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Petroleum Source Rock and Reservoir Quality Data from Outcrop Samples, Onshore North Slope of Alaska East of Prudhoe Bay

by

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PETROLEUM SOURCE ROCK AND RESERVOIR QUALITY DATA FROM OUTCROP SAMPLES, ONSHORE NORTH SLOPE OF ALASKA EAST OF PRUDHOE BAY

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Introduction

This report presents data collected by the U.S. Geological Survey and the Alaska Department of Geological and Geophysical Surveys on the North Slope of Alaska between Prudhoe Bay and the Canadian border during July of 1979. A more extensive interpretive report is planned to supersede this report; data only are presented here in order that they be made available to the public prior to the Beaufort Sea Sale.

Plates 1 and 2 show locations where samples were collected. Table I shows which samples were collected at which location. Detailed stratigraphic sections and traverses were measured at some locations, and Plates 3 through 14 depict these stratigraphic sections and traverses and show sample locations within them.

Geochemical Data

Eighty-one samples were processed by Geochem Laboratories, Inc., for organic geochemical analysis. Weight percent of organic carbon and a summary of the visual Kerogen data (organic matter type and thermal alteration index [TAI]) for these samples are reported in Table II. The $C_{15}+$ pentane-soluble extract data for these samples are reported in Table III. Sample locations can be determined by referring to Plates 1 and 2, Table I, and appropriate stratigraphic sections and traverses.

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[1]U.S. Geological Survey

[2]Alaska Division of Geological and Geophysical Surveys

Porosity and Permeability Data

Seventy-six samples were processed for porosity and permeability by Chemical and Geological Laboratories of Alaska, Inc. These data appear in Table IV. The locations of the samples can be determined by referring to Plates 1 and 2, Table I, and appropriate stratigraphic sections and traverses.

Paleontological Data

Seventy-seven samples were processed by Anderson, Warren and Associates, Inc., for Foraminiferal age and environment determinations, and 74 samples were processed by the same firm for palynological age and environment determinations. These data appear in Tables V and VI, respectively. Sample locations can be determined by referring to Plates 1 and 2, Table I, and appropriate stratigraphic sections and traverses.

Table I

SAMPLE LOCATIONS - CROSS REFERENCE

Map Location Number	Field Sample Number
1	78- to 96-WL-79
2	97- to 99-WL-79
3	48-GB-79
4	129- to 142-GB-79
5	143- to 148-GB-79
6	149- to 154-GB-79
7	155- to 157-GB-79
8	23- to 47-GB-79, 53- to 61-GB-79
9	62- to 80-GB-79
10	11- to 20-WL-79
11	7- to 10-WL-79
12	1- to 6-WL-79
13	5- to 15-IP-79, 5- to 22-GB-79
14	49- to 52-GB-79
15	16- to 28-IP-79, 26- to 28-WL-79, 68- to 77-WL-79
16	33- to 69-WL-79
17	29- to 32-WL-79
18	1- to 4-IP-79, 1- to 4-GB-79
19	122- to 128-GB-79
20	97- to 102-GB-79
21	88- to 96-GB-79
22	103- to 121-GB-79
23	30- to 59-IP-79

Table II

SUMMARY OF ORGANIC CARBON CONTENT AND VISUAL KEROGEN DATA*

Field Sample Identification Number	Percent Organic Carbon	Thermal Alteration Index (TAI)	Visual Kerogen Data: Organic Matter Type 1st Population	Organic Matter Type 2nd Population	Organic Matter Type Total Population
2-GB-79	2.90	2 to 2+	Am;H;W	W-C;-;-	Am;H-W;C
6-GB-79	1.37	2 to 2+	H;W;Am	W-C;-;-	H-W;C;Am
9-GB-79	1.16	2 to 2+	H-W;-;-	W-C;-;-	W;H-C;-
11-GB-79	1.15	2- to 2	H-W;-;Al	W-C;-;-	W;H-C;Al
13-GB-79	1.25; 1.23	2- to 2	Am-H;-;W	C;W;-	Am-H;-;W-C
16-GB-79	1.25	2- to 2	H-W;-;-	W-C;-;-	W;H-C;-
18-GB-79	1.35	2- to 2	H;W;-	W-C;-;-	H;W;C
20-GB-79	1.00	2- to 2	H;W;-	W-C;-;-	H-W;C;-
24-GB-79	2.10	2- to 2	H-W;-;-	W-C;-;-	H-W;C;-
27-GB-79	1.14	2- to 2	H-W;-;-	W-C;-;-	W;H-C;-
30-GB-79	1.29	2- to 2	H;W;-	W-C;-;-	H-W;C;-
35-GB-79	1.10	2- to 2	H;W;-	W-C;-;-	H-W;C;-
38-GB-79	1.12	2- to 2	H;W;-	W-C;-;-	H-W;C;-
42-GB-79	1.30	2- to 2	W;H;-	W-C;-;-	W;H-C;-
46-GB-79	1.01	2- to 2	H-W;-;-	W-C;-;-	H-W;-;C
48-GB-79	2.65	2-	Am(Al);-;H(W)	C;-;-	Am(Al);-;H(W-C)
50-GB-79	0.96	2- to 2	H;W;-	W-C;-;-	W-C;H;-
53-GB-79	1.29	2- to 2	H;W;-	W-C;-;-	H;W;C
56-GB-79	0.98	2- to 2	H;W;-	W-C;-;-	H;W;C
59-GB-79	1.01	2- to 2	W;H;-	W-C;-;-	W;H;C
62-GB-79	0.62	3	H;W;-	W-C;H;-	W-C;H;-
66-GB-79	0.70; 0.70	3 to 3+	H;W;-	W-C;-;-	W-C;H;-
69-GB-79	0.43	3- to 3	H-W;-;-	W-C;-;H*	W-C;H;-
73-GB-79	1.00	3- to 3	H;-;W	W-C;-;H*	W-C;-;H
77-GB-79	0.96	3	H;W;-	W-C;-;-	H;W;C

