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PALYNOLOGICAL ZONATION AND CORRELATION OF SIXTY-SEVEN WELLS, EASTERN CANADA

M.S. BARSS
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PALYNOLOGICAL ZONATION AND CORRELATION OF SIXTY-SEVEN WELLS, EASTERN CANADA

Abstract

Ordovician to Pleistocene sediments in 67 wells from eastern Canada are dated, zoned and correlated using palynomorphs. Five hundred and eighty spore and pollen species, 591 dinoflagellate species and 16 acritarch and miscellaneous palynomorph species delineate 49 zones and subzones in the Gulf of St. Lawrence, Scotian Shelf and Grand Banks, and 12 biostratigraphically significant assemblages on the Labrador Shelf. The wells analyzed contain a predominantly Carboniferous succession in the Gulf of St. Lawrence, an Upper Triassic to Pleistocene succession on the Scotian Shelf, Devonian to Carboniferous and Upper Triassic to Pleistocene successions on the Grand Banks, and Ordovician, Carboniferous and Cretaceous to Pleistocene successions on the Labrador Shelf.

Résumé

On date, on répartit par zone et on met en relations, à l'aide de palynomorphes, des sédiments allant de l'Ordovicien au Pléistocène et provenant de 67 puits de l'Est du Canada. Cinq cent quatre vingt espèces à spores et à pollen, 591 espèces de dinoflagellées et 16 espèces d'acritarches ainsi que diverses espèces palynomorphes délimitent 49 zones et sous-zones dans le golfe du Saint-Laurent, sur le plateau continental Scotian et sur les Grands bancs, ainsi que 12 assemblages ayant une signification biostratigraphique sur le plateau continental du Labrador. Les puits analysés renferment une échelle stratigraphique à prédominance Carbonifère dans le golfe du Saint-Laurent, une échelle stratigraphique allant du Trias supérieur américain au Pléistocène sur le plateau continental Scotian, des échelles stratigraphiques allant du Dévonien au Carbonifère et du Trias supérieur américain au Pléistocène sur les Grands bancs, et des échelles stratigraphiques allant de l'Ordovicien, du Carbonifère et du Crétacé au Pléistocène sur le plateau continental du Labrador.

INTRODUCTION

This paper presents a compilation of palynological data from 67 of the 133 hydrocarbon exploratory wells drilled in eastern Canada from 1966 to mid-1978. Sixty of the wells are from the continental shelf. The purpose of the paper is twofold. It represents the first comprehensive compilation of biostratigraphic data and age correlation of Devonian to Pleistocene sediments present in wells extending from the Scotian Shelf to the Grand Banks to the Labrador Shelf, a distance of over 2000 miles (3200 kilometres). Second, it lists all biostratigraphically significant species present in the wells. These include dinoflagellates, acritarchs, spores and miscellaneous palynomorphs, ranging in age from Late Paleozoic to Pleistocene.

The area of eastern Canada included in the present study extends from approximately 42°N to 59°N and 48°W to 65°W (Fig. 1). The 67 wells which have been analyzed for palynology lie in four major physiographic regions. Three onshore and three offshore wells examined from the Gulf of St. Lawrence penetrated a mostly Carboniferous succession, as did the North Sydney P-05 well, which is discussed with the above wells because of its proximity and similar section. Twenty-two offshore and one onshore (Sable Island C-67) wells examined from the Scotian Shelf penetrated an Upper Triassic to Pleistocene succession. Twenty-six offshore wells examined from the Grand Banks of Newfoundland penetrated Devonian-Carboniferous and Upper Triassic to Pleistocene successions. Eleven offshore wells examined from the Labrador Shelf penetrated Ordovician, Carboniferous and Cretaceous to Pleistocene successions. One possible Jurassic occurrence was noted. Some of the above wells also encountered Recent sediments which were rarely sampled, and "basement" as defined by Jansa and Wade (1975).

Several of the wells included in this paper contain the type sections of formations and members defined by

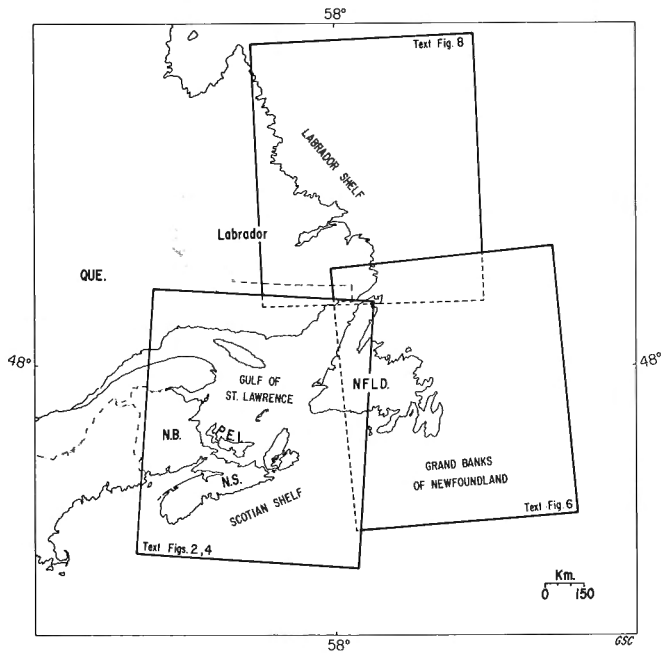

Figure 1: Index map for text figures 2, 4, 6 and 8.

Given (1977), Jansa and Wade (1975) and McIver (1972). These are the Abenaki, Argo, Banquereau, Dawson Canyon, Eurydice, Iroquois, Logan Canyon, Missisauga, Mohawk, Mohican, Verrill Canyon and Wyandot Formations, and the the Baccaro, Missaine, Naskapi, Sable and Scatari Members. The palynologically-defined ages of these and several informal units discussed in Hardy (1975), Jansa *et al.* (1977), Swift *et al.* (1975) and Upshaw

Table 1

Palynological zonation, Gulf of St. Lawrence,
Scotian Shelf and Grand Banks

"AGE"				ZONE OR SUBZONE	
QUAT.	PLEISTOCENE			Artemisia-Taraxacum Zone	Spiniferites scabratus Subzone
TERTIARY	NEOGENE	PLIOCENE			Hystrichosphaeridium choanophorum Subzone
		MIOCENE	LATE	Cannosphaeropsis sp. A Zone	
			MIDDLE	Pentadinium laticinctum Zone	
			EARLY	Apteodinium sp. B Zone	
	PALEOGENE	OLIGOCENE	LATE	Chiropteridium dispersum Zone	
			MIDDLE		
			EARLY	Deflandrea heterophlycta Zone	*Cordosphaeridium funiculatum subzone *Areosphaeridium arcuatum subzone
		EOCENE	LATE	Diphyes colligerum Zone	
			MIDDLE	Adnatosphaeridium reticulense Zone	
			EARLY	Areoligera senonensis Zone	
		PALEOCENE	LATE	Ceratiopsis speciosa Zone	
			EARLY	Palaeoperidinium pyrophorum-Ceratiopsis diebelii Zone	
CRETACEOUS	LATE		MAASTRICHTIAN	Dinogymnium euclaensis Zone	
			CAMPANIAN	Odontochitina operculata Zone	*Trichodinium castaneum subzone
			SANTONIAN	Cordosphaeridium truncigerum Zone	
			CONIACIAN	Oligosphaeridium pulcherrimum Zone	
			TURONIAN	Surculosphaeridium longifurcatum Zone	
			CENOMANIAN	Cleistosphaeridium polypes Zone	
	EARLY		ALBIAN	Spinidinium cf. S. vestitum-Eucommiidites minor Zone	Rugubivesiculites rugosus Subzone
			APTIAN	Subtilisphaera perlucida-Systematophora schindewolfii Zone	Aptea attadalica Subzone
			BARREMIAN	Doidyx anaphrissa Zone	
			HAUTERIVIAN	Ctenidodinium elegantulum Zone	
			VALANGINIAN	Phoberocysta neocomica Zone	
			BERRIASIAN		
JURASSIC	LATE		PORTLANDIAN	Ctenidodinium panneum Zone	
			KIMMERIDGIAN	Gonyaulacysta cladophora Zone	
			OXFORDIAN	Gonyaulacysta jurassica Zone	*Compositosphaeridium costatum subzone
	MIDDLE		CALLOVIAN	Valensiella vermiculata Zone	*Stephanelytron scarburghense subzone *Cleistosphaeridium tribuliferum subzone
			BATHONIAN	Gonyaulacysta filapicata Zone	
			BAJOCIAN	Mancodinium semitabulatum Zone	
			AALENIAN		
	EARLY		TOARCIAN	Nannoceratopsis gracilis Zone	
			PLIENSBACHIAN		
			SINEMURIAN	Echinitosporites cf. E. iliacoides Zone	
			HETTANGIAN	Cycadopites subgranulosus Zone	
				Classopollis meyeriana Zone	
TRIASSIC	LATE		RHAETIAN		
			NORIAN		
			CARNIAN		
	MIDDLE		LADINIAN		
			ANISIAN		
	EARLY		SCYTHIAN		
PERMIAN	LATE		TATARIAN		
			KAZANIAN		
	EARLY		KUNGURIAN		
			ARTINSKIAN		
			SAKMARIAN	Vittatina Zone	
CARBONIFEROUS	LATE		STEPHANIAN	Potonieisporites Zone	
			WESTPHALIAN D	Thymospora Zone	
			WESTPHALIAN C	Torispora Zone	
			WESTPHALIAN B	Vestispora Zone	
			WESTPHALIAN A		
			NAMURIAN	Potonieisporites elegans-Knoxisporites seniradiatus Zone	
	EARLY		VISEAN		
			TOURNAISIAN	Vallatisporites vallatus-Pustulatisporites pretiosus Zone	
DEVONIAN	LATE		FAMENNIAN		
			FRASNIAN		
	MIDDLE		GIVETIAN		
			EIFELIAN		
	EARLY		EMSIAN		
			SIEGENIAN		
			GEDINNIAN		
SILURIAN					
ORDOVICIAN					
CAMBRIAN					

* informal subzone

et al. (1974), are given in the section on Age of Formations at the end of this paper.

The palynological zonations recognized in wells from the Gulf of St. Lawrence, Scotian Shelf and Grand Banks wells are shown in Table 1. They were erected for Paleozoic spores by Barss and Hacquebard (1967) and Barss, (*in* Hacquebard, 1972), and for Mesozoic-Cenozoic spores and dinoflagellates by Bujak and Williams (1977, 1978), Williams (1975) and Williams and Bujak (1977b). All zones were defined in accordance with the American Commission on Stratigraphic Nomenclature (1961, articles 20g, 21). Six informal subzones are also shown in Table 1. These are the *Areosphaeridium arcuatum, Cleistosphaeridium tribuliferum, Compositosphaeridium costatum, Cordosphaeridium funiculatum, Stephanelytron scarburghense,* and *Trichodinium castaneum* subzones.

The informal Labrador Shelf zonation used in this paper is shown in Table 2. Details have been published in Bujak and Williams (1977b) and Gradstein and Williams (1976).

Table 2

Informal palynological zonation, Labrador Shelf

"AGE"				ASSEMBLAGE
QUAT.	PLEISTOCENE			Tsugaepollenites igniculus assemblage
TERTIARY	NEOGENE	PLIOCENE		
		MIOCENE	LATE	Operculodinium centrocarpum assemblage
			MIDDLE	
			EARLY	Epicephalopyxis indentata assemblage
	PALEOGENE	OLIGOCENE	LATE	Cordosphaeridium fibrospinosum-Deflandrea sp. C assemblage
			MIDDLE	
			EARLY	Wetzeliella ovalis assemblage
		EOCENE	LATE	Wetzeliella lunaris assemblage
			MIDDLE	
			EARLY	Areoligera senonensis assemblage
		PALEOCENE	LATE	Ceratiopsis speciosa assemblage
				Eisenackia circumtabulata assemblage
			EARLY	Palaeoperidinium pyrophorum assemblage
CRETACEOUS	LATE	MAASTRICHTIAN		Amphidiadema nucula-Hexagonifera chlamydata assemblage
		CAMPANIAN		
		SANTONIAN		
		CONIACIAN		
		TURONIAN		
		CENOMANIAN		
	EARLY	ALBIAN		
		APTIAN		Cerebropollenites mesozoicus assemblage
		BARREMIAN		
		HAUTERIVIAN		
		VALANGINIAN		
		BERRIASIAN		

The four major areas considered are discussed in separate sections in the following order: Gulf of St. Lawrence, Scotian Shelf, Grand Banks, and Labrador Shelf. Each section includes a map showing the well locations and a figure illustrating the ages of sediments encountered as determined from palynology. Following this are reports for each well which detail the palynostratigraphic subdivision, the age and depths of zones, and list biostratigraphically significant species. The well reports are arranged alphabetically within each section. Three lists of identified palynomorphs, with author citations, are given in the appendix. These are spores and pollen, dinoflagellates, and acritarchs and miscellaneous palynomorphs.

Within each report under the heading of "Selected palynomorphs", species are grouped irrespective of affinity within the zone in which they have their highest occurrence. This is not a full listing since long ranging, rare, or undescribed taxa have been omitted. Taxa that are common or have their earliest occurrences within an interval are also indicated where they are considered to be biostratigraphically or environmentally significant. Author citations for formal taxa are not given in the text, but are listed in the appendix. All informal taxa that are listed have been previously illustrated and the author and year of the illustration are given in the text and appendix. The terms dinoflagellate, dinoflagellate cyst and dinocyst are used synonymously.

The material studied mostly comprises 30ft (10 m) composite cuttings samples taken at 100ft (30 m) intervals. In some Paleozoic red bed successions, cuttings samples were selected on the basis of lithology. All cuttings samples analyzed were processed at the Eastern Petroleum Geology Subdivision of the Atlantic Geoscience Centre, using the standard palynological processing techniques described in Barss and Williams (1973). Where conventional cores were available, samples were processed at E.P.G.S. for palynology. Additional palynological slides from sidewall and conventional core samples were provided by individual oil companies. Details of the number and type of samples analyzed are given in the individual well reports and do not include samples for which no organic residue remained after palynological processing.

Since cuttings samples predominate, the highest occurrence of species (excluding reworking) in the well is the primary basis for delineation of zones. Each zone or subzone therefore generally is defined at the highest sample in which the marker species of the zone or subzone occur. Because of the method of sampling, i.e., a 30ft composite sample approximately every 100ft, the gaps occurring between zones are purposely not dated since the boundary between the zones lies somewhere within these unexamined intervals. In some instances a zone is indicated by a single footage when the zone was found only in a single sidewall core. Subzones are indented to set them apart from zones. All footages quoted are from rotary table.

Where sidewall core and conventional core samples are available, additional information regarding the earliest occurrence of species may be available. However, contamination of core samples has been noted both from palynomorphs within the well and palynomorphs present in the drilling mud that are not indigenous to eastern Canada.

All slides studied are available for public examination at the Resource Management and Conservation Branch and the Geological Survey of Canada facilities at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

Acknowledgements

The authors are grateful to Rita McGregor and Carol Mitchell who persevered through the typing of this manuscript, to Gary Grant for drafting the text-figures and to John Wade for critically reading the manuscript and making many valuable suggestions for its improvement.

GULF OF ST. LAWRENCE

Six wells have been analyzed from the Gulf of St. Lawrence and one well from the Sydney Basin, North Sydney P-05, is included here because of proximity and similarity of section encountered. The seven wells analyzed are:

Bradelle L-49	(7)
East Point E-49	(2)
Green Gables No. 1	(5)
Irishtown No. 1	(6)
North Sydney P-05	(1)
Northumberland Strait F-25	(3)
Tyrone No. 1	(4)

The numbers in brackets refer to the geographic locations of these wells shown in Fig. 2. A comparison of the palynological ages of rocks dated in each well is illustrated in Fig. 3.

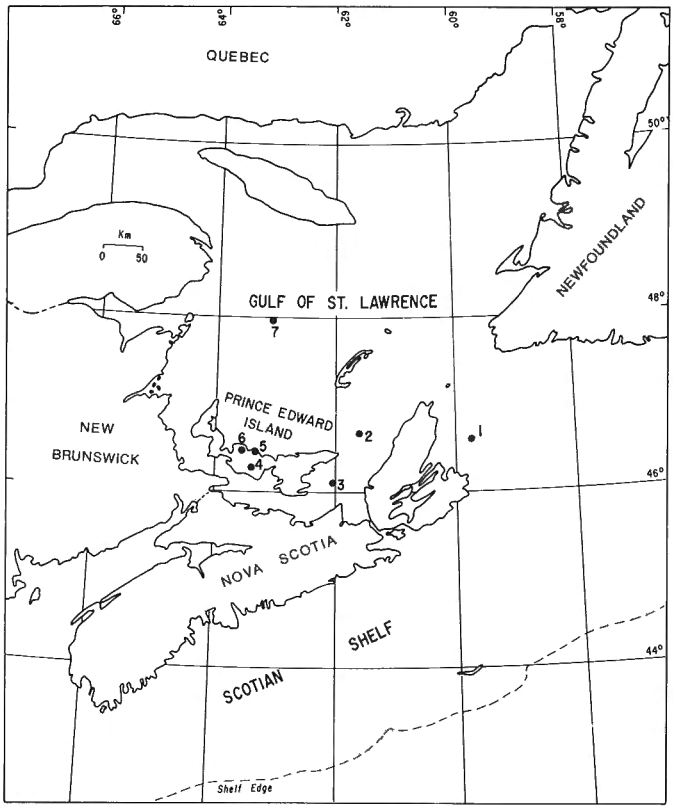

Figure 2: Well locations, Gulf of St. Lawrence.

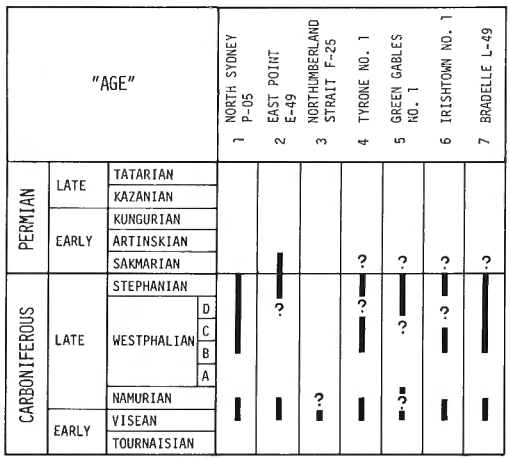

Figure 3: Palynological ages of sediments in Gulf of St. Lawrence wells.

Details of individual zone thicknesses and taxa occurrences are given below for each well.

Shell-Soquip-Amoco
BRADELLE L-49

GSC locality: D110

Location: 47°58'31.95"N; 64°07'08.82"W

RT elevation: 98' Water depth: 186'

Casing set at: 878, 2920, and 5254'

Total depth: 14503' Interval studied: 1060-14500'

Analyzed by: M.S. Barss

One hundred and seventeen cuttings samples and 3 conventional core samples were processed and examined. Only one conventional core sample (7357ft) was palyniferous.

One hundred and four of 108 sidewall core sample slides examined are barren of fossils. The slides from 3943, 5092, and 5270ft contain a total of five fossils. The slide from 5543ft although containing about a dozen fossils, is not considered reliable.

Caving occurs throughout the well. A Permian age for a part of the 284-1060ft interval is based on caved fossils found in lower samples. In the interval from 7000 to 14 500ft, numerous specimens from the *Vestispora* zone and some from the *Potonieisporites* zone are present.

A few acritarch specimens occur at 4800-4830, 4900-4930, 5700-5730, 5900-5930, 6300-6330, 6400-6430, and 6500-6530ft. These are probably recycled from older rocks.

The following age determinations and biostratigraphic zonation have been made:

284- 1060' possible Permian in part
1060- 3630' *Potonieisporites* Zone (Stephanian)
3700- 5630' late Westphalian C-Westphalian D
5700- 6930' *Vestispora* Zone (late Westphalian B-early Westphalian C)
7000-14500' late Viséan-early Namurian

Selected palynomorphs

284-1060': possible Permian in part

Possibly contains some Permian age rocks based on caved specimens of *Vittatina, Abiespollenites, Hamiapollenites* and *Cirratriradites* cf. *C. splendens* found in lower samples.

1060-3630': *Potonieisporites* Zone (Stephanian)

Apiculatisporis aculeatus, A. imbricatus, A. latigranifer, A. cf. *A. verrucifer, Cadiospora magna, Calamospora microrugosa, C. pallida, Cirratriradites flabelliformis, Columnisporites* sp., *Convolutispora* sp., *Crassispora* sp., *Cyclogranisporites microgranus, Endosporites globiformis, E. ornatus, Florinites antiquus, Laevigatosporites desmoinesensis, L. medius, L. minimus, Leiotriletes adnatus, Limitisporites monstruosus, L.* sp. Barss, 1967, pl. XXXIII, fig. 5, *Lophotriletes* sp., *Lycospora pusilla, Microreticulatisporites sulcatus, Pityosporites* sp., *Potonieisporites novicus, P. simplex, Protohaploxypinus globus, Punctatisporites discretus, P. obliquus, Raistricka* sp., *Schopfipollenites* sp., *Striatoabietites* spp., *Striomonosaccites* sp., *Triquitrites bransonii, T. pulvinatus, Verrucosisporites microtuberosus, Vesicaspora* sp., *Vestigisporites* sp., *Vestispora fenestrata, V. laevigata.*

3700-5630': late Westphalian C-Westphalian D

Calamospora minuta, Cirratriradites foveatus, C. saturni, Columnisporites ovalis, Convolutispora sp., *Crassispora kosankei, Cyclogranisporites aureus, C.* cf. *C. provectus, Densosporites sphaerotriangularis, Dictyotriletes* cf. *D. reticulocingulum, Endosporites pellucidus, E. zonalis, Entylissa* sp., *Florinites circularis, F. junior, F. mediapudens, F. millotti, F. pumicosus, F. visendus, Granulatisporites guliferus, G. minutus, Guthorlisporites* cf. *G. velensis, Illinites* cf. *I. unicus, Knoxisporites rotatus, Lophotriletes commissuralis, L. gibbosus, L.* cf. *L. ibrahimi, L. microsaetosus, Mooreisporites inusitatus, Orbisporis* sp., *Punctatisporites sinuatus, Punctatosporites minutus, Raistrickia crocea, R. saetosa, Reticulatisporites annulatus, R. muricatus, Schopfipollenites ellipsoides, Schopfites colchesterensis, Spakmanites* sp., *Speciososporites triletoides, Thymospora obscura, Torispora securis, Triquitrites additus, T. crassus, Verrucosisporites* sp., *Vestigisporites* sp., *Vestispora irregularis, V. profunda, V.* cf. *V. pseudoreticulata.*

Sidewall core samples

3943': *Lycospora pusilla*

5092': *Calamospora pallida*

5270': *Punctatosporites* sp., cf. *Punctatosporites minutus*

5543': *Deltoidospora* sp., *Endosporites ornatus, Florinites* sp., *Potonieisporites novicus, Punctatisporites* sp., *Raistrickia saetosa, Verrucosisporites microtuberosus.* The reliability of this sidewall core sample is questionable because the cuttings samples indicate late Westphalian C-Westphalian D at 3700-5600ft whereas *Potonieisporites novicus* is restricted to younger rocks.

5700-6930': *Vestispora* Zone
(late Westphalian B-early Westphalian C)

Alatisporites trialatus, Apiculatasporites sp., *Apiculatisporis abditus, A. grumosus, A.* cf. *A. irregularis,* cf. *Armatisporites* sp., *Calamospora mutabilis, Camptotriletes* cf. *C. bucculentus, C. superbus, Cristatisporites* cf. *C. connexus, C.* cf. *C. solaris, Densosporites anulatus, D.* cf. *D. aseki, D. duriti, D.* cf. *D. intermedius, D. pseudoannulatus, Dictyotriletes bireticulatus, D. mediareticulatus, Grumosisporites* cf. *G. varioreticulatus, Knoxisporites* cf. *K. hageni, K. stephanephorus, K. triradiatus, Leiotriletes tumidus, Lophotriletes* sp., *Pustulatisporites* sp., *Radiizonates* sp., *Raistrickia protensa, R.* cf. *R. superba, R.* cf. *R. vulgata, Reticulatisporites polygonalis, Savitrisporites nux, Triquitrites sculptilis, Verrucosisporites* sp., *Vestispora costata, V. tortuosa.*

7000-14500': late Viséan-early Namurian

Spores with * occur in a conventional core sample from 7357ft.
*Ahrensisporites guerickei, *Apiculatisporis* spp., *Auroraspora solisortus, Convolutispora* cf. *C. mellita, *C. sculptilis, *C. varicosa, *C. vermiformis, Cristatisporites* cf. *C. echinatus, Cyclogranisporites* cf. *C. lasius, Densosporites rarispinosus, *Dictyotriletes* sp. Barss, 1967, pl. XIII, fig. 16, *D.* sp. Barss, 1967, pl. XIII, fig. 15, *Discernisporites concentricus, *D. irregularis, *D. micromanifestus, Endosporites minutus, *Foveotriletes insculptus, Grandispora* cf. *G. procincta, G.* cf. *G. spinosa, *Gulisporites* sp., *Knoxisporites* cf. *K. dissidius, K. hederatus, K.* cf. *K. literatus, *K. stephanephorus, Lophotriletes mosaicus, L. pseudaculeatus, Lycospora noctuina* var. *noctuina, ?Murospora* sp., *?Proprisporites* sp., *Punctatisporites glaber, P. heterofiliferus, P. incomptus, P. irrasus, P. solidus, P. trifidus, P. validus, *Raistrickia* sp. Barss, 1967, pl. XIII, fig. 1, *cf. *Remysporites magnificus, Reticulatisporites decoratus, Retusotriletes incohatus, Rugospora minuta, R.* sp. Barss, 1967, pl. VI, fig. 2 *R.* spp., *Schopfites claviger, ?Secarisporites remotus, Spelaeotriletes* cf. *S. arenaceus, S.* sp. A Neves and Belt, 1970, *S.* sp. B Neves and Belt, 1970, *S.* sp., *Tricidarisporites arcuatus,* cf. *Vallatisporites* sp., cf. *Velamisporites perinatus, Verrucosisporites congestus, V. nitidus.*

* * * * *

HB-Fina
EAST POINT E-49

GSC locality: D14

Location: 46°38'29.09"N; 61°37'26.07"W

KB elevation: 32' Water depth: 203'

Casing set at: 274, 816, 2740, and 9525'

Total depth: 11569' Interval studied: 1080-11530'

Analyzed by: M.S. Barss

Forty-eight cuttings samples and 17 conventional core samples were examined from the East Point well. Only 31 of the cuttings samples and six of the core samples yielded spores. The low productivity is due mainly to the abundance of red clastics especially in the upper half of the well, where only five samples contain spores. From 7400 to 10 850ft, twenty-nine samples are palyniferous. In the interval from 9540 to 10 850ft prolonged oxidation was required to make the fossils transparent and suitable for identifications. However, many specimens remained opaque and most identifications were attempted only to the generic level. Below 10 850ft the samples are barren.

The following age determinations and biostratigraphic zonation have been made:

1080- 3450'	barren
3450- 3460'	*Vittatina* Zone (Sakmarian)
3460- 5180'	barren
5180- 5710'	*Potonieisporites* Zone (Stephanian)
5710- 7400'	barren
7400- 9370'	Westphalian D?-Stephanian
9370- 9540'	barren
9540- 9560'	probably late Viséan-early Namurian
9560- 9840'	barren
9840-10850'	late Viséan-early Namurian
10850-11530'	barren

The *Vittatina* and *Potonieisporites* Zones are the upper two of five zones delineated by Barss and Hacquebard (1967) for the Pictou Group in the Atlantic Provinces. The late Viséan-early Namurian assemblage compares with the assemblage reported by Neves and Belt (1970) from the Pomquet River section, near Antigonish, Nova Scotia. The presence of palynomorphs assignable to *Chomotriletes, Micrhystridium, Multiplicisphaeridium,* and *Veryhachium* is consistent with

their findings, and appears to be a recurring event that can be used for dating rocks of this age in the area.

Selected palynomorphs

1080-3450': barren

3450-3460': *Vittatina* Zone (Sakmarian)

Cirratriradites cf. *C. splendens*, *Convolutispora* sp., *Deltoidospora* spp., *Endosporites ornatus*, *Granulatisporites granulatus*, *Limitisporites* cf. *L. monstruosus*, *Lycospora* sp., *Piceapollenites* spp., *Potonieisporites novicus*, *Protohaploxypinus globus*, *Striatoabietites* spp., *Verrucosisporites verrucosus*, *Vesicaspora* sp., *Vittatina* spp.

3460-5180': barren

5180-5710': *Potonieisporites* Zone (Stephanian)

Apiculatisporis sp., *Calamospora microrugosa*, *Cirratriradites* sp., *Columnisporites ovalis*, *C.* sp. 2 Peppers, 1964, *Convolutispora* sp., *Cyclogranisporites microgranus*, *C. orbicularis*, *Deltoidospora* sp., *Endosporites globiformis*, *E. ornatus*, *Florinites antiquus*, *Florinites circularis*, *F. junior*, *F. mediapudens*, *F. pumicosus*, *Granulatisporites granulatus*, *Guthorlisporites* sp., *Laevigatosporites desmoinesensis*, *L. medius*, *L. minimus*, *L. vulgaris*, *Limitisporites monstruosus*, *Lophotriletes microsaetosus*, *Lycospora pusilla*, *Microreticulatisporites sulcatus*, *Potonieisporites novicus*, *P. simplex*. *Protohaploxypinus* sp., *Punctatosporites minutus*, *Raistrickia crinita*, *R. crocea*, *R. irregularis*, *R. saetosa*, *Striatopodocarpites* sp., *Striomonosaccites* sp., *Taenaeisporites* sp., *Triquitrites crassus*, *Verrucosisporites* cf., *V. grandiverrucosus*, *V.* cf. *V. sifati*, *Vesicaspora* sp.

5710-7400': barren

7400-9370': Westphalian D?-Stephanian

Apiculatisporis latigranifer, *Cadiospora* cf. *C. magna*, *Calamospora microrugosa*, *C. minuta*, *C. pallida*, *Cirratriradites annulatus*, *C. saturni*, *Columnisporites ovalis*, *Convolutispora* spp., *Crassispora kosankei*, *Cyclogranisporites aureus*, *Deltoidospora* sp., *Densosporites* sp., *Endosporites globiformis*, *E. ornatus*, *Florinites antiquus*, *F. circularis*, *F. junior*, *F. mediapudens*, *F. millotti*, *F. pumicosus*, *F. similis*, *F. visendus*, *Granulatisporites granulatus*, *Illinites* sp., *Knoxisporites* cf. *K. stephanephorus*, *Laevigatosporites desmoinesensis*, *L. medius*, *L. minimus*, *L. vulgaris*, *Latensina*, sp., *Lophotriletes commissuralis*, *L. gibbosus*, *L. microsaetosus*, *Lycospora pusilla*, *Microreticulatisporites sulcatus*, *Murospora kosankei*, *Pityosporites* sp., *Potonieisporites novicus*, *P. simplex*, *Punctatosporites minutus*, *Raistrickia crocea*, *R. irregularis*, *R. saetosa*, *Schopfipollenities ellipsoides*, cf. *Thymospora obscura*, *Torispora securis*, *T. verrucosus*, *Triquitrites bransonii*, *T. pulvinatus*, *T. sculptilis*, *Vestigisporites* sp., *Vestispora fenestrata*, *V.* cf. *V. irregularis*, *V. laevigata*, *V. profunda*, *Wilsonites* sp.

9370-9540': barren

9540-9460': probably late Viséan-early Namurian

Dictyotriletes sp., *Discernisporites* sp., *Knoxisporites* cf. *K. triradiatus*, cf. *Spelaeotriletes* sp., cf. *Vallatisporites* sp.

