS/Husky Walakpa No. 2 well penetrated the following biostratigraphic sequence based on foraminiferal analysis:

- 2400+ feet (130-2530') of Hauterivian to probable Albian age (Early Brookian & Beaufortian - Rift Sequence) generally upward shallowing base of slope bottomsets, slope foresets and alluvial plain to outer shelf topsets sitting on basal middle shelf to upper slope Hauterivian deposits.

- 1460 feet (2530-3990') of Pliensbachian to Valanginian age (Beaufortian - Incipient Rift Sequence) middle shelf to slope sedimentation.

- 300 feet (3990-4290') of Late Triassic (Norian) age (Late Ellesmerian) inner to middle shelf deposition.

- 70+ feet (4290-4360'T.D.) of indeterminate age (Franklinian) black basement argillite.

PALYNOLOGY REPORT

Interpreted by:

Hideyo Haga

PALYNOLOGY SUMMARY

130-2210'

Age.	Early Cretaceous Aptian - Early Albian
Zone.	P-M18
Environment.	Marine - Marginal Marine
Remarks.	This age assignment is based on negative evidence.

2210-2540'

Age.	Early Cretaceous Barremian - Aptian
Zone.	P-M18a
Environment.	Marine

2540-2628'C

Age.	Early Cretaceous Hauterivian
Zone.	P-M19
Environment.	Marine

2628C-2660'

Age.	Early Cretaceous Possible Valanginian
Zone.	P-M20?
Environment.	Marginal? Marine

2660-2988'C

Age.	Late Jurassic Oxfordian
Zone.	P-M22
Environment.	Marine
Remarks.	Possibly in Callovian - Early Oxfordian, P-M22a zonule, by 2890 feet.

2988C-3693'?C

Age.	Early - Middle Jurassic Undifferentiated
Zones.	P-M24 to P-M23
Environment.	Marine - Marginal Marine
Remarks.	Youngest strata in this interval are probably of Toarcian age. The P-M24 zonule appears to top at 3010 feet.

3693?C-4260'

Age.	Late Triassic Norian - Rhaetian?
Zones.	P-M26 to P-M25?
Environment.	Marginal Marine - Nonmarine

4260-4360'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Barren of indigenous palynomorphs.
Remarks.	In argillite lithology.

INTRODUCTION

Purpose and Scope

The USGS/Husky Walakpa No. 2 well completed drilling in February, 1981. During the drilling process, a palynological study of selected sample material from the well was conducted. A total of 107 palynology samples were examined in the original investigation. The sample total consisted of 48 ditch-cutting composites, 45 conventional core fragments, and 6 sidewall cores taken between 130 feet and the total depth of 4360 feet.

In subsequent years, selective intervals have been reprocessed for palynology. These preparations are on reposit at the State of Alaska Geological Materials Center in Eagle Creek, Alaska. Data from 8 of these newer sample preparations are herein incorporated.

This report provides an updated format for all the data. Some of the taxa have been revised to reflect newer taxonomic assignments that have evolved over the decades since the initial study.

Procedures

At the time the well was drilled, the palynological samples were processed in San Diego, California, using techniques that were standard for the early 1980's. The chemical treatments involved the use of hydrochloric, hydrofluoric and nitric acids. The resulting kerogen residues were further concentrated by physical separation with heavy liquids and a sieving/panning technique. Permanent slide mounts were made of the residue concentrates. The coverslip mounting medium used was a synthetic resin sold under the brand name of "Coverbond".

The palynomorph distribution chart data were entered into a desktop PC using proprietary software to compile new format charts. The charts are located in the pocket.

The Palynomorph Distribution Chart (Figure P-1) lists the occurrence and abundance of recorded taxa in each sample. Included on this chart are the diversity and abundance curves for the spore-pollen and the microplankton cysts.

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

RESULTS

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. These categories are based on the absence or presence and diversity of microplankton.

The samples available for examination begin at 130 feet and the youngest units encountered at that depth were of Early Cretaceous age. The oldest dateable assemblage is of Late Triassic age.

130-2210'

Age. Early Cretaceous
Aptian to Early Albian

Zone. P-M18

Environment. Marine to Marginal Marine

Palynomorphs. The interval carries a general Aptian - Albian palynomorph assemblage.

The spore-pollen forms include undifferentiated bisaccates, *Callialasporites dampieri*, *Camarozonosporites insignis*, species of *Cicatricosisporites, Gleicheniidites senonicus* and *Foraminisporis*.

Numerous occurrences of reworked spore-pollen from the Paleozoic and Triassic were also recorded.

The dinocyst assemblage includes the species *Cyclonephelium distinctum, Muderongia asymmetrica, Oligosphaeridium complex, Palaeoperidinium*

cretaceum, *Pseudoceratium polymorphum*, and *P. retusum*.

Scattered occurrences of reworked Triassic, Jurassic and Neocomian dinocysts are common to this interval.

Discussion. Although the assemblage is similar to the Middle - Late Albian, P-M17 zonule, an absence of Albian-restrictive species is significant. In particular, the marker species *Luxadinium propatulum*, *Ovoidinium verrucosum*, *Spinidinium vestitum* and *Wigginsiella grandstandica* were not present. Therefore, this age assignment is based mainly on negative evidence.