Field Sample Identification Number	Percent Organic Carbon	Thermal Alteration Index (TAI)	Visual Kerogen Data: Organic Matter Type 1st Population	Organic Matter Type 2nd Population	Organic Matter Type Total Population
81-GB-79	2.84	1+	Am(Al);-;H	H-W-C;-;-	Am(Al);-;H(W-C)
84-GB-79	4.84	1+	Am(Al);-;H	W;C;-	Am(Al);-;H-W(C)
88-GB-79	9.82	1+ to 2-	Am(Al);H;W	W-C;-;-	Am(Al);H;W(C)
91-GB-79	12.41	1+ to 2-	Am(Al);H;-	W-C;-;-	Am(Al);H;W-C
94-GB-79	10.01	1+ to 2-	Am(Al);-;H	W-C;-;-	Am(Al);-;H-W-C
97-GB-79	2.24	1+ to 2-	W;Am-H;-	W-C;-;-	W;Am-H;C
100-GB-79	2.30	1+ to 2-	Am-H-W;-;-	W-C;-;-	Am-H-W;-;-
103-GB-79	0.94; 0.95	1+ to 2-	W;-;H	W-C;-;-	W-C;-;H
107-GB-79	1.30	1+ to 2-	H-W;-;-	W-C;-;H*	H-W;C;-
111-GB-79	2.45	2-	W;H;-	C;-;-	W;H;C
115-GB-79	0.83	2- to 2	W;H;-	W-C;-;	W;H;C
119-GB-79	2.82	1+ to 2-	W;H;Am	W-C;-;-	W;H;Am(C)
123-GB-79	0.93	2+ to 3-	H;W;Am	W-C;-;H*	W-C;H;Am
126-GB-79	1.46	3	W;H;Am	W-C;-;-	W;H-C;Am
129-GB-79	1.20	1+ to 2-	H;W;-	W-C;-;	H;W;C
133-GB-79	1.08	2 to 2+	H;W;Am	C;W;-	H;W;C(Am)
137-GB-79	1.11	2 to 2+	H;W;-	C;H-W;-	H;W;C
140-GB-79	1.21	2 to 2+	H;W;-	C;W;	H;W;C
143-GB-79	1.60	2 to 2+	H-W;-;Am-C	C;-;-	H-W;C;Am
146-GB-79	1.31; 1.28	2 to 2+	H-W;-;-	C;-;-	H-W;C;-
149-GB-79	1.20	2 to 2+	H-W;C;-	C;-;H-W	H-W;C;-
152-GB-79	1.17	2+	H;W;C	W-C;-;-	H;W;C
155-GB-79	3.95	3 to 3+	Am;H;W	W-C;-;-	Am;H;W(C)
2-IP-79	1.31	2 to 2+	H;W;Am	W-C;-;-	H;W;Am-C
6-IP-79	1.35	2 to 2+	H;W;Am	W-C;-;-	H;W;C(Am)

Field Sample Identification Number	Percent Organic Carbon	Thermal Alteration Index (TAI)	Visual Kerogen Data: Organic Matter Type 1st Population	Organic Matter Type 2nd Population	Organic Matter Type Total Population
9-IP-79	1.32	2 to 2+	H;W;Am	C;H-W;-	H;W-C;Am
11-IP-79	1.00	2 to 2+	H-W;-;C	W-C;-;H	W;H-C;-
19-IP-79	1.25	3 to 3+	W-C;H;Am	W-C;-;-	W-C;H;Am
26-IP-79	4.77	2+ to 3-	Am;H;W		Am;H;W
31-IP-79	1.12	2 to 2+	H;W;C	C;W;-	H;W-C;-
35-IP-79	0.95; 0.92	2- to 2	H;W;C	W-C;-;-	H;W-C;-
40-IP-79	1.02	2- to 2	H;W;-	W-C;-;-	H;W-C;-
48-IP-79	0.97	2 to 2+	H;W;C	W-C;-;-	H;W;C
56-IP-79	4.02	2 to 2+	H;W-C;-	W-C;H;-	H-W;C;-
9-WL-79	6.50	2- to 2	H;W;-	C;W;-	H-W;C;-
9-WL-79	6.68	2- to 2	H;W;C	C;W;-	H;W-C;-
26-WL-79	3.65; 3.61	3 to 3+	Am;H;-		Am;H;-
30-WL-79	0.42	3 to 3+	H;Am-W;C		H;Am-W;-
34-WL-79	0.49	3 to 3+	H-C;Am;W		H-C;Am;W
38-WL-79	0.42	3+	W-C;H;-	C;W;-	W-C;H;-
41-WL-79	2.33	3 to 3+	Am;H;C		Am;H;C
44-WL-79	1.13	3	Am;H;W-C		Am;H;W-C
48-WL-79	0.64	3- to 3	Am;-;H	W-C;-;-	Am;W-C;H
51-WL-79	1.95; 1.94	3 to 3+	H;Am;-		H;Am;-
53-WL-79	1.70	2- to 2	H;W;C	C;H;W	H;W-C;-
55-WL-79	0.56	3+ to 4-	H-C;W;-	-;-;H	H-C;W;-
58-WL-79	1.11	3 to 3+	W-C;H;Am	-;-;H	W-C;H;Am
61-WL-79	0.99	3+ to 4-	W-C;H;-	-;-;H	W-C;H;-
64-WL-79	1.09	3 to 3+	W-C;H;-	-;H;-	W-C;H;-
67-WL-79	1.31	3 to 3+	H-C;W;-	-;H-W;-	H-C;W;-

Field Sample Identification Number	Percent Organic Carbon	Thermal Alteration Index (TAI)	Visual Kerogen Data		
			Organic Matter Type 1st Population	Organic Matter Type 2nd Population	Organic Matter Type Total Population
78-WL-79	1.00	1+ to 2-	H;W;-	C;H;W	H;C;W
82-WL-79	2.02	1+ to 2-	H-W;-;-	C;H;W;-	H-W;-;C
85-WL-79	1.79	1+ to 2-	H-W;-;-	W-C;-;-	H-W;C;-
88-WL-79	1.40	1+ to 2-	H-W;-;-	H-C;W;-	H-W;C;-
91-WL-79	1.22; 1.25	2- to 2	H;W;C	H-C;-;-	H;W;C
94-WL-79	1.41	1+ to 2-	H;W;Am	H-C;-;-	H;W;Am(C)

KEROGEN KEY

Predominant:	Secondary:	Trace
60-100%	20-40%	1-20%

Al = Algal
Am = Amorphous-Sapropel
H = Herbaceous-Spore/Cuticle
H* = Degraded Herbaceous
W = Woody
C = Coaly
U = Unidentified Material

*Determinations by: Geochem Laboratories, Inc., Houston, Texas

Table III

CONCENTRATION OF C_{15}+ EXTRACTED MATERIALS IN ROCK*

Field Sample Number	Total Extract (ppm)	Preciptd. Asphaltene (ppm)
2-GB-79	1152	284
6-GB-79	581	248
9-GB-79	709	385
11-GB-79	572	287
13-GB-79	715	389
16-GB-79	723	390
18-GB-79	454	178
20-GB-79	390	191
24-GB-79	1293	651
27-GB-79	483	236
30-GB-79	874	461
35-GB-79	705	426
38-GB-79	768	448
42-GB-79	980	555
46-GB-79	737	435
48-GB-79	21144	13638
50-GB-79	4440	1470
53-GB-79	1084	589
56-GB-79	746	403
59-GB-79	595	293
62-GB-79	132	68
66-GB-79	163	76
69-GB-79	167	79
73-GB-79	299	78
77-GB-79	395	87
81-GB-79	6055	1259
84-GB-79	6996	2003
88-GB-79	13442	4880
91-GB-79	9673	4465
94-GB-79	6696	2350
97-GB-79	14999	1057
100-GB-79	17314	1833
103-GB-79	205	110
107-GB-79	239	122
111-GB-79	246	129