9560-9840': barren

9840-10850': late Viséan-early Namurian

Apiculatisporis sp., *Auroraspora solisortus*, *Calamospora* sp., *Chomotriletes* sp., cf. *Cirratriradites* sp., *Convolutispora* sp., *Deltoidospora* sp., *Discernisporites* sp., *Florinites* cf. *F. visendus*, *Grandispora echinata*, *Ibrahimispores brevispinosus*, *Incertae sedis* Neves and Belt, 1970, *Lycospora* sp., *Michystridium* spp., *Multiplicisphaeridium* sp., *Rugospora* sp., *Schopfites claviger*, cf. *Schulzospora rara*, *Velamisporites* sp., *Veryhachium* sp.

10850-11530': barren

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HB-Fina *et al.*
GREEN GABLES No. 1

GSC locality: D1030

Location: 46°28'38.8"N; 63°21'40.2"W

KB elevation: 224.4' Ground elevation: 203.4'

Casing set at: 1198 and 6800'

Total depth: 11252' Interval studied: 2800-11100'

Analyzed by: M.S. Barss

Twenty of 30 samples selected from the predominately red rocks encountered in the well were palyniferous. The following age determinations and biostratigraphic zonation have been made:

0- 2800'	not sampled
2800- 4540'	*Potonieisporites* Zone (Stephanian)
4540- 5430'	not sampled
5430- 5460'	*Thymospora* Zone (Westphalian D)
5460- 5630'	not sampled
5630- 6510'	Westphalian
6510- 7560'	no palynomorphs recovered
7560- 7740'	*P. elegans-K. seniradiatus* Zone (late Namurian)
7740-10210'	no palynomorphs recovered
10210-11100'	late Viséan-possibly early Namurian
11100-11252'	not sampled

Selected palynomorphs

0-2800': not sampled

2800-4540': *Potonieisporites* Zone (Stephanian)

Baculatisporites sp., *Cadiospora* cf. *C. magna*, *Calamospora microrugosa*, *C. pallida*, *Cirratriradites* sp., *Columnisporites ovalis*, *Crassispora kosankei*, cf. *Cycadopites* sp., *Endosporites ornatus* (common at 4520-4540ft), *Florinites triletus*, *Guthorlisporites* sp., *Leiotriletes adnatus*, *Limitisporites monstruosus*, *Lophotriletes microsaetosus*, *Potonieisporites bharadwaji*, *P. novicus*, *Protohaploxypinus globus*, *Punctatisporites minutus*, *Raistrickia* sp., *Schopfipollenites ellipsoides*, *Striatoabietites* sp., *Striatopodocarpites* sp., *Striomonosaccites* sp., *Triquitrites crassus*, *Verrucosisporites microtuberosus*, *V. pergranulus*, *Vesicaspora* sp., *Vestigisporites* sp., *Vittatina* sp. Barss, 1967, pl. XXXVI, fig. 4, *V.* spp.

The specimens of *Vittatina* and cf. *Cycadopites*, sp. suggest a Permian age for part of this interval. They could however represent caving from above 2800ft.

4540-5430': not sampled

5430-5460': *Thymospora* Zone (Westphalian D)

Apiculatisporis sp., *Calamospora microrugosa, C. pallida, Crassispora kosankei, Endosporites ornatus, Florinites circularis, F. mediapudens, F. visendus, Laevigatosporites desmoinesensis, Lycospora pusilla, Microreticulatisporites sulcatus, Punctatosporites minutus, Raistrickia crocea, Schopfites dimorphus, Vestispora fenestrata, V.* cf. *V. profunda.*

5460-5630': not sampled

5630-6510': Westphalian

Similar assemblage to 5430-5460ft with the following additional species but without *Schopfites dimorphus:*
Crassispora plicata (at 6270-6300ft), *Cyclogranisporites aureus, Florinites antiquus, F. parvus, Lophotriletes microsaetosus, Microreticulatisporites nobilis, Triquitrites bransonii, T. sculptilis, Wilsonites kosankei.*

6510-7560': no palynomorphs recovered

7560-7740': *Potonieisporites elegans-Knoxisporites seniradiatus* Zone (late Namurian)

Acanthotriletes sp., *Apiculatasporites* sp., *Auroraspora solisortus, Calamospora pallida, Convolutispora* sp., *Cristatisporites* sp., *Granulatisporites politus, Florinites mediapudens, F. visendus, Knoxisporites* cf. *K. dissidius, K. triradiatus, Leiotriletes adnatoides, Lycospora noctuina* var. *noctuina, L. pusilla, Potonieisporites elegans, Punctatisporites* sp., *Raistrickia* sp., *Schopfipollenites ellipsoides, Spelaeotriletes* sp.

7740-10210': no palynomorphs recovered

10210-11100': late Viséan-possibly early Namurian

Convolutispora sp., *Crassispora trychera, Densosporites variomarginatus, Endosporites* sp. Barss, 1967, pl. VI, fig. 4, *Foveosporites* sp., *Granulatisporites* sp., *Knoxisporites triradiatus, Murospora* sp., *Punctatisporites irrasus, P. planus, P.* spp. (abundant), *Retusotriletes incohatus, Rugospora minuta, Schopfites claviger, Schopfipollenites ellipsoides, Spelaeotriletes* cf. *S. arenaceous, S.* sp. B Neves and Belt, 1970, *Velamisporites* sp., *Vallatisporites ciliaris.*

11100-11252': not sampled

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HB-Fina *et al.*
IRISHTOWN No. 1

GSC locality: D1029

Location: 46°29'46.268"N; 63°35'38.748"W

KB elevation: 152' Ground elevation: 131'

Casing set at: 255, 1500, and 9825'

Total depth: 13477' Interval studied: 2690-9930'

Analyzed by: M.S. Barss

Twelve of 17 samples selected from the predominately red rocks encountered in the well were palyniferous. The following age determinations and biostratigraphic zonation have been made:

0- 2690' not sampled
2690- 2710' possibly *Vittatina* Zone (Sakmarian)
2840- 4990' Westphalian-Stephanian
5170- 5200' *Vestispora* Zone
(late Westphalian B-early Westphalian C)
5260- 6240' late Viséan-early Namurian
6240- 9930' no palynomorphs recovered
9930-13477' not sampled

Selected palynomorphs

0-2690': not sampled

2690-2710': possibly *Vittatina* Zone (Sakmarian)

Cadiospora magna, Calamospora breviradiata, C. minuta, Convolutispora sp., *Cordaitina triangularis, Deltoidospora* sp., *Florinites circularis, F. junior, Granulatisporites* sp., *Latensina* sp., *Lycospora pusilla, Potonieisporites bharadwaji, P. novicus, Protohaploxpinus globus, Punctatosporites minutus, P. obliquus, Schopfipollenites* sp., *Striatoabietites* sp. Barss, 1970, pl. XXXV, fig. 18, *Triquitrites crassus, Verrucosisporites pergranulatus.*

Specimens of *Vittatina* found in samples below this interval are believed to be caved from this interval or above.

2840-4990': Westphalian-Stephanian

Acanthotriletes sp., *Apiculatisporis* sp., *Calamospora mutabilis, C. pallida, Columnisporites ovalis, Converrucosisporites* sp., *Convolutispora* sp., *Crassispora kosankei, Cyclogranisporites aureus, C. microgranus, Endosporites ornatus, E. globiformis, Florinites antiquus, F. pumicosus, Knoxisporites stephanephorus* (at 4960-4990ft), *Laevigatosporites desmoinesensis, L. medius, Lophotriletes* sp., *Potonieisporites novicus, Protohaploxypinus* sp., *Raistrickia aculeatus, R. crocea, Reticulatisporites* sp., *Schopfipollenites ellipsoides, Striomonosaccites* sp., *Triquitrites trigonappendix, Verrucosisporites* sp., *Vesicaspora* sp., *Vestispora fenestrata, V. laevigata.*

5170-5200': *Vestispora* Zone
(late Westphalian B-early Westphalian C)

Calamospora microrugosa, Vestispora costata, V. profunda, V. tortuosa.

5260-6240': late Viséan-early Namurian

Apiculatisporis sp., *Cirratriradites* sp., *Convolutispora florida, C. mellita, Crassispora trychera, Dictyotriletes submarginatus, Discernisporites micromanifestus, Grandispora spinosa, Ibrahimispores brevispinosus, Knoxisporites stephanephorus, K. triradiatus, Punctatisporites irrasus, P. planus, Raistrickia* sp., *Retusotriletes incohatus, Reticulatisporites* sp., *Rugospora corporata* var. *corporata, R. minuta, R. polyptycha, Schopfites calviger, Secarisporites remotus, Spelaeotriletes arenaceous, S.* sp. A Neves and Belt, 1970, *S.* sp. B Neves and Belt, 1970, *Velamisporites perinatus.*

6240-9930': no fossils recovered

The rocks in this interval are predominately halite-anhydrite with a "volcanic sequence" below 8338ft.

9930-13477': not sampled

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Murphy *et al.*
NORTH SYDNEY P-05

GSC locality: D134

Location: 46°34'46.24"N; 59°45'01.65"W

RT elevation: 98' Water depth: 206'

Casing set at: 904 and 2613'

Total depth: 5449' Interval studied: 1700-4970'

Analyzed by: M.S. Barss

Fifty-five cuttings samples and fifty-eight sidewall cores were studied from the well. The cuttings samples are nearly all palyniferous and cavings occur throughout the well. Most of the sidewall core preparations supplied by Murphy Oil Company are barren. Only two of the cores (2676 and 2875ft) provided biostratigraphic control additional to that obtained from the cuttings samples.

The following age determinations and biostratigraphic zonation have been made:

1700- 2310' *Potonieisporites* Zone (Stephanian)
2390- 3410' *Thymospora* Zone (Westphalian D)
3500- 4010' *Torispora* Zone (late Westphalian C)
4180- 4410' *Vestispora* Zone
(late Westphalian B-early Westphalian C)
4510- 4970' late Viséan-early Namurian

In the onshore section of the Morien Group in the Sydney Coalfield, the *Potonieisporites*, *Thymospora*, *Torispora*, and *Vestispora* Zones were delineated by Barss and Hacquebard (1967). The *Potonieisporites* Zone occurs in the uppermost part of the section at Point Aconi, approximately 14 miles northwest of Sydney, and presumably extends into the offshore. The thickness of the interval is not known. The remaining three zones represent the interval from approximately the Point Aconi coal seam horizon, to the contact with the Canso and Windsor Groups at the southern boundaries of the coalfield. The thickness of the strata in this interval can exceed 6600ft.

In the North Sydney P-05 well this interval is approximately 2000ft thick. The *Thymospora* Zone is approximately 1100ft, the *Torispora* Zone approximately 600ft, and the *Vestispora* Zone approximately 300ft. These thicknesses compare with maximum thicknesses of 1300, 2300, and >3000ft respectively, for these zones in the onshore area.

The nearest comparison for the late Viséan-early Namurian age rocks encountered is approximately 40 miles WSW in coastline sections of the St. Ann and Cape Dauphin Formations (GSC Map 359A).

Numerous coal seams were encountered in North Sydney P-05, but no attempt was made to correlate individual coal horizons because of caving in the well. "Basement" was encountered at 5010ft.

Selected palynomorphs

1700-2310': *Potonieisporites* Zone (Stephanian)

Apiculatisporis latigranifer, A. verrucifer, Apiculatasporites sp., *Cadiospora magna, Calamospora breviradiata, C. microrugosa, C. minuta, C. pallida, C. pedata, C. perrugosa, Cirratriradites* sp., *Columnisporites* sp., *Convolutispora* sp., *Cyclogranisporites aureus, Endosporites globiformis, E. ornatus, E. zonalis, Florinites antiquus, F. circularis, F. eremus, F. junior, F. mediapudens, F. pumicosus, F. similis, Granulatisporites minutus, Guthorlisporites* sp., *Laevigatosporites desmoinesensis, L. medius, L. minimus, Leiotriletes adnatoides, L. sphaerotriangulus, Limitisporites monstruosus, Lophotriletes* sp., *Lycospora pusilla, Potonieisporites novicus, P. simplex, Protohaploxypinus globus, Punctatisporites* sp., *Punctatosporites minutus, Raistrickia aculeata, R. saetosa, Reticulatisporites reticulatus, Schopfipollenites ellipsoides, Striatopodocarpites* sp., *Striomonosaccites* sp., *Taeniaesporites* sp., *Triquitrites bransonii, T. pulvinatus, T. spinosus, Verrucosisporites donarii, Vestispora fenestrata, V. laevigata, Vestigisporites* sp., *Wilsonites* sp.

2390-3410': *Thymospora* Zone (Westphalian D)

Alatisporites trialatus, Apiculatisporis irregularis, Calamospora mutabilis, Cirratriradites annulatus, C. flabelliformis, C. foveatus, C. saturni, Columnisporites ovalis, Crassispora kosankei, Cyclogranisporites microgranus, C. micaceus, C. minutus, Dictyotriletes sp., *Florinites visendus, Granulatisporites granulatus, Knoxisporites* cf., *K. stephanephorus, Laevigatosporites vulgaris, Lophotriletes gibbosus, L. microsaetosus, Lycospora pusilla, Microreticulatisporites sulcatus, Punctatosporites granifer, Raistrickia crocea, Savitrisporites* sp., *Schopfites colchesterensis, S. dimorphus, Spakmanites* cf. *S. facierugosus, Speciosporites minutus, S. triletoides, Thymospora obscura, T. perverrucosa, T. verrucosa, Torispora securis, T. verrucosus, Triquitrites crassus, Vestispora* cf. *V. colchesterensis, V. profunda.*

3500-4010': *Torispora* Zone (late Westphalian C)

Acanthotriletes sp., *Alatisporites* cf., *A. hexalatus, Apiculatisporis priscus, Cyclogranisporites pergranulus, Knoxisporites* sp., *Mooreisporites inusitatus, Murospora* sp., *Verrucosisporites microtuberosus, Vestispora irregularis, Vesicaspora* sp.

4180-4410': *Vestispora* Zone
(late Westphalian B-early Westphalian C)

Vestispora tortuosa, V. costata, V. magna.

4510-4970': late Viséan-early Namurian

Auroraspora cf. *A. solisortus, Convolutispora florida, C. usitata, C.* cf. *C. vermiformis, C.* sp., *Costatascyclus crenulatus, Discernisporites* sp. A Neves and Belt, 1970, *D. irregularis, D. micromanifestus, Grandispora* cf. *G. echinata, G.* cf. *G. procincta, G. spinosa, Knoxisporites triradiatus, Proprisporites* cf. *P. undosus, Punctatisporites glaber, Schopfites claviger, Spelaeotriletes* cf. *S. arenaceous, Velamisporites* cf. *V. perinatus,* cf. *Vallatisporites* sp.

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HB-Fina
NORTHUMBERLAND STRAIT F-25

GSC locality: D15

Location: 46°04'23.8"N; 62°03'45.5"W

KB elevation: 31' Water depth: 98'

Casing set at: 878, 520, 2137, and 6771'

Total depth: 9876' Interval studied: 370-9830'

Analyzed by: M.S. Barss

Forty-two cuttings samples were processed, of which 22 are palyniferous. Twenty-one of these occur in the interval from 370 to 4120ft. No fossils were recovered from the "massive salt", from 4515 to 6610ft on company sample log. One sample below the salt (6640-6650ft) is palyniferous.

The following age determinations have been made:

370- 1150' possibly early Namurian
1150- 1330' barren
1330- 4120' late Viséan
4120- 6640' barren
6640- 6650' Viséan
6650- 9830' barren

The early Namurian age is suggested because of the occurrence of the acritarch *Micrhystridium* sp. Occurrence of acritarchs in the HB-Fina East Point E-49 well and in the Pomquet River section near Antigonish as reported by Neves and Belt (1970), appear to be restricted to latest Viséan-early Namurian time in this area.

Selected palynomorphs

370-1150': possibly early Namurian

Calamospora sp., *Lycospora* sp., *Micrhystridium* sp., *Punctatisporites glaber, P. planus, P. solidus, Retusotriletes* sp., *Rugospora minuta, Spelaeotriletes* sp. Barss, 1967, pl. XIV, fig. 11, *Velamisporites* sp.

1150-1330': barren

1330-4120': late Viséan

Apiculatisporis aculeatus, A. baccatus, Calamospora aerarius, C. mutabilis, C. perrugosa, Camptotriletes sp., *Cirratriradites granulatipunctatus, Convolutispora vermiformis, Crassispora* sp. A Neves and Belt, 1970, *Cyclogranisporites* sp., *Discernisporites irregularis, D.* sp. Barss, 1967, pl. VI, fig. 9, *Endosporites* sp., *Foveosporites insculptus, Grandispora balteata, Knoxisporites triradiatus, K.* cf. *K. rotatus, Lycospora pusilla, Murospora* sp. Barss, 1967, pl. V, fig. 13, *Phylothecotriletes* sp., *Punctatisporites irrasus, P.* sp. Barss, 1967, pl. V, fig. 10, *Retusotriletes incohatus, Rugospora minuta, R.* sp. Barss, 1967, pl. VI, fig. 15, *Secarisporites remotus, Spelaeotriletes arenaceous, S.* sp. Barss, 1967, XIV, fig. 11, *S.* sp. B Neves and Belt, 1970, *Stenozonotriletes* sp., *Velamisporites magnus, V. perinatus, Verrucosisporites* sp.

4120-6640': barren

6640-6650': Viséan

Dictyotriletes sp., *Lycospora* sp., *Punctatisporites punctatus, Rugospora* sp. Barss, 1967, pl. VI, fig. 22.

6650-9830': barren

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Soquip *et al.*
TYRONE NO. 1

GSC locality: D143

Location: 45°16'05"N, 63°20'19"W

RT elevation: 360'

Casing set at: 40 and 2032'

Total depth: 13688' Interval studied: 4290-12610'

Analyzed by: M.S. Barss

Twenty-six samples were examined between 4290 and 12 610ft. The interval 0-4290ft, composed entirely of red beds, and the interval from 12 610 to 13 688ft, composed mainly of limestone and conglomerate, were not sampled. All residues were oxidized. Prolonged oxidation was required below 10 000ft to make the fossils transparent and suitable for identification. However, many specimens remained opaque, indicating a high degree of maturation.

The following age determinations and biostratigraphic zonation have been made:

0- 4290' possibly Permian in part
4290- 5960' *Potonieisporites* Zone (Stephanian)
5960- 8240' no palynomorphs recovered
8240- 9550' probably Westphalian C
9550- 9830' no palynomorphs recovered
9830-10250' *Vestispora* Zone
(late Westphalian B-early Westphalian C)
10330-12610' late Viséan-early Namurian
12610-13688' not sampled

In the 4290-5960ft interval, which is assigned to the *Potonieisporites* Zone of Barss and Hacquebard, 1967, there are specimens of *Vittatina* and a specimen of *Hamiapollenites tractiferinus* that would indicate a Permian rather than Stephanian age. Since the stratigraphic range of these types is not known with absolute certainty in Eastern Canada and there is the possibility that they are caved from the upper 4290ft of the well, it is therefore suggested that some Permian age rocks may occur in the interval 0-4290ft.

Red beds comprise most of the interval from 5960-8240ft and as a result no palynomorphs were recovered from the samples processed.

Vestispora fenestrata, V. laevigata, and *V. profunda,* together with *Reticulatisporites polygonalis* characterize the interval from 8240-9550ft and suggest a probable Westphalian C age. Some reworking may occur in this interval. No palynomorphs were recovered from 9550-9830ft.

The interval from 9870-10 250ft is assigned to the *Vestispora* Zone of Barss and Hacquebard, 1967, based mainly on the occurrence of *Vestispora cancellata* which is the index type for the zone.

The assemblage from 10 330-12 610ft compares with the assemblage reported by Neves and Belt, 1970, from the late Viséan-early Namurian. The presence of acritarchs, assignable to *Micrhystridium* and *Veryhachium*, is significant in that this association of palynomorphs appears to be a marker that can be used to date rocks of this age in this area.

Selected palynomorphs

0-4290': possibly Permian in part

This age is based on the occurrence of *Cycadopites* sp., *Piceapollenites* sp., *Vittatina subsaccata* at 4290-4320ft, and *Hamiapollenites tractiferinus* at

5930-5960ft. These palynomorphs are believed to be caved from the 0-4290ft interval.

4290-5960': *Potonieisporites* Zone (Stephanian)

Acanthotriletes sp., *Apiculatisporis* sp., *?Cadiospora* sp., *Calamospora hartungiana, C. microrugosa, C. minuta, C. pallida, Cirratriradites ornatus, C.* cf. *C. splendens, Columnisporites ovalis, Complexisporites* sp., *Convolutispora* spp., *Cordaitina* cf. *C. triangulus, Cyclobaculisporites* sp., *C. provectus, Endosporites ornatus, Florinites junior, F. mediapudens, F. millotti, F. minutus, F. pumicosus, ?Gondisporites* sp., *Granulatisporites elegans, G. granulatus, Guthorlisporites magnificus, G.* cf. *G. velensis, Illinites unicus, Indospora* sp., *Laevigatosporites desmoinesensis, L. minimus, L. vulgaris, Leiotriletes adnatus, Limitisporites monstruosus, Lophotriletes commissuralis, L. microsaetosus, Lueckisporites* sp., *Lycospora rotunda, Microreticulatisporites nobilis, Neoraistrickia* sp., *Piceapollenites* sp., *Potonieisporites novicus, P. simplex, Protohaploxypinus globus, P.* cf. *P. compactus, Punctatosporites minutus, Raistrickia saetosa, Schopfipollenites ellipsoides, Secarisporites crenatus, Striatoabietites* spp., *Striatopodocarpites* spp., *Thymospora obscura, T. thiessenii, Triquitrites trigonappendix, Trivolites* sp., *Tuberculatosporites* sp., *Verrucosisporites donarii, Vesicaspora* sp., *Vestigisporites* sp., *Wilsonites delicatus.*

5960-8240': no palynomorphs in samples processed

8240-9550': possibly Westphalian C

Apiculatisporis sp., *Calamospora breviradiata, C. mutabilis, Convolutispora* sp., *Cyclogranisporites medius, Lycospora pressoides, L. pusilla, Punctatisporites minutus, Reticulatisporites polygonalis, Spinosporites* sp., *Vestispora fenestrata, V. laevigata, V. profunda.*

There are some reworked fossils in the sample from 9520-9550ft.

9550-9830': no palynomorphs in samples processed

9830-10250': *Vestispora* Zone
(late Westphalian B-early Westphalian C)

Apiculatisporis aculeatus, Auroraspora solisortus, Calamospora microrugosa, Crassispora kosankei, Densosporites sp., *Florinites visendus, Knoxisporites* cf. *K. corpeus, K. triradiatus, Lophotriletes mosaicus, Raistrickia crocea, Reticulatisporites* sp., *?Savitrisporites* sp., *Secarisporites* sp., *Vestispora tortuosa.*

10330-12610': late Viséan-early Namurian

Apiculatisporis spinulistratus, Convolutispora ampla, C. florida, Discernisporites sp., *Grandispora* sp., *Knoxisporites rotatus, K. stephanephorus, Lycospora noctuina* var. *noctuina, Punctatisporites glaber, Reticulatisporites* sp., *Retusotriletes incohatus, Rugospora minuta, Schulzospora elongata, S. rara, Spelaeotriletes* sp. B Neves and Belt, 1970, *Vallatisporites ciliaris, Velamisporites magnus, V. perinatus.*

In addition a few specimens of acritarchs assignable to *Micrhystridium* and *Veryhachium* occur at 10 330-10 350, 10 640-10 660, and 11 050-10 070ft.

12610-13688': not sampled

* * * * *

SCOTIAN SHELF

The 23 wells analyzed from the Scotian Shelf are:

Argo F-38	(22)
Bluenose G-47	(10)
Cohasset D-42	(6)
Cree E-35	(7)
Dauntless D-35	(15)
Esperanto K-78	(14)
Eurydice P-36	(20)
Fox I-22	(21)
Hercules G-15	(23)
Iroquois J-17	(16)
Mic Mac J-77	(18)
Missisauga H-54	(17)
Mohawk B-93	(1)
Mohican I-100	(2)
Naskapi N-30	(3)
Ojibwa E-07	(4)
Oneida O-25	(5)
Primrose A-41	(11)
Primrose 1a-A-41	(12)
Sable Island C-67	(9)
Sauk A-57	(13)
Triumph P-50	(8)
Wyandot E-53	(19)

The numbers in brackets refer to the geographic locations shown in Fig. 4. A comparison of the palynological ages of rocks dated in each well is illustrated in Fig. 5. Details of individual zone thicknesses and taxa occurrences are given below for each well.

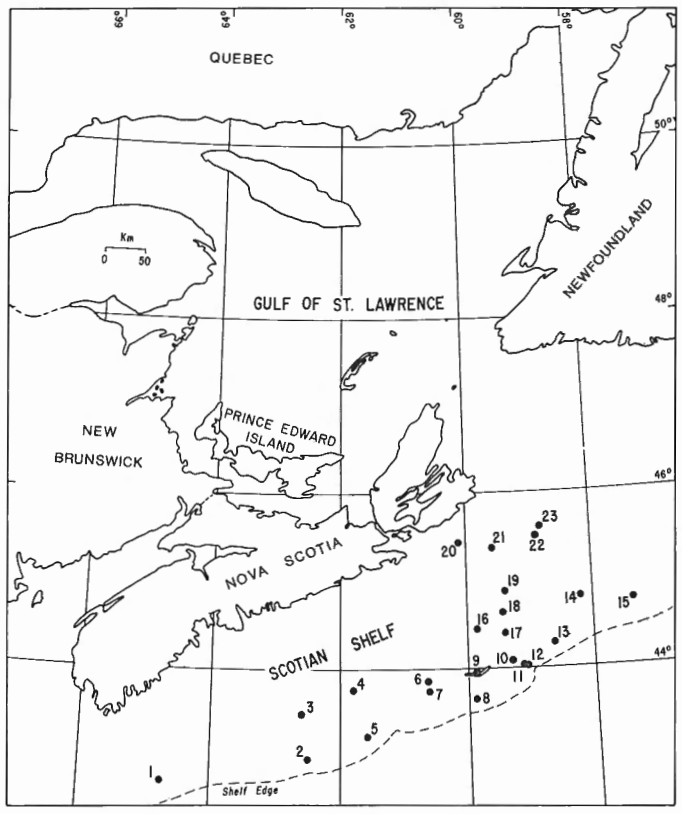

Figure 4: Well locations, Scotian Shelf.

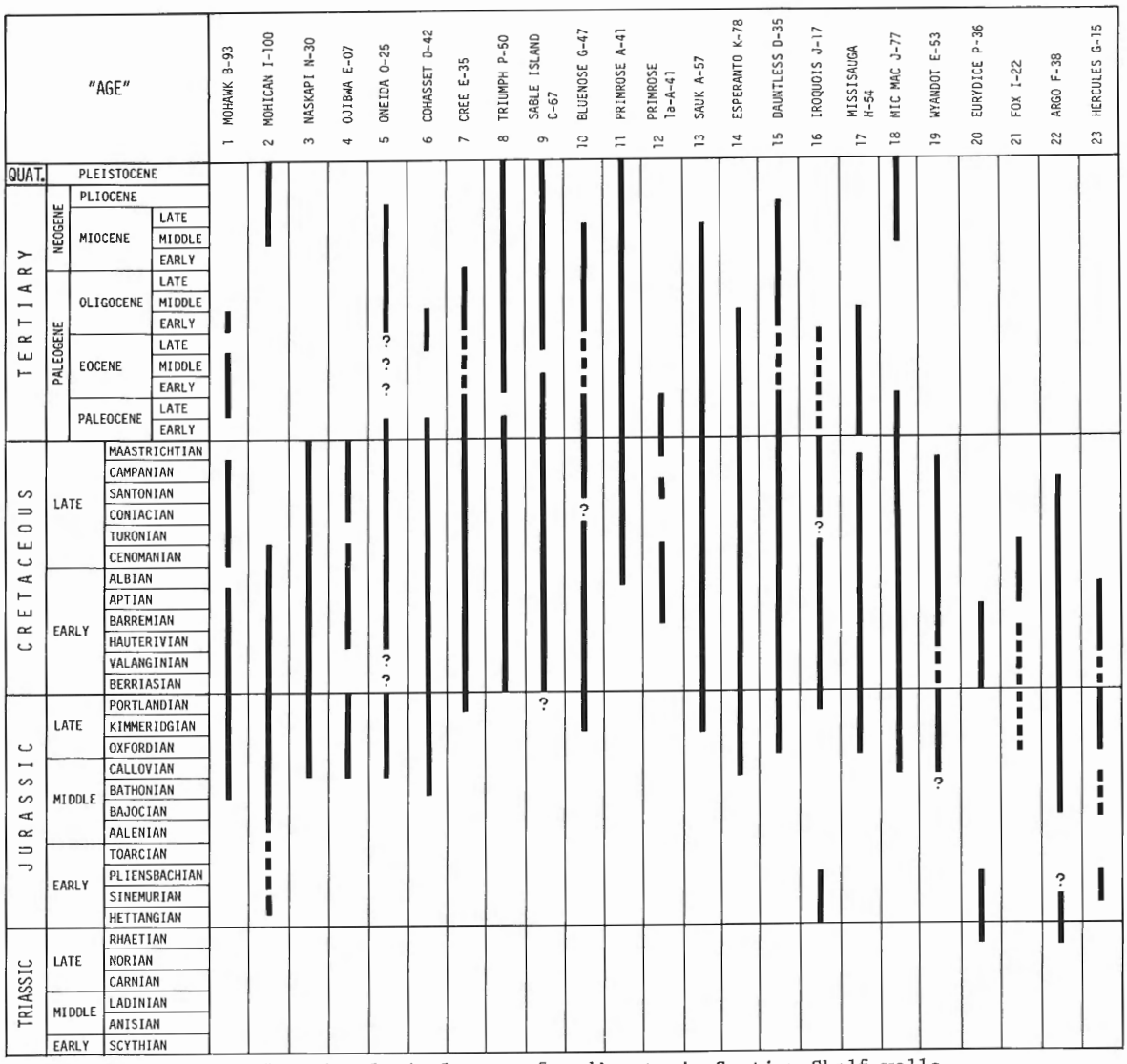

Figure 5: Palynological ages of sediments in Scotian Shelf wells.

Shell
ARGO F-38

GSC locality: D17

Location: 45°27'23.22"N; 58°50'24.34"W

RT elevation: 103' Water depth: 235'

Casing set at: 923, 2927, and 6285'

Total depth: 11116' Interval studied: 945-11087'

Analyzed by: J.P. Bujak

Palynological analysis of 104 cuttings samples and 75 sidewall core samples indicates the following age determinations and biostratigraphic zonation:

945- 975' Santonian
1000- 1449' Coniacian-Santonian
1480- 1510' *S. longifurcatum* Zone (Turonian)
1570- 2128' *C. polypes* Zone (Cenomanian)
2128- 3283' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
3390- 3665' *S. perlucida-S. schindewolfii* Zone (Aptian)
3670- 4875' Neocomian-Barremian
4940- 5140' *C. panneum* Zone (Portlandian)
5183- 5357' *G. cladophora* Zone (Kimmeridgian)
5410- 5940' *G. jurassica* Zone
(Oxfordian-early Kimmeridgian)
6010- 6502' Bathonian-Callovian
6510- 6740' Bajocian
6810- 7140' age indeterminate
7150- 7540' Early Jurassic
7545' possibly *E.* cf. *E. iliacoides* Zone
(late Sinemurian-early Pliensbachian)
7610- 8120' Early Jurassic
8180-10110' *C. subgranulosus* Zone
(late Hettangian-early Sinemurian)
10110-11087' *C. meyeriana* Zone
(Rhaetian-early Hettangian)

The oldest sediments in the well are Rhaetian from 11 087 to 10 110ft. These and the overlying Liassic succession from 10 110 to 7150ft contain assemblages dominated by the pollen *Classopollis* which probably occupied upland slopes and lowlands near the coast and preferred well-drained soils and a warm climate (Srivastava, 1976). From 6740 to 5183ft a Bathonian to Kimmeridgian succession contains progressively more diverse

dinoflagellate assemblages in younger strata indicating increasing marine influence. Overlying Portlandian and Neocomian-Barremian strata contain few marine palynomorphs. There is an increase in marine palynomorph diversity through the Aptian to Cenomanian succession from 3665 to 1570ft. These strata are overlain by marine Turonian to Santonian sediments from 1510 to 945ft.