2210-2540'

Age. Early Cretaceous
Barremian to Aptian

Zone. P-M18a

Environment. Marine

Palynomorphs. The spore-pollen assemblage is greatly reduced, and consists mainly of bisaccates and *Lycopodiumsporites*.

The Barremian - Aptian interval is marked by an increase in dinocyst abundances. This increase includes the species *Cyclonephelium distinctum*, *Odontochitina operculata*, *Oligosphaeridium complex*, and *Palaeoperidinium cretaceum*. Also appearing consistently are *Gardodinium trabeculosum* and *Imbatodinium jaegeri*.

Discussion. The organic recovery of this interval is amorphous-rich and reflects a low energy, oxygen-poor depositional condition.

2540-2628'C

Age. Early Cretaceous
Hauterivian

Zone. P-M19

Environment. Marine

Palynomorphs. This relatively thin interval contained many core samples.

The spore-pollen assemblage remains diminished.

The important dinocyst markers include *Imbatodinium micropodum, Lunatadinium dissolutum, Muderongia simplex* and *Oligosphaeridium complex* (thick-wall).

2628C-2660'

Age. Early Cretaceous
Possible Valanginian

Zone. P-M20?

Environment. Marginal? Marine

Palynomorphs. This thin interval is represented mainly in core samples.

The dinocyst species diminish and the assemblage is nearly monospecific, namely, *Lunatadinium dissolutum*.

The beginning of consistent occurrences of reworked Paleozoic spores suggests a Valanginian age.

Discussion. The absence of Valanginian dinocyst markers permits only a very tentative age assignment.

2660-2988'C

Age. Late Jurassic
Oxfordian

Zone. P-M22

Environment. Marine

Palynomorphs. The spore-pollen assemblage remains relatively unimportant. The assemblage includes *Classopollis classoides, Gleicheniidites senonicus* and *Lycopodiumsporites*.

The reworked forms include several Paleozoic and Permo-Triassic pollen and spores.

The dinocyst assemblage includes the key forms *Acanthaulax senta, Endoscrinium galeritum, Gonyaulacysta cladophora, G. jurassica, Nannoceratopsis pellucida* and *Pareodinia osmingtonensis*. Toward the bottom of the section, a single specimen of *Stephanelytron redcliffense* was recorded.

Discussion. The presence of *Stephanelytron redcliffense* at 2890 feet suggests that the lower part of this interval may be of Callovian - Early Oxfordian (P-M22a) age.

2988C-3693'?C

Age. Early to Middle Jurassic
Undifferentiated

Zones. P-M24 to P-M23

Environment. Marine

Palynomorphs. The spore-pollen assemblage is similar to the above interval. The reworked forms remain consistent.

The appearance of *Nannoceratopsis gracilis*, *N. senex*, and *N.* cf. *N. raunsgaardii* mark the dinocyst assemblage.

Discussion. The dinocyst assemblage suggests that the interval probably tops within the Toarcian age.

The apparent base of dinocyst occurrences, as evidenced by the core sample recoveries, is at about 3010 feet. This would also suggest that the P-M24 zonule may top at that depth.

The questionable depth for the base of the interval is discussed below.

3693?C-4260'

Age. Late Triassic
Norian to Rhaetian?

Zones. P-M26 to P-M25?

Environment. Marginal Marine to Nonmarine

Palynomorphs. The spore-pollen assemblage remains similar to the Jurassic intervals above.

The Late Triassic dinocysts recorded are *Suessia swabiana, Sverdrupiella manicata, S. sabinensis* and *S. usitata*. The acritarch *Micrhystridium* spp. occurs consistently through the interval.

Discussion. The dinocysts are sparse and occur sporadically. The top of this section is identified by a single specimen of *Suessia* and, therefore, questioned as Rhaetian. The better assemblage, representing Norian strata, appears below 3820 feet.

4260-4360'T.D.

Age. Indeterminate

Environment. Indeterminate

Palynomorphs. Barren of indigenous palynomorphs.

Discussion. This basal interval recovered no indigenous forms. The washed lithology indicates the presence of argillite.

CONCLUSIONS

Palynological analysis of the USGS/Husky Walakpa No. 2 well provides the following generalized palynostratigraphic succession:

- Marine to marginal marine Aptian - Early Albian strata are identified between 130 feet and 2210 feet.

- Marine Barremian - Aptian age strata occur from 2210 feet to 2540 feet.

- Marine Hauterivian strata are represented by the interval between 2540 feet and 2628C feet.

- Marginal? marine strata of possible Valanginian age is interpreted for the thin interval 2628C feet to 2660 feet.

- Late Jurassic, Oxfordian, marine strata appear between 2660 feet and 2988C feet. This section may include a Callovian - Early Oxfordian unit below 2890 feet.

- Marine strata of Early to Middle Jurassic age are identified between 2988C feet and 3693?C feet. The top of this interval may be as old as Toarcian. The P-M24 zonule probably tops at 3010 feet.

- Marginal marine to nonmarine strata of Late Triassic age are noted between 3693?C feet and 4260 feet. The upper part of the interval is possibly of Rhaetian age, but based on weak evidence. The Norian age section is better defined, but the evidence appears below 3820 feet.

- The bottom interval from 4260 feet to the total depth of 4360 feet is of indeterminate age. This section contains argillitic lithology.