Field Sample Number	Total Extract (ppm)	Preciptd. Asphaltene (ppm)
115-GB-79	218	132
119-GB-79	424	197
123-GB-79	160	113
126-GB-79	286	191
129-GB-79	504	246
133-GB-79	575	322
137-GB-79	841	462
140-GB-79	750	392
143-GB-79	535	252
146-GB-79	560	353
149-GB-79	820	584
152-GB-79	290	137
155-GB-79	1807	759
2-IP-79	1277	289
6-IP-79	373	248
9-IP-79	433	234
11-IP-79	446	289
19-IP-79	577	279
26-IP-79	792	357
31-IP-79	610	404
35-IP-79	274	145
40-IP-79	207	91
48-IP-79	496	327
56-IP-79	677	299
9-WL-79	1824	707
9-WL-79	3104	1340
26-WL-79	1654	700
30-WL-79	102	64
34-WL-79	477	406
38-WL-79	137	73
41-WL-79	134	59
44-WL-79	167	131
48-WL-79	123	96
51-WL-79	237	154
53-WL-79	188	116
55-WL-79	207	177
58-WL-79	153	81
61-WL-79	406	393
64-WL-79	318	181
67-WL-79	314	101

Field Sample Number	Total Extract (ppm)	Preciptd. Asphaltene (ppm)
78-WL-79	862	630
82-WL-79	757	357
85-WL-79	744	401
88-WL-79	1044	322
91-WL-79	832	275
94-WL-79	579	239

*Determinations by: Geochem Laboratories, Inc., Houston, Texas

Table IV

POROSITY AND PERMEABILITY*

Field Sample No.	Effective Porosity Percent	Horizontal Permeability Millidarcies
49-GB-79	6.6	0.26
65-GB-79	1.2	-0.01
72-GB-79	5.1	-0.01
76-GB-79	5.6	0.02
80-GB-79	5.2	0.01
118-GB-79	4.4	0.04
16-IP-79	5.0	0.01
17-IP-79	6.2	0.02
18-IP-79	4.1	-0.01
22-IP-79	8.0	0.04
23-IP-79	4.4	-0.01
24-IP-79	7.1	0.02
25-IP-79	4.4	0.01
30-IP-79	3.6	0.04
34-IP-79	3.0	0.04
38-IP-79	3.1	0.11
39-IP-79	4.0	0.09
43-IP-79	2.6	0.09
44-IP-79	4.5	1.18
45-IP-79	5.1	0.08
46-IP-79	5.6	0.15
47-IP-79	3.0	0.08
51-IP-79	1.0	-0.01
59-IP-79	4.2	0.12
29-WL-79	4.0	0.02
32-WL-79	3.5	0.01
33-WL-79	2.1	-0.01
37-WL-79	0.6	-0.01
106-GB-79	3.4	2.29
110-GB-79	3.2	0.26
122-GB-79	3.0	0.01
132-GB-79	0.4	-0.01
136-GB-79	3.1	0.04
68-WL-79	6.9	0.08
69-WL-79	6.8	0.08

Field Sample No.	Effective Porosity Percent	Horizontal Permeability Millidarcies
70-WL-79	3.0	0.01
71-WL-79	7.5	0.03
72-WL-79	11.9	20.00
73-WL-79	5.5	0.08
74-WL-79	6.0	0.20
75-WL-79	3.5	-0.01
76-WL-79	3.8	-0.01
1-GB-79	0.7	-0.01
4-GB-79	2.8	-0.01
5-GB-79	6.8	0.17
8-GB-79	3.8	0.01
15-GB-79	3.1	-0.01
22-GB-79	4.8	0.02
23-GB-79	9.4	0.06
33-GB-79	5.5	0.05
34-GB-79	3.6	0.03
41-GB-79	0.7	-0.01
45-GB-79	0.4	-0.01
48-GB-79	22.8	683.00
1-IP-79	3.2	0.02
5-IP-79	6.4	0.11
10-IP-79	3.2	0.03
14-IP-79	2.1	0.01
15-IP-79	10.9	1.29
2-WL-79	11.6	2.07
5-WL-79	16.2	162.00
10-WL-79	15.5	11.00
11-WL-79	16.2	43.00
12-WL-79	15.2	34.00
13-WL-79	17.6	56.00
14-WL-79	16.0	114.00
15-WL-79	17.3	39.00
16-WL-79	16.4	38.00
17-WL-79	16.3	38.00
18-WL-79	18.1	306.00
20-WL-79	18.5	339.00
21-WL-79	18.6	267.00
22-WL-79	16.9	2.80
23-WL-79	17.3	80.00
24-WL-79	20.8	2731.00
25-WL-79	16.8	3200.00

*Determinations by Chemical & Geological Laboratories of Alaska, Inc.

Table V

SUMMARY OF FORAMINIFERAL AGE AND ENVIRONMENT DATA*

Frequency symbols used in fossil assemblages: R = rare, F = frequent, C = common, A = abundant, FL = flood.

3-GB-79

Ammobaculites fragmentarius (R), Arenaceous spp. (F), Gaudryina tappanae (R), Haplophragmoides coronis (F), H. duoflatis (C), H. inflatigrandis (R), Miliammina ischnia (R), Trochammina squamata (R), round frosted quartz floaters (R), pyrite (F), pyrite sticks (F), fecal pellets (F). Dark gray sandy bentonitic shale.

AGE: Early Cretaceous (Neocomian) F-12 to F-13
ENVIRONMENT: Middle Neritic to Upper Bathyal (turbid)

7-GB-79

Arenaceous sp. (R), fecal pellets (R). Dark brown silty shale.

AGE: Indeterminate
ENVIRONMENT: Possible Marine

17-GB-79

No Foraminifera found. Brownish-gray very fine-grained sandstone or siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

19-GB-79

No Foraminifera found. Fecal pellets (F). Brownish-gray iron-stained very fine-grained sandstone or siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

21-GB-79

Bathysiphon vitta (R), Hippocrepina sp. (R), coal (R). Brown sandy siltstone.

AGE: Indeterminate
ENVIRONMENT: Marginal Marine to Inner Neritic

25-GB-79

No Foraminifera found. Brown sandy siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

28-GB-79

Arenaceous sp. (R), Cyclammina 7 (R), Haplophragmoides cf. excavatus (F), fecal pellets (C). Brown iron-stained shale.