Reworked palynomorphs are rare in the well and primarily include Lower Jurassic spores in the Middle and Upper Jurassic intervals.

Selected palynomorphs

945-975': Santonian

Chatangiella tripartita, Exochosphaeridium bifidum, Hystrichodinium pulchrum, Hystrichosphaeridium cooksoniae, Odontochitina costata, Palaeohystrichophora infusorioides, Palaeoperidinium pyrophorum, Spinidinium echinoideum, Surculosphaeridium longifurcatum.

This sample contains only one species known to occur above the Cretaceous. The species, *P. pyrophorum*, has a stratigraphic range of Campanian to lower Paleocene on the Scotian Shelf-Grand Banks.

1000-1449': Coniacian-Santonian

Chatangiella victoriensis, Cleistosphaeridium huguoniotii, Cyclonephelium distinctum, Isabelidinium belfastense, I. cooksoniae, Odontochitina operculata, Oligosphaeridium complex, Schizocystia laevigata, Senoniasphaera rotundata, Spinidinium sverdrupianum, Trithyrodinium suspectum, Xenascus ceratioides.

1480-1510': *Surculosphaeridium longifurcatum* Zone (Turonian)

?Horologinella extrema, Surculosphaeridium longifurcatum (common).

1570-2128': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus, A. unicus, Camarozonosporites insignis, Cicatricosisporites hallei, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Costatoperforosporites foveolatus, Dinopterygium cladoides, Klukisporites pseudoreticulatus, Liliacidites peroreticulatus, Oligosphaeridium totum, Rouseisporites reticulatus, Schizosporis reticulatus.*

2128-3283': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Biretisporites cf. *B. potoniae, Cicatricosisporites hughesi, Converrucosisporites exquisitus, Eucommiidites minor, Klukisporites foveolatus, Pilosisporites trichopapillosus, Spinidinium vestitum, S.* cf. *S. vestitum, sensu* Williams, 1975, *Trilobosporites apiverrucatus, T. purverulentus, T. tribotrys, Vitreisporites pallidus.*

3390-3665': *Subtilisphaera perlucida-Systematophora schindewolffii* Zone (Aptian)

Cicatricosisporites australiensis (common), *Concavissimisporites punctatus, Coronatispora valdensis, Cyclonephelium eisenackii, Pilosisporites trichopapillosus* (common), *Subtilisphaera pirnaenis.*

3670-4875': Neocomian-Barremian

Aequitriradites verrucosus, Cicatricosisporites brevilaesuratus, Classopollis classoides, Tenua hystrix.

4940-5140': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites dampieri, C. trilobatus, Cerebropollenites mesozoicus, Densoisporites velatus (common).

Also present within this interval is a reworked specimen of the Early Jurassic species *Convolutispora klukiforma.*

5183-5357': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Ctenidodinium culmulum, C. pachydermum, C. panneum, Epiplosphaera reticulospinosa, Gonyaulacysta jurassica (variety with smooth crests), *Lanterna sportula, Pareodinia ceratophora, Systematophora fasciculigera.*

5410-5940': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Ctenidodinium continuum, Gonyaulacysta granuligera, G. jurassica, Systematophora orbifera, S. turonica.

6010-6502': Bathonian-Callovian

Meiourogonyaulax sp. Williams, 1975, *Tenua* sp.

6510-6740': Bajocian

Araucariacites punctatus, Mancodinium semitabulatum.

6810-7140': age indeterminate

Palynomorphs were not seen in samples from this interval.

7150-7540': Early Jurassic

Classopollis classoides (common).

Samples from this interval either did not yield palynomorphs or contained only *C. classoides.*

7545': possibly *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Classopollis meyeriana, Cycadopites cf. *C. jansonii, C. nitidus* (common).

7610-8120': Early Jurassic

Samples without palynomorphs or with only *C. classoides.*

8180-10110': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Convolutispora klukiforma, Echinitosporites cf. *E. iliacoides* Bujak and Williams, 1977, *Neoraistrickia* cf. *N. elongata, Porcellispora longdonensis, Verrucosisporites* sp.

10110-11087': *Classopollis meyeriana* Zone (Rhaetian-early Hettangian)

Converrucosisporites sp., *Classopollis meyeriana* (abundant), *?Cycadopites* sp. B Bujak and Williams, 1977.

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Mobil-Tetco
BLUENOSE G-47

GSC locality: D94

Location: 44°06'20.79"N; 59°21'27.35"W

RT elevation: 98' Water depth: 267'

Casing set at: 525, 882, 3883, and 9752'

Total depth: 15050' Interval studied: 990-15050'

Analyzed by: G.L. Williams

Palynological analysis of 38 sidewall core and 148 cuttings samples indicates the following age determinations and biostratigraphic zonation:

990- 1200'	*P. laticinctum* Zone (middle Miocene)
1260- 1920'	*Apteodinium* sp. B Zone (early Miocene)
1980- 2280'	*C. dispersum* Zone (middle-late Oligocene)
2340- 2910'	*D. heterophlycta* Zone (early Oligocene)
2970- 3000'	Eocene
3060- 3810'	*C. speciosa* Zone (late Paleocene)
3870- 4250'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
4310- 4670'	*D. euclaensis* Zone (Maastrichtian)
4730- 5030'	Santonian-Campanian
5090- 5210'	*S. longifurcatum* Zone (Turonian)
5270- 6050'	*C. polypes* Zone (Cenomanian)
6120- 7800'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
7870- 9540'	*S. perlucida-S. schindewolfii* Zone (Aptian)
9170- 9540'	*A. attadalica* Subzone (early Aptian)
9570-10700'	*D. anaphrissa* Zone (Barremian)
10770-12100'	*C. elegantulum* Zone (Hauterivian)
12170-14582'	*P. neocomica* Zone (Berriasian-Valanginian)
14670-15050'	Kimmeridgian-Portlandian

The oldest sediments in Bluenose G-47 are dated palynologically as Kimmeridgian-Portlandian and are approximately 400ft thick. They are sequentially overlain by a more or less complete and expanded Lower Cretaceous section, which extends from 14 582 to 6120ft. The 1840ft of Upper Cretaceous sediments contain sparse palynomorph assemblages, so that recognition of the stages is difficult. The Coniacian may be missing but more probably is unrecognized. The Tertiary section includes a thick Paleocene sequence, a condensed Eocene and an expanded lower Oligocene section. This is similar to other Scotian Shelf wells such as Dauntless D-35. The youngest dated sediments are middle Miocene.

The depositional environments have been deduced primarily from the sidewall cores, which frequently contain high contaminant counts; interpretations must therefore be treated with some reservations. The Upper Jurassic-Cenomanian sediments generally contain dinocysts, although the interval from 11 096 to 9540ft (Hauterivian-Barremian), is predominantly non-marine. The early Aptian represents a period of transgression. The major transgression however commenced in the Albian and extended throughout the Late Cretaceous. The paucity of spores and pollen in the Late Cretaceous sediments indicates that the influx of terrigenous material was minimal during that time. There is a slight increase in pollen grains in the Paleocene which may indicate shallowing of the environment in the vicinity of Bluenose G-47 and the influx of greater amounts of terrigenous material. The younger Tertiary sediments contain few pollen and generally rich dinocyst assemblages except in the early Miocene where several samples are barren. The absence of sidewall cores above 4450ft precludes the detailed determination of paleoenvironments in the younger sediments.

Selected palynomorphs

990-1200': *Pentadinium laticinctum* Zone (middle Miocene)

Apteodinium sp. Gocht, 1969, *Caryapollenites simplex, Cordosphaeridium multispinosum, Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Nematosphaeropsis* sp. B Williams and Brideaux, 1975, *Operculodinium centrocarpum, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

1260-1920': *Apteodinium* sp. B Zone (early Miocene)

Cordosphaeridium cantharellum, Cyclopsiella trematophora, Epicephalopyxis indentata, Hystrichosphaeropsis obscura, Pentadinium sp.
Reworked species include *Deflandrea denticulata* and *Surculosphaeridium longifurcatum.*

1980-2280': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Deflandrea phosphoritica, Pentadinium laticinctum subsp. *granulatum, ?Wilsonidium aechmophorum.*

2340-2910': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium multicornutum, Chiropteridium aspinatum, C. dispersum, Cyclonephelium cf. *C. exuberans, Hystrichokolpoma eisenackii, Maduradinium spatiosum, Polysphaeridium pastielsii, Wetzeliella* sp. A Williams and Bujak, 1977b.

2970-3000': Eocene

Areoligera medusettiformis, Cordosphaeridium fibrospinosum, Deflandrea hialina, D. sp.

3060-3810': *Ceratiopsis speciosa* Zone (late Paleocene)

Apectodinium homomorphum, Areoligera medusettiformis (common), *A. medusettiformis, sensu* Gocht, 1969 (common), *Cannosphaeropsis* cf. *C. utinensis, Cyclonephelium ordinatum, Deflandrea dartmooria, D. denticulata, Extratriporopollenites* spp., *Palambages* sp., *Podocarpidites* sp. Williams and Bujak, 1977b, *Spiniferites septatus, S. wetzelii, Thalassiphora delicata, T. pelagica, Turbiosphaera filosa.*

3870-4250': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis speciosa, Eisenackia sp., *Palaeoperidinium pyrophorum.*

4310-4670': *Dinogymnium euclaensis* Zone (Maastrichtian)

Caligodinium aceras, Ceratiopsis diebelii, C. pannucea, Cordosphaeridium cf. *C. gracile, Dinogymnium acuminatum, D. undulosum, Dorocysta* sp., *Exochosphaeridium bifidum, Gonyaulacysta pyra, Hystrichosphaeridium tubiferum, Isabelidinium belfastense, Lejeunia magnifica, Oligosphaeridium complex, O. pulcherrimum, Palaeocystodinium benjaminii, Rugubivesiculites rugosus, Schizocystia rugosa, Spinidinium densispinatum, S. styloniferum, Svalbardella* sp. Wilson, 1971, *Tanyosphaeridium variecalamum, Trithyrodinium striatum.*

4730-5030': Santonian-Campanian

Hystrichodinium pulchrum, Hystrichokolpoma sequanaportus, Kleithriasphaeridium loffrense, Trithyrodinium suspectum.

5090-5210': *Surculosphaeridium longifurcatum* Zone (Turonian)

Cleistosphaeridium huguoniotii, Cyclonephelium distinctum, C. vannophorum, Odontochitina operculata, Oligosphaeridium anthophorum, Surculosphaeridium longifurcatum (common).

5270-6050': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium polypes subsp. A Williams, 1975, *Cyclonephelium paucispinum, C. vannophorum* (common), *Hystrichosphaeridium* sp. A Bujak and Williams, 1978, *Palaeohystrichophora infusorioides, Palaeoperidinium* sp. A Bujak and Williams, 1978, *Rouseisporites reticulatus, Silicisphaera ferox, Xenascus ceratioides.*

6120-7800': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Alisporites grandis, Appendicisporites bifurcatus, A. bilateralis, A. jansonii, A. potomacensis, Aptea cf. *A. attadalica, Cicatricosisporites hallei, C. hughesi, Costatoperforosporites foveolatus, Cribroperidinium intricatum, C. muderongense, sensu* Habib, 1972, *Cyclonephelium paucispinum, Florentinia laciniata, Kalyptea* sp. A Brideaux, 1971, *Klukisporites pseudoreticulatus, Lophotriletes babsae, Oligosphaeridium totum, Osmundacidites wellmannii, Palaeoperidinium cretaceum, Prolixosphaeridium granulosum, Rouseisporites reticulatus, Senoniasphaera microreticulata, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *?Spiniferites dentatus, Surculosphaeridium* cf. *S. longifurcatum, Trilobosporites apiverrucatus, T. purverulentus.*

7870-9540': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites problematicus, Aptea attadalica, A. polymorpha, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, Coronatispora valdensis, Eucommiidites minor, Gonyaulacysta granulata, Kleithriasphaeridium cf. *K. eoinodes, Muderongia* sp., *Pareodinia ceratophora* (with kalyptra), *Pilosisporites trichopapillosus, P. verus, Schizosporis reticulatus, Spiniferites speciosus, Subtilisphaera perlucida, S. pirnaensis, sensu* Millioud, 1969, *Taurocusporites segmentatus, Vitreisporites pallidus, V.* sp. Singh, 1971.

Reworked species include *Achomosphaera neptuni, Occisucysta* sp. A Bujak and Williams, 1978, and *Pseudoceratium pelliferum.*

9170-9540': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica (common), *Callialasporites trilobatus, Densoisporites perinatus, Kleithriasphaeridium eoinodes, Trichodinium ciliatum, Trilobosporites trioreticulosus.*

9570-10700': *Doidyx anaphrissa* Zone (Barremian)

Cannigia colliveri, Muderongia perforata, Oligosphaeridium asterigerum, Oligosphaeridium cf. *O. complex, sensu* Williams, 1978, *Pseudoceratium pelliferum, Pterodinium magnoserratum, Tenua hystrix.*

10770-12100': *Ctenidodinium elegantulum* Zone (Hauterivian)

Aequitriradites spinulosus, Callaiosphaeridium asymmetricum, Cassiculosphaeridia magna, Coronifera oceanica, Ctenidodinium elegantulum, Dingodinium cerviculum, Endoscrinium campanulum, Gardodinium trabeculosum, Hystrichodinium voigtii, H. sp., *Kleithriasphaeridium eoinodes, Lithodinia stoveri, Muderongia tetracantha, Occisucysta* sp. A Bujak and Williams, 1978, *Phoberocysta* sp., *Trilobosporites jurassicus.*

12170-14582': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Cleistosphaeridium sp. Williams, 1978, *Cyclopsiella* sp., *Gonyaulacysta serrata, Hystrichosphaeridium recurvatum, Pseudoceratium* cf. *P. pelliferum.*

14670-15050': Kimmeridgian-Portlandian

Ctenidodinium culmulum, Endoscrinium luridum, Gonyaulacysta aculeata, G. ambigua, G. cladophora, Polystephanephorus sarjeantii, Senoniasphaera jurassica, Systematophora cf. *S. areolata, Verrucosisporites* sp.

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Mobil-Tetco
COHASSET D-42

GSC locality: D96

Location: 43°51'06.52"N; 60°37'13.89"W

RT elevation: 103' Water depth: 135'

Casing set at: 406, 754, 3528, 10150, and 12024'

Total depth: 14525' Interval studied: 810-14525'

Analyzed by: J.P. Bujak

Palynological analysis of 140 cuttings samples indicates the following age determinations and biostratigraphic zonation:

810- 840'	age indeterminate
1080- 1200'	*D. heterophlycta* Zone (early Oligocene)
1260- 1470'	*D. colligerum* Zone (late Eocene)
1530- 1650'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
1710- 3360'	*D. euclaensis* Zone (Maastrichtian)
3420- 3540'	Santonian-Campanian
3600- 3630'	*O. pulcherrimum* Zone (Coniacian)
3690- 4020'	*S. longifurcatum* Zone (Turonian)
4080- 4890'	*C. polypes* Zone (Cenomanian)
4950- 6500'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
6580- 7300'	*S. perlucida-S. schindewolfii* Zone (Aptian)
7380- 8000'	*D. anaphrissa* Zone (Barremian)
8070- 8300'	*C. elegantulum* Zone (Hauterivian)
8370- 9400'	*P. neocomica* Zone (Berriasian-Valanginian)
9470- 9920'	*C. panneum* Zone (Portlandian)
9970-11300'	*G. cladophora* Zone (Kimmeridgian)
11370-12600'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
12670-13700'	*V. vermiculata* Zone (Callovian)
13770-14525'	*G. filapicata* Zone (Bathonian)

A Middle Jurassic succession from 14 525 to 12 670ft containing marine palynomorphs is overlain by an Upper Jurassic succession from 12 600 to 9470ft. Dinoflagellates are common in the Oxfordian and Kimmeridgian, but are rare in Portlandian strata which were probably deposited in non-marine or marginally marine environments. Overlying Lower Cretaceous strata contain increasingly more diverse dinoflagellate assemblages in younger strata indicating increasing marine influence, and are succeeded by a marine Upper Cretaceous succession from 4890 to 1710ft.

Upper Eocene and lower Oligocene strata from 1470 to 1080ft contain diverse dinoflagellate assemblages indicating neritic depositional environments. The highest sample examined, from 840 to 810ft, could not be dated as no *in situ* palynomorphs occur.

Reworked Early Cretaceous species are common in Upper Cretaceous strata and reworked Barremian or older Cretaceous species occur in the Albian.

Selected palynomorphs

810-840': age indeterminate

The reworked Cretaceous species *Exochosphaeridium bifidum* is present in this interval.

1080-1200': *Deflandrea heterophlycta* Zone (early Oligocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Chiropteridium aspinatum, C. dispersum, Cordosphaeridium cantharellum, C. funiculatum, Deflandrea heterophlycta, D. phosphoritica, Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Eocladopyxis peniculatum, Gonyaulacysta giuseppei, Hemicystodinium zoharyi, Hystrichokolpoma rigaudiae, Palaeocystodinium golzowense, Pentadinium laticinctum, P. laticinctum* subsp. *granulatum, Polysphaeridium pastielsii, P. simplex, Systematophora placacantha, Thalassiphora pelagica, Wetzeliella lunaris, W.* sp. A Williams and Bujak, 1977b.

1260-1470': *Diphyes colligerum* Zone (late Eocene)

Achilleodinium biformoides, Areosphaeridium arcuatum, A. multicornutum, Cordosphaeridium gracile, C. inodes, Cyclonephelium exuberans subsp. *ellipsoidalis, Cyclopsiella elliptica, Heteraulacacysta leptalea, Homotryblium tenuispinosum, Kisselovia coleothrypta, Phthanoperidinium comatum.*

1530-1650': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Areoligera senonensis, Ceratiopsis diebelii, Cyclonephelium ordinatum, Hystrichosphaeridium tubiferum, Lejeunia sp. III Drugg, 1967, *Palaeocystodinium australinum, Palaeoperidinium pyrophorum, Rugubivesiculites reductus, Spinidinium densispinatum, Trithyrodinium evittii.*

1710-3360': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia cf. *A. minor, Cyclonephelium distinctum, Dinogymnium digitus, D. euclaensis, D. undulosum, Hystrichodinium pulchrum, Isabelidinium belfastense, I. cooksoniae, Membranilarnacia* sp. Wilson, 1971, *Spongodinium delitiense, Tanyosphaeridium variecalamum, Triblastula utinensis.*

Also present in this interval are reworked specimens of the species *Biretisporites potoniae, Cicatricosisporites brevilaesuratus, Foveotriletes subtriangularis, Ischyosporites punctatus, Lycopodiumsporites crassimacerius, Lycopodiumsporites reticulumsporites,* and *Muderongia simplex.*

3420-3540': Santonian-Campanian

Chatangiella victoriensis, Diconodinium arcticum, Gleicheniidites senonicus, Odontochitina operculata, Palaeohystrichophora infusorioides, Trichodinium castaneum.

Also present in this interval is a reworked specimen of the Early Cretaceous species *Trilobosporites marylandensis.*

3600-3630': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Acanthotriletes varispinosus, Cicatricosisporites australiensis, Cyathidites australis, Deltoidospora hallei, Surculosphaeridium longifurcatum.

3690-4020': *Surculosphaeridium longifurcatum* Zone (Turonian)

Chlamydophorella nyei, Coronifera oceanica, Cyclonephelium distinctum subsp. *brevispinatum, C. vannophorum, Deltoidospora diaphana, Rouseisporites reticulatus, Surculosphaeridium longifurcatum* (common), *Xenascus ceratioides.*

Also present in this interval are reworked specimens of the Early Cretaceous species *Aequitriradites spinulosus.*

4080-4890': *Cleistosphaeridium polypes* Zone (Cenomanian)

Callialasporites dampieri, Cicatricosisporites annulatus, C. hughesi, Costatoperforosporites foveolatus, Cleistosphaeridium polypes, Cribroperidinium edwardsii, C. orthoceras, Cyclonephelium eisenackii, C. vannophorum (common), *Dinopterygium cladoides, Epelidosphaeridia spinosa, Foveotriletes subtriangularis, Hystrichosphaeridium cooksoniae, Oligosphaeridium anthophorum, O. pulcherrimum, O. totum, Palaeoperidinium cretaceum, Perinopollenites elatoides, Protoellipsodinium spinosum, Schizosporis reticulatus, Spinidinium vestitum, Subtilisphaera pirnaensis.*

Also present within this interval are reworked specimens of *Appendicisporites* spp., *Trilobosporites* spp., and *Muderongia simplex.*

4950-6500': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Aptea polymorpha, Apteodinium granulatum, Concavissimisporites punctatus, Converrucosisporites exquisitus, Cyclonephelium paucispinum, Eucommiidites minor, E. troedssonii, Gonyaulacysta episoma, Liliacidites reticulatus, Lycopodiumsporites expansus, Ovoidinium scabrosum, Pareodinia ceratophora, Rouseisporites triangularis, Spinidinium cf. *S. vestitum, sensu* Williams, 1975, *Trilobosporites* spp., *Vitreisporites pallidus, Xiphophoridium alatum.*

Also present within this interval are reworked specimens of the species *Muderongia simplex.*

6580-7300': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea attadalica, Classopollis classoides, Oligosphaeridium asterigerum, Pilosisporites notensis, P. trichopapillosus, Pseudoceratium expolitum, P. pelliferum, Subtilisphaera pirnaensis (common), *Taurocusporites segmentatus.*

7380-8000': *Doidyx anaphrissa* Zone (Barremian)

Cicatricosisporites brevilaesuratus, Cribroperidinium sepimentum, Doidyx anaphrissa, Eopseudoceratium gochtii, Kraeuselisporites linearis, Lithodinia stoveri, Muderongia perforata, M. simplex (common), *Polystephanephorus sarjeantii.*

8070-8300': *Ctenidodinium elegantulum* Zone (Hauterivian)

Callialasporites trilobatus (common), *Contignisporites cooksonii, Systematophora complicata.*

8370-9400': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Aequitriradites spinulosus, Appendicisporites problematicus, Batioladinium jaegeri, Dingodinium cerviculum, Phoberocysta neocomica, Trilobosporites bernissartensis.

9470-9920': *Ctenidodinium panneum* Zone (Portlandian)

Converrucosisporites variverrucatus, Dictyophyllidites equiexinus, Leptolepidites psarosus, Tenua sp.

At 9470ft there is a marked increase in spores of the genera *Converrucosisporites* and *Verrucosisporites*.

9970-11300': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Ctenidodinium culmulum, C. schizoblatum, Dictyophyllidites harrisii, Epiplosphaera areolata, E. bireticulata, E. reticulospinosa, Gonyaulacysta granulata, G. granuligera, G. sp. F Gitmez and Sarjeant, 1972, *Lanterna pattei, Pareodinia dasyforma, Systematophora areolata, Taeniophora iunctispina, Trilobosporites jurassica.*

11370-12600': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Gonyaulacysta cf. *G. angulosa, Leptodinium* cf. *L. arcuatum, L. egemenii, L.* cf. *L. regale, L. subtile, Occisucysta* sp., *Scriniodinium crystallinum, Systemaphora fasciculigera, S. orbifera.*

12670-13700': *Valensiella vermiculata* Zone (Callovian)

Ellipsoidictyum cinctum, Gen. et sp. 1 Gocht, 1970, *Gonyaulacysta aldorfensis, Valensiella vermiculata.*

13770-14525': *Gonyaulacysta filapicata* Zone (Bathonian)

Concavissimisporites southeyensis, Ctenidodinium pachydermum, Gen. et sp. 2 Gocht, 1970, *Gonyaulacysta filapicata, Valensiella ovula.*

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Shell
CREE E-35

GSC locality: D6

Location: 43°44'20.70"N; 60°35'55.89"W

RT elevation: 103' Water depth: 175'

Casing set at: 936, 2916, and 6438'

Total depth: 13070' Interval studied: 1431-13070'

Analyzed by: G.L. Williams

Palynological analysis of 101 cuttings samples and 56 sidewall core samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

1431- 1709' *C. dispersum* Zone (middle-late Oligocene)
1771- 1898' *D. heterophlycta* Zone (early Oligocene)
1980- 2000' Eocene
2007' *C. speciosa* Zone (late Paleocene)
2118- 2250' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
2272- 3800' *D. euclaensis* Zone (Maastrichtian)
3960- 4110' *O. operculata* Zone (Campanian)
4180- 4220' *C. truncigerum* Zone (Santonian)
4270- 4300' *O. pulcherrimum* Zone (Coniacian)
4360- 4400' *S. longifurcatum* Zone (Turonian)
4570- 5300' *C. polypes* Zone (Cenomanian)
4700- 5300' early Cenomanian
5360- 7470' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
5360- 6327' *R. rugosus* Subzone (late Albian)
6370- 7470' early Albian
7530- 8480' *S. perlucida-S. schindewolfii* Zone (Aptian)
8550- 9435' *D. anaphrissa* Zone (Barremian)
9480- 9980' *C. elegantulum* Zone (Hauterivian)
10050-12380' *P. neocomica* Zone (Berriasian-Valanginian)
10050-10780' (assemblage 3)
10874-11980' (assemblage 2)
12050-12380' (assemblage 1)
12450-13070' *C. panneum* Zone (Portlandian)

There appears to be a more or less unbroken depositional record in Shell Cree E-35 from the Portlandian to the Paleocene. The Eocene is represented by a very condensed sequence which is overlain by almost 500ft of lower Oligocene sediments. The Lower Cretaceous is approximately 7000ft thick and is overlain by over 3000ft of Upper Cretaceous sediments. The thickness of the Lower Cretaceous, together with the abundance of dinocysts, permits more refined zonation of this part of the section.

The depositional environment has been generally stable. The relative abundance of dinocysts in the Portlandian-Cenomanian is taken to denote deposition in an inner neritic environment, with occasional outer neritic episodes. There is considerable reworking of Kimmeridgian-Portlandian species of dinoflagellates into the Berriasian-Valanginian, Aptian species into the Albian, and Albian species into the Cenomanian. The paucity of dinocysts in the Turonian-Campanian may indicate deeper water conditions. In the early Maastrichtian the abundance of peridiniacean cysts suggests shallower water, possibly inner neritic, conditions prevailed in the vicinity of Cree E-35 during this time. The late Maastrichtian-Eocene represents deeper water conditions, with the return of shallow water deposition in the Oligocene.

Selected palynomorphs

1431-1709': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Chiropteridium dispersum, Cyclopsiella vieta, Deflandrea phosphoritica, D. spinulosa, Homotryblium plectilum, Impletosphaeridium transfodum, Pentadinium laticinctum, P. laticinctum granulatum.*

1771-1898': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium aspinatum, Cordosphaeridium cantharellum C. funiculatum, Deflandrea heterophlycta, Eocladopyxis peniculatum, Heteraulacacysta campanula, Leptodinium incompositum, Palaeocystodinium cf. *P. golzowense, Phthanoperidinium amoenum, Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Thalassiphora pelagica, Wetzeliella* sp. A Williams and Bujak, 1977b.

1980-2000': Eocene

Areoligera medusettiformis, A. senonensis, Gonyaulacysta giuseppei.

2007': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis speciosa.

2118-2250': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Cordosphaeridium fibrospinosum, Danea mutabilis, Fibradinium sp., *Hystrichosphaeridium tubiferum, Palaeoperidinium pyrophorum, Turbiosphaera filosa.*

2272-3800': *Dinogymnium euclaensis* Zone (Maastrichtian)

Chlamydophorella sp., *Dinogymnium acuminatum, D. digitus, D. euclaensis, Exochosphaeridium bifidum, Gonyaulacysta wetzelii, Horologinella* sp., *Isabelidinium belfastense, I. cooksoniae, I. korojonense, Lejeunia magnifica, Microdinium irregulare, Palaeostomocystis fragilis, Rugubivesiculites rugosus, Spiniferites scabrosus.*

3960-4110': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, Exochosphaeridium striolatum, Oligosphaeridium complex.

4180-4220': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis.

4270-4300': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Camarozonosporites insignis, Cyclonephelium vannophorum, Fromea amphora, Hystrichosphaeropsis ovum, Oligosphaeridium pulcherrimum, Spiniferites cingulatus, Triblastula utinensis.

4360-4400': *Surculosphaeridium longifurcatum* Zone (Turonian)

Canningia reticulata, Odontochitina costata, Subtilisphaera pirnaensis, Surculosphaeridium longifurcatum.

4570-5300': *Cleistosphaeridium polypes* Zone (Cenomanian)

Chlamydophorella nyei, Cleistosphaeridium huguoniotii, C. polypes, C. polypes subsp. A Williams, 1975, *Kleithriasphaeridium loffrense.*

4700-5300': early Cenomanian

Appendicisporites jansonii, A. unicus (one specimen), *Callaiosphaeridium asymmetricum, Cicatricosisporites augustus* (one specimen), *C. hallei* (one specimen), *C. hughesi* (one specimen), *Classopollis classoides, Concavissimisporites variverrucatus, Cribroperidinium intricatum, C. orthoceras, Cyclonephelium vannophorum* (common), *Dinopterygium cladoides, Epelidosphaeridia spinosa, Eucommiidites minor* (4888ft), *Hystrichosphaeridium bowerbankii, H. cooksoniae, Liliacidites dividuus, L. peroreticulatus, Oligosphaeridium anthophorum, O. totum, Palaeoperidinium cretaceum, Retitricolpites maximus, R. virgeus, Rouseisporites reticulatus, Subtilisphaera pontis-mariae, Tricolpites micromunus, Vitreisporites pallidus,* (4888ft), *Xenascus ceratioides.*

5360-7470': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

5360-6327': *Rugubivesiculites rugosus* Subzone (late Albian)

Cicatricosisporites annulatus, Osmundacidites wellmanii, Retitricolpites maximus (base), *Rugubivesiculites rugosus* (base), *Tricolpites micromunus* (base), *T. parvus* (restricted to this zone), *Trilobosporites apiverrucatus, Vitreisporites* sp. Singh, 1971.

Isolated specimens of *Callialasporites dampieri* and *Densoisporites perinatus* occur in this interval and are presumed to be reworked.

6370-7470': early Albian

Alisporites grandis, Appendicisporites problematicus, Aptea polymorpha, Canningia colliveri, Hystrichosphaeridium cf. *H. cooksoniae, Liliacidites crassatus, Senoniasphaera microreticulata, Surculosphaeridium* cf. *S. longifurcatum, sensu* Williams, 1975, *Trilobosporites purverulentus.*

In this interval occur isolated specimens of *Cerebropollenites mesozoicus* (7047ft), *Cicatricosisporites subrotundus* (6690-6740ft), *Aptea attadalica* (7170-7220ft), *Doidyx anaphrissa* (7470ft), *Exesipollenites tumulus* (7256ft), *Klukisporites foveolatus* (7170-7220ft), and *Pilosisporites trichopapillosus* (6785ft). These are assumed to be reworked from the Neocomian or Aptian.

7530-8480': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bifurcatus, Aptea attadalica, Callialasporites dampieri, Cerebropollenites mesozoicus, Classopollis classoides (common), *Contignisporites fornicatus, Coronifera oceanica, Cribroperidinium sepimentum, Doidyx anaphrissa, Florentinia laciniata, Kleithriasphaeridium eoinodes, Oligosphaeridium asterigerum, Pilosisporites trichopapillosus, Prolixosphaeridium granulosum, Schizosporis reticulatus, Subtilisphaera perlucida, S. pirnaensis, sensu* Millioud, 1969, *Tenua* sp.

8550-9435': *Doidyx anaphrissa* Zone (Barremian)

Aequitriradites spinulosus, Cicatricosisporites australiensis, Coronatispora valdensis, Equisetosporites sp., *Hystrichosphaeridium recurvatum, Muderongia perforata, Pseudoceratium pelliferum, ?Spiniferites dentatus.*

In this interval occur isolated specimens of *Gonyaulacysta granulata* which are presumed to be reworked.