AGE: Probable Paleogene
ENVIRONMENT: Inner Neritic

31-GB-79

Haplophragmoides cf. excavatus (R), coal (F). Brownish-gray sandy shale.

AGE: Indeterminate
ENVIRONMENT: Marginal Marine

36-GB-79

No Foraminifera found. Fecal pellets (F). Brown siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

39-GB-79

Bathysiphon sp. (R), Haplophragmoides cf. excavatus (R), fecal pellets (F). Brownish-gray muddy fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT. Marginal Marine

43-GB-79

Bathysiphon sp. (R), coal (R). Brown muddy fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Probable Mariginal Marine

51-GB-79

Arenaceous spp. (A), Bathysiphon vitta (F), Haplophragmoides excavatus (F), H. spp. (F), pyrite (R), fecal pellets (R). Brown siltstone.

AGE: Probable Cretaceous
ENVIRONMENT: Marginal Marine to Inner Neritic

54-GB-79

Arenaceous spp. (R), Cyclammina 7 (F), Haplophragmoides cf. excavatus (R), coal (F). Brown iron-stained sandy shale.

AGE: Probable Paleogene (Paleocene)
ENVIRONMENT: Middle Neritic

57-GB-79

Cyclammina 71 (R), C. 7 (C), Haplophragmoides cf. excavatus (F), Cenosphaera sp. (R), coal (R), fecal pellets (F). Brown sandy shale.

AGE: Probable Paleogene (Paleocene)
ENVIRONMENT: Middle Neritic to Upper Bathyal

60-GB-79

Cyclammina 71 (R), C. 7 (A), Haplophragmoides cf. excavatus (F), pyrite (R), coal (R), fecal pellets (F). Orange-brown iron-stained siltstone.

AGE: Probable Paleogene (Paleocene)
ENVIRONMENT: Middle Neritic to Upper Bathyal

63-GB-79

Ammobaculites alaskensis (F), A. cf. vetusta (R), Ammodiscus cheradospirus (R), Arenaceous spp. (F), Bathysiphon sp. (R), Haplophragmoides spp. (F), Recurvoides sp. (R). Dark brown siltstone.

AGE: Probable Early to Middle Jurassic
ENVIRONMENT: Probable Inner to Middle Neritic

67-GB-79

Ammobaculites alaskensis (F), A. barrowensis (R), Ammodiscus cheradospirus (C), Arenaceous spp. (F), Bathysiphon anomalocoelia (F), Haplophragmoides spp. (R), pyrite (R). Brown very fine-grained sandstone.

AGE: Probable Early to Middle Jurassic
ENVIRONMENT: Probable Inner to Middle Neritic

70-GB-79

Ammobaculites alaskensis (R), Ammodiscus cheradospirus (R), Haplophragmoides spp. (F), fecal pellets (F). Brown iron-stained very fine-grained sandstone.

AGE: Probable Early to Middle Jurassic
ENVIRONMENT: Inner to Middle Neritic

74-GB-79

Ammobaculites alaskensis (F), Ammodiscus cheradospirus (F), Arenaceous spp. (F), Gaudryina cf. milleri (R), Gaudryina dyscrita (R), Haplophragmoides spp. (C), fecal pellets (C). Dark reddish-brown iron-stained siltstone.

AGE: Early to Middle Jurassic
ENVIRONMENT: Middle to Outer Neritic

78-GB-79

Ammobaculites alaskensis (F), Arenaceous spp. (F), Bathysiphon anomalocoelia (R), Gaudryina topagorukensis (R), G. dyscrita (R), Haplophragmoides spp. (F), fecal pellets (C). Dark brown to black siltstone.

AGE: Early to Middle Jurassic
ENVIRONMENT: Middle to Outer Neritic

82-GB-79

No Foraminifera found. Inoceramus prisms (C), gypsum (A). Buff tan inoceramus sandstone.

AGE: Mesozoic (Jurassic to Cretaceous)
ENVIRONMENT: Marginal Marine to Inner Neritic

85-GB-79

No Foraminifera found. Jarosite (C). Mottled dark gray paper shale.

AGE: Possible Late Cretaceous (based on lithology only)
ENVIRONMENT: Indeterminate

89-GB-79

No Foraminifera found. Cenosphaera sp. (R), gypsum (A). Dark gray mottled paper shale.

AGE: Possible Late Cretaceous (based on lithology only)
ENVIRONMENT: Possible Marine

92-GB-79

No Foraminifera found. Light and dark gray mottled bentonitic shale.

AGE: Possible Late Cretaceous (based on lithology only)
ENVIRONMENT: Indeterminate

95-GB-79

No Foraminifera found. Gypsum (R). Dark gray bentonitic shale.

AGE: Possible Late Cretaceous (based on lithology only)
ENVIRONMENT: Indeterminate

98-GB-79

No Foraminifera found. Coal (F), megaspores (R). Brownish-gray muddy fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

101-GB-79

No Foraminifera found. Pyrite (R), coal (R), calcispheres? (R). Light brownish-gray medium to coarse-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

104-GB-79

No Foraminifera found. Fecal pellets (A). Dark brown iron-stained silty shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

108-GB-79

No Foraminifera found. Calcispheres? (R). Dark brown iron-stained muddy very fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

112-GB-79

No Foraminifera found. Coal (A), fecal pellets (F). Black carbonaceous shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

116-GB-79

No Foraminifera found. Dark brown to black medium-grained cherty muddy sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

120-GB-79

No Foraminifera found. Coal (R), fecal pellets (C). Dark brown iron-stained shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

124-GB-79

Ammobaculites reophacoides (R), Ammodiscus rotalarius (R), Arenaceous spp. (large, coarse) (C), A. spp. (F), Gaudryina milleri (R), G. tailleuri (R), Glomospira corona (R), Glomospirella arctica (R), Haplophragmoides inflatigrandis (F), H. duoflatis (C), H. goodenoughensis (R), Saccammina lathrami (R), rounded frosted quartz floaters (F), pyrite (R), fecal pellets (C). Dark gray sandy shale.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Outer Neritic to Middle Bathyal

127-GB-79

No Foraminifera found. Inoceramus prisms (R), limonite (C). Black weathered shale.

AGE: Indeterminate
ENVIRONMENT: Probable Marine

130-GB-79

No Foraminifera found. Megaspores (F). Brownish-gray fine to medium-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

134-GB-79

No Foraminifera found. Coal (F), plant debris (F), megaspores (R). Brown siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

138-GB-79

No Foraminifera found. Megaspores (R), plant debris (C), vein calcite (A). Brown fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

141-GB-79

No Foraminifera found. Light brownish-gray sandy dolomite?

AGE: Indeterminate
ENVIRONMENT: Indeterminate

144-GB-79

No Foraminifera found. Cenosphaera sp. (R). Dark brown fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Possible Marine

147-GB-79

No Foraminifera found. Pyrite (A), pyrite spheres (C). Dark brown pyritic fine to medium-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

150-GB-79

No Foraminifera found. Fecal pellets (C). Dark brown muddy fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

153-GB-79

No Foraminifera found. Fecal pellets (F). Brown sandy siltstone or shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

156-GB-79

No Foraminifera found. Pyrite (F). Mottled dark gray iron-stained bentonitic shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

3-IP-79

Haplophragmoides coronis (R), rounded frosted quartz floaters (R), fecal pellets (F). Black shale.

AGE: Possible Early Cretaceous (Neocomian)
ENVIRONMENT: Probable Marine

7-IP-79

No Foraminifera found. Brown sandy shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

12-IP-79

Arenaceous spp. (R). Brown iron-stained muddy sandstone.

AGE: Indeterminate
ENVIRONMENT: Possible Marine

20-IP-79

Ammobaculites reophacoides (R), Arenaceous spp. (R), Gaudryina tailleuri (R), Haplophragmoides coronis (R), fecal pellets (F). Dark orange-brown iron-stained shale.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Probable Neritic

27-IP-79

Ammobaculites reophacoides (R), Ammodiscus mackenziensis (R), Conorboides cf. hofkeri (C), Gaudryina tailleuri (R), G. tappanae (F), Haplophragmoides coronis (F), H. canui (R), rounded frosted quartz floaters (C), oil staining (F). Black sandy shale.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Middle Neritic to Upper Bathyal

32-IP-79

No Foraminifera found. Vein calcite (A), fecal pellets (R). Dark brown siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

36-IP-79

No Foraminifera found. Pyrite (R), coal (R), vein calcite (F). Dark brown siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

41-IP-79

No Foraminifera found. Fecal pellets (R). Dark brown to black fine-grained muddy sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

49-IP-79

Hyperammina sp. (R), Haplophragmoides sp. (R), fecal pellets (C). Dark brown sandy siltstone.

AGE: Indeterminate
ENVIRONMENT: Possible Marginal Marine to Inner Neritic

54-IP-79

No foraminifera found. Dark orange-brown iron-stained fine to medium-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

57-IP-79

No Foraminifera found. Fecal pellets (F), black chert? pebble breccia (R). Black iron-stained shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

1-WL-79

No foraminifera found. Coal (F), fecal pellets (F). Dark gray to black shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

8-WL-79

No Foraminifera found. Coal (C). Yellow-brown iron-stained fine-grained coaly sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

27-WL-79

No Foraminifera found. Jarosite? (F). Dark gray shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

31-WL-79

No foraminifera found. Limonite (C). Orange-brown limonitic siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

35-WL-79

No Foraminifera found. Limonite (F). Dark gray limonitic quartzitic siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

39-WL-79

No Foraminifera found. Fecal pellets (F). Reddish-brown silty shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

42-WL-79

No Foraminifera found. Black chert? pebbles (FL). Black chert? pebble breccia.

AGE: Indeterminate (Possible Triassic suggested by lithology only)
ENVIRONMENT: Indeterminate

45-WL-79

No Foraminifera found. Monotis/Halobia fragments (C), ostracods (medium-large) (R), black chert? pebbles (F). Black shelly calcareous shale.

AGE: Probable Triassic (F-19)
ENVIRONMENT: Marine

49-WL-79

No Foraminifera found. Echinoid spines (R). Dark gray silty shale.

AGE: Indeterminate
ENVIRONMENT: Possible Marine

52-WL-79

No Foraminifera found. Monotis/Halobia fragments (FL), coal (R), gypsum (F). Dark gray shell hash.

AGE: Probable Triassic (F-19)
ENVIRONMENT: Marine

56-WL-79

Arenaceous spp. (large, coarse) (F), Gaudryina tailleuri (R), Glomospirella sp. (R), G. S (R), Haplophragmoides canui (R), H. duoflatis (R), H. coronis (R), H. inflatigrandis (F), rounded frosted quartz floaters (F). Brownish-gray sandy siltstone.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Outer Neritic to Middle Bathyal

59-WL-79

Ammobaculites reophacoides (F), Arenaceous spp. (large, coarse) (C), Bathysiphon scintillata (R), Gaudryina milleri (R), Glomospirella S (R), Haplophragmoides goodenoughensis (F), H. duoflatis (C), H. inflatigrandis (C), H. canui (R), rounded frosted quartz floaters (A), fecal pellets (C). Dark brown pebble shale.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Outer Neritic to Middle Bathyal

62-WL-79

No Foraminifera found. Vein calcite (F), fecal pellets (F). Black siltstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

65-WL-79

Ammobaculites reophacoides (R), Gaudryina tailleuri (R), Haplophragmoides coronis (R), H. duoflatis (R), fecal pellets (C), limonite (F). Dark gray to black shale.

AGE: Early Cretaceous (Neocomian)
ENVIRONMENT: Middle to Outer Neritic

68-WL-79

Ammobaculites reophacoides (R), Gaudryina tailleuri (R), Haplophragmoides coronis (R), rounded frosted quartz floaters (R). Black shale.

AGE: Early Creatceous (Neocomian)
ENVIRONMENT: Middle to Outer Neritic

79-WL-79

No Foraminifera found. Calcisphaera? sp. (R). Gray fine- to medium-grained cherty sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

83-WL-79

Elphidium? ustulatum (R), pyrite (C), coal (F), fecal pellets (F), plant debris (F). Brownish-gray very fine-grained sandstone or siltstone.

AGE: Probable Neogene
ENVIRONMENT: Marginal Marine to Inner Neritic

86-WL-79

Buliminella curta (F), Elphidiella? brunnescens (F), Elphidium? ustulatum (F), Globulina inaequalis (R), Nonion planatum (R), Nonionella sp. (R), Quinqueloculina sp. (F), pyrite spheres (A), pyrite (F), coal (R). Dark gray very fine-grained pyritic sandstone.

AGE: Neogene (Probable Miocene) Equivalent to 1810-13970' interval in Alaska State A well
ENVIRONMENT: Inner to Middle Neritic

89-WL-79

Buliminella curta (F), Cibicides fletcheri (R), C. perlucidus (R), Elphidiella? brunnescens (F), Elphidium? ustulatum (R), Globulina inaequalis (R), Nonion planatum (R), Quinqueloculina sp. (R), pyrite (R), coal (F). Gray very fine-grained sandstone.