9480-9980': *Ctenidodinium elegantulum* Zone (Hauterivian)

Ctenidodinium elegantulum, Dingodinium cerviculum, Oligosphaeridium perforatum, Spiniferites sp., *Systematophora schindewolfii, Tenua hystrix.*

10050-12380': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

10050-10780': (assemblage 3)

Achomosphaera neptuni, Cicatricosisporites purbeckensis, Gonyaulacysta serrata, Occisucysta sp. A Bujak and Williams, 1978.

In this interval occur isolated specimens of *Densoisporites perinatus, Polycingulatisporites radiatus,* and *Tenua* sp. These specimens may be reworked.

10874-11980': (assemblage 2)

Batioladinium exigua, Biorbifera sp., *Ctenidodinium* sp., *Leptodinium* sp. (11 450ft), *Pareodinia ceratophora* (with kalyptra), *P. kondratjevi, Phoberocysta* sp.

In this interval occur isolated specimens of *Ctenidodinium culmulum* and *Gonyaulacysta granulata.* They are presumed to be reworked.

12050-12380': (assemblage 1)

Callialasporites dampieri (common), *Cyclopsiella* sp., *Hystrichodinium pulchrum* (common), *Litosphaeridium siphoniphorum, sensu* Warren, 1967, *Phoberocysta neocomica.*

12450-13070': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites obrutus, Contignisporites cooksonii, Ctenidodinium culmulum, C. panneum, Klukisporites pseudoreticulatus, Plicatella abaca, Systematophora cf. *S. areolata.*

In the interval 12 850-12 980ft occur single specimens of *Gonyaulacysta granulata, G. longicornis,* and *G. perforans.* These are presumed to be reworked.

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Mobil-Tetco
DAUNTLESS D-35

GSC locality: D27

Location: 44°44'08.26"N; 57°20'46.62"W

RT elevation: 103' Water depth: 227'

Casing set at: 350, 794, 3227, and 8407'

Total depth: 15555' Interval studied: 1030-15495'

Analyzed by: G.L. Williams

Palynological analysis of 76 cuttings samples, 71 sidewall cores, and four conventional cores from the subject well has indicated the following age determinations and biostratigraphic zonation:

1030- 1390' *Cannosphaeropsis* sp. A Zone (late Miocene)
1512- 1853' early-middle Miocene
2036- 2529' *C. dispersum* Zone (middle-late Oligocene)
2783- 3010' *D. heterophlycta* Zone (early Oligocene)
3160- 3190' Eocene
3340- 4192' *C. speciosa* Zone (late Paleocene)
4240- 4654' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
4826- 4964' *D. euclaensis* Zone (Maastrichtian)
5142- 5890' *O. operculata* Zone (Campanian)
6040- 6386' *C. truncigerum* Zone (Santonian)
6486- 6580' Turonian-Coniacian
6752- 7322' *C. polypes* Zone (Cenomanian)
7467- 8900' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
7467- 7765' *R. rugosus* Subzone (late Albian)
7784- 8900' early Albian
9030- 9834' *S. perlucida-S. schindewolfii* Zone (Aptian)
9900-10740' *D. anaphrissa* Zone (Barremian)
10900-11740' *C. elegantulum* Zone (Hauterivian)
11890-13870' *P. neocomica* Zone (Berriasian-Valanginian)
13870-15390' Kimmeridgian-Portlandian
15495' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)

Dauntless D-35 encountered approximately 2500ft of Upper Jurassic, 6403ft of Lower Cretaceous, 2456ft of Upper Cretaceous and over 3500ft of Tertiary sediments. In the Upper Jurassic and Lower Cretaceous, dinocysts are present throughout, apart from at 9060, 9050 and 8370ft, but never in any abundance. Spores and bivesiculate pollen fluctuate in numbers from few to hundreds per sample. The Upper Jurassic sediments were presumably deposited in a neritic, frequently near shore, environment. Sidewall core control between 12 000 and 10 000ft is so poor that meaningful interpretations of the paleoenvironment cannot be made. However, the samples at 11 010, 10 992 and 10 940ft show an increase in dinocyst taxa and a corresponding decrease in spores and bivesiculate pollen. From 10 900 to 7467ft the only dinocysts in several of the samples are species of *Subtilisphaera*, suggesting inner neritic, possibly near shore, deposition.

Cenomanian-Coniacian sediments are dominated by spores and bivesiculates except in the samples from 7254 and 7322ft. Deposition in the Santonian-Maastrichtian, with dinocysts being abundant at 6386, 5142, 4964, 4910 and 4826ft, appears to have been in an open marine environment. The very low dinocyst counts in the cuttings samples from 6280 to 5500ft may reflect very deep water deposition.

The Paleocene assemblages are dominated by angiosperm pollen, with the common occurrence of *Ceratiopsis* species possibly denoting shallow water near shore environments. Pollen and dinocysts which are generally abundant throughout the Paleogene, show a marked decrease in the Miocene, where paucity of data precludes environmental interpretation.

Selected palynomorphs

1030-1390': *Cannosphaeropsis* sp. A Zone (late Miocene)

Hemicystodinium sp. Williams, 1975, *Micrhystridium* sp., *Spiniferites pseudofurcatus.*

1512-1853': early-middle Miocene

Homotryblium cf. *H. plectilum, Hystrichosphaeridium choanophorum, Lejeunia fallax, Palaeocystodinium golzowense, Vozzhennikovia tenella.*

2036-2529': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Alnipollenites verus, Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Caryapollenites simplex, Chiropteridium aspinatum, C. dispersum, Cordosphaeridium cantharellum, Corylus tripollenites, Deflandrea phosphoritica, D. spinulosa, Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Engelhardtioipollenites* sp. A Williams and Brideaux, 1975, *Impletosphaeridium transfodum, Palaeocystodinium* cf. *P. golzowense, Pentadinium laticinctum granulatum, Polysphaeridium pastielsii, Retitricolpites* sp. M, *Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Thalassiphora pelagica,* Triporate type M Williams and Brideaux 1975, *Wetzeliella* sp. A Williams and Bujak, 1977b.

2783-3010': *Deflandrea heterophlycta* Zone (early Oligocene)

Deflandrea sp. C Williams and Bujak, 1977b.

3160-3190': Eocene

Areoligera senonensis (common), *Ascostomocystis* sp., *Chlamydophorella* sp., *Cordosphaeridium gracile.*

3340-4192': *Ceratiopsis speciosa* Zone (late Paleocene)

Baltisphaeridium sp., *Ceratiopsis speciosa, Cyclonephelium ordinatum, Deflandrea denticulata, Extratriporopollenites* sp. C Williams and Brideaux, 1975, *Horologinella* sp., *Platycaryapollenites* sp., *Trigonopyxidia* sp.

At 3507ft there is a marked influx of angiosperm pollen. This persists throughout the Paleocene.

4240-4654': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Cannosphaeropsis utinensis, Ceratiopsis striata, Fibradinium annetorpense, Lejeunia magnifica, Membranosphaera sp., *Momipites tenuipolus, Palaeocystodinium australinum.*

4826-4964': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia acuminata, sensu Clarke and Verdier, 1967, *Ceratiopsis diebelii, C.* cf. *C. diebelii, Chatangiella tripartita, sensu* Vozzhennikova, 1967, *C. vnigri, Dinogymnium acuminatum, D. digitus, D. euclaensis, D. undulosum, Exochosphaeridium bifidum, Horologinella apiculata, Isabelidinium cretaceum, Palaeotetradinium* sp., *Trithyrodinium evittii.*

5142-5890': *Odontochitina operculata* Zone (Campanian)

Gardodinium deflandrei, Hystrichosphaeridium cf. *H. salpingophorum, Odontochitina costata, O. operculata, Trichodinium castaneum.*

6040-6386': *Cordosphaeridium truncigerum* Zone (Santonian)

Achomosphaera sagena, Canningia reticulata, Chatangiella victoriensis, Chlamydophorella discreta, Oligosphaeridium complex, Palaeohystrichophora infusorioides (common), *Xenascus ceratioides.*

6486-6580': Turonian-Coniacian

Classopollis classoides, Cleistosphaeridium huguoniotii, Surculosphaeridium longifurcatum.

Spores and bivesiculate pollen predominate in the sample from 6580ft.

6752-7322': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus, Cleistosphaeridium polypes subsp. A Williams, 1975, *Cribroperidinium orthoceras, Cyclonephelium vannophorum* (abundant at 7254ft), *Ephedripites* sp., *Florentinia radiculata, Gleicheniidites senonicus* (abundant), *Palaeoperidinium* sp. A Bujak and Williams, 1978, *Retitricolpites georgensis, R. virgeus, Vitreisporites pallidus.*

Down to 7180ft the bivesiculates and trilete spores, particularly the schizeaceous spores, predominate. Dinocysts become abundant at 7254 and 7322ft.

7467-8900': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

7467-7765': *Rugubivesiculites rugosus* Subzone (late Albian)

Appendicisporites jansonii, Coronifera oceanica, Eucommiidites minor (common at 7495ft), *Hystrichosphaeridium* sp. A Bujak and Williams, 1978, *Oligosphaeridium totum, Palaeoperidinium cretaceum, Retitricolpites virgeus* (base), *Trilobosporites apiverrucatus, Vitreisporites pallidus* (common).

7784-8900': early Albián

Aequitriradites spinulosus, Alisporites grandis, Liliacidites peroreticulatus, Lophotriletes babsae, Pseudoceratium expolitum, Surculosphaeridium cf. *S. longifurcatum.*

Dinocysts are rare in the Albian, the assemblages being dominated by spores and bivesiculate pollen.

9030-9834': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea attadalica, Callialasporites trilobatus, Canningia colliveri, Decussosporites sp., *Doidyx anaphrissa* (two specimens), *Pilosisporites trichopapillosus, Subtilisphaera perlucida.*

9900-10740': *Doidyx anaphrissa* Zone (Barremian)

Doidyx anaphrissa (common), *Kleithriasphaeridium eoinodes, Muderongia simplex.*

10900-11740': *Ctenidodinium elegantulum* Zone (Hauterivian)

Batioladinium sp. A Bujak and Williams, 1978, *Ctenidodinium elegantulum, Diacanthum hollisteri, Dingodinium cerviculum, Gonyaulacysta serrata, Kleithriasphaeridium fasciatum, Pareodinia ceratophora, P. kondratjevii, Pseudoceratium pelliferum, Systematophora schindewolfii.*

11890-13870': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Endoscrinium campanulum, Lithodinia stoveri (common), *Phoberocysta neocomica.*

The interval 12 646-13 700ft contains a mixed Kimmeridgian-Portlandian and Berriasian-Valanginian assemblage. Taxa present include *Appendicisporites* sp. (13 235ft), *Ctenidodinium* sp., *Gonyaulacysta ambigua* (one specimen at 12 670-12 700ft), *Lanterna sportula* (one specimen at 12 670-12 700ft), *Pareodinia ceratophora, Pilosisporites trichopapillosus, Plicatella abaca* (one specimen at 12 646ft), *Subtilisphaera perlucida* (13 235ft), *Systematophora fasciculigera* (one specimen at 13 070-13 100ft), and *S. schindewolfii.*

The interval is tentatively assigned to the Berriasian-Valanginian since the three Late Jurassic species are represented only by single specimens.

13870-15390': Kimmeridgian-Portlandian

Amphorula metaelliptica, Epiplosphaera reticulospinosa, Gonyaulacysta aculeata, Scriniodinium crystallinum, Senoniasphaera jurassica, Systematophora orbifera, Tenua roultii.

15495': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Acanthaulax sp., *Gonyaulacysta jurassica, Meiourogonyaulax* sp., *Systematophora orbifera* (common).

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Mobil-Tetco
ESPERANTO K-78

GSC locality: D13

Location: 44°47'31.26"N; 58°11'19.24"W

RT elevation: 103' Water depth: 225'

Casing set at: 348, 946, 2482, and 5365'

Total depth: 11615' Interval studied: 1010-11615'

Analyzed by: J.P. Bujak

Palynological analysis of 53 cuttings samples, 63 sidewall core samples and three conventional core

samples indicates the following age determinations and biostratigraphic zonation:

1010- 1500' *D. heterophlycta* Zone (early Oligocene)
1600' *D. colligerum* Zone (late Eocene)
?1600-?1710' *A. reticulense* Zone (middle Eocene)
1710- 1740' *A. senonensis* Zone (early Eocene)
1802- 2379' *C. speciosa* Zone (late Paleocene)
2400- 2910' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
3120- 3150' *D. euclaensis* Zone (Maastrichtian)
3170- 3360' *O. operculata* Zone (Campanian)
3380- 4060' *C. truncigerum* Zone (Santonian)
4220- 4362' *O. pulcherrimum* Zone (Coniacian)
4430- 4460' *S. longifurcatum* Zone (Turonian)
4620- 5033' *C. polypes* Zone (Cenomanian)
5120- 6160' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
5120- 5500' *R. rugosus* Subzone (late Albian)
5530- 6160' early Albian
6192- 6988' *S. perlucida-S. schindewolfii* Zone (Aptian)
7130- 7700' *D. anaphrissa* Zone (Barremian)
7730- 8720' *C. elegantulum* Zone (Hauterivian)
8730- 9083' *P. neocomica* Zone (Berriasian-Valanginian)
9130- 9360' *C. panneum* Zone (Portlandian)
9530-10316' *G. cladophora* Zone (Kimmeridgian)
10330-11360' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
11530-11615' *V. vermiculata* Zone (Callovian)

The oldest sediments in the well are Callovian from 11 615 to 11 530ft and are overlain by a more or less complete depositional sequence, which extends into the Oligocene.

Dinoflagellates are common in the Callovian to Kimmeridgian indicating marine deposition, but Portlandian strata mostly contain spores suggesting marginal marine or non-marine deposition with minor marine intercalations. The Berriasian to Cenomanian sequence contains increasingly more diverse dinoflagellate assemblages in the younger sediments reflecting increasing marine influence. Dinoflagellates also occur throughout the Upper Cretaceous and lower Tertiary with greatest diversity in the Santonian and middle Eocene to lower Oligocene.

Reworked Late Jurassic species occur in the Berriasian-Valanginian interval, and Late Cretaceous and Eocene reworked species occur in lower Oligocene strata.

Selected palynomorphs

1010-1500': *Deflandrea heterophlycta* Zone (early Oligocene)

Alnipollenites verus, Betulaepollenites sp., *Carpinipites* sp., *Caryapollenites simplex, Chiropteridium aspinatum, C. dispersum, C. lobospinosum, Cordosphaeridium cantharellum, C. funiculatum, Cyclonephelium textum, C.* sp. A Williams and Brideaux, 1975, *Deflandrea heterophlycta, D. phosphoritica, D. spinulosa, Distatodinium paradoxum, Engelhardtioipollenites* sp. A Williams and Brideaux, 1975, *Gonyaulacysta giuseppei, Homotryblium plectilum, H. tenuispinosum, Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Operculodinium centrocarpum, Palaeocystodinium golzowense, Pentadinium laticinctum, Polysphaeridium pastielsii, P. simplex, Samlandia chlamydophora, Spiniferites pseudofurcatus, S. ramosus, Systematophora placacantha, Tectatodinium pellitum, Wetzeliella lunaris, W.* sp. A Williams and Bujak, 1977b.

Also present in this interval are reworked specimens of *Apectodinium homomorphum* and *Spinidinium sverdrupianum.*

1600': *Diphyes colligerum* Zone (late Eocene)

Achomosphaera ramulifera, Cordosphaeridium gracile, Kisselovia tenuivirgula subsp. *crassiramosa, Lanternosphaeridium axiale, Leptodinium incompositum, Thalassiphora pelagica, Trigonopyxidia* sp., *Wetzeliella ovalis.*

?1600-?1710': *Adnatosphaeridium reticulense* Zone (middle Eocene)

The occurrence of the following species at 1710-1740ft indicates that they are caved from middle Eocene sediments that are present within the interval ?1600-?1710ft.

Adnatosphaeridium reticulense, Cyclonephelium intricatum, Dinopterygium cladoides, sensu Morgenroth, 1966a, *Eocladopyxis peniculatum, Hystrichokolpoma eisenackii, Phthanoperidinium comatum.*

1710-1740': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (abundant), *Areoligera medusettiformis, Cordosphaeridium fibrospinosum, C. inodes, Cyclonephelium ordinatum, Deflandrea* cf. *D. cygniformis, Lanternosphaeridium lanosum, Epicophalopyxis indentata.*

1802-2379': *Ceratiopsis speciosa* Zone (late Paleocene)

Achomosphaera alcicornu, Alterbia microgranulata, Areoligera medusettiformis (abundant), *A.* cf. *A. senonensis, Ceratiopsis* cf. *C. speciosa, Extratriporopollenites* sp., *Trithyrodinium evittii* (common at 1802ft), *Turbiosphaera filosa, Wetzeliella pilata.*

The occurrence of *T. evittii* at 1802ft indicates that the upper part of the *Ceratiopsis speciosa* Zone is absent.

2400-2910': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Hystrichosphaeridium tubiferum, Palaeoperidinium pyrophorum, Rugubivesiculites reductus.

3120-3150': *Dinogymnium euclaensis* Zone (Maastrichtian)

Ceratiopsis diebelii, Deflandrea delineata, Isabelidinium bakeri, I. belfastense, I. cretaceum, Palaeocystodinium australinum.

3170-3360': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, Cyclonephelium distinctum, Isabelidinium cooksoniae, Membranilarnacia sp. Wilson, 1971, *Odontochitina operculata, Spiniferites ramosus* (large form), *Trichodinium castaneum.*

3380-4060': *Cordosphaeridium truncigerum* Zone (Santonian)

Alterbia acuminata, Chatangiella victoriensis, Dinogymnium acuminatum, D. euclaensis, D. heterocostatum, Dinopterygium cladoides, Exochosphaeridium bifidum, E. striolatum, Hystrichodinium pulchrum, Kleithriasphaeridium cf. *K. readei, Palynodinium grallator, Silicisphaera ferox, Spinidinium sverdrupianum, Spiniferites cingulatus, Stephodinium coronatum, Surculosphaeridium longifurcatum* (single specimen), *Xenascus ceratioides, Xiphophoridium alatum.*

4220-4362': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Chlamydophorella nyei, Florentinia mantellii, Kleithriasphaeridium readei, Odontochitina costata, Palaeohystrichophora infusorioides, Prolixosphaeridium xanthiopyxides.

4430-4460': *Surculosphaeridium longifurcatum* Zone (Turonian)

Endoscrinium campanulum.

4620-5033': *Cleistosphaeridium polypes* Zone (Cenomanian)

Biretisporites potoniae, Cicatricosisporites hughesi, Cleistosphaeridium polypes, Cribroperidinium orthoceras, Cyclonephelium vannophorum, Eucommiidites minor, Ischyosporites disjunctus, Klukisporites foveolatus, Liliacidites dividuus, L. peroreticulatus, L. reticulatus, Oligosphaeridium pulcherrimum, O. totum, Vitreisporites pallidus.

5120-6160': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

5120-5500': *Rugubivesiculites rugosus* Subzone (late Albian)

Appendicisporites jansonii, A. problematicus, Apteodinium granulatum, Cicatricosisporites annulatus, Costatoperforosporites foveolatus, Gonyaulacysta episoma, Hystrichosphaeridium cooksoniae, Retitricolpites georgensis, Rouseisporites reticulatus, Spinidinium cf. *S. vestitum, sensu* Williams, 1975, *Tricolpites parvus* (base), *Trilobosporites tribotrys, Vitreisporites* sp. Singh, 1971.

5530-6160': early Albian

Cyclonephelium eisenackii, Kalyptea sp., *Palaeostomocystis fragilis, Trilobosporites apiverrucatus.*

6192-6988': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aequitriradites spinulosus (rare), *Appendicisporites unicus, Callialasporites dampieri, Cicatricosisporites australiensis* (rare), *Classopollis classoides* (rare), *Doidyx anaphrissa, Klukisporites areolatus, Oligosphaeridium asterigerum, Schizosporis reticulatus, Subtilisphaera pirnaensis, Systematophora schindewolfii, Trilobosporites purverulentus.*

7130-7700': *Doidyx anaphrissa* Zone (Barremian)

Aptea attadalica (common), *Contignisporites multimuratus, Densoisporites velatus, Muderongia simplex, Pilosisporites trichopapillosus, Pseudoceratium pelliferum.*

7730-8720': *Ctenidodinium elegantulum* Zone (Hauterivian)

Acanthaulax sp., *Classopollis classoides* (common), *Contignisporites cooksonii, Ctenidodinium elegantulum, Dingodinium cerviculum, Gonyaulacysta serrata, Matonisporites phlebopteroides, Muderongia tetracantha, Pseudoceratium expolitum, P. nudum, Systematophora complicata.*

8730-9083': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Occisucysta sp., *Phoberocysta neocomica.*

Also present within this interval are reworked specimens of *Systematophora orbifera.*

9130-9360': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites trilobatus, Ctenidodinium culmulum, C. panneum, Leptolepidites psarosus, Pilosisporites sp. A Bujak and Williams, 1977, *Pyxidiella* sp. Williams, 1975, *Rubinella major, Trilobosporites bernissartensis.*

At 9258ft there is an abundance of verrucate spores.

9530-10316': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Epiplosphaera areolata, E. reticulospinosa, Gonyaulacysta cladophora, G. granulata, G. granuligera, Pareodinia kondratjevii, Senoniasphaera jurassica, Systematophora fasciculigera, S. orbifera, S. turonica, Taeniophora iunctispina.

10330-11360': *Gonyaulacysta jurassica* Zone (Oxfordian-lower Kimmeridgian)

Adnatosphaeridium caulleryi, Antulisporites varigranulatus, Hystrichodinium cf. *H. pulchrum, Lanterna pattei, Leptodinium egemenii, Scriniodinium crystallinum, Tubotuberella apatela.*

11530-11615': *Valensiella vermiculata* Zone (Callovian)

Hystrichogonyaulax nealei, Meiourogonyaulax sp. Williams, 1975, *Tenua* sp.

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Shell
EURYDICE P-36

GSC locality: D34

Location: 45°25'47.30"N; 60°04'46.97"W

RT elevation: 98' Water depth: 540'

Casing set at: 1251, 2716, and 5308'

Total depth: 9728' Interval studied: 1340-9728'

Analyzed by: J.P. Bujak

Palynological analysis of 44 cuttings samples, 43 sidewall core samples and 8 conventional core samples indicates the following age determinations and biostratigraphic zonation:

1340- 1700'	Barremian-Neocomian
1765- 2575'	*E.* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)
2640- 8814'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)
8920- 9700'	*C. meyeriana* Zone (Rhaetian-early Hettangian)
9700- 9728'	barren

Between 9700 and 1765ft there is a succession of Lower Jurassic and possibly Rhaetian sediments. Rich palynofloral assemblages permit the subdivision of the succession into palynomorph zones which have been dated relative to northwest European, Grand Banks, and Hartford Basin assemblages. Marine palynomorphs are absent from this succession, indicating non-marine deposition.

Jansa and Wade (1975) defined the Eurydice Formation in the Eurydice P-36 well from 9728 to 7850ft. Palynological dating indicates this section is Rhaetian to Lower Lias (probably Hettangian).

The Liassic sediments are unconformably overlain by a Lower Cretaceous, probably Barremian and/or Neocomian succession between 1700 and 1340ft. Assemblages from these sediments mostly comprise non-marine palynomorphs, but the occasional presence of Lower Cretaceous dinoflagellates suggests either marginal marine conditions or predominantly non-marine conditions with minor marine intercalations.

Selected palynomorphs

1340-1700': Barremian-Neocomian

Aptea attadalica, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, C. hallei, C. hughesi, Classopollis classoides, Cyathidites minor, Eucommiidites troedssonii, Gleicheniidites senonicus, Trilobosporites apiverrucatus, Vitreisporites pallidus.

1765-2575': *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Alisporites sp., *Araucariacites punctatus, Convolutispora klukiforma, Classopollis classoides* (abundant), *C. itunensis* (abundant), *C. meyeriana, Cycadopites deterius, C.* cf. *C. jansonii, C. nitidus, Echinitosporites* cf. *E. iliacoides, sensu* Bujak and Williams, 1977, *E.* sp. A Bujak and Williams, 1977, *Kraeuselisporites reissingeri.*

2640-8814': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Convolutispora sp., *Cycadopites subgranulosus, ?C.* sp. A Bujak and Williams, 1977, *?C.* sp. B Bujak and Williams, 1977, *Deltoidospora* sp., *Neoraistrickia* cf. *N. elongata, Verrucosisporites* cf. *V. cheneyi.*

8920-9700': *Classopollis meyeriana* Zone (Rhaetian-early Hettangian)

Classopollis meyeriana (abundant), *Converrucosisporites cameronii.*

9700-9728': barren

Conventional core samples examined from this interval are devoid of palynomorphs.

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Shell
FOX I-22

GSC locality: D23

Location: 45°21'33.6"N, 59°33'16"W

RT elevation: 103' Water depth: 275'

Casing set at: 791 and 1807'

Total depth: 2722' Interval studied: 830-2570'

Analyzed by: G.L. Williams

The palynological analysis of 30 sidewall cores and 10 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

830- 950'	*C. polypes* Zone (Cenomanian)
980- 1790'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
1808- 2150'	*S. perlucida-S. schindewolfii* Zone (Aptian)
2150- 2180'	Neocomian
2300- 2385'	Late Jurassic
2403- 2570'	age indeterminate
2570'	"basement"

The sediments encountered in the interval 2570-830ft in Shell Fox I-22 are predominantly terrestrial or non-marine deposits. There is a weak brackish water or very shallow marine pulse evident from the sidewall core at 1808ft. This is the only sidewall core from which dinocysts have been recovered. The dominance of *Classopollis* in the interval 2385-2300ft indicates that the climate existing at that time was relatively dry.

Selected palynomorphs

830-950': *Cleistosphaeridium polypes* Zone (Cenomanian)

Classopollis classoides.

980-1790': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites problematicus, Deltoidospora juncta, Eucommiidites minor, Liliacidites peroreticulatus, Taxodiaceaepollenites hiatus, Vitreisporites pallidus.

1808-2150': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Cyclonephelium vannophorum, Decussosporites microreticulatus, Doidyx anaphrissa, Ephedripites, Muderongia sp., *Pilosisporites trichopapillosus, Reticulisporites vermiformis, Subtilisphaera pirnaensis, sensu* Millioud, 1969.

2150-2180': Neocomian

Cicatricosisporites brevilaesuratus, C. cf. *C. venustus.*

2300-2385': Late Jurassic

Classopollis classoides (90% of the assemblage), *Foraminisporis wonthaggiensis, Perinopollenites elatoides, Pilosisporites* sp.

2403-2570': age indeterminate

2570': "basement"

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Union *et al.*
HERCULES G-15

GSC locality: D130

Location: 45°34'20.65"N; 58°46'13.06"W

RT elevation: 98' Water depth: 400'

Casing set at: 1055 and 2678'

Total depth: 3547' Interval studied: 1160-3460'

Analyzed by: G.L. Williams

Palynological analysis of 25 cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

1160- 1280'	*S. perlucida-S. schindewolfii* Zone (Aptian)
1340- 1820'	*D. anaphrissa* Zone (Barremian)
1970- 2000'	*C. elegantulum* Zone (Hauterivian)
2060- 2480'	Berriasian-Hauterivian
2550- 2680'	Portlandian
2750- 2860'	*G. cladophora* Zone (Kimmeridgian)
2950- 2980'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
3050- 3180'	undated, age diagnostic palynomorphs absent

3250- 3280' Middle Jurassic (Bajocian-Bathonian)
3350- 3460' *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

According to the well history report (Union Oil, February, 1975) the interval 2986-2633ft represents the Iroquois Formation with the Mohawk, Abenaki and Mic Mac Formations being absent. The Iroquois Formation has been dated palynologically as Sinemurian-Pliensbachian in both Shell Iroquois J-17 and Shell Eurydice P-36. Since coeval sediments are recognised in Hercules G-15 only between 3460 and 3350ft it is preferable to exclude the sediments above 3350ft in the Iroquois Formation. The hypothesis that the Abenaki Formation is absent in this well would also appear to be incorrect.

Paleoenvironmental interpretations are only tentative since sidewall cores were not taken in Hercules G-15. The interval 3460-3350ft does not contain any dinocysts or acritarchs and is either non-marine or very shallow marine. Strata from 3280 to 3250ft contain acritarchs and are interpreted as more open marine. The presence of several dinocysts in the Oxfordian-Kimmeridgian indicates an open marine or neritic environment. The interval from 2680 to 2060ft is non-marine. There is a weak marine pulse from 2000 to 1790ft followed by a return to non-marine deposition up to 1160ft. Caved Albian-Cenomanian species in the top cuttings sample at 1190-1160ft indicate sediments of this age higher up the hole.

Selected palynomorphs

1160-1280': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Alisporites grandis, Appendicisporites problematicus, Callialasporites dampieri, Camarozonosporites insignis, Cicatricosisporites hallei, Eucommiidites minor, Gleicheniidites senonicus, Rouseisporites reticulatus, Schizosporis reticulatus, Trilobosporites apiverrucatus.

Reworked species include *Cleistosphaeridium polypes* subsp. A Williams, 1975 and *Rugubivesiculites rugosus.*

1340-1820': *Doidyx anaphrissa* Zone (Barremian)

Appendicisporites potomacensis, Canningia colliveri, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, Classopollis classoides, Eucommiidites troedssonii.

1970-2000': *Ctenidodinium elegantulum* Zone (Hauterivian)

Endoscrinium campanulum, Lycopodiumsporites crassimacerius, Perinopollenites elatoides, Schizosporis parvus, Vitreisporites pallidus.

2060-2480': Neocomian

No new taxa appear.

2550-2680': Portlandian

Classopollis classoides (common), *Trilobosporites* cf. *T. jurassicus.*

2750-2860': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Ctenidodinium culmulum, Epiplosphaera areolata, Leptolepidites psarosus, Pareodinia ceratophora, Tasmanites sp., *Tenua rioulti, Vitreisporites* sp. Singh, 1971.

2950-2980': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Ctenidodinium ornatum, Occisucysta sp. A Williams and Bujak, 1978.

3050-3180': undated, age diagnostic palynomorphs absent

3250-3280': Middle Jurassic (Bajocian-Bathonian)

Micrhystridium stellatum.

3350-3460': *Echinitosporites* cf. *E. iliacoides* Zone (Sinemurian-Pliensbachian)

Echinitosporites cf. *E. iliacoides, sensu* Bujak and Williams, 1977, *Stereisporites perforatus.*

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Shell
IROQUOIS J-17

GSC locality: D24

Location: 44°26'31.37"N; 59°47'12.28"W

RT elevation: 103' Water depth: 195'

Casing set at: 969, 2083, and 4349'

Total depth: 6845' Interval studied: 1033-6800'

Analyzed by: G.L. Williams

Palynological analysis of 97 sidewall core and 20 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1033'	Eocene
1200'	Paleocene
1300- 1625'	*D. euclaensis* Zone (Maastrichtian)
1632- 1680'	*O. operculata* Zone (Campanian)
1664- 1680'	*T. castaneum* subzone
1700- 1780'	*C. truncigerum* Zone (Santonian)
1840- 2019'	Turonian-Coniacian (probably Coniacian)
2090- 2640'	*C. polypes* Zone (Cenomanian)
2725- 3980'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
2725- 3198'	*R. rugosus* Subzone (late Albian)
3446- 3980'	early Albian
4105- 4604'	*S. perlucida-S. schindewolfii* Zone (Aptian)
4620- 4900'	*D. anaphrissa* Zone (Barremian)
4968-?5340'	*C. elegantulum* Zone (Hauterivian)
5557- 5702'	*P. neocomica* Zone (Berriasian-Valanginian)
5820- 5905'	*C. panneum* Zone (Portlandian)
5920- 6079'	*E.* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)
6080- 6800'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)

Shell Iroquois J-17 encountered salt at 6707ft and was subsequently abandoned at 6845ft while still in the Argo Formation, which is herein dated late Hettangian-early Sinemurian.

McIver, 1972, designated the interval 6707 to 5922ft as the type section of the Iroquois Formation, which is a dolomite-shale sequence. This is dated late Hettangian-early Sinemurian to late Sinemurian-early Pliensbachian.

This accords with the age assigned to the Iroquois Formation in Shell Eurydice P-36 by Bujak and Williams (1977).

The Iroquois Formation appears to be immediately overlain by approximately 100 feet of Portlandian. There is thus a significant hiatus representing the Toarcian, all of the Middle Jurassic and most of the Late Jurassic. Sedimentation from the Portlandian to the Maastrichtian appears to have been more or less continuous in the vicinity of the subject well, although rates of deposition varied considerably.

Subdivision of the Tertiary is difficult. Both Paleocene and Eocene sediments are recognized, the latter containing several reworked specimens of Late Cretaceous species.

The paleoenvironmental data are obtained from sidewall cores. Marine palynomorphs are absent below 5557ft, indicating in part non-marine deposition through the Valanginian. The onset of shallow marine, inner neritic conditions in the Hauterivian continued into the early Albian. Non-marine episodes occurred in the Albian and Cenomanian. A marine transgression commencing in the Cenomanian gave rise to deeper water conditions throughout the Late Cretaceous. The Tertiary data are too sparse other than to indicate marine deposition.

Selected palynomorphs

1033': Eocene

Areoligera medusettiformis, Chiropteridium aspinatum, Cyclonephelium exuberans, Homotryblium tenuispinosum, Impletosphaeridium transfodum, Pentadinium laticinctum granulatum, Spiniferites ramosus, S. ramosus subsp. *multibrevis, Wetzeliella symmetrica, Wilsonidium tabulatum.*

Reworked specimens of Late Cretaceous species include *Chatangiella tripartita, Cleistosphaeridium polypes* subsp. A Williams, 1975, *Palaeohystrichophora infusorioides, Palaeoperidinium cretaceum, Rugubivesiculites rugosus,* and *Surculosphaeridium longifurcatum.*

1200': Paleocene

Areoligera senonensis, Ceratiopsis pannucea, Hystrichosphaeridium tubiferum, Spiniferites cingulatus.

1300-1625': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia macrocysta, A. raijae, Ceratiopsis diebelii, Cordosphaeridium fibrospinosum, Cyclonephelium expansum, C. cf. *C. exuberans, Deflandrea dartmooria, Exochosphaeridium striolatum, Isabelidinium belfastense, Kleithriasphaeridium loffrense, Lejeunia tricuspis, Oligosphaeridium complex, Palaeoperidinium pyrophorum, Palaeostomocystis laevigata, Palynodinium grallator, Renidinium membraniferum, Rugubivesiculites rugosus, Spiniferites scabrosus, Tricolpites crassimurus.*

1632-1680': *Odontochitina operculata* Zone (Campanian)

Dinogymnium undulosum, Isabelidinium cretaceum, Odontochitina costata, Pterospermopsis spinosa.

1664-1680': *Trichodinium castaneum* subzone (early Campanian)

Alterbia balmei, Palaeohystrichophora infusorioides.

1700-1780': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis, Hystrichodinium pulchrum, Surculosphaeridium longifurcatum, Triblastula utinensis.

1840-2019': Turonian-Coniacian (probably Coniacian)

Cicatricosisporites hallei, Cyclonephelium membraniphorum, C. vannophorum, Oligosphaeridium cf. *O. totum, Silicisphaera ferox, Tricolpites micromunus, T. parvus, Xenascus ceratioides, Xiphophoridium alatum.*

2090-2640': *Cleistosphaeridium polypes* Zone (Cenomanian)

Araucariacites australis, Camarozonosporites insignis, Chlamydophorella nyei, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Cribroperidinium intricatum, Cyclonephelium vannophorum* (common), *Dinopterygium cladoides, Epelidosphaeridia spinosa, Liliacidites dividuus, Microdinium ornatum, Oligosphaeridium pulcherrimum, Palaeoperidinium* sp., *Retitricolpites georgensis, Surculosphaeridium longifurcatum* (common), *Tricolpites micromunus* (common), *Xenascus ceratioides* (common).

2725-3980': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

2725-3198': *Rugubivesiculites rugosus* Subzone (late Albian)

Alisporites grandis, Appendicisporites jansonii, A. potomacensis, Arcellites reticulatus, Cicatricosisporites augustus, Densoisporites velatus, Eucommiidites minor, Gleicheniidites senonicus, Hystrichosphaeridium cooksonii, Oligosphaeridium totum, Osmundacidites sp., *Palaeoperidinium cretaceum, Rouseisporites reticulatus, Rugubivesiculites convolutus* (base), *R. rugosus* (base), *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Tricolpites micromunus* (base), *Trilobosporites apiverrucatus, Vitreisporites pallidus, Vitreisporites* sp. Singh, 1971.

3446-3980': early Albian

Appendicisporites problematicus, Canningia colliveri Cribroperidinium orthoceras, Cyclonephelium eisenacki Gonyaulacysta helicoidea, Hystrichosphaeridium sp. A Bujak and Williams, 1978, *Oligosphaeridium anthophorum, Palaeoperidinium* cf. *P. cretaceum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975 (common).

4105-4604': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bilateralis, Callaiosphaeridium asymmetricum, Cerebropollenites mesozoicus, Cicatricosisporites hughesi, Canninginopsis tabulata, Florentinia laciniata, Perinopollenites elatoides, Pilosisporites trichopapillosus, Spiniferites sp., *Subtilisphaera perlucida, Systematophora schindewolfii.*

4620-4900': *Doidyx anaphrissa* Zone (Barremian)

Aequitriradites spinulosus, Appendicisporites bifurcatus Cicatricosisporites brevilaesuratus, Coptospora sp., *Costatoperforosporites foveolatus, Hystrichosphaeridium recurvatum, Kleithriasphaeridium eoinodes, Klukisporites pseudoreticulatus, Muderongia simplex, Pseudoceratium pelliferum.*

4968-?5340': *Ctenidodinium elegantulum* Zone (Hauterivian

Aptea polymorpha, Cicatricosisporites australiensis, Ctenidodinium sp., *Dingodinium cerviculum, Gonyaulacysta granulata, Muderongia perforata, Occisucysta* sp. A Bujak and Williams, 1978, *Oligosphaeridium* cf. *O. complex, Pareodinia ceratophora* (with kalyptra).

5557-5702': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Cicatricosisporites hughesi (base), *Endoscrinium campanulum*, *Oligosphaeridium perforatum*, *Tenua* sp.

5820-5905': *Ctenidodinium panneum* Zone (Portlandian)

Amphorula metaelliptica, *Trilobosporites jurassicus*.

5920-6079': *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Classopollis classoides (common), *Echinitosporites* cf. *E. iliacoides*, *sensu* Bujak and Williams, 1977.

6080-6800': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Classopollis classoides (common), *C. meyeriana*, *Cycadopites subgranulosus*, *Kraeuselisporites reissingeri*.

The sidewall core sample from 6315ft contains *Muderongia simplex*, *Oligosphaeridium anthophorum*, *O. perforatum*, *Pilosisporites* sp., *Tenua hystrix*, and *Trilobosporites apiverrucatus*. The sidewall core has presumably been taken from a displaced block of Neocomian aged sediments.

* * * * *

Shell
MIC MAC J-77

GSC locality: D7

Location: 44°36'42.81"N; 59°26'10.86"W

RT elevation: 85' Water depth: 206'

Casing set at: 860, 2986, and 8524'

Total depth: 12750' Interval studied: 915-12700'

Analyzed by: G.L. Williams

Palynological analysis of 149 sidewall core and 152 cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

915- 1055'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1070- 1361'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1395'	*P. laticinctum* Zone (middle Miocene)
1468'	?Paleocene
1500- 1620'	*C. speciosa* Zone (late Paleocene)
1680- 2035'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
2040- 2055'	*D. euclaensis* Zone (Maastrichtian)
2080- 2555'	*O. operculata* Zone (Campanian)
2620- 2815'	*C. truncigerum* Zone (Santonian)
2862- 2899'	*O. pulcherrimum* Zone (Coniacian)
2955- 3160'	*S. longifurcatum* Zone (Turonian)
3185- 4093'	*C. polypes* Zone (Cenomanian)
4104- 5443'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
5480- 6418'	*S. perlucida-S. schindewolfii* Zone (Aptian)
6190- 6418'	*A. attadalica* Subzone (early Aptian)
6490- 7565'	*D. anaphrissa* Zone (Barremian)
7590- 8316'	*C. elegantulun* Zone (Hauterivian)
8348- 9220'	*P. neocomica* Zone (Berriasian-Valanginian)
9290- 9520'	*C. panneum* Zone (Portlandian)
9540-10620'	*G. cladophora* Zone (Kimmeridgian)
10690-11920'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
11952-12700'	*V. vermiculata* Zone (Callovian)

There appears to be a more or less unbroken depositional record in Shell Mic Mac J-77 from the Callovian to Paleocene. The upper Paleocene rocks are immediately overlain by middle Miocene sediments in which there are high percentages of reworked Paleocene palynomorphs. The Jurassic-Lower Cretaceous rocks attain a combined thickness of over 8500ft. This is overlain by 900ft of Cenomanian and approximately 1100ft of Turonian-Maastrichtian.

The depositional environment has shown marked fluctuations. Throughout the Callovian-Kimmeridgian the sediments were deposited primarily in shallow marine environments, with some non-marine episodes. The Portlandian to Hauterivian is predominantly non-marine, with occasional marginal marine episodes. A marine transgression, commencing in the Barremian, reached its peak in the Aptian. Non-marine to marginal marine conditions persisted throughout the Albian, apart from 4240 to 4104ft where there is a weak marine transgression. A marine transgression commencing in the Cenomanian (first recognized in the sidewall core at 3310ft) gave rise to a neritic environment which persisted throughout the Late Cretaceous in the vicinity of Shell Mic Mac J-77. The Paleocene began deposition in an inner neritic environment, ending as non-marine in the uppermost part. The Miocene appears to represent marginal marine deposition.

Reworked specimens are common throughout, particularly in the Early Cretaceous and Miocene-Pleistocene.

Selected palynomorphs

915-1055': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Pinus spp.

Reworked species dominate the assemblages in this interval. Such species include *Areoligera medusettiformis*, *Chatangiella victoriensis*, *Cordosphaeridium cantharellum*, *C. fibrospinosum*, *C. funiculatum*, *Isabelidinium belfastense*, *Lejeunia magnifica*, *Odontochitina costata*, *Operculodinium* cf. *O. hirsutum*, *Palaeoperidinium pyrophorum*, *Rugubivesiculites convolutus*, *R. reductus*.

1070-1361': *Cannosphaeropsis* sp. A Zone (late Miocene)

Caryapollenites simplex, *Gonyaulacysta* cf. *G. granulata*, *sensu* Benedek, 1972, *Systematophora* sp.

1395': *Pentadinium laticinctum* Zone (middle Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Pentadinium laticinctum*.

1468': ?Paleocene

Extratriporopollenites sp.

1500-1620': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis speciosa, *Extratriporopollenites* spp., *Palaeocystodinium benjaminii*, *Spinidinium* sp.

1680-2035': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Areoligera senonensis, *Ceratiopsis diebelii*, *C. speciosa* (base), *C. striata*, *Cordosphaeridium fibrospinosum*, *C. gracile*, *C. inodes*, *Danea mutabilis*, *Ginginodinium ornatum*, *Hystrichosphaeridium tubiferum*, *Membranilarnacia tenella*, *Muratodinium fimbriatum*, *Operculodinium* cf. *O. hirsutum*, *sensu* Gocht, 1969, *Palaeoperidinium pyrophorum*, *Spiniferites cingulatus*, *S. crassipellis*, *Tanyosphaeridium variecalamum*, *Trigonopyxidia ginella*, *Turbiosphaera filosa*.

2040-2055': *Dinogymnium euclaensis* Zone (Maastrichtian)

Ceratiopsis striata (base), *Dinogymnium euclaensis, Isabelidinium belfastense, I. cooksoniae, Spongodinium delitiense.*

2080-2555': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, C. victoriensis, Cribroperidinium sp., *Dinogymnium microgranulosum, Exochosphaeridium bifidum, Gonyaulacysta wetzelii, Odontochitina costata, Palaeohystrichophora infusorioides, Rugubivesiculites reductus, R. rugosus, Spinidinium* cf. *S. echinoideum, Trichodinium castaneum.*

2620-2815': *Cordosphaeridium truncigerum* Zone (Santonian)

Camarozonosporites insignis, Canningia reticulata, Cordosphaeridium truncigerum, Exochosphaeridium striolatum, Gleicheniidites senonicus, Kleithriasphaeridium loffrense, Microdinium ornatum, Pterospermopsis spinosa, Senoniasphaera rotundata, Surculosphaeridium longifurcatum, Xenascus ceratioides.

In the sidewall core from 2620ft are reworked specimens of the Early Cretaceous species *Callialasporites dampieri* and *Cicatricosisporites brevilaesuratus.*

2862-2899': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Callaiosphaeridium asymmetricum, Rouseisporites reticulatus (2894ft), *Silicisphaera ferox, Xiphophoridium alatum.*

Also present in this zone are reworked specimens of the Early Cretaceous species *Aequitriradites spinulosus, Appendicisporites bifurcatus* and *A. potomacensis.*

2955-3160': *Surculosphaeridium longifurcatum* Zone (Turonian)

Aiora fenestrata, Chatangiella tripartita (base), *Cleistosphaeridium huguonioti, Cyclonephelium distinctum, Endoscrinium campanulum* (common), *Gleicheniidites senonicus* (common), *Liliacidites dividuus, Microdinium irregulare, Surculosphaeridium longifurcatum* (common).

3185-4093': *Cleistosphaeridium polypes* Zone (Cenomanian)

Baculatisporites comaumensis, Biretisporites potoniae, Cicatricosisporites annulatus, C. hallei, C. hughesi, Classopollis classoides, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Costatoperforosporites foveolatus, Cyclonephelium vannophorum, Acanthotriletes* sp., *Florentinia laciniata, Liliacidites peroreticulatus, Oligosphaeridium anthophorum, O. totum, Palaeoperidinium* sp. A Bujak and Williams, 1978, *Retitricolpites virgeus, Vitreisporites* sp. Singh, 1971.

4104-5443': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Aequitriradites spinulosus, Alisporites grandis, Appendicisporites potomacensis, Concavissimisporites minor, C. variverrucatus, Cribroperidinium intricatum, C. orthoceras, Eucommiidites minor, Hystrichosphaeridium sp. A Bujak and Williams, 1978, *Lycopodiumsporites crassatus, Palaeoperidinium cretaceum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Trichodinium castaneum* (base), *Trilobosporites apiverrucatus, T. purverulentus, Vitreisporites pallidus.*

5480-6418': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea polymorpha, Pilosisporites sp., *Subtilisphaera perlucida, S. pirnaensis, sensu* Millioud, 1969, *Systematophora schindewolfii, Trilobosporites tribotrys.*

6190-6418': *Aptea attadalica* Subzone (early Aptian)

Callialasporites dampieri, Canninginopsis tabulata, Doidyx sp., *Pilosisporites trichopapillosus.*

6490-7565': *Doidyx anaphrissa* Zone (Barremian)

Cerebropollenites mesozoicus, Cicatricosisporites brevilaesuratus, Classopollis classoides (abundant), *Densoisporites perinatus, Dingodinium cerviculum, Doidyx anaphrissa, Eopseudoceratium gochti, Exesipollenites tumulus, Klukisporites pseudoreticulatus, Muderongia perforata, M. simplex, Pilosisporites trichopapillosus* (common), *Polystephanephorus sarjeantii, Pseudoceratium pelliferum, Subtilisphaera perlucida* (common), *Tenua hystrix.*

7590-8316': *Ctenidodinium elegantulum* Zone (Hauterivian)

Batioladinium jaegeri, B. sp. A Bujak and Williams, 1978, *Callialasporites trilobatus, Ctenidodinium elegantulum, Kleithriasphaeridium fasciatum, Oligosphaeridium perforatum, Verrucosisporites* sp.

8348-9220': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Cicatricosisporites australiensis, Hystrichodinium sp., *Meiourogonyaulax* sp.

9290-9520': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites dampieri (common), *Pilosisporites* sp. A Bujak and Williams, 1977.

9540-10620': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Couperisporites jurassicus, Epiplosphaera reticulospinosa, Gen. et sp. 1, Bujak and Williams, 1977, Gen. et sp. 2, Bujak and Williams, 1977, *Gonyaulacysta ambigua, G. cladophora, G. granulata Occisucysta* sp. A Bujak and Williams, 1978, *Parvocavatus tuberosus, Pilosisporites trichopapillosus, sensu* Norris, 1969, *Staplinisporites* sp., *Systematophora fasciculigera, S. orbifera, Tenua* sp., *Trilobosporites jurassicus.*

10690-11952': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Adnatosphaeridium caulleryi, Callialasporites segmentatus, Contignisporites cooksonii, Gonyaulacysta jurassica, Leptodinium egemenii, Pareodinia ceratophora, Prolixosphaeridium parvispinum, Systematophora turonica.

11952-12700': *Valensiella vermiculata* Zone (Callovian)

Ctenidodinium sp., *Gonyaulacysta aldorfensis, Leptodinium subtile* subsp. *pectinigerum, Valensiella vermiculata.*

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Shell
MISSISAUGA H-54

GSC locality: D9

Location: 44°23'20.39"N; 59°22'47.56"W

RT elevation: 85' Water depth: 335'

Casing set at: 909.6, 1720, and 4905'

Total depth: 13787' Interval studied: 1100-13680'

Analyzed by: G.L. Williams

Palynological analysis of 175 sidewall core and 14 cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

1100- 1450'	*D. heterophlycta* Zone (early Oligocene)
1475- 1600'	*D. colligerum* Zone (late Eocene)
1620- 1658'	*A. reticulense* Zone (middle Eocene)
1690- 1750'	*A. senonensis* Zone (early Eocene)
1804- 2327'	*C. speciosa* Zone (late Paleocene)
2496- 3004'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
3104- 3331'	*O. operculata* Zone (Campanian)
3507- 3600'	*C. truncigerum* Zone (Santonian)
3655- 3737'	*O. pulcherrimum* Zone (Coniacian)
3835- 4025'	*S. longifurcatum* Zone (Turonian)
4076- 4858'	*C. polypes* Zone (Cenomanian)
4943- 7425'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
4943- 5820'	*R. rugosus* Subzone (late Albian)
5945- 7425'	early Albian
7490- 7885'	*S. perlucida-S. schindewolfii* Zone (Aptian)
8048- 8720'	*D. anaphrissa* Zone (Barremian)
8780- 9885'	*C. elegantulum* Zone (Hauterivian)
10179-11533'	*P. neocomica* Zone (Berriasian-Valanginian)
11713-12030'	*C. panneum* Zone (Portlandian)
12206-13229'	*G. cladophora* Zone (Kimmeridgian)
13300-13680'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)

There appears to be a more or less unbroken depositional record in Shell Missisauga H-54 from the Oxfordian to the lower Oligocene, apart from the apparent absence of Maastrichtian sediments. The Lower Cretaceous, extending from 11 533 to 4943ft, is over 5500ft thick. The Eocene is very condensed, only 275ft being recognised between 1750-1475ft.

The depositonal environment has shown considerable fluctuation in the vicinity of Missisauga H-54. In the Oxfordian and Kimmeridgian the sediments were deposited predominantly in a shallow marine environment. The Portlandian is inner neritic to non-marine. The Berriasian-Valanginian are non-marine, with occasional marginal marine periods. The Hauterivian-Barremian sediments were deposited in a marginal marine to inner neritic environment. The Aptian, marginal marine in the lowermost part, is predominantly non-marine. The Albian-Cenomanian are inner neritic to non-marine with dinoflagellates becoming abundant in the late Cenomanian and denoting a marine transgression. This marine transgression gave rise to a neritic environment which persisted throughout the Late Cretaceous and early Tertiary.

Selected palynomorphs

1100-1450': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, Ascostomocystis potane, Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Chiropteridium aspinatum, Cordosphaeridium cantharellum, C. funiculatum, Cyclonephelium exuberans, Deflandrea heterophlycta, D. phosphoritica, D. spinulosa, Gonyaulacysta giuseppei, Hystrichokolpoma rigaudiae, Kisselovia coleothrypta, Pentadinium laticinctum, P. laticinctum* subsp. *granulatum, Phthanoperidinium comatum, P. echinatum, Polysphaeridium pastielsii, Tsugaepollenites igniculus, Wetzeliella symmetrica, sensu* Gocht, 1969, *W.* sp. B Williams and Brideaux, 1975.

1475-1600': *Diphyes colligerum* Zone (late Eocene)

Achilleodinium biformoides, Adnatosphaeridium reticulense, sensu Gocht, 1969, *Apectodinium homomorphum, Areoligera senonensis, sensu* Gocht, 1969, *Batiacasphaera compta, Cordosphaeridium gracile, Cyclonephelium* sp. C Williams and Brideaux, 1975, *Deflandrea* sp. C Williams and Bujak, 1977b, *Dinopterygium* sp. A Williams and Bujak, 1977a, *Epicephalopyxis indentata, Leptodinium victorianum, Muratodinium fimbriatum, Pyxidiella* sp., *Rottnestia borussica, Samlandia chlamydophora, Thalassiphora pelagica.*

1620-1658': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Areoligera medusettiformis, Deflandrea oebisfeldensis, Diphyes colligerum, Hystrichokolpoma eisenackii, Rhombodinium cf. *R. condylos, Spiniferites cornutus, Wilsonidium echinosuturatum.*

1690-1750': *Areoligera senonensis* Zone (early Eocene)

Cyclonephelium ordinatum, Deflandrea dartmooria.

1804-2327': *Ceratiopsis speciosa* Zone (late Paleocene)

Aiora fenestrata, Ceratiopsis speciosa, Extratriporopollenites spp., *Rugubivesiculites rugosus, Turbiosphaera filosa.*

2496-3004': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Cordosphaeridium fibrospinosum, Deflandrea denticulata, Fibradinium sp., *Hystrichosphaeridium tubiferum, Isabelidinium bakeri, Palaeoperidinium pyrophorum, Spiniferites septatus.*

3104-3331': *Odontochitina operculata* Zone (Campanian)

Alterbia acuminata, Cannosphaeropsis utinensis, Dinogymnium digitus, D. euclaensis, D. undulosum, Hystrichokolpoma sequanaportus, Lejeunia magnifica, Odontochitina costata, Silicisphaera ferox, Spiniferites cingulatus, S. scabrosus, Xenascus ceratioides.

3507-3600': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis, Exochosphaeridium bifidum, Gardodinium deflandrei, Palaeohystrichophora infusorioides, Spinidinium cf. *S. echinoideum, Trichodinium castaneum.*

3655-3737': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Canningia reticulata, Forma P Evitt, 1967, *Gleicheniidites senonicus, Hystrichodinium pulchrum, Kleithriasphaeridium loffrense, K. readeii, Senoniasphaera rotundata, Subtilisphaera pirnaensis, Surculosphaeridium longifurcatum.*

3835-4025': *Surculosphaeridium longifurcatum* Zone (Turonian)

Cyclonephelium distinctum, Dinopterygium cladoides, Oligosphaeridium pulcherrimum, Subtilisphaera pirnaensis (common), *Surculosphaeridium longifurcatum* (abundant).

4076-4858': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites bilateralis (one specimen at 4370ft), *A. jansonii, Canningia colliveri, Cicatricosisporites hallei, C. pseudotripartitus, Cleistosphaeridium huguoniotii, C. polypes* subsp. A Williams, 1975, *Cyclonephelium vannophorum, Epelidosphaeridia spinosa, Hystrichosphaeridium cooksoniae, Liliacidites dividuus, Oligosphaeridium anthophorum, O. totum, Retitricolpites maximus, R. virgeus, Tricolpites micromunus, T. parvus.*

4943-7425': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

4943-5820': *Rugubivesiculites rugosus* Subzone (late Albian)

Aequitriradites spinulosus (one specimen at 5615ft), *Alisporites grandis, Appendicisporites potomacensis, A. problematicus, Cribroperidinium intricatum, Eucommiidites minor, E. troedssonii, Liliacidites peroreticulatus, Palaeoperidinium cretaceum, P.* sp. A Bujak and Williams, 1978, *Rouseisporites reticulatus, Rugubivesiculites rugosus* (base), *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Tricolpites micromunus* (base), *T. parvus* (base), *Trilobosporites apiverrucatus, Vitreisporites pallidus.*

5945-7425': early Albian

Appendicisporites unicus, Aptea polymorpha (two specimens at 5976ft), *Callialasporites dampieri* (one specimen at 5945ft), *Cerebropollenites mesozoicus, Cicatricosisporites augustus, C. subrotundus, Contignisporites cooksonii, Cribroperidinium orthoceras, Distaltriangulisporites perplexus, Florentinia mantellii, Klukisporites foveolatus* (one specimen at 6035ft), *Osmundacidites wellmanii, Subtilisphaera perlucida* (one specimen at 7380ft), *Trilobosporites marylandensis* (one specimen at 6920ft).

Several of the species recorded from this interval, such as *Aptea polymorpha, Callialasporites dampieri, Cerebropollenites mesozoicus, Contignisporites cooksonii, Klukisporites foveolatus,* and *Subtilisphaera perlucida* appear to be reworked.

7490-7885': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea attadalica, Cicatricosisporites brevilaesuratus, Costatoperforosporites foveolatus, Pilosisporites trichopapillosus.

8048-8720': *Doidyx anaphrissa* Zone (Barremian)

Cicatricosisporites australiensis, Dingodinium cerviculum, Doidyx anaphrissa, Hystrichosphaeridium recurvatum, Kleithriasphaeridium eoinoides, Muderongia perforata, M. simplex, Subtilisphaera perlucida (common), *Systematophora schindewolfii.*

8780-9885': *Ctenidodinium elegantulum* Zone (Hauterivian)

Batioladinium jaegeri, Cerebropollenites mesozoicus (common), *Ctenidodinium elegantulum, Cyclonephelium vannophorum* (base), *Dingodinium cerviculum* (common), *Exesipollenites tumulus, Gonyaulacysta serrata, Perinopollenites elatoides, Polystephanephorus sarjeantii, Pseudoceratium pelliferum.*

10179-11533': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Cicatricosisporites purbeckensis, Pareodinia cf. *P. villosa, Plicatella abaca, Pseudoceratium* cf. *P. pelliferum, Systematophora complicata.*

11713-12030': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites obrutus, Coronatispora valdensis, Ctenidodinium culmulum, Leptolepidites psarosus, Systematophora areolata.

12206-13229': *Gonyaulacysta cladophora* Zone (Kimmeridgian

Epiplosphaera reticulospinosa, Gonyaulacysta aculeata, G. granuligera, Pareodinia kondratjevii, Parvocavatus tuberosus, Pilosisporites trichopapillosus (base), *Senoniasphaera jurassica, Systematophora orbifera, S. turonica, Tenua* sp., *Trilobosporites jurassicus.*

13300-13680': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Adnatosphaeridium caulleryi, Ctenidodinium ornatum, Endoscrinium eisenackii, Gonyaulacysta cf. *G. cladophora, Leptodinium egemenii, Staplinisporites caminus, Tenua* sp., *Trilobosporites jurassicus* (common).

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Shell
MOHAWK B-93

GSC locality: D5

Location: 42°42'10.52"N; 64°43'53.50"W

RT elevation: 103' Water depth: 384'

Casing set at: 1148 and 3488'

Total depth: 6975' Interval studied: 1190-6930'

Analyzed by: G.L. Williams

Palynological analysis of 109 sidewall core and cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

1190- 1220' *D. heterophlycta* Zone (early Oligocene)
1280- 1700' *A. reticulense* Zone (middle Eocene)
1760- 1820' *A. senonensis* Zone (early Eocene)
1880- 1970' *C. speciosa* Zone (late Paleocene)
2007- 2400' *O. operculata* Zone (Campanian)
2500- 3015' Coniacian-Santonian
3200- 3408' *S. longifurcatum* Zone (Turonian)
3450- 4250' *C. polypes* Zone (Cenomanian)
4385- 4425' *S. perlucida-S. schindewolfii* Zone (Aptian)
4468- 4815' Hauterivian-Barremian
4830- 5000' *C. elegantulum* Zone (Hauterivian)
5160- 5290' *P. neocomica* Zone (Berriasian-Valanginian)
5315- 5395' *C. panneum* Zone (Portlandian)
5537- 6000' *G. cladophora* Zone (Kimmeridgian)

6015- 6155' *G. jurassica* Zone
(Oxfordian-early Kimmeridgian)
6255- 6490' *V. vermiculata* Zone (Callovian)
6550-?6930' *G. filapicata* Zone (Bathonian)

Shell Mohawk B-93 encountered basement at 6930ft. The oldest datable overlying sediments are Bathonian which are known to extend from?6930 to 6550ft. These are overlain by a more or less complete Upper Jurassic and Cretaceous section, although sediments of Albian and Maastrichtian age have not been recognized. The Campanian is apparently overlain by upper Paleocene sediments, indicating a hiatus across the Cretaceous-Tertiary boundary. The youngest Tertiary sediments have been dated early Oligocene.

Throughout the Jurassic and most of the Lower Cretaceous, deposition appears to have been predominantly very shallow marine to non-marine. Deeper water conditions prevailed during deposition of the Upper Cretaceous sediments. The sparse Tertiary dinocyst assemblages preclude paleoenvironmental determinations.

Selected palynomorphs

1190-1220': *Deflandrea heterophlycta* Zone
(early Oligocene)

Chiropteridium aspinatum, Cordosphaeridium fibrospinosum, C. funiculatum, Cyclonephelium pastielsii, Hemicystodinium sp. Williams, 1975, *Pentadinium laticinctum* subsp. *granulatum, Perisseiasphaeridium* sp., *Wetzeliella lunaris.*

1280-1700': *Adnatosphaeridium reticulense* Zone
(middle Eocene)

Areoligera senonensis, sensu Gocht, 1969, *Homotryblium tenuispinosum, Wetzeliella articulata, W. varielongituda* (common at 1280-1340ft).

1760-1820': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum, Thalassiphora pelagica, Wilsonidium echinosuturatum.

1880-1970': *Ceratiopsis speciosa* Zone (late Paleocene)

Adnatosphaeridium reticulense, sensu Gocht, 1969, *Areoligera medusettiformis, Ceratiopsis speciosa, Cordosphaeridium gracile, Deflandrea* cf. *D. delineata, D. oebisfeldensis.*

2007-2400': *Odontochitina operculata* Zone (Campanian)

Alterbia acuminata, A. asymmetrica, Canningia reticulata, Chatangiella granulifera, C. vnigri, Dinogymnium acuminatum, D. euclaensis, D. microgranulosum, D. undulosum, Exochosphaeridium bifidum, Forma P Evitt, 1967, *Gardodinium deflandrei, Horologinella apiculata, Odontochitina operculata, Palaeohystrichophora infusorioides* (comes in at 2100ft), *Palaeoperidinium pyrophorum, Rugubivesiculites reductus, R. rugosus, Senoniasphaera rotundata, Spinidinium* cf. *S. echinoideum, Spiniferites cingulatus cingulatus.*

2500-3015'; Coniacian-Santonian

Chatangiella victoriensis (common at 2500ft), *Isabelidinium* cf. *I. cooksoniae, Palaeostomocystis fragilis, Trichodinium castaneum.*

3200-3408': *Surculosphaeridium longifurcatum* Zone
(Turonian)

Areoligera sp. A Bujak and Williams, 1978, *Cyclonephelium vannophorum, Subtilisphaera pirnaensis.*

3450-4250': *Cleistosphaeridium polypes* Zone
(Cenomanian)

Aptea cf. *A. attadalica* (four specimens at 3662ft), *Apteodinium grande, Camarozonosporites insignis, Cicatricosisporites augustus, C. hallei, Classopollis classoides, Cleistosphaeridium huguoniotii, C. polypes, Coronifera oceanica, Cribroperidinium intricatum* (appears at 3950ft), *C. orthoceras, Cyclonephelium paucispinum, C. vannophorum* (common), *Hystrichosphaeridium cooksoniae, Oligosphaeridium anthophorum, O. complex, O. irregulare, O. totum, Palaeohystrichophora infusorioides* (base), *Palaeoperidinium cretaceum, Retitricolpites virgeus, Silicisphaera ferox, Subtilisphaera pontis-mariae, Surculosphaeridium longifurcatum, Tricolpites parvus.*

4385-4425': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea cf. *A. attadalica, sensu* Williams, 1975, *Cribroperidinium sepimentum.*

4468-4815': Hauterivian-Barremian

Dingodinium cerviculum, Kleithriasphaeridium fasciatum, Muderongia sp., *Oligosphaeridium asterigerum, Pseudoceratium pelliferum, Subtilisphaera perlucida.*

4830-5000': *Ctenidodinium elegantulum* Zone (Hauterivian)

Cerebropollenites mesozoicus, Ctenidodinium elegantulum, Eopseudoceratium gochtii, Systematophora complicata.