AGE: Neogene (Probable Miocene) Equivalent to 1810-3970' interval in Alaska State A well
ENVIRONMENT: Inner to Middle Neritic

92-WL-79

Angulogerina fluens (F), Cibicides perlucidus (F), Elphidiella? brunnescens (C), Elphidium? ustulatum (F), Globulina inaequalis (R), Gyroidina cf. girardana (R), pyrite (C), coal (F), pyrite sticks (C), calcisphaera? (R). Gray fine- to medium-grained cherty sandstone.

AGE: Neogene (Probable Miocene) Equivalent to 1810-3970' interval in Alaska State A well
ENVIRONMENT: Inner to Middle Neritic

95-WL-79

Angulogerina fluens (A), Buliminela curta (F), Cibicides lobatulus (F), C. perlucidus (F), C. fletcheri (R), Dentalina soluta (R), Elphidiella? brunnescens (C), Elphidium? ustulatum (F), Gyroidina girardana (R), Lagena saccata (R), Nonion planatum (F), Quinqueloculina akneriana (R), Q. cf. sphaera (F), pyrite (C), pyrite sticks (C). Dark brown pyritic fine-grained muddy sandstone.

AGE: Neogene (Probable Miocene) Equivalent to 1810-3970' interval in Alaska State A well
ENVIRONMENT: Inner to Middle Neritic

98-WL-79

No Foraminifera found. Coal (F). Orange-brown sandy shale.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

*Determinations by Anderson, Warren & Associates, Inc., San Diego, California

Table VI

SUMMARY OF PALYNOLOGICAL AGE AND ENVIRONMENT DATA*

Frequency symbols used in fossil assemblages: R = rare, F = frequent, C = common, A = abundant.

10-GB-79

Undifferentiated bisaccates (A), Aquilapollenites sp. (R), Expressipollis accuratus (R), Gleicheniidites senonicus (R), Taxodiaceae (F).

Chatangiella sp. (single), Cleistosphaeridium sp. (single), ?Odontochitina operculata (R, fragments), Oligosphaeridium complex (thick-wall) (single).

AGE: Probable Late Cretaceous (Campanian-Maestrichtian)
All forms presumed indigenous
ENVIRONMENT: Marginal Marine

12-GB-79

Undifferentiated bisaccates (A), Betulaceae (R), Aequitriradites spinulosus (single, reworked), Paraalnipollenites confusus (single).

Odontochitina operculata (single, reworked), Oligosphaeridium complex (thick-wall) (single, reworked).

AGE: Paleogene (Paleocene) with reworked Cretaceous
ENVIRONMENT: Nonmarine

14-GB-79

Undifferentiated bisaccates (F), ?Betulaceae (R). Poor preservation.

Tasmanaceae (single).

AGE: Tertiary
ENVIRONMENT: Nonmarine?

26-GB-79

Undifferentiated bisaccates (R), Taxodiaceae (R).

AGE: Tertiary?
ENVIRONMENT: Nonmarine?

29-GB-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Sphagnum (R), Taxodiaceae (R), Alnus (R), Betulaceae (R).

AGE: Tertiary
ENVIRONMENT: Nonmarine

32-GB-79

Undifferentiated bisaccates (F), Betulaceae (R). Poor preservation.

AGE: Tertiary
ENVIRONMENT: Nonmarine?

37-GB-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Alnus (R), Betulaceae (R).

Chatangiella sp. complex (single, reworked), Odontochitina operculate (R, reworked).

AGE: Tertiary, with reworked Cretaceous
ENVIRONMENT: Nonmarine?

40-GB-79

Undifferentiated bisaccates (F), Taxodiaceae (R), Alnus (R), Betulaceae (R).

Oligosphaeridium complex (single, reworked).

AGE: Tertiary
ENVIRONMENT: Nonmarine?

44-GB-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Aquilapollenites trialatus (single, reworked).

Odontochitina operculata (single, reworked), Oligosphaeridium complex (single, reworked), Cyclonephelium distinctum (single, reworked), Gardodinium trabeculosm (single, reworked).

AGE: Probable Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

47-GB-79

Undifferentiated bisaccates (C), Lycopodiumsporites sp. (R), Betulaceae (R), Densosporites sp. (single, reworked).

Oligosphaeridium complex (R, reworked), Cyclonephelium distinctum (R, reworked), Muderongia sp. (single, reworked).

AGE: Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

52-GB-79

Chantangiella cf. coronata (F), C. spp. (C), Isabelidinium cooksoniae (C). Poor preservation.

AGE: Late Cretaceous (Campanian)
ENVIRONMENT: Marine

55-GB-79

Undifferentiated bisaccates (F), Aquilapollenites senonicus (single, reworked), A. trialatus (single, reworked), ?Ulmus (single).

AGE: Possible Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

58-GB-79

Undifferentiated biasaccates (F), Vitreisporites pallidus (R, reworked), Lycopodiumsporites sp. (R), Sphagnum (F), Alnus (F), Betulaceae (R).

Micrhystridium sp. (R), Pterospermopsis sp. (R), Odontochitina operculata (single, reworked), Oligosphaeridium complex (single, reworked).

AGE: Tertiary with reworked Cretaceous
ENVIRONMENT: Marginal Marine

61-GB-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Taxodiaceae (R), Alnus (R), Betulaceae (R). Poor preservation.

AGE: Tertiary
ENVIRONMENT: Nonmarine

64-GB-79

Classopollis classoides (R), Rogalskaisporites cicatricosus (R), Taeniaesporites sp. (R).

AGE: Possible Triassic
ENVIRONMENT: Nonmarine?

68-GB-79

Micrhystridium sp. (R), Gnetaceapollenites sp. (R), Striatites richteri (R), Taeniaesporites sp. (R).

AGE: Possible Permian-Triassic
ENVIRONMENT: Marginal Marine

71-GB-79

Taeniaesporites sp. (R).

AGE: Possible Permian-Triassic
ENVIRONMENT: Nonmarine?

75-GB-79

Classopollis classoides (single), Taeniaesporites sp. (single).

AGE: Possible Triassic
ENVIRONMENT: Nonmarine?

Note: The samples 64-, 68-, 71-, and 75-GB-79 yielded only Permian-Triassic palynomorphs. We have encountered, in North Slope subsurface core samples, situations in which the foraminiferal recoveries indicate an Early to Middle Jurassic age while the palynomorphs indicate Triassic ages. It is presumed in these cases that the foram Jurassic ages are the valid age assignments.

79-GB-79

Classopollis classoides (single), indeterminate spore (single).

AGE: Mesozoic
ENVIRONMENT: Nonmarine?

83-GB-79

Undifferentiated bisaccates (R), Osmundacidites sp. (R), Taxodiaceae (C).

Spiniferites ramosus (R), ?S. cingulatus (R).

AGE: Possible Late Cretaceous
ENVIRONMENT: Marine

86-GB-79

Undifferentiated bisaccates (R), Taxodiaceae (C).