5160-5290': *Phoberocysta neocomica* Zone
(Berriasian-Valanginian)

Endoscrinium campanulum, Gonyaulacysta sp., *Pareodinia kondratjevii, Polystephanephorus sarjeantii.*

5315-5395': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium culmulum, C. panneum.

5537-6000': *Gonyaulacysta cladophora* Zone
(Kimmeridgian)

Cicatricosisporites australiensis, Coronatispora valdensis, Densoisporites perinatus, Leptolepidites psarosus, Scriniodinium crystallinum.

6015-6155': *Gonyaulacysta jurassica* Zone
(Oxfordian-early Kimmeridgian)

Ctenidodinium ornatum, C. aff. *C. tenellum, sensu* Gocht, 1970, *Gonyaulacysta jurassica, Hystrichogonyaulax cornigera, Systematophora orbifera, Tenua* sp.

6255-6490': *Valensiella vermiculata* Zone (Callovian)

Contignisporites fornicatus, Ctenidodinium continuum, C. pachydermum, Endoscrinium eisenackii, Gen. et sp. 2 Gocht, 1970, *Lithodinia jurassica, Stephanelytron caytonense, Systematophora turonica, Tenua rioultii.*

6550-?6930': *Gonyaulacysta filapicata* Zone (Bathonian)

Leptodinium regale.

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Shell
MOHICAN I-100

GSC locality: D74

Location: 42°59'39.04"N; 62°28'51.32"W

RT elevation: 98' Water depth: 503'

Casing set at: 1189, 3231, and 6621'

Total depth: 14414' Interval studied: 1276-14229'

Analyzed by: G.L. Williams

Palynological analysis of 164 sidewall cores and 30 conventional core samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1276- 5227' *Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1276- 4728' *S. scabratus* Subzone (Pleistocene)
1276- 2220' "Late Albian reworked zone"
2293- 2643' Interglacial
2810- 2988' "Campanian reworked zone"
3148- 3550' Interglacial
3628- 3880' Glacial
4010- 4728' Interglacial
4728- 5227' *H. choanophorum* Subzone (Pliocene)
5273- 5336' *Cannosphaeropis* sp. A Zone (late Miocene)
5353- 5508' *P. laticinctum* Zone (middle Miocene)
5538- 5544' *C. polypes* Zone (Cenomanian)
5580- 5622' *P. laticinctum* Zone (middle Miocene) (caved)
5666- 5818' *C. polypes* Zone (Cenomanian)
5847- 6990' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
5847- 6380' *R. rugosus* Subzone (late Albian)
6400- 6990' early Albian
7050- 7400' *S. perlucida-S. schindewolfii* Zone (Aptian)
7400' *A. attadalica* Subzone
7580- 7872' *D. anaphrissa* Zone (Barremian)
7910- 8595' *C. elegantulum* Zone (Hauterivian)
8668' *P. neocomica* Zone (Berriasian-Valanginian)
8840- 9234' *C. panneum* Zone (Portlandian)
9270- 9900' *G. cladophora* Zone (Kimmeridgian)
10000-10622' *G. jurassica* Zone
(Oxfordian-early Kimmeridgian)
10945-11379' *V. vermiculata* Zone (Callovian)
11663-12227' *G. filapicata* Zone (Bathonian)
12358-12498' *M. semitabulatum* Zone (Aalenian-Bajocian)
12940-13828' late Early Jurassic
14224-14229' *C. subgranulosus* Zone
(late Hettangian-early Sinemurian)

Shell Mohican I-100 penetrated approximately 92ft (14322-14414ft) of Argo Formation (J.A. Wade, pers. comm.) before reaching total depth of 14 414ft. Overlying the Argo salt at 14 322ft is the Iroquois Formation which extends to 12 426ft. The oldest datable sediments of late Hettangian-early Sinemurian age represent part of the Iroquois Formation. The youngest part of the Iroquois can not be more precisely dated than late Early Jurassic. This is sequentially overlain by a more or less complete Middle and Upper Jurassic and Lower Cretaceous section extending to 5847ft although much of the Berriasian and Valanginian may be missing. Approximately 250ft of Cenomanian is immediately overlain by middle Miocene rocks, so that most of the Upper Cretaceous and all of the Paleogene is missing. The Neogene section is complete apart from the absence of the lower Miocene. The thick Pleistocene sequence (at least 3400ft) has been subdivided primarily on the presence or absence of reworked species and secondarily on the age of these reworked species.

The Lower Jurassic sediments are devoid of dinocysts and were presumably deposited in a predominantly non-marine environment. The Bajocian contains only two dinocysts while the overlying Bathonian has a predominance of spores. Palynomorphs increase in the Callovian-Oxfordian sediments which appear to represent inner neritic deposition. The greatest dinocyst diversity observed in the Jurassic, occurs in the Kimmeridgian especially between 9334 and 9314ft where *Endoscrinium luridum Pareodinia ceratophora* (with kalyptra), *Polystephanephorus sarjeantii*, and *Scriniodinium crystallinum* are particularly abundant.

The Berriasian-Barremian sediments were deposited in an inner neritic to non-marine environment, with dinocysts being absent at 9158, 7872, and 7725ft. The *Aptea attadalica* subzone is recognised at 7400ft; this is also present in Shell Mohawk B-93, Shell Naskapi N-30 and Shell Oneida O-25 and usually equates with the Naskapi shale. Throughout the Aptian-Cenomanian the paleoenvironment appears to have been neritic. The overlying Neogene sediments are predominantly marine. The Pleistocene sea level fluctuations are reflected in the reworked assemblages.

Selected palynomorphs

1276-5227': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Ambrosia sp., *Artemisia* sp., *Hemicystodinium* sp., *Operculodinium centrocarpum, O. israeliainum, Pinus* spp., *Quercoidites* sp.

1276-4728': *S. scabratus* Subzone (Pleistocene)

1276-2220': "Late Albian reworked zone"

Appendicisporites problematicus, Classopollis classoides, Cyclonephelium vannophorum, Eucommiidites minor, Liliacidites peroreticulatus, Rugubivesiculites rugosus, Surculosphaeridium longifurcatum, Vitreisporites pallidus.

2293-2643': Interglacial

Hemicystodinium sp. (abundant at 2643ft), *Pinus* spp. (abundant at 2454ft), *Spiniferites ramosus* (abundant at 2643ft).

In this interval reworked species include *Diphyes colligerum, Hemicystodinium zoharyi, Kisselovia coleothrypta,* and *Wetzeliella articulata.*

2810-2988': "Campanian reworked zone"

Alterbia acuminata, Ceratiopsis diebelii, Chatangiella tripartita, C. victoriensis, Dinogymnium euclaensis.

3148-3550': Interglacial

Ambrosia sp., *Canningia* sp., *Hemicystodinium* sp., *Operculodinium giganteum, Pinus* spp., *Spiniferites ramosus.*

3628-3880': Glacial

Densoisporites (common). Other taxa are *Apectodinium homomorphum* (Paleocene-Eocene), *Chatangiella victoriensis* (Senonian), and *Palaeohystrichophora* sp. (Albian).

4010-4728': Interglacial

Operculodinium centrocarpum, O. israelianum, Spiniferites scabratus.

4728-5227': *Hystrichosphaeridium choanophorum* Subzone (Pliocene)

Hystrichosphaeridium choanophorum, Leptodinium patulum, Lingulodinium cf. *L. machaerophorum, Thalassiphora delicata.*

5273-5336': *Cannosphaeropsis* sp. A Zone (late Miocene)

Hystrichosphaeropsis obscura.

5353-5508': *Pentadinium laticinctum* Zone (middle Miocene)

Artemisia sp. (base), *Caryapollenites simplex, Hemicystodinium* sp. Williams, 1975, *Polysphaeridium pastielsii, Sumatradinium* sp., *Tiliaepollenites* sp., *Ulmipollenites* sp.

5538-5544': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, Classopollis classoides, Cleistosphaeridium polypes, Cyclonephelium vannophorum, Oligosphaeridium complex, Rugubivesiculites rugosus, Surculosphaeridium longifurcatum, Tricolpites parvus.

5580-5622': *Pentadinium laticinctum* Zone (middle Miocene) (caved)

Caryapollenites simplex, Hemicystodinium sp. Williams 1975, *Ilexpollenites* sp., *Spiniferites pseudofurcatus, Tiliaepollenites* sp.

5666-5818': *Cleistosphaeridium polypes* Zone (Cenomanian)

Classopollis classoides, Cleistosphaeridium huguoniotii, C. polypes, C. polypes subsp. A Williams, 1975, *Cyclonephelium vannophorum, Dinopterygium cladoides, Epelidosphaeridia spinosa, Hystrichosphaeridium* sp. A Bujak and Williams, 1978, *Litosphaeridium siphoniphorum, Odontochitina operculata, Oligosphaeridium dictyophorum, O. pulcherrimum, Palaeohystrichophora infusorioides, Rugubivesiculites rugosus, Surculosphaeridium longifurcatum, Tricolpites parvus, Xenascus ceratioides.*

5847-6990': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

5847-6380': *Rugubivesiculites rugosus* Subzone (late Albian)

Aequitriradites spinulosus, Alisporites grandis, Appendicisporites jansonii, A. problematicus, Cribroperidinium orthoceras, Eucommiidites minor, Liliacidites peroreticulatus, Palaeoperidinium cretaceum, Polysphaeridium laminaspinosum, Rugubivesiculites rugosus (base), *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Tricolpites parvus* (base), *Trilobosporites apiverrucatus, Vitreisporites pallidus.*

6400-6990': early Albian

Contignisporites cooksonii, Coronifera oceanica Florentinia mantellii, Oligosphaeridium complex (peak), *Spinidinium* cf. *S. vestitum* (base), *Subtilisphaera asymmetrica.*

7050-7400': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea attadalica, Subtilisphaera perlucida, Systematophora complicata, S. schindewolfii.

7400': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica (peak), *Diacanthum hollisteri.*

7580-7872': *Doidyx anaphrissa* Zone (Barremian)

Kleithriasphaeridium fasciatum (at 7700ft), *Pareodinia kondratjevii, Pseudoceratium pelliferum.*

7910-8595': *Ctenidodinium elegantulum* Zone (Hautervian)

Batioladinium exiguum, Ctenidodinium elegantulum, Cyclonephelium vannophorum, Dingodinium cerviculum Lithodinia stoveri, Muderongia simplex.

8668': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Systematophora cf. *S. areolata.*

8840-9234': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium culmulum, C. panneum, Dictyopyxidia sp.

9270-9900': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Endoscrinium luridum, Gonyaulacysta ambigua, G. cladophora, Leptodinium egemenii, Pareodinia ceratophora, Pilosisporites trichopapillosus (base), *Polystephanephorus sarjeantii, Prolixosphaeridium granulosum, Scriniodinium crystallinum, Systematophora orbifera, Tenua* sp.

10000-10622': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Compositosphaeridium costatum, Gonyaulacysta cladophora (peak), *G. jurassica, Tenua rioultii.*

10945-11379': *Valensiella vermiculata* Zone (Callovian)

Adnatosphaeridium caulleryi, Ctenidodinium ornatum, Ellipsoidictyum cinctum, Gen. et sp. 2 Gocht, 1970, *Gonyaulacysta aldorfensis, G. jurassica* (base), *Leptodinium subtile, Valensiella ampulla.*

11663-12227': *Gonyaulacysta filapicata* Zone (Bathonian)

Gonyaulacysta filapicata, Lithodinia jurassica, sensu Gocht, 1970, *Tenua* sp.

12358-12498': *Mancodinium semitabulatum* Zone (Aalenian-Bajocian)

Callialasporites dampieri (base), *Gonyaulacysta* sp.

12940-13828': late Early Jurassic

Classopollis classoides (peak), *Verrucosisporites* sp.

14224-14229': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Cycadopites subgranulosus.

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Shell
NASKAPI N-30

GSC locality: D4

Location: 43°29'46.78"N; 62°33'59.54"W

RT elevation: 85' Water depth: 312'

Casing set at: 1088 and 3176'

Total depth: 7235' Interval studied: 1175-6920'

Analyzed by: G.L. Williams

Palynological analysis of 148 sidewall core and cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1175- 1540' *D. euclaensis* Zone (Maastrichtian)
1582- 2215' *O. operculata* Zone (Campanian)
2290- 2620' *C. truncigerum* Zone (Santonian)
2695- 2815' *O. pulcherrimum* Zone (Coniacian)
2860- 3025' *S. longifurcatum* Zone (Turonian)
3095- 3778' *C. polypes* Zone (Cenomanian)
3908- 4345' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
3908- 3948' *R. rugosus* Subzone (late Albian)
3948- 4710' early Albian
4403- 4710' *S. perlucida-S. schindewolfii* Zone (Aptian)
4403- 4710' *A. attadalica* Subzone (early Aptian)
4774- 4925' *D. anaphrissa* Zone (Barremian)
4985- 5126' *C. elegantulum* Zone (Hauterivian)
5255- 5550' *P. neocomica* Zone (Berriasian-Valanginian)
5620- 5713' *C. panneum* Zone (Portlandian)
5790- 6320' *G. cladophora* Zone (Kimmeridgian)
6390- 6600' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
6600- 6820' *V. vermiculata* Zone (Callovian)
6820- 6920' barren

Shell Naskapi N-30 encountered basement at 6992ft and bottomed at 7235ft. According to Williams *et al.*, 1974, basement is a heterogeneous rock suite composed of schists and metaquartzite. The oldest datable sediments are Callovian between 6820 and 6600ft. These are sequentially overlain by a more or less complete Upper Jurassic and Cretaceous sequence, with probable Paleogene sediments indicated as lying above the highest sample (see Selected palynomorphs). There is a suggestion of two interruptions in deposition in the late Aptian and the late Campanian.

The Callovian to Albian sediments were probably deposited in an innner neritic environment, while in the Late Cretaceous outer neritic sedimentation predominated.

Selected palynomorphs

1175-1540': *Dinogymnium euclaensis* Zone (Maastrichtian)

Chatangiella granulifera, C. tripartita, C. vnigri, Dinogymnium acuminatum, D. digitus, D. euclaensis, D. microgranulosum, D. undulosum, Isabelidinium cf. *I. cooksoniae, Rugubivesiculites reductus, R. rugosus.*

The cuttings sample at 1180-1220ft contains numerous late Paleocene-early Eocene species including *Wilsonidium echinosuturatum.* Samples were not available for study above 1175ft.

1582-2215': *Odontochitina operculata* Zone (Campanian)

Canningia reticulata, Dinogymnium undulosum (base), *Horologinella apiculata, Hystrichosphaeridium bowerbankii, Odontochitina costata, Oligosphaeridium anthophorum, Palaeohystrichophora infusorioides, Senoniasphaera rotundata, Spinidinium* cf. *S. echinoideum, Tanyosphaeridium variecalamum, Trichodinium castaneum, Xenascus ceratioides.*

The presence of *Palaeohystrichophora infusorioides* and *Trichodinium castaneum* in the samples suggests that the late Campanian is absent.

2290-2620': *Cordosphaeridium truncigerum* Zone (Santonian

Chatangiella victoriensis, C. vnigri (base), *Chlamydophorella* sp., *Cordosphaeridium truncigerum, Cyclonephelium vannophorum* (at 2455ft, probably reworked), *Dinogymnium acuminatum* (base), *Dinopterygium cladoides,* Forma P Evitt, 1967, *Hystrichosphaeridium cooksoniae* (at 2455ft, probably reworked), *Isabelidinium* cf. *cooksoniae, sensu* Clarke and Verdier, 1967, *Kleithriasphaeridium readei, Palaeohystrichophora infusorioides* (common), *Subtilisphaera pirnaenis, Surculosphaeridium longifurcatum.*

2695-2815': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Cyclonephelium paucispinum, Oligosphaeridium pulcherrimum.

2860-3025': *Surculosphaeridium longifurcatum* Zone (Turonian)

Areoligera sp. A Bujak and Williams, 1978, *Coronifera oceanica, Polysphaeridium laminaspinosum, Surculosphaeridium longifurctum* (common).

3095-3778': *Cleistosphaeridium polypes* Zone (Cenomanian)

Callaiosphaeridium asymmetricum, Camarozonosporites insignis (common), *Classopollis classoides, Cleistosphaeridium huguoniotii, C. polypes* subsp. A Williams, 1975, *Converrucosisporites exquisitus, Cribroperidinium intricatum, Cyclonephelium vannophorum, Epelidosphaeridia spinosa, Gleicheniidites senonicus* (common), *Retitricolpites virgeus, Subtilisphaera pontis-mariae, Tricolpites parvus.*

3908-4345': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

3908-3948': *Rugubivesiculites rugosus* Subzone (late Albian)

Cribroperidinium intricatum (common), *Eucommiidites minor, Palaeostomocystis fragilis, Spinidinium vestitum, Spinidinium* cf. *S. vestitum, sensu* William 1975, *Tricolpites parvus* (base).

3948-4345': early Albian

Cicatricosisporites pseudotripartitus, Cleistosphaeridium polypes (base), *Lycopodiumsporites crassimacerius, Oligosphaeridium complex* (common), *Protoellipsodinium* sp., *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975 (base), *Subtilisphaera pontis-mariae* (base), *Trilobosporites apiverrucatus, Vitreisporites pallidus.*

4403-4710': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

4403-4710': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica, A. cf. *A. attadalica, sensu* Williams, 1975, *A. polymorpha, Callialasporites trilobatus, Canningia colliveri, Doidyx anaphrissa, Pilosisporites trichopapillosus, Polystephanephorus* sp., *Pseudoceratium* sp., *Subtilisphaera perlucida, Trilobosporites trioreticulosus.*

All the samples within this interval contain numerous dinocysts.

4774-4925': *Doidyx anaphrissa* Zone (Barremian)

Doidyx anaphrissa (common), *Lithodinia stoveri, Muderongia simplex, Subtilisphaera perlucida* (common).

4985-5126': *Ctenidodinium elegantulum* Zone (Hauterivian)

Ctenidodinium elegantulum, Gonyaulacysta serrata, Muderongia simplex (base), *Pseudoceratium pelliferum.*

5255-5550': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Dingodinium cerviculum, Pareodinia ceratophora, Systematophora complicata, S. schindewolfii.

5620-5713': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium panneum, Prolixosphaeridium xanthiopyxides, Wanaea sp.

5790-6320': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Ctenidodinium culmulum, Dingodinium cerviculum (base), *Gonyaulacysta cladophora, G. granulata, Micrhystridium stellatum, Pareodinia kondratjevii, Polystephanephorus sarjeantii, Senoniasphaera jurassica, Systematophora fasciculigera.*

6390-6600': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Ctenidodinium ornatum, Ellipsoidictyum sp., *Gonyaulacysta jurassica* subsp. *longicornis, Leptodinium egemenii, Systematophora areolata.*

6600-6820': *Valensiella vermiculata* Zone (Callovian)

Lithodinia sp., *Valensiella vermiculata.*

6820-6920': barren

* * * * *

Union *et al.* Shell
OJIBWA E-07

GSC locality: D121

Location: 43°46'20.44"N; 61°46'14.42"W

RT elevation: 98' Water depth: 248'

Casing set at: 946, 2236, and 4312'

Total depth: 7643' Interval studied: 970-7620'

Analyzed by: J.P. Bujak

Palynological analysis of 86 cuttings samples indicates the following age determinations and biostratigraphic zonation:

970- 1360' *D. euclaensis* Zone (Maastrichtian)
1420- 2230' *O. operculata* Zone (Campanian)
2290- 2410' *C. truncigerum* Zone (Santonian)
2470- 2860' *O. pulcherrimum* Zone (Coniacian)
2920- 3310' *C. polypes* Zone (Cenomanian)
3370- 4210' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
4270- 4800' *S. perlucida-S. schindewolffii* Zone (Aptian)
4670- 4800' *A. attadalica* Subzone (early Aptian)
4870- 5300' Barremian-early Aptian
5370- 5500' *D. anaphrissa* Zone (Barremian)
5570- 5900' Neocomian (probably Hauterivian only)
5970- 6100' *C. panneum* Zone (Portlandian)
6170- 6900' *G. cladophora* Zone (Kimmeridgian)
6970- 7470' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
7470- 7620' *V. vermiculata* Zone (Callovian)

Between 7620 and 5970ft there appears to be a complete succession of Callovian to Portlandian strata. Assemblages from this interval contain diverse and abundant dinocysts of excellent preservation indicating predominantly marine deposition. Spores are also common and well preserved suggesting nearshore environments. Some reworking of Early Jurassic spores was noted in the Callovian and Oxfordian-lower Kimmeridgian intervals. In the Kimmeridgian and Portlandian, occasional singletons of species diagnostic of the immediately underlying zones may represent either reworking or the persistence in low numbers of the species into younger strata.

In the Lower Cretaceous interval, from 5900 to 3370ft, there is no evidence of Berriasian-Valanginian strata. Rare individuals of species diagnostic of these stages on the Scotian Shelf were noted in the upper part of the Hauterivian and in the Barremian intervals, but these are considered to be reworked. The Hauterivian and Barremian intervals are relatively thin (both less than 350ft), although the Barremian may extend to 4870ft if specimens of Barremian and older species recorded at and below 4870ft are *in situ*. Aptian and Albian strata are well developed in the well.

The Upper Cretaceous interval (3310-970ft) appears to include a complete Cenomanian to Maastrichtian succession with the exception of the Turonian which could not be recognized palynologically. Reworked Early Cretaceous dinocyst and spore species are common in the Upper Cretaceous and are generally well preserved.

Selected palynomorphs

970-1360': *Dinogymnium euclaensis* Zone (Maastrichtian)

Areoligera cf. *A. senonensis, Cannosphaeropsis* sp. Wilson, 1971, *Ceratiopsis diebelii, Cyclonephelium distinctum, Hystrichosphaeridium tubiferum, Isabelidinium bakeri, I. belfastense, Membranilarnacia* sp. Wilson, 1971, *Odontochitina costata* (one specimen at 1240ft, probably reworked), *Oligosphaeridium complex, Palaeocystodinium australinum, Spongodinium delitiense.*

Also present in this interval are reworked specimens of the spores *Cicatricosisporites hughesi* and *Vitreisporites pallidus.* A single specimen of the Campanian and older dinocyst *Odontochitina costata* was noted at 1240ft and is either reworked or indicates the presence of Campanian strata at 1240ft.

1420-2230': *Odontochitina operculata* Zone (Campanian)

Dinogymnium acuminatum, D. digitus, Hystrichodinium pulchrum, Odontochitina operculata, Spinidinium sverdrupianum, Trichodinium castaneum, Xenascus ceratioides.

Also present in this interval is a reworked specimen of the Early Cretaceous species *Appendicisporites problematicus.*

2290-2410': *Cordosphaeridium truncigerum* Zone (Santonian)

Canningia reticulata, Chantangiella victoriensis, Isabelidinium cooksoniae, Rugubivesiculites reductus, R. rugosus, Surculosphaeridium longifurcatum (rare, may be reworked).

Reworked specimens of Early Cretaceous dinocysts and spores are common in this interval and include the species *Appendicisporites jansonii, Cicatricosisporites hughesi, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Densoisporites velatus,* and *Schizosporis reticulatus.*

2470-2860': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Cyclonephelium vannophorum, Oligosphaeridium pulcherrimum, Spinidinium vestitum.

Also present are reworked specimens of the Early Cretaceous spores *Cicatricosisporites annulatus* and *Taurocusporites segmentatus.*

2920-3310': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Cicatricosisporites hughesi, Costatoperforosporites foveolatus, Cyclonephelium vannophorum* (abundant), *Dinopterygium cladoides, Epelidosphaeridia spinosa, Kleithriasphaeridium loffrense, Oligosphaeridium totum, Palaeoperidinium cretaceum, Surculosphaeridium longifurcatum* (abundant).

Also present in the sample at 3010-3040ft is a reworked specimen of the typically Barremian and older dinocyst *Muderongia tetracantha.*

3370-4210': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites problematicus, Concavissimisporites punctatus, Cribroperidinium edwardsii, C. intricatum, C. orthoceras, Cyclonephelium eisenackii, Gonyaulacysta episoma, Hystrichosphaeridium cooksoniae, Klukisporites foveolatus, Lycopodiumsporites austroclavitidites, Schizosporis reticulatus, Spinidinium cf. *S. vestitum, sensu* Williams, 1975, *Trilobosporites apiverrucatus, Xiphophoridium alatum.*

A number of species in this interval may represent reworking or an extension of their ranges into the *S.* cf. *S. vestitum-E. minor* Zone. All occur commonly in the well below the *S.* cf. *S. vestitum-E. minor* Zone, but are rare and only sporadically present between 3370 and 4210ft. They include *Aptea attadalica, Callialasporites dampieri, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, Densoisporites velatus, Muderongia simplex,* and *Subtilisphaera pirnaensis.*

4270-4800': *Subtilisphaera perlucida-Systematophora schindewolffii* Zone (Aptian)

Aptea attadalica, Callialasporites dampieri, Cicatricosisporites australiensis, Endoscrinium campanulum (common at 4370ft), *Subtilisphaera pirnaensis, Systematophora schindewolfii.*

4670-4800': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica (abundant), *Callialasporites trilobatus, Cerebropollenites mesozoicus, Costatoperforosporites foveolatus, Ephedra* sp., *Gonyaulacysta serrata, Muderongia simplex* (rare, may be reworked), *Pareodinia ceratophora* (rare, may be reworked), *Pilosisporites verus, Subtilisphaera pirnaensis.*

4870-5300': Barremian-early Aptian

Aequitriradites spinulosus, A. verrucosus, Muderongia simplex, M. tetracantha, Pseudoceratium nudum, P. pelliferum.

Also present in the interval are probably reworked specimens of the species *Ctenidodinium culmulum* and *Dingodinium cerviculum.*

5370-5500': *Doidyx anaphrissa* Zone (Barremian)

Batioladinium jaegeri, Muderongia simplex (abundant).

Also present in the interval are reworked specimens of the species *Ctenidodinium culmulum, Gonyaulacysta jurassica,* and *Phoberocysta neocomica.*

5570-5900': Neocomian (probably Hauterivian only)

Ctenidodinium elegantulum, Dingodinium cerviculum, Occisucysta sp., *Phoberocysta* sp.

Specimens of the following Berriasian-Valanginian or Jurassic species recorded in the interval are considered to be reworked: *Achomosphaera neptuni* at 5570 and 5770ft, *Ctenidodinium pachydermum* at 5870ft, *C. culmulum* at 5870ft, and *C. panneum* 5570ft. There is no evidence of Berriasian-Valanginian strata in the well and the Berriasian-Valanginian species *Phoberocysta neocomica* and *Achomosphaera neptuni* recorded at 5370, 5570, and 5770ft are probably reworked.

5970-6100': *Ctenidodinium panneum* Zone (Portlandian)

Callialasporites trilobatus (common), *Cerebropollenites mesozoicus* (abundant), *Classopollis classoides, Densoisporites velatus* (common), *Ctenidodinium culmulum* (common), *C. panneum, Epiplosphaera bireticulata, Gonyaulacysta granulata, Hystrichodinium* cf. *H. pulchrum, Senoniasphaera jurassica* (rare), *Tenua villersensis.*

6170-6900': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Adnatosphaeridium cf. *A. caulleryi, Gonyalacysta cladophora* (abundant), *Occisucysta* sp., *Parvocavatus tuberosus, ?Phthanoperidinium* spp., *Pilosisporites* sp. A Bujak and Williams, 1977, *Senoniasphaera jurassica* (abundant), *Systematophora areolata, S. complicata, S. fasciculigera, S. turonica, Wallodinium* spp.

Also present in the interval at 6870ft is a possibly reworked specimen of the species *Leptodinium egemenii.*

6970-7470': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Chytroeisphaeridia chytroeides, Endoscrinium eisenackii, Gonyaulacysta jurassica (rare), *Hystrichogonyaulax nealei, Leptodinium egemenii, Scriniodinium crystallinum* (rare), *Tubotuberella apatela.*

7470-7620': *Valensiella vermiculata* Zone (Callovian)

Cerebropollenites sp., *Compositosphaeridium costatum, Ctenidodinium ornatum.*

A single specimen of the Pliensbachian and older spore *Kraeuselisporites reissingeri* present in this interval is considered reworked.

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Shell
ONEIDA O-25

GSC locality: D3

Location: 43°14'57.36"N; 61°33'36.49"W

RT elevation: 85' Water depth: 270'

Casing set at: 791, 2422, and 6836'

Total depth: 13484' Interval studied: 900-13104'

Analyzed by: G.L. Williams

The palynological analysis of 205 sidewall and cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

900- 1205'	middle-late Miocene
1290- 1545'	*Apteodinium* sp. B Zone (early Miocene)
1610- 2050'	*C. dispersum* Zone (middle-late Oligocene)
2130- 2255'	*D. heterophlycta* Zone (early Oligocene)
2255- 2285'	?Eocene
2285- 2440'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
2450- 3760'	*D. euclaensis* Zone (Maastrichtian)
3790- 4022'	*O. operculata* Zone (Campanian)
4039- 4312'	*C. truncigerum* Zone (Santonian)
4404- 4520'	*O. pulcherrimum* Zone (Coniacian)
4550- 4620'	*S. longifurcatum* Zone (Turonian)
4620- 6330'	*C. polypes* Zone (Cenomanian)
6420- 6970'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
6420- 6593'	*R. rugosus* Subzone (late Albian)
6621- 6971'	early Albian
7000- 8353'	*S. perlucida-S. schindewolfii* Zone (Aptian)
8410- 8890'	*D. anaphrissa* Zone (Barremian)
8890- 9430'	*C. elegantulum* Zone (Hauterivian)
9430- 9600'	Berriasian-Valanginian?
9600- 9930'	*C. panneum* Zone (Portlandian)
10005-11000'	*G. cladophora* Zone (Kimmeridgian)
11000-11930'	age indeterminate
11930-12100'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
12130-12360'	*V. vermiculata* Zone (Callovian)
12360-13104'	barren

Given (1977) erected the Mohican Formation and defined the type section as the interval 13 483 to 12 680ft in Oneida O-25. The age of this interval has not been determined palynologically because of the paucity of the assemblages. Williams (1975) stated that in Oneida O-25, from ?13 104 to 11 354ft was Middle Jurassic, 11 354 to 11 000ft Oxfordian and 11 000 to 10 005ft Kimmeridgian. Subsequently more detailed analysis has shown that the Callovian-Oxfordian boundary lies between 12 130 and 12 100ft. It therefore appears probable that at least the upper part of the Mohican Formation is Callovian.

The Middle and Upper Jurassic sediments in Oneida O-25 are overlain by a more or less complete Cretaceous section, with probably much of the Berriasian-Valanginian being absent. The top of the Campanian, according to Ascoli (1977) and based on calcareous benthic foraminifera, is at 2990ft. Presumably the palynological pick represents depressed tops, reflecting environmental control. The Tertiary record appears to be somewhat discontinuous, although caved late Paleocene-Eocene palynomorphs suggest that sediments of this age are present but represent a condensed sequence. This is confirmed by Ascoli (1977) who recovered Eocene calcareous benthic foraminifera from 2225 to 2285ft in this well.

No paleoecological determinations based on palynomorphs have been made.

Selected palynomorphs

900-1205': middle-late Miocene

Caryapollenites simplex, Cyclopsiella elliptica, Hemicystodinium zoharyi, Homotryblium plectilum, Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Operculodinium centrocarpum, Palaeocystodinium golzowense, Polysphaeridium pastielsii, Spiniferites mirabilis, S. pseudofurcatus.

Reworked Albian-Cenomanian species are common in the interval 900-1115ft.

1290-1545': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Cordosphaeridium cantharellum, Distatodinium paradoxum, sensu* Benedek, 1972, *Ilexpollenites* sp. A Williams and Brideaux, 1975, *Periporopollenites* sp. Z Williams and Brideaux, 1975, *Tricolporites* sp. D Williams and Brideaux, 1975.

1610-2050': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium aspinatum, C. dispersum, C. lobospinosum, Cordosphaeridium minimum, Dinopterygium cladoides, sensu Morgenroth, 1966a, *Pentadinium laticinctum* subsp. *granulatum, Rhombodinium intermedium, Sapotaceoipollenites* sp., *Systematophora ancyrea, Tectatodinium* sp. Benedek, 1972, *Thalassiphora delicata.*

2130-2255': *Deflandrea heterophlycta* Zone (early Oligocene)

Cyclonephelium exuberans, Deflandrea phosphoritica, D. spinulosa, D. sp. C Williams and Bujak, 1977b, *Kisselovia* cf. *K. coleothrypta, Polysphaeridium simplex, Thalassiphora pelagica, Wilsonidium* cf. *W. lineidentatum.*

Reworked Albian-Cenomanian species are present in the cuttings sample from 2130-2160ft.

2285-2440': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Areoligera senonensis, Ceratiopsis diebelii, Cordosphaeridium gracile, C. inodes, C. sp. 2 Gocht, 1969, *Cyclonephelium ordinatum, Hystrichosphaeridium tubiferum, Hystrichosphaeropsis ovum, Palaeoperidinium pyrophorum, Spiniferites septatus, Svalbardella* sp. Wilson, 1971, *Tanyosphaeridium variecalamum.*

The sidewall core at 2332ft contains a mixed Paleocene-Oligocene suite. However, the cuttings sample at 2285-2315ft has abundant specimens of *Palaeoperidinium pyrophorum* which is not known from post-early Paleocene sediments. This sample is therefore assumed to be Paleocene. *Cordosphaeridium gracile,* which is abundant in the cuttings sample at 2410-2440ft has seldom been recorded from sediments older than late Paleocene and does not range into the Oligocene. Its presence in such numbers may indicate a thin wedge of late Paleocene or Eocene higher up the hole.

2450-3760': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia acuminata, Chatangiella tripartita, Cyclonephelium distinctum, Deflandrea sp. Wilson, 1971, *Dinogymnium acuminatum, D. digitus* var. A Williams and

Brideaux, 1975, *D. euclaensis, D. undulosum, Exochosphaeridium bifidum, Fibradinium* sp. A Williams and Brideaux, 1975, *Horologinella* sp., *Isabelidinium cooksoniae, Lejeunia magnifica, Rugubivesiculites reductus, R. rugosus, Spiniferites cingulatus* subsp. *cingulatus, Spongodinium delitiense.*

3790-4022': *Odontochitina operculata* Zone (Campanian)

Deflandrea sp. B Williams and Brideaux, 1975, *Exochosphaeridium striolatum, Kleithriasphaeridium loffrense, Odontochitina costata, Oligosphaeridium anthophorum, Xenascus ceratioides.*

4039-4312': *Cordosphaeridium truncigerum* Zone (Santonian)

Canningia reticulata, Chatangiella victoriensis, Oligosphaeridium sp. A Williams and Brideaux, 1975, *Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Trichodinium castaneum.*

4404-4520': *Oligosphaeridium pulcherrimum* Zone (Oligocene)

Camarozonosporites insignis, Chlamydophorella nyei, Cicatricosisporites sp., *Cyathidites australis.*

4550-4620': *Surculosphaeridium longifurcatum* Zone (Turonian)

Callaiosphaeridium asymmetricum, Surculosphaeridium longifurcatum.

4620-6330': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites bifurcatus, A. problematicus, A. tricornitatus, Cicatricosisporites hallei, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Cribroperidinium intricatum, Cyclonephelium vannophorum, Hystrichosphaeridium cooksoniae, Kalyptea* sp. A Brideaux, 1971, *Litosphaeridium siphoniphorum, Oligosphaeridium totum, Retitricolpites georgensis, R. virgeus, Spinidinium vestitum, Striatopollis paraneus, Tricolpites parvus.*

6420-6970': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

6420-6593': *Rugubivesiculites rugosus* Subzone (late Albian)

Rugubivesiculites rugosus (base), *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Trilobosporites tribotrys, Tricolpites parvus* (base).

6621-6971': early Albian

Appendicisporites unicus, Lycopodiumsporites crassimacerius, Neoraistrickia robusta, Rouseisporites triangularis.

7000-8353': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bilateralis, Aptea attadalica, Kleithriasphaeridium eoinodes, Muderongia staurota, Protoellipsodinium sp., *Pseudoceratium expolitum, Subtilisphaera perlucida, Surculosphaeridium* cf. *S. longifurcatum, sensu* Williams, 1975, *Trilobosporites trioreticulosus.*

8410-8890': *Doidyx anaphrissa* Zone (Barremian)

Cicatricosisporites brevilaesuratus, Contignisporites cooksonii, Costatoperforosporites fistulosus, C. foveolatus, Cyclonephelium distinctum subsp. *brevispinatum, Kleithriasphaeridium fasciatum, Lithodinia stoveri, Muderongia perforata, Pilosisporites trichopapillosus, Pseudoceratium pelliferum.*

8890-9430': *Ctenidodinium elegantulum* Zone (Hauterivian)

Callialasporites trilobatus, Concavissimisporites variverrucatus, Ctenidodinium elegantulum, Pareodinia ceratophora, Systematophora complicata.

9430-9600': Berriasian-Valanginian?

Re-evaluation of the interval 9200-9600ft casts considerable doubt on the presence of Berriasian-Valanginian sediments in Oneida O-25. This is at variance with Williams (1975) and Ascoli (1977).

9600-9930': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium culmulum, Lanterna sp., *Pyxidiella* sp., *Verrucosphaera* sp.

10005-11000': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Epiplosphaera reticulospinosa, Gonyaulacysta cladophora, Hystrichodinium sp., *Leptolepidites psarosus, Pareodinia ceratophora* (with kalyptra), *Pareodinia kondratjevii, Polystephanephorus sarjeantii, Senoniasphaera jurassica, Systematophora areolata, S. orbifera, Taeniophora iunctispina, Tenua* sp.

11000-11930': age indeterminate

Williams (1975) stated that in Oneida O-25, the interval 13 104?-11 354ft was Callovian and 11 354-11 000ft was Oxfordian. This was based on the stratigraphically restricted ranges of species which are now known to extend into younger sediments, from data obtained in the analysis of other wells.

11930-12100': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Adnatosphaeridium caulleryi, A. cf. *A. caulleryi, Gonyaulacysta jurassica, Tenua* sp.

12130-12360': *Valensiella vermiculata* Zone (Callovian)

Ctenidodinium continuum, C. ornatum, C. aff. *C. tenellum, sensu* Gocht, 1970, Gen. et sp. 2 Gocht, *Leptodinium subtile.*

12360-13104': barren

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Shell
PRIMROSE A-41

GSC locality: D86

Location: 44°00'05.68"N; 59°06'18.26"W

RT elevation: 98' Water depth: 360'

Casing set at: 1175 and 4278'

Total depth: 6101' Interval studied: 1230-6030'

Analyzed by: G.L. Williams

Palynological analysis of 6 conventional core, 65 sidewall core and 64 cuttings samples from the subject well has indicated the following age determinations and

biostratigraphic zonation:

1230- 1620' *Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1680- 2094' *Cannosphaeropsis* sp. A Zone (late Miocene)
2130- 2340' *P. laticinctum* Zone (middle Miocene)
2400- 2675' *Apteodinium* sp. B Zone (early Miocene)
2724' *C. dispersum* Zone (middle-late Oligocene)
2760- 3046' *D. heterophlycta* Zone (early Oligocene)
3113- 3600' *D. colligerum* Zone (late Eocene)
3668- 3690' *A. reticulense* Zone (middle Eocene)
3815- 3928' *A. senonensis* Zone (early Eocene)
3930- 4395' *C. speciosa* Zone (late Paleocene)
4420- 4520' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
4600- 4820' *D. euclaensis* Zone (Maastrichtian)
4829- 4965' *O. operculata* Zone (Campanian)
4970- 5150' *C. truncigerum* Zone (Santonian)
5153- 5305' *O. pulcherrimum* Zone (Coniacian)
5320' Cenomanian-Turonian
5480- 5910' *C. polypes* Zone (Cenomanian)
5910- 6030' *S.* cf. *S. vestitum-E. minor* Zone (Albian)

Shell Primrose A-41 encountered Argo salt at 6057ft. The well was subsequently abandoned at 6101ft and plugged back to 4091ft from where la-A-41 was directionally drilled parallel to the salt flank. The oldest datable sediments overlying the Argo salt in A-41 are Albian. These are sequentially overlain by a more or less complete Upper Cretaceous-Tertiary sequence although the presence of the Turonian is questionable. The Cenomanian is considerably thicker than the other Upper Cretaceous Stages. In the Tertiary the middle Eocene and middle to upper Oligocene sediments are very thin. Reworked species are common throughout the well and particularly in the Miocene and Plio-Pleistocene.

The paleoenvironmental data are obtained from sidewall cores. Schizeaceous spores occur throughout the Albian-Cenomanian, with bivesiculates being abundant in a sidewall core at 5320ft. In the overlying sidewall core (5305ft) spores and pollen are absent, only dinocysts being present. This predominance of dinocysts persists throughout the Late Cretaceous possibly indicating deposition in deeper water or further from shore. There is an influx of pollen in the late Paleocene interpreted as reflecting possible shallowing of the environment. Throughout the Eocene-Oligocene dinocysts predominate with spores and pollen being rare or absent. Deposition was presumably far from shore. The onset of shallower water, closer to shore deposition in the Miocene is suggested by the reappearance of spores and pollen plus the presence of reworked species. Reworking reaches a peak in the Plio-Pleistocene. The age of most of the reworked material ranges from Aptian to Miocene, with Senonian species being most abundant. In the cuttings sample from 1440-1410ft are a Chitinozoan specimen and *Veryhachium* sp., both reworked from Lower Paleozoic sediments.

Selected palynomorphs

1230-1620': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Pinus spp., *Spiniferites ramosus*.

Reworked species include *Aptea attadalica, A. polymorpha, Ceratiopsis speciosa, Chatangiella victoriensis, Cicatricosisporites hughesi, Cordosphaeridium funiculatum, Extratriporopollenites* sp., *Isabelidinium belfastense, Pilosisporites trichopapillosus, Systematophora ancyrea, Veryhachium trispinosum, Vitreisporites pallidus,* and *Wilsonidium echinosutura-tum*. There is also a single chitinozoan in the cuttings sample 1410-1440ft.

1680-2094': *Cannosphaeropsis* sp. A Zone (late Miocene)

Apteodinium sp. Gocht, 1969, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Operculodinium centrocarpum, O. israelianum, Spiniferites pseudofurcatus, S. scabratus, Systematophora ancyrea*.

Reworked species include *Chatangiella victoriensis, Cleistosphaeridium polypes, Hystrichosphaeridium tubiferum, Oligosphaeridium anthophorum, O. pulcherrimum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Surculosphaeridium longifurcatum,* and *Wetzeliella* sp. B Williams and Brideaux, 1975.

2130-2340': *Pentadinium laticinctum* Zone (middle Miocene)

Cordosphaeridium multispinosum, Pentadinium laticinctum, Tanyosphaeridium sp. A Williams and Brideaux, 1975, *Tuberculodinium vancampoae*.

2400-2675': *Apteodinium* sp. B Zone (early Miocene)

Caryapollenites simplex, Cordosphaeridium cantharellum, Hystrichosphaeropsis obscura.

2724': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Pentadinium laticinctum granulatum.

2760-3046': *Deflandrea heterophlycta* Zone (early Oligocene)

Apteodinium sp. B Williams and Brideaux, 1975, *Chiropteridium aspinatum, Deflandrea* cf. *D. spinulosa, Distatodinium paradoxum, Hystrichokolpoma eisenackii, Palaeocystodinium golzowense, Polysphaeridium pastielsii, Wetzeliella* sp. A Williams and Brideaux, 1975.

3113-3600': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium reticulense (2 specimens at 3474ft), *Areosphaeridium arcuatum, Cyclonephelium* sp. B Williams and Brideaux, 1975, *Cyclopsiella trematophora, Deflandrea* sp. C Williams and Bujak, 1977b, *Diphyes colligerum, Distatodinium ellipticum, Hystrichokolpoma cinctum, Leptodinium incompositum, L. victorianum, Phthanoperidinium comatum, Polystephanephorus* sp., *Rhombodinium draco, Tectatodinium pellitum*.

3668-3690': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium reticulense, A. vittatum, Apectodinium homomorphum (2 specimens at 3668ft), *Areoligera medusettiformis, Cordosphaeridium cracenospinosum*.

3815-3928': *Areoligera senonensis* Zone (early Eocene)

Comasphaeridium cf. *C. cometes, Nematosphaeropsis balcombiana*.

3930-4395': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis speciosa, Cordosphaeridium fibrospinosum, Deflandrea dartmooria, D. cf. *D. denticulata, Extratriporopollenites* sp., *Hystrichosphaeridium tubiferum, Podocarpidites* sp., *Polysphaeridium simplex, Spiniferites septatus, Turbiosphaera filosa*.

Reworked species include *Palaeohystrichophora infusorioides* and *Palaeoperidinium pyrophorum*.

4420-4520': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Amphidiadema sp., *Ceratiopsis diebelii*, *Fibradinium annetorpense*, *Isabelidinium bakeri* (1 specimen at 4510-4520ft), *Microdinium saeptum*, *Palaeocystodinium benjaminii*, *Palaeoperidinium pyrophorum*, *Spiniferites cingulatus*, *Tanyosphaeridium magdalium*.

4600-4820': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia macrocysta, *Amphidiadema* cf. *A. nucula*, *Cannosphaeropsis utinensis*, *Cordosphaeridium* cf. *C. gracile*, *sensu* Williams, 1975, *Exochosphaeridium bifidum*, *Hystrichosphaeropsis ovum*, *Hystrichosphaeridium* sp. A Williams and Bujak, 1977b, *Isabelidinium belfastense*, *Lejeunia tricuspis*, *Spiniferites cingulatus* (common), *S. scabrosus*, *Svalbardella* sp. Wilson, 1971, *Trithyrodinium* sp.

4829-4965': *Odontochitina operculata* Zone (Campanian)

Alterbia acuminata, *Ceratiopsis diebelii* (base), *Chatangiella vnigri*, *Cleistosphaeridium huguoniotii*, *Cyclonephelium distinctum*, *Dinogymnium westralium*, *Exochosphaeridium striolatum*, *Gillinia hymenophora*, *Isabelidinium cooksoniae*, *Microdinium ornatum*, *Odontochitina costata*, *O. operculata*, *Palaeohystrichophora infusorioides*, *Palaeostomocystis fragilis*, *Spinidinium* cf. *S. echinoideum*, *Trichodinium castaneum*, *Xenascus ceratioides*.

Reworked species include *Dinopterygium cladoides*, *Hystrichosphaeridium arundum*, *Oligosphaeridium pulcherrimum*, and *Vitreisporites pallidus*.

4970-5150': *Hystrichosphaeridium truncigerum* Zone (Santonian)

Coronifera oceanica, *Cribroperidinium edwardsii*, *Dinogymnium undulosum*, Forma P. Evitt, 1967, *Gardodinium deflandrei*, *Hystrichosphaeridium difficile*, *Kleithriasphaeridium loffrense*, *Odontochitina* cf. *O. costata*, *O. porifera*, *Silicisphaera ferox*, *Stephodinium coronatum*, *Triblastula utinensis*.

5153-5305': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Caligodinium aceras, *Callaiosphaeridium asymmetricum*, *Chatangiella victoriensis*, *Dinopterygium cladoides*, *Florentinia mantellii*, *Hystrichosphaeridium bowerbankii*, *H. paracostatum*, *Hystrichosphaeropsis ovum* (common), *Oligosphaeridium* cf. *O. pulcherrimum*, *Rugubivesiculites rugosus*, *Senoniasphaera protrusa*, *Surculosphaeridium longifurcatum*, *Tenua* sp.

5320': Cenomanian-Turonian

Alisporites sp., *Appendicisporites* sp., *Canningia colliveri*, *Cicatricosisporites hughesi*, *Rouseisporites reticulatus*.

5480-5910': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, *Cleistosphaeridium polypes*, *C. polypes* subsp. A Williams, 1975, *Cribroperidinium* cf. *C. intricatum*, *Cyclonephelium hughesii*, *C. paucispinum*, *C. vannophorum*, *Oligosphaeridium totum*, *Palaeoperidinium cretaceum*, *P.* sp. A Bujak and Williams, 1978.

5910-6030': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites jansonii, *A. problematicus*, *Cicatricosisporites hallei*, *Endoscrinium campanulum*.

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Shell
PRIMROSE 1a-A-41

GSC locality: D97

Location: 44°00'05.68"N; 59°06'18.26"W

RT elevation: 98' Water depth: 360'

Casing set at: 6929'

Total depth: 11865' Interval studied: 4512-11865'

Analyzed by: G.L. Williams

Palynological analysis of two conventional core, 47 sidewall core and 59 cuttings samples from the subject well has indicated the following age determinations and biostratigraphic zonation:

4512'	*C. speciosa* Zone (late Paleocene)
4680'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
4988- 5047'	*C. truncigerum* Zone (Santonian)
6060- 6290'	*C. polypes* Zone (Cenomanian)
6360- 6790'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
6829'	*D. euclaensis* Zone (Maastrichtian)
6860- 7090'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
7160- 8090'	Early Jurassic (Hettangian-Pliensbachian)
8143'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
8160- 8590'	Early Jurassic (Hettangian-Pliensbachian)
8660- 8890'	barren
8960- 9190'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
9260-11500'	*S. perlucida-S. schindewolfii* Zone (Aptian)
10360-11500'	*A. attadalica* Subzone (early Aptian)
11513-11865'	*D. anaphrissa* Zone (Barremian)

Shell Primrose A-41 was abandoned at 6101ft and plugged back to 4091ft from where 1a-A-41 was directionally drilled parallel to the flank of a salt diapir. The palynostratigraphy indicates that 1a-A-41 bottomed in Barremian sediments. These are overlain by the typical Scotian Shelf early Aptian assemblages from 11 500 to 10 360ft, which are characteristic of the Naskapi shale. The Aptian is over 2200ft thick in Primrose 1a-A-41, probably due to the very high dip readings of 72° to 90° prevailing on the flank of the diapir. The overlying Albian sediments alternate with Lower Jurassic sediments which lithologically and age wise correlate with the Iroquois Formation. Presumably this material was brought up by the salt during intrusion and now in part flanks the salt. The intervals dated Early Jurassic have a Thermal Alteration Index (TAI) of 4- with the spores and pollen being black.

The Albian intermittently extends from 9190 to 6360ft, with Lower Jurassic sediments from 8590 to 8160ft and 8090 to 7160ft and Maastrichtian in a sidewall core at 6829ft. The overlying Cenomanian is considerably thinner (about 230ft) possibly indicating that it was less affected by salt tectonics in 1a-A-41, or simply reflecting inadequate sample coverage, since there is no control from 6060 to 5047ft. The youngest datable sediments at 4512ft are late Paleocene.

The paleoenvironment (based on sidewall cores) during the Barremian was shallow water marine to nonmarine with some high concentrations of bivesiculates. A marine transgression in the early Aptian correlates with an influx of dinocysts from 10 815 to 10 350ft. Palynomorphs are too rare in the sidewall cores from the interval 10 350 to 8447ft to allow interpretations concerning paleoenvironment. The cuttings samples up to 9160ft however have very high bivesiculate counts and a high percentage of hylogen commonly equated with the influx of terrigenous organic matter. The conventional core at 8143ft contains a late Albian palyno-

morph assemblage with several bivesiculates and a few dinocysts. Depositional environment was shallow marine. The "overlying" Lower Jurassic Iroquois Formation contains numerous carbonized specimens of the pollen *Classopollis classoides*. Unfortunately carbonization of the palynomorphs precludes recognition of other species so that environmental interpretations are not possible. The Albian, above 7090ft and the Cenomanian sidewall cores contain very few palynomorphs.

However the cuttings samples have rich and diverse dinocyst assemblages with few spores and pollen. Deposition is interpreted as being in a shallow water marine environment. The Santonian and Paleocene are characterized by a preponderance of dinocysts, with pollen being rare or absent. This suggests deposition in deeper water or further from shore.

Selected palynomorphs

4512': *Ceratiopsis speciosa* Zone (late Paleocene)

Areoligera medusettiformis, Baltisphaeridium sp., *Ceratiopsis speciosa, Spiniferites ramosus.*

4680': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Hystrichokolpoma sequanaportus, Hystrichosphaeridium tubiferum, Isabelidinium bakeri, Spiniferites scabrosus.

4988-5047': *Cordosphaeridium truncigerum* Zone (Santonian)

Dinogymnium euclaensis, D. westralium, Dinopterygium cladoides, Exochosphaeridium bifidum, Fibradinium annetorpense, ?Hexagonifera chlamydata, Hystrichodinium pulchrum, Odontochitina costata, O. porifera, Palaeohystrichophora infusorioides, Spiniferites cingulatus, Tanyosphaeridium variecalamum, Xenascus ceratioides, Xiphophoridium alatum.

6060-6290': *Cleistosphaeridium polypes* Zone (Cenomanian)

Callaiosphaeridium asymmetricum, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Cribroperidinium intricatum, C. orthoceras, Cyclonephelium vannophorum, Epelidosphaeridia spinosa, Hystrichosphaeridium cooksoniae, Oligosphaeridium pulcherrimum, Palaeoperidinium* sp. A Bujak and Williams, 1978, *Rugubivesiculites rugosus, Spiniferites porosus, Surculosphaeridium longifurcatum.*

6360-6790': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites problematicus, Caligodinium aceras, Camarozonosporites insignis, Cicatricosisporites hallei, Dinopterygium cladoides, Hystrichosphaeridium sp. A Bujak and Williams, 1978, *Oligosphaeridium anthophorum, O. complex, Osmundacidites wellmanii, Palaeoperidinium cretaceum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Surculosphaeridium* cf. *S. longifurcatum, sensu* Williams, 1975, *Trichodinium castaneum.*

6829': *Dinogymnium euclaensis* Zone (Maastrichtian)

Ceratiopsis diebelii, Fibradinium annetorpense, Hystrichosphaeridium sp. A Williams and Bujak, 1977b, *Subtilidinium minutum.*

6860-7090': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Alisporites grandis, Coronifera oceanica.

7160-8090': Early Jurassic (Hettangian-Pliensbachian)

Classopollis classoides (abundant), *Tasmanites* sp.

8143': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Exochosphaeridium striolatum, Rugubivesiculites reductus, R. rugosus.

8160-8590': Early Jurassic (Hettangian-Pliensbachian)

Classopollis classoides.

8660-8890': barren

8960-9190': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Cyclonephelium eisenackii.

9260-11500': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea polymorpha, Callialasporites dampieri, Cerebropollenites mesozoicus, Cicatricosisporites augustus, C. hughesi, Coronatispora valdensis, Cribroperidinium muderongense, Oligosphaeridium albertense, Subtilisphaera perlucida, S. pirnaensis, sensu Millioud, 1969, *Systematophora schindewolfii, Trilobosporites apiverrucatus, Vitreisporites pallidus, V.* sp. *sensu* Singh, 1971.

Reworked species include *Gonyaulacysta serrata* and *Muderongia simplex.*

10360-11500': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica, A. polymorpha (common), *Canningia colliveri, Gardodinium trabeculosum* (one specimen at 10 815ft), *Klukisporites pseudoreticulatus, Oligosphaeridium* cf. *O. complex, sensu* Williams, 1978, *Pareodinia ceratophora* (one specimen at 10 960ft), *Pilosisporites trichopapillosus, P. verus, Spiniferites speciosus, Trilobosporites purverulentus.*

Reworked species include *Muderongia perforata* and *Pseudoceratium pelliferum.*

11513-11865': *Doidyx anaphrissa* Zone (Barremian)

Cicatricosisporites australiensis, Callialasporites dampieri (common), *Contignisporites cooksonii, Densoisporites velatus, Muderongia simplex, Oligosphaeridium perforatum, Pseudoceratium pelliferum.*

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Mobil
SABLE ISLAND C-67

GSC locality: D1

Location: 43°56'04.9"N; 59°55'01.4"W

KB elevation: 27' Ground level: 12.64'

Casing set at: 563, 3012, 10690, and 14902'

Total depth: 15106' Interval studied: 178-14899'

Analyzed by: G.L. Williams

Palynological analysis of 249 sidewall core and 150 cuttings samples from the subject well indicates the

following age determinations and biostratigraphic zonation:

178- 860'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
892- 1272'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1295- 1334'	*P. laticinctum* Zone (middle Miocene)
1350- 1545'	*Apteodinium* sp. B Zone (early Miocene)
1569- 2430'	*C. dispersum* Zone (middle-late Oligocene)
2460- 2630'	*D. heterophlycta* Zone (early Oligocene)
2700- 3130'	*D. colligerum* Zone (late Eocene)
3186- 3420'	*A. senonensis* Zone (early Eocene)
3423- 3804'	*C. speciosa* Zone (late Paleocene)
3900- 4025'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
4104- 4430'	*D. euclaensis* Zone (Maastrichtian)
4468- 4516'	*O. operculata* Zone (Campanian)
4635- 4745'	*C. truncigerum* Zone (Santonian)
4926'	*O. pulcherrimum* Zone (Coniacian)
4938'	*S. longifurcatum* Zone (Turonian)
5126- 5742'	*C. polypes* Zone (Cenomanian)
5844- 8121'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
5844- 7014'	*R. rugosus* Subzone (late Albian)
7016- 8121'	early Albian
8121- 9180'	*S. perlucida-S. schindewolfii* Zone (Aptian)
9280-10166'	*D. anaphrissa* Zone (Barremian)
10564-12140'	*C. elegantulum* Zone (Hauterivian)
12220-14258'	*P. neocomica* Zone (Berriasian-Valanginian)
14258-14899'	Portlandian?-Berriasian

Mobil Sable Island C-67 reached total depth at 15 106ft in sediments which have not been dated precisely. According to the contained palynomorphs the interval 14 899-14 258ft is Portlandian?-Berriasian Ascoli (1977) stated that the arenaceous benthic fauna recovered from 14 258 to 14 150ft was Tithonian. Sequentially overlying these sediments is a more or less complete Cretaceous-Tertiary sequence. It is possible that part of the Campanian, the middle Eocene and Pliocene are absent. Alternatively they may be represented by condensed sequences.

Paleoenvironmental determinations are included in the following section:

Selected palynomorphs

178-860': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Alnipollenites verus, Ambrosia sp., *Artemisia* sp., *Carpinipites* sp. B Williams and Brideaux, 1975, *Caryapollenites simplex, Ilexpollenites* sp. A Williams and Brideaux, 1975, *Operculodinium centrocarpum* (one specimen), *Periporopollenites* sp. Z Williams and Brideaux, 1975, *Pinus* spp., *Pollenites pseudolaesus.*

This is interpreted to be a non-marine sequence which is characterised by a high degree of reworked Cretaceous species. These include *Chatangiella tripartita, Cicatricosisporites hallei, Classopollis classoides, Dinogymnium digitus,* and *Rugubivesiculites rugosus.*

892-1272': *Cannosphaeropsis* sp. A Zone (late Miocene)

Artemisia sp. (base), *Betulaepollenites* sp., *Hystrichokolpoma rigaudiae, Lingulodinium* cf. *L. machaerophorum, Operculodinium* cf. *O. israelianum, Palaeocystodinium golzowense.*

The depositional environment in the interval 892-925ft is marine. There are very few dinocysts between 993 and 1272ft, which may indicate deeper water conditions.

1295-1334': *Pentadinium laticinctum* Zone (middle Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Pentadinium laticinctum, Spiniferites mirabilis.*

1350-1545': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux, 1975, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Hemicystodinium zoharyi, Ulmipollenites* sp.

Reworked species include *Camarozonosporites insignis, Chiropteridium aspinatum, Deflandrea heterophlycta,* and *Rugubivesiculites reductus.*

1569-2430': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium aspinatum, C. dispersum, Deflandrea phosphoritica, Homotryblium plectilum, Lingulodinium machaerophorum, Palaeocystodinium cf. *P. golzowense, Pentadinium laticinctum granulatum, Rhombodinium intermedium, Wetzeliella* sp. B Williams and Brideaux, 1975.

Dinocysts are abundant at 2292 and 2460ft. The environment is open marine with shallower water conditions indicated at 2460ft.

2460-2630': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium aspinatum (abundant), *C. lobospinosum, Cordosphaeridium cantharellum, Deflandrea heterophlycta, Dinopterygium cladoides, sensu* Morgenroth 1966, *Distatodinium ellipticum, Eocladopyxis peniculatum, Polysphaeridium pastielsii, Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Thalassiphora pelagica, Wetzeliella articulata, W. lunaris.*

2700-3130': *Diphyes colligerum* Zone (late Eocene)

Cordosphaeridium fibrospinosum, Cyclonephelium intricatum, Deflandrea spinulosa, Diphyes colligerum, Distatodinium craterum, Pentadinium laticinctum granulatum (base), *Pyxidiella* sp., *Systematophora ancyrea.*

The sediments in this interval were deposited in a near shore, in part non-marine, environment.

3186-3420': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (abundant), *Areoligera senonensis, sensu* Gocht 1969, *Comasphaeridium* cf. *C. cometes, sensu* Williams and Brideaux, 1969, *Deflandrea hialina, Duosphaeridium nudum, Kisselovia coleothrypta.*

3423-3804': *Ceratiopsis speciosa* Zone (late Paleocene)

Apectodinium homomorphum (base), *Ceratiopsis speciosa, Cordosphaeridium* sp. 2 Gocht, *Cyclonephelium pastielsii* (base), *Extratriporopollenites* spp., *Hystrichosphaeridium salpingophorum, Operculodinium* cf. *O. hirsutum, sensu* Gocht 1969, *Spiniferites septatus, Triatriopollenites* sp. A Williams and Brideaux, 1975, Triporate Type O Williams and Brideaux, 1975.

3900-4025': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Deflandrea delineata, Eisenackia circumtabulata, Palaeocystodinium benjaminii, Palaeoperidinium pyrophorum.

4104-4430': *Dinogymnium euclaensis* Zone (Maastrichtian)

Areoligera senonensis (abundant), *Ceratiopsis striata, Chatangiella tripartita, Cordosphaeridium* cf. *C. gracile, sensu* Williams, 1975, *Dinogymnium curvatum, D. undulosum, Hystrichosphaeridium tubiferum, Palaeostomocystis fragilis, Rugubivesiculites reductus, R. rugosus.*

4468-4516': *Odontochitina operculata* Zone (Campanian)

Achomosphaera sagena, Cannosphaeropsis utinensis, Hystrichosphaeridium sp. A Williams and Bujak, 1977b, *Isabelidinium cooksoniae, Kleithriasphaeridium loffrense, Odontochitina operculata, Spinidinium* cf. *S. echinoideum, Spiniferites cingulatus, Tanyosphaeridum variecalamum.*

4635-4745': *Cordosphaeridium truncigerum* Zone (Santonian)

Alterbia acuminata, Canningia reticulata, Chatangiella victoriensis, Chlamydophorella sp. A Bujak and Williams, 1978, *Cordosphaeridium truncigerum, Dinogymnium acuminatum, D. heterocostatum, Dinopterygium cladoides, Odontochitina costata, Oligosphaeridium complex, O.* sp. A Williams and Brideaux, 1975, *Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Stephodinium coronatum, Trichodinium castaneum, Xenascus ceratioides.*

The environment of deposition is interpreted as open marine.