Deflandrea sp. (single), Hystrichosphaeridium stellatum (R), Isabelidinium acuminatum (R), Odontochitina operculata (R), Wallodinium lunum (R), Pterospermopsis sp. (F).

AGE: Late Cretaceous
ENVIRONMENT: Marine

90-GB-79

Undifferentiated bisaccates (R), Taxodiaceae (F).

Hystrichodinium cf. Voigti (single), Isabelidinium acuminatum (R), Pterospermopsis sp. (F), Odontochitina operculata (F), Oligosphaeridium complex (R), Palaeoperidinium basilium (R).

AGE: Late Cretaceous
ENVIRONMENT: Marine

93-GB-79

Undifferentiated bisaccates (F), Taxodiaceae (C).

Chatangiella biapertura (single), Chlamydophorella nyei (R), Isabelidinium cooksoniae (R), I. acuminatum (F), Pterospermopsis sp. (F), indeterminate yellow cysts (C), Odontochitina operculata (R), Oligosphaeridium complex (F).

AGE: Late Cretaceous
ENVIRONMENT: Marine

96-GB-79

Undifferentiated bisaccates (R), Taxodiaceae (C).

Isabelidinium cooksoniae (R), I. acuminatum (R), indeterminate yellow cysts (F), Oligosphaeridium complex (R).

AGE: Late Cretaceous
ENVIRONMENT: Marine

99-GB-79

Undifferentiated bisaccates (A), Vitreisporites pallidus (single, reworked), Laevigatosporites sp. (F), Lycopodiumsporites sp. (R), Osmundacidites sp. (F), Sphagnum sp. (F), Taxodiaceae (C), Alnus (F), Betulaceae (R), Carya (R), Juglans (R), Tilia (F), Ulmus (R).

Cyclonephelium exuberans (R), paralecaniella indentata (F), Odontochitina operculata (single, reworked), Oligosphaeridium complex (single, reworked), Gardodinium trabeculosum (single, reworked).

AGE: Paleogene (Eocene) with reworked Cretaceous
ENVIRONMENT: Marine

102-GB-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Sphagnum (R), Taxodiaceae (F), Juglans (R), Tilia (R).

Cyclonephelium distinctum (single, reworked), Deflandrea wetzelii (A), Pterospermopsis sp. (R).

AGE: Paleogene (Eocene) with reworked Cretaceous
ENVIRONMENT: Marine

105-GB-79

?Alnus (R), Spinozonotriletes sp. (single, reworked). Very poor preservation.

Oligosphaeridium complex (single fragment, reworked?). Very poor preservation.

AGE: Probable Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

109-GB-79

Undifferentiated bisaccates (R), Betulaceae (F), ?Ulmus (R). Poor preservation.

AGE: Tertiary
ENVIRONMENT: Nonmarine

113-GB-79

Laevigatosporites sp. (R), Alnus (F), Betulaceae (C), Juglans (R), ?Paraalnipollenites confusus (single), ?Ulmus (R). Poor preservation.

AGE: Probable Paleogene (Paleocene)
ENVIRONMENT: Nonmarine

117-GB-79

Undifferentiated bisaccates (R), Lycopodiumsporites sp. (R), Betulaceae (F), ?Paraalnipollenites confusus (single). Poor preservation.

AGE: Probable Paleogene (Paleocene)
ENVIRONMENT: Nonmarine

121-GB-79

Undifferentiated bisaccates (F), Laevigatosporites sp. (F), Alnus (F), Betulaceae (C), ?Ulmus (F).

AGE: Tertiary
ENVIRONMENT: Nonmarine

131-GB-79

Undifferentiated bisaccates (F).

Spiniferites sp. (single), Chatangiella sp. (single, reworked).

AGE: Possible Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

125-GB-79

Undifferentiated bisaccates (R), Alnus (R), Betulaceae (R), Densospore (R, reworked).

AGE: Indeterminate with Quaternary contamination
ENVIRONMENT: Indeterminate

128-GB-79

Betulaceae (single, recent contaminant), Compsitae Artemisia-type (single, recent contaminant).

AGE: Indeterminate with Quaternary contamination
ENVIRONMENT: Indeterminate

135-GB-79

Undifferentiated bisaccates (C). Poor preservation.

Veryhachium sp. (R), Oligosphaeridium complex (R), Odontochitina operculata (single, reworked?).

AGE: Possible Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

139-GB-79

Alnus (R), ?Betulaceae (R), Hystricosporites sp. (single, reworked), Cicatricosisporites australiense (R, reworked).

Oligosphaeridium complex (R, reworked), Odontochitina operculata (single, reworked).

Age: Probable Tertiary with reworked Cretaceous and Devonian
ENVIRONMENT: Nonmarine?

142-GB-79

Betulaceae (R).

Oligosphaeridium complex (single, reworked?).

AGE: Tertiary
ENVIRONMENT: Nonmarine?

145-GB-79

Undifferentiated bisaccates (A), Alnus (R), Betulaceae (R), Aquilapollenites trialatus (R, reworked), A. senonicus (single, reworked).

Oligosphaeridium complex (single, reworked), Chatangiella decorosa (single, reworked).

AGE: Probable Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

148-GB-79

Undifferentiated bisaccates (A), Lycopodiumsporites sp. (R), Osmundacidites sp. (R), Alnus (R), Betulaceae (R), Aquilapollenites magnus (single, reworked), A. sp. (single, reworked), Juglans (R).

Oligosphaeridium complex (single, reworked).

AGE: Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine

151-GB-79

Undifferentiated bisaccates (C), Alnus (R), Aquilapollenites trialatus (single, reworked).

AGE: Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine

154-GB-79

Undifferentiated bisaccates (A), Alnus (R), Aquilapollenites sp. (single, reworked), ?Paraalnipollenites confusus (single).

AGE: Probable Paleogene (Paleocene) with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

157-GB-79

Undifferentiated bisaccates (R).

Chatangiella coronata (C), C. spp. (F), ?Diconodinium arcticum (F), Oligosphaeridium complex (R). Poor preservation.

AGE: Late Cretaceous (Campanian)
ENVIRONMENT: Marine

4-IP-79

Cyclonephelium distinctum (single), Gardodinium trabeculosum (single).

AGE: Early Cretaceous
ENVIRONMENT: Marine

8-IP-79

Undifferentiated bisaccates (C), Lycopodiumsporites sp. (R), Taxodiaceae (R), ?Betulaceae (single), Aquilapollenites trialatus (single, reworked?). Poor preservation.

Cyclonephelium distinctum (single, reworked?), Baltisphaeridium sp. (single), ?Gonyaulacysta sp. (single, reworked), Odontochitina operculata (single, reworked?), Oligosphaeridium complex (single, reworked?).

AGE: Possible Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

13-IP-79

Undifferentiated bisaccates (C), indeterminate spores (F). Poor preservation.

AGE: Indeterminate
ENVIRONMENT: Nonmarine?

21-IP-79

?Classopollis classoides (R, poor preservation), rare indeterminate spore fragments, poor preservation.

AGE: Mesozoic
ENVIRONMENT: No marine evidence

28-IP-79

Barren of palynomorphs.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

33-IP-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Betulaceae (R), Paraalnipollenites confusus (single).

?Odontochitina operculata (single, reworked), Oligosphaeridium complex (R, reworked).

AGE: Paleogene (Paleocene) with reworked Cretaceous
ENVIRONMENT: Nonmarine

37-IP-79

Undifferentiated bisaccates (F), Lycopodiumsporites sp. (R), Taxodiaceae (R), Alnus (R), Hymenozonotriletes lepidophytus (single, reworked).

Odontochitina operculata (R, reworked), Oligosphaeridium complex (thick-wall) (R, reworked).

AGE: Tertiary with reworked Cretaceous and Devonian
ENVIRONMENT: Nonmarine

42-IP-79

Undifferentiated bisaccates (R), Alnus (R).

Isabelidinium cooksoniae (single, reworked), Odontochitina operculata (single, reworked).

AGE: Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

50-IP-79

Undifferentiated bisaccates (C), Taxodiaceae (R), Betulaceae (R), Paraalnipollenites confusus (R).

Odontochitina operculata (R, reworked), Oligosphaeridium complex (R, reworked), Palaeoperidinium cretaceum (R, reworked).

AGE: Paleogene (Paleocene) with reworked Cretaceous
ENVIRONMENT: Nonmarine

55-IP-79

Lycopodiumsporites sp. (R), Alnus (R), ?Paraalnipollenites confusus (single, poor preservation).

AGE: Tertiary (possible Paleocene?)
ENVIRONMENT: Nonmarine

58-IP-79

Undifferentiated bisaccates (F), Alnus (R), Betulaceae (F), Ulmus (F).

Gardodinium trabeculosum (single, reworked).

AGE: Tertiary (probable Paleogene) with reworked Early Cretaceous
ENVIRONMENT: Nonmarine

4-WL-79

Undifferentiated bisaccates (C), Deltoidospora sp. (C), Alnus (R), ?Ulmus sp. (R).

Odontochitina operculata (single, reworked).

AGE: Tertiary with reworked Cretaceous
ENVIRONMENT: Nonmarine?

7-WL-79

Undifferentiated bisaccates (R), Cicatricosisporites sp. (single), Expressipollis accuratus (single, reworked).

Cyclonephelium distinctum (single, reworked).

AGE: Probable Tertiary with reworked Late Cretaceous
ENVIRONMENT: Nonmarine?

28-WL-79

Rare, unidentifiable dinocysts(?), very poor preservation. Organics brown-dark brown.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

36-WL-79

Barren of palynomorphs. Brown organics.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

40-WL-79

Undifferentiated bisaccates (R).

AGE: Indeterminate
ENVIRONMENT: Nonmarine?

43-WL-79

Micrhystridium sp. (F). Brown organics, poor preservation.

AGE: Indeterminate
ENVIRONMENT: Marginal Marine

46-WL-79

Essentially barren of Palynomorphs. Organics brown.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

50-WL-79

Indeterminate spore (R, poorly preserved). Brown organics.

AGE: Indeterminate
ENVIRONMENT: Nonmarine?

53-WL-79

Indeterminate spore (single, poor preservation). Brown, poorly preserved organics.

AGE: Indeterminate
ENVIRONMENT: Nonmarine?

57-WL-79

?Classopollis classoides (R), Densosporites (R, reworked), Lycospora sp. (R, reworked). Brown organics.

?Tenua sp. (R).

AGE: Possible Cretaceous
ENVIRONMENT: Marginal Marine

60-WL-79

Indeterminate spore (R, poor preservation). Brown organics.

AGE: Indeterminate
ENVIRONMENT: Nonmarine

63-WL-79

Indeterminate spore (R). Brown organics. Poor preservation.

?Oligosphaeridium complex (thick-wall) (R, fragments).

AGE: Possible Early Cretaceous
ENVIRONMENT: Marine

66-WL-79

Undifferentiated bisaccates (R), Classopollis classoides (F). Poorly preserved. Brown-dark brown organics.

?Cyclonephelium distinctum (F), Oligosphaeridium complex (thick-wall) (R), ?Tenua sp. (R).

AGE: Probable Early Cretaceous (Neocomian)
ENVIRONMENT: Marine

69-WL-79

Undifferentiated bisaccates (R), Vitreisporites pallidus (R). Poor preservation.

Batioladinium jaegeri (R), Cribroperidinium edwardsi (R), Cyclonephelium distinctum (A), Gardodinium trabeculosum (F), Oligosphaeridium complex (C), O. complex (thick-wall) (C), ?Pseudoceratium nudum (single).

AGE: Early Cretaceous. Probable Neocomian (Hauterivian-Barremian)
ENVIRONMENT: Marine

80-WL-79

Undifferentiated bisaccates (A), Tsuga (F), Laevigatosporites sp. (F), Osmundacidites sp. (F), Betulaceae (C), Juglans (R).

Spiniferites mirabilis (single).

AGE: Neogene-Quaternary(?)
ENVIRONMENT: Marginal Marine

84-WL-79

Undifferentiated bisaccates (C), Tsuga (F), Laevigatosporites sp. (R), Lycopodiumsporites sp. (R), Sphagnum (R).

AGE: Tertiary-Quaternary(?)
ENVIRONMENT: Nonmarine?

90-WL-79

Undifferentiated bisaccates (A), Tsuga (R), Laevigatosporites sp. (R).

AGE: Tertiary-Quaternary(?)
ENVIRONMENT: Nonmarine?

93-WL-79

Undifferentiated bisaccates (F), Tsuga (R), Sphagum (R).

?Lejeunia sp. (single).

AGE: tertiary-Quaternary(?)
ENVIRONMENT: Marginal Marine

96-WL-79

Undifferentiated bisaccates (C), Tsuga (F), Laevigatosporites sp. (R), Betulaceae (R), ?Aquilapollenites sp. (single, reworked).

AGE: Tertiary-Quaternary(?)
ENVIRONMENT: Nonmarine?

99-WL-79

Undifferentiated bisaccates (A), Tsuga (R), Laevigatosporites sp. (F), Taxodiaceae (R), Alnus (F), Juglans (R), Tilia (R).

Cyclonephelium exuberans (R), Deflandrea wetzelii (F).

AGE: Paleogene (Eocene)
ENVIRONMENT: Marine

*Determinations by Anderson, Warren and Associates, Inc., San Diego, California