4926': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978, *Canningia* cf. *C. reticulata, Surculosphaeridium longifurcatum.*

4938': *Surculosphaeridium longifurcatum* Zone (Turonian)

Camarozonosporites insignis, Cleistosphaeridium huguoniotii, Coronifera oceanica, Heterosphaeridium heteracanthum, Litosphaeridium siphoniphorum, Psaligonyaulax deflandrei, Senoniasphaera protrusa (base), *Surculosphaeridium longifurcatum* (common).

5126-5742': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cicatricosisporites hallei, Cleistosphaeridium polypes (common), *Cribroperidinium* sp. Brideaux, 1971, *Cyclonephelium vannophorum* (common), *Kalyptea* sp. A Brideaux, 1971, *Oligosphaeridium anthophorum, O. totum, Palaeohystrichophora infusorioides, Retitricolpites georgensis.*

5844-8121': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

5844-7014': *Rugubivesiculites rugosus* Subzone (late Albian)

Appendicisporites problematicus, Callaiosphaeridium asymmetricum, Costatoperforosporites fistulosus, Cribroperidinium edwardsii, Cyclonephelium paucispinum (common at 6032ft), *Eucommiidites minor* (common at 6032ft), *Hystrichosphaeridium cooksoniae, Protoellipsodinium spinosum, Rugubivesiculites rugosus* (base), *Spinidinium vestitum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Tricolpites parvus* (base), *Trilobosporites apiverrucatus, T. trioreticulosus.*

7016-8121': early Albian

Appendicisporites bifurcatus, Cicatricosisporites annulatus, C. augustus, Concavissimisporites variverrucatus (common at 6737ft), *Hystrichosphaeridium cooksoniae* (base), *Oligosphaeridium albertense, Osmundacidites wellmanii, Senoniasphaera microreticulata, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975 (base).

8121-9180': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites spinosus, Aptea attadalica, Callialasporites trilobatus, Cribroperidinium sepimentum, Dingodinium cerviculum, Endoscrinium campanulum, Neoraistrickia truncata, Subtilisphaera perlucida, Surculosphaeridium cf. *S. longifurcatum, sensu* Williams, 1975, *Systematophora schindewolfii, Vitreisporites pallidus.*

9280-10166': *Doidyx anaphrissa* Zone (Barremian)

Callaiosphaeridium cf. *C. asymmetricum, Cyclonephelium distinctum* subsp. *brevispinatum, Doidyx anaphrissa, Gonyaulacysta serrata, Hystrichodinium voigtii, Kleithriasphaeridium eoinodes, Lithodinia stoveri, Muderongia simplex, Odontochitina operculata* (base), *Oligosphaeridium asterigerum, Pareodinia ceratophora, P. ceratophora* (with kalyptra), *Pilosisporites trichopapillosus, Polystephanephorus* sp., *Protoellipsodinium* sp., *Pseudoceratium pelliferum.*

10564-12140': *Ctenidodinium elegantulum* Zone (Hauterivian)

Batioladinium jaegeri, Ctenidodinium elegantulum, Cyclonephelium cf. *C. distinctum, C. vannophorum* (base), *Oligosphaeridium complex, Systematophora complicata, Wanaea fimbriata.*

12220-14258': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Appendicisporites problematicus (base at 13 415ft), *Biorbifera johnewingii, Canningia hirtella* (13 405-13 406ft), *Cicatricosisporites australiensis, Contignisporites cooksonii, Cyclonephelium distinctum* (base at 14 258ft), *Phoberocysta neocomica, Systematophora complicata* (base), *Trilobosporites apiverrucatus* (base at 13 415ft).

Dinocysts are absent from the interval 12 220-12 878ft which is interpreted to be non-marine. Schizeaceous spores predominate, indicating that this area was a swampy, subtropical, flat lying lowland.

14258-14899': Portlandian?-Berriasian

Present in this interval are *Appendicisporites* sp. (14 869ft), *Cicatricosisporites australiensis* (down to 14 899ft), and *Oligosphaeridium anthophorum* (14 719ft). According to Norris (1969) *C. australiensis* does not extend downwards into the Jurassic in southern England. This species is however present in the Kimmeridgian-Portlandian of the Scotian Shelf, so its presence does not rule out a Late Jurassic age for the interval 14 258-14 899ft.

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Shell
SAUK A-57

GSC locality: D29

Location: 44°16'05.70"N; 58°37'44.41"W

RT elevation: 85' Water depth: 197'

Casing set at: 876, 3320, and 7644'

Total depth: 15010' Interval studied: 1119-14350'

Analyzed by: G.L. Williams

Palynological analysis of 131 sidewall core and 69 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1119- 1706' *P. laticinctum* Zone (middle Miocene)
1862- 2078' *Apteodinium* sp. B Zone (early Miocene)

2264- 2292' *C. dispersum* Zone (middle-late Oligocene)
2464- 2495' *D. heterophlycta* Zone (early Oligocene)
2651- 3091' *D. colligerum* Zone (late Eocene)
3218- 3440' *A. reticulense* Zone (middle Eocene)
3448- 3558' *A. senonensis* Zone (early Eocene)
3610- 4000' *C. speciosa* Zone (late Paleocene)
4150- 4502' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
4652- 4776' *D. euclaensis* Zone (Maastrichtian)
4837- 5000' *O. operculata* Zone (Campanian)
5020- 5230' *C. truncigerum* Zone (Santonian)
5394- 5425' *O. pulcherrimum* Zone (Coniacian)
5522' *S. longifurcatum* Zone (Turonian)
5560- 6130' *C. polypes* Zone (Cenomanian)
6295- 7825' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
6295- 6940' *R. rugosus* Subzone (late Albian)
6987- 7825' early Albian
7914- 9656' *S. perlucida-S. schindewolfii* Zone (Aptian)
8985- 9656' *A. attadalica* Subzone (early Aptian)
9678-10294' *D. anaphrissa* Zone (Barremian)
10390-11318' *C. elegantulum* Zone (Hauterivian)
11322-13957' *P. neocomica* Zone (Berriasian-Valanginian)
13990-14090' *C. panneum* Zone (Portlandian)
14170-14350' *G. cladophora* Zone (Kimmeridgian)

Shell Sauk A-57 bottomed at 15 010ft in limestone. There are no palynological samples below 14 350ft. The interval 14 350-14 170ft is dated Kimmeridgian. The Kimmeridgian sediments are overlain by a more or less unbroken sequence ranging from the Portlandian to the middle Miocene, there being no observable breaks in the biostratigraphic record. The 100ft or so of Portlandian is overlain by over 7500ft of Lower Cretaceous sediments, with the Berriasian-Valanginian and Aptian being particularly thick.

The Upper Cretaceous is more condensed, extending from 6130 to 4652ft with all the Stages being recognised. The Tertiary is represented by thick Paleocene and Eocene sequences. Overlying this sequentially are Oligocene to middle Miocene sediments.

The contained dinocysts indicate that the Kimmeridgian sediments were deposited in a neritic environment. Although there is some indication of shallowing in the Portlandian-Valanginian, inner neritic conditions seem to have prevailed for most of this time. The Hauterivian-Barremian is characterised by slightly richer dinocyst assemblages, perhaps indicating slight deepening, or alternatively, an influx of nutrients. In the Aptian-Albian there is a reduction in dinocyst numbers although spores remain common. This may denote shallowing.

Abundant dinocysts occur at 7574, 7212, and 6987ft perhaps reflecting weak transgressions. Dinocysts occur throughout the Late Cretaceous, but spores are rare. This is taken to indicate a deeper water environment, possibly outer shelf or deeper, and distant from the existing shoreline. Pollen predominates in the Paleocene, however, the Eocene-Miocene samples generally contain a predominance of dinocysts. This may indicate the existence of very shallow marine or non-marine conditions in the late Paleocene giving way to a neritic environment in the Eocene-Miocene.

Reworked species are common in the Early Cretaceous.

Selected palynomorphs

1119-1706': *Pentadinium laticinctum* Zone (middle Miocene)

Apteodinium sp. Gocht 1969, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Hystrichokolpoma rigaudiae, Lejeunia fallax, Lingulodinium machaerophorum, Maduradinium spatiosum, Operculodinium centrocarpum, Palaeocystodinium golzowense, Polysphaeridium pastielsii, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Tsugaepollenites igniculus, Tuberculodinium vancampoae.*

1862-2078': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969 (common), *A.* sp. B Williams and Brideaux, 1975, *Cordosphaeridium cantharellum, Gonyaulacysta tenuitabulata, Tanyosphaeridium* sp. A Williams and Brideaux, 1975 (common).

2264-2292': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Cyclonephelium sp., *Spiniferites crassipellis.*

2464-2495': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium aspinatum, Cyclonephelium pastielsii, Deflandrea spinulosa, Spiniferites pseudofurcatus.

2651-3091': *Diphyes colligerum* Zone (late Eocene)

Apectodinium homomorphum, Areoligera medusettiformis, Cyclonephelium intricatum, C. ordinatum, Thalassiphora pelagica, Wetzeliella symmetrica, Wetzeliella sp. B Williams and Brideaux, 1975.

3218-3440': *Adnatosphaeridium reticulense* Zone (middle Eocene)

?Adnatosphaeridium patulum, Cyclopsiella vieta, Dinopterygium sp., *Muratodinium fimbriatum.*

3448-3558': *Areoligera senonensis* Zone (early Eocene)

Deflandrea denticulata, Spinidinium styloniferum.

3610-4000': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis cf. *C. speciosa, Extratriporopollenites* spp., *Hystrichosphaeridium tubiferum.*

4150-4502': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis speciosa, Fibradinium annetorpense, Hamulatisporis amplus, Lejeunia magnifica, Palaeoperidinium pyrophorum, Rugubivesiculites convolutus, Spiniferites septatus, Turbiosphaera filosa.

4652-4776': *Dinogymnium euclaensis* Zone (Maastrichtian)

Cannosphaeropsis utinensis, Ceratiopsis diebelii, Exochosphaeridium bifidum, Hystrichodinium pulchrum, Isabelidinium belfastense, I. cooksoniae, Kleithriasphaeridium loffrense, Lejeunia tricuspis, Silicisphaera ferox (one specimen at 4776ft), *Spiniferites scabrosus, Spongodinium delitiense.*

4837-5000': *Odontochitina operculata* Zone (Campanian)

Cyclonephelium distinctum, Dinogymnium undulosum, Odontochitina costata, Palaeohystrichophora infusorioides, Triblastula utinensis, Xenascus ceratioides.

5020-5230': *Cordosphaeridium truncigerum* Zone (Santonian)

Alterbia macrocysta, Chatangiella victoriensis, C. vnigri, Cordosphaeridium truncigerum, Dorocysta sp. A Bujak and Williams, 1978, *Spinidinium* cf. *S. echinoideum, Spiniferites cingulatus, Surculosphaeridium longifurcatum, Trichodinium castaneum.*

5394-5425': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Callaiosphaeridium asymmetricum, Chlamydophorella nyei, Dinopterygium cladoides.

5522': *Surculosphaeridium longifurcatum* Zone (Turonian)

Classopollis classoides, Epelidosphaeridia spinosa.

5560-6130': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, Cicatricosisporites hallei, Cleistosphaeridium polypes, Coronifera oceanica, Cribroperidinium intricatum, C. orthoceras, Cyclonephelium hughesii, C. vannophorum, Florentinia laciniata, Hystrichosphaeridium sp. A Bujak and Williams, 1978, *Liliacidites dividuus, L. peroreticulatus, Oligosphaeridium anthophorum, O. complex, O.* sp. A Williams and Brideaux, 1975, *Palaeoperidinium* sp. A Bujak and Williams, 1978, *Rouseisporites reticulatus.*

6295-7825': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

6295-6940': *Rugubivesiculites rugosus* Subzone (late Albian)

Alisporites grandis, Appendicisporites jansonii, A. potomacensis, A. unicus, Cicatricosisporites augustus, Endoscrinium campanulum (one specimen at 6650ft), *Eucommiidites minor, Oligosphaeridium totum, Retitricolpites virgeus* (base), *R. vulgaris* (base), *Rugubivesiculites reductus* (base), *R. rugosus* (base), *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, *Surculosphaeridium* cf. *S. longifurcatum, sensu* Williams, 1975, *Tricolpites micromunus, T. parvus, Vitreisporites pallidus.*

6987-7825': early Albian

Appendicisporites problematicus, Caligodinium aceras, Canningia colliveri, Cleistosphaeridium huguoniotii, Ovoidinium sp. (at 7765-7785ft), *Palaeoperidinium cretaceum, Senoniasphaera microreticulata, Trilobosporites apiverrucatus, T. marylandensis.*

Single specimens of the following species *Aequitriradites spinulosus, Aptea polymorpha, Callialasporites dampieri, Cerebropollenites mesozoicus, Coronatispora valdensis, Cribroperidinium sepimentum,* and *Doidyx anaphrissa* are also present. These are presumed to be reworked.

7914-9656': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bifurcatus, Callialasporites dampieri, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, Cyclonephelium eisenackii, Schizosporis parvus, S. reticulatus, Spiniferites speciosus, Subtilisphaera pirnaensis, sensu Millioud, 1969, *Systematophora schindewolfii, Trilobosporites purverulentus, T. trioreticulosus.*

A single specimen of *Kleithriasphaeridium eoinodes* may be at 8295-8325ft reworked.

8985-9656': *Aptea attadalica* Subzone (early Aptian)

Aequitriradites spinulosus, Aptea attadalica, Callaiosphaeridium cf. *C. asymmetricum, Pilosisporites trichopapillosus.*

Single specimens of the following species *Muderongia simplex, Oligosphaeridium asterigerum, Polystephanephorus sarjeantii,* and *Pseudoceratium pelliferum* are also present. These are presumed to be reworked.

9678-10294': *Doidyx anaphrissa* Zone (Barremian)

Aptea polymorpha, Coronatispora valdensis, Costatoperforosporites foveolatus, Cribroperidinium muderongense, sensu Habib, 1972, *Equisetosporites* sp., *Klukisporites pseudoreticulatus, Muderongia perforata, M. simplex, Occisucysta* sp. A Bujak and Williams, 1978, *Spiniferites* sp.

10390-11318': *Ctenidodinium elegantulum* Zone (Hauterivian)

Achomosphaera cf. *A. neptuni, Contignisporites cooksonii, Densoisporites velatus, Dingodinium cerviculum, Gardodinium eisenackii, Gonyaulacysta granuligera, Leptodinium* sp., *Lithodinia stoveri, Litosphaeridium siphoniphorum, sensu* Warren, 1967, *Oligosphaeridium* cf. *O. complex, sensu* Williams, 1978, *Oligosphaeridium dividum, Systematophora turonica, Tenua hystrix.*

11322-13957': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Cantulodinium sp., *Cassiculosphaeridia magna, Cicatricosisporites purbeckensis, Cyclonephelium* cf. *C. vannophorum, Oligosphaeridium* cf. *O. totum, Phoberocysta neocomica, Phthanoperidinium* sp., *Tenua* sp.

13990-14090': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium culmulum, Systematophora orbifera, Trilobosporites jurassicus.

14170-14350': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Cicatricosisporites australiensis, Parvocavatus tuberosus.

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Shell
TRIUMPH P-50

GSC locality: D12

Location: 43°39'51.62"N; 59°51'02.36"W

RT elevation: 85' Water depth: 296'

Casing set at: 983, 3386, and 7521'

Total depth: 15077' Interval studied: 960-15070'

Analyzed by: J.P. Bujak

Palynological analysis of 74 cuttings samples and 157 sidewall core samples indicates the following age determinations and biostratigraphic zonation:

960- 2100' *Artemisia-Taraxacum* Zone (Plio-Pleistocene)
2104- 2280' *Cannosphaeropsis* sp. A Zone (late Miocene)
2350- 2860' early-middle Miocene
2892- 4060' *C. dispersum* Zone (middle-late Oligocene)
4095- 4490' *D. heterophlycta* Zone (early Oligocene)
4095- 4300' *C. funiculatum* subzone (late-early Oligocene)

4300- 4490' *A. arcuatum* subzone (early-early Oligocene)
4530- 4825' *D. colligerum* Zone (late Eocene)
4825- 5030' *A. reticulense* Zone (middle Eocene)
5080- 5210' *A. senonensis* Zone (early Eocene)
5210- 5300' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
5365- 5577' *D. euclaensis* Zone (Maastrichtian)
5636- 5695' *O. operculata* Zone (Campanian)
5750- 5990' Coniacian-Santonian
6100- 6365' *S. longifurcatum* Zone (Turonian)
6365- 7950' *C. polypes* Zone (Cenomanian)
8000-10600' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
10600-11430' *S. perlucida-S. schindewolfii* Zone (Aptian)
11000-11430' *A. attadalica* Subzone (early Aptian)
11600-12167' *D. anaphrissa* Zone (Barremian)
12200-12975' *C. elegantulum* Zone (Hauterivian)
13000-15070' *P. neocomica* Zone (Berriasian-Valanginian)

The oldest sediments in the well comprise a Lower Cretaceous succession of Berriasian to Albian age from 15 070 to 8000ft. There is no evidence of Jurassic in the lowest sidewall core at 15 015ft. Dinoflagellates are rare in the Berriasian-Valanginian, which from the well location probably indicates a relatively deep water environment. Marine palynomorphs became more common in younger strata with more diverse assemblages being present, indicating increasing marine influence.

An Upper Cretaceous succession occurs from 7950 to 5365ft, and contains diverse dinoflagellate assemblages indicating fully marine depositional environments. Lower Paleocene strata are overlain by lower Eocene to Plio-Pleistocene succession, with most palynological zones being recognized. Dinoflagellates occur throughout indicating marine deposition.

Minor reworking was noted in the well with Early Cretaceous palynomorphs occurring in the Cenomanian, Eocene palynomorphs occurring in the Oligocene, and Cretaceous palynomorphs occurring in the Plio-Pleistocene.

Selected palynomorphs

960-2100': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Lejeunia sp., *Multispinula quanta, Operculodinium israelianum, Selenopemphyx nephroides, Spiniferites ramosus, Tectatodinium pellitum.*

Also present in this interval are reworked specimens of the Cretaceous species *Surculosphaeridium longifurcatum.*

2104-2280': *Cannosphaeropsis* sp. A Zone (late Miocene)

Achomosphaera ramulifera, Palaeocystodinium golzowense.

2350-2860': early-middle Miocene

Hystrichokolpoma rigaudiae, Hystrichosphaeropsis obscura, Lingulodinium machaerophorum, Operculodinium centrocarpum, Pentadinium laticinctum, Spiniferites pseudofurcatus, Systematophora ancyrea.

2892-4060': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Cordosphaeridium cantharellum, Deflandrea phosphoritica, D. spinulosa, Pentadinium laticinctum subsp. *granulatum, Polysphaeridium pastielsii, P. simplex.*

Also present in this interval is a reworked specimen of the Eocene and older species *Cordosphaeridium gracile* at 3260ft.

4095-4490': *Deflandrea heterophlycta* Zone (early Oligocene)

4095-4300': *C. funiculatum* subzone (late-early Oligocene)

Chiropteridium aspinatum, Cyclonephelium intricatum, Deflandrea heterophlycta, Homotryblium plectilum, Systematophora placacantha, Wetzeliella sp. A Williams and Bujak, 1977b.

4300-4490': *A. arcuatum* subzone (early-early Oligocene)

Chiropteridium lobospinosum, Cordosphaeridium funiculatum, Cyclopsiella sp., *Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Leptodinium incompositum, Phthanoperidinium comatum, Wetzeliella articulata.*

4530-4825': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium multispinosum, Areosphaeridium fenestratum, A. multicornutum, Cordosphaeridium gracile, Cyclonephelium exuberans subsp. *ellipsoidale, C.* sp. A Williams and Brideaux, 1975, *Distatodinium craterum, D. ellipticum, Gonyaulacysta giuseppei, Hystrichokolpoma salacium, Kisselovia reticulata, Lantermosphaeridium axiale, Phthanoperidium echinatum, Rottnestia borussica, Wilsonidium lineidentatum.*

4825-5030': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Apectodinium homomorphum, Cordosphaeridium inodes, Deflandrea wetzelii, Diphyes colligerum, Hystrichokolpoma eisenackii, Hystrichosphaeridium pseudorecurvatum.

5080-5210': *Areoligera senonensis* Zone (early Eocene)

Alterbia microgranulata, Apectodinium homomorphum (abundant).

5210-5300': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Areoligera cf. *A. senonensis, Cyclonephelium ordinatum, Hystrichosphaeridium tubiferum, Palaeoperidinium pyrophorum.*

5365-5577': *Dinogymnium euclaensis* Zone (Maastrichtian)

Adnatosphaeridium sp. Wilson, 1971, *Amphidiadema rectangularis, Cannosphaeropsis utinensis, Deflandrea bakeri, Oligosphaeridium complex, Palaeocystodinium australinum, Spiniferities ramosus* (large form), *Spongodinium delitiense, Trithyrodinium evittii, T. suspectum.*

5636-5695': *Odontochitina operculata* Zone (Campanian)

Chatangiella victoriensis, Cyclonephelium distinctum, Hystrichodinium pulchrum, Isabelidinium cooksoniae, Odontochitina costata, O. operculata, Palaeostomocystis fragilis, Silicisphaera ferox, Spinidinium sverdrupianum, Xenascus ceratioides.

5750-5990': Coniacian-Santonian

Chlamydophorella nyei, Cordosphaeridium truncigerum, Hystrichosphaeridium paracostatum, Nelsoniella aceras, Senoniasphaera protrusa, S. rotundata, Spinidinium styloniferum, Xiphophoridium alatum.

6100-6365': *Surculosphaeridium longifurcatum* Zone (Turonian)

Cleistosphaeridium polypes, C. polypes subsp. A, *sensu* Williams, 1975, *Cyclonephelium distinctum* subsp. *brevispinatum, C. vannophorum, Surculosphaeridium longifurcatum* (abundant).

6365-7950': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus, Camarozonosporites insignis, Cicatricosisporites hallei, C. hughesi, Cleistosphaeridium polypes (abundant), *Cyclonephelium vannophorum* (abundant), *Epelidosphaeridia spinosa, Hystrichosphaeridium cooksoniae, Liliacidites dividuus, Lycopodiumsporites austroclavitidites, Oligosphaeridium totum* subsp. *minor, O. totum* subsp. *totum, Palaeohystrichophora infusorioides, Rouseisporites reticulatus, Spinidinium vestitum.*

A single reworked specimen of the Barremian and older species *Muderongia simplex* occurs at 6540ft, and the Albian and older species *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, at 7475ft.

8000-10600': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Cribroperidinium orthoceras, Cyclonephelium paucispinum, Densoisporites velatus, Foveotriletes subtriangularis, Klukisporites foveolatus, K. pseudoreticulatus, Pilosisporites verus, Rouseisporites triangularis, Schizosporis reticulatus, Spinidinium cf. *S. vestitum, sensu* Williams, 1975 (common), *Trilobosporites apiverrucatus.*

Also present in this interval are single (?reworked) specimens of the species *Muderongia* sp. and *Batioladinium jaegeri* at 9238ft and *Subtilisphaera pirnaensis* at 9600ft.

10600-11430': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Pseudoceratium pelliferum, Subtilisphaera pirnaensis, Systematophora cf. *S. schindewolfii.*

11000-11430': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica, Callialasporites dampieri, Muderongia simplex (single specimen at 11 200ft).

11600-12167': *Doidyx anaphrissa* Zone (Barremian)

Aequitriradites spinulosus, Cicatricosisporites australiensis, Muderongia simplex, M. tetracantha, Pseudoceratium nudum.

12200-12975': *Ctenidodinium elegantulum* Zone (Hauterivian) (Hauterivian)

Dingodinium cerviculum, Occisucysta sp., *Pareodinia ceratophora, Pilosisporites trichopapillosus, Spiniferites* sp. (with short spines).

13000-15070': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Callialasporites trilobatus, Klukisporites pseudoreticulatus (common at 14 405ft), *Pilosisporites verus* (common at 14 400ft).

The following Cretaceous species are present in a sidewall core sample from 15 015ft: *Oligosphaeridium complex, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, and *Subtilisphaera pirnaensis.* Thermal alteration index and state of preservation indicate that *Subtilisphaera pirnaensis* and *Spinidinium* cf. *S. vestitum, sensu* Williams, 1975, probably represent contamination. However specimens of *Oligosphaeridium complex* are considered to be in place.

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Shell
WYANDOT E-53

GSC locality: D18

Location: 44°52'20.70"N; 59°23'54.059"W

RT elevation: 103' Water depth: 397'

Casing set at: 1036, 2501, and 5110'

Total depth: 10005' Interval studied: 1085-9720'

Analyzed by: G.L. Williams

Palynological analysis of eight conventional core (9402-9445.5ft), 97 sidewall core and 60 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1085- 1369'	*O. operculata* Zone (Campanian)
1425- 1530'	*C. truncigerum* Zone (Santonian)
1535- 1650'	*O. pulcherrimum* Zone (Coniacian)
1750- 1890'	*S. longifurcatum* Zone (Turonian)
1950- 2685'	*C. polypes* Zone (Cenomanian)
2748- 3922'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
3940- 4660'	*S. perlucida-S. schindewolfii* Zone (Aptian)
4630- 4660'	*A. attadalica* Subzone (early Aptian)
4820- 5590'	*D. anaphrissa* Zone (Barremian)
5740- 6190'	*C. elegantulum* Zone (Hauterivian)
6284- 6482'	Neocomian (Berriasian-?Hauterivian)
6560- 6810'	*C. panneum* Zone (Portlandian)
6980- 7553'	*G. cladophora* Zone (Kimmeridgian)
7580- 8545'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
8580- 9426'	*V. vermiculata* Zone (Callovian)
9440- 9720'	late Bathonian?-Callovian

Shell Wyandot E-53 encountered basement at 9720ft. Above 9720ft there appears to be a more or less unbroken depositional record from the late Bathonian? to the Maastrichtian, although the presence of Berriasian-Valanginian sediments cannot be confirmed. The presence of the Maastrichtian sediments above 1085ft is inferred from the dinoflagellates of this age, in the cuttings sample at 1130-1100ft.

The depositional environment has shown considerable fluctuations. The conventional core samples from 9444.5 to 9440ft contain numerous spores but only two dinocysts. This assemblage is inferred to denote a non-marine to littoral environment. At 9426ft there is a marked influx of dinocysts indicating a marine transgression. Throughout the Callovian, Oxfordian, Kimmeridgian and early Portlandian the sediments were deposited predominantly in shallow marine environments with some non-marine episodes. The upper Portlandian to Hauterivian sediments are non-marine, with occasional marginal marine periods. A marine transgression commencing in the Barremian reached its peak in the early Aptian. The abundance of schizeaceous spores throughout the Albian indicates a non-marine environment in a humid subtropical climate. A marine transgression beginning in the Cenomanian (first recognized in the sidewall core at 2525ft) gave rise to a neritic environment which persisted throughout the Late Cretaceous in the vicinity of Wyandot E-53.

Selected palynomorphs

1085-1369': *Odontochitina operculata* Zone (Campanian)

Areoligera medusettiformis, A. senonensis, Canningia reticulata (at 1369ft), *Chatangiella tripartita, C. victoriensis, Dinogymnium acuminatum, D. microgranulosum,*

Exochosphaeridium bifidum, E. striolatum, Forma P Evitt, 1967, *Gardodinium deflandrei, Hystrichodinium pulchrum, Hystrichosphaeridium tubiferum, Microdinium irregulare, Odontochitina costata, O. operculata, Palaeohystrichophora infusorioides, Rugubivesiculites rugosus, Senoniasphaera* cf. *S. protrusa* (at 1369ft), *S. rotundata, Spinidinium* cf. *S. echinoideum, Spiniferites scabrosus, Trichodinium castaneum, Xenascus ceratioides.*

Palaeoperidinium pyrophorum is present in the cuttings sample from 1100 to 1130ft; this may indicate the presence of Maastrichtian sediments at an unspecified footage above 1085ft.

1425-1530': *Cordosphaeridium truncigerum* Zone (Santonian)

Chlamydophorella nyei, Cicatricosisporites hallei, Gleicheniidites senonicus, Impletosphaeridium whitei, Microdinium ornatum, Rugubivesiculites convolutus, Silicisphaera ferox, Surculosphaeridium longifurcatum.

1535-1650': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978, *Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Chatangiella tripartita* (base), *C. victoriensis* (base), *Cyclonephelium vannophorum, Dinopterygium cladoides, Kleithriasphaeridium loffrense, Oligosphaeridium anthophorum, Spiniferites cingulatus.*

1750-1890': *Surculosphaeridium longifurcatum* Peak Zone (Turonian)

Cleistosphaeridium huguoniotii, Dinopterygium cladoides (common at 1890ft), *Kleithriasphaeridium* cf. *K. readei, Retitricolpites georgensis, Stephodinium coronatum, Subtilisphaera pirnaensis, Surculosphaeridium longifurcatum* (common at 1890ft).

Several Aptian-Albian palynomorph species are present in this interval. These include: *Aequitriradites spinulosus, Appendicisporites potomacensis, A. unicus, Callialasporites dampieri, Eucommiidites minor,* and *Pareodinia ceratophora* (with kalyptra).

1950-2685': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, Classopollis classoides, Cleistosphaeridium polypes subsp. A Williams, 1975, *Cribroperidinium orthoceras, Cyclonephelium vannophorum* (common), *Eucommiidites minor, Liliacidites peroreticulatus, Oligosphaeridium totum, Palaeoperidinium* sp A Bujak and Williams, 1978, *Retitricolpites virgeus, R. vulgaris, Subtilisphaera pontis-mariae, Tricolpites micromunus, T. parvus.*

2748-3922': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Alisporites grandis, Baculatisporites comaumensis, Cerebropollenites mesozoicus, Cicatricosisporites augustus, C. hughesi, Concavissimisporites variverrucatus, Costatoperforosporites foveolatus, Cyathidites minor, Gleicheniidites senonicus Ross (abundant), *Liliacidites textus, Retitricolpites georgensis* (base at 2905ft), *Rouseisporites reticulatus, Schizosporis reticulatus* (one specimen at 3386ft), *Striatopollis paraneus* (base at 3067ft), *Tricolpites micromunus* (base at 2905ft), *T. parvus* (base at 3520ft), *Trilobosporites apiverrucatus, Vitreisporites pallidus, V.* sp. Singh, 1971.

3940-4660': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bifurcatus, A. potomacensis, Aptea polymorpha, Callialasporites dampieri, Gardodinium eisenackii, Muderongia sp., *Ovoidinium* sp., *Pareodinia* sp., *Subtilisphaera perlucida, S.* cf. *S. perlucida, sensu* Bujak and Williams, 1978.

4630-4660': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica, Canningia colliveri, Pareodinia ceratophora (with kalyptra), *Pilosisporites trichopapillosus, Subtilisphaera pirnaensis, sensu* Millioud, 1969.

4820-5590': *Doidyx anaphrissa* Zone (Barremian)

Aptea polymorpha (base), *Cribroperidinium sepimentum, Densoisporites perinatus* (one specimen at 5550-5590ft), *Exesipollenites tumulus, Kleithriasphaeridium eoinodes, Muderongia perforata, M. staurota, Oligosphaeridium perforatum, Palaeoperidinium cretaceum, Perinopollenites elatoides, Phthanoperidinium* sp., *Polystephanephorus sarjeantii, Pseudoceratium pelliferum.*

5740-6190': *Ctenidodinium elegantulum* Zone (Hauterivian)

Aequitriradites spinulosus, ?Batioladinium gochtii, B. sp. A Bujak and Williams, 1978, *Cicatricosisporites brevilaesuratus, Gonyaulacysta* sp., *Tenua hystrix.*

6284-6482': Neocomian (Berriasian-?Hauterivian)

Klukisporites pseudoreticulatus, Muderongia perforata (base).

6560-6810': *Ctenidodinium panneum* Zone (Portlandian)

Amphorula metaelliptica, Callialasporites dampieri (abundant), *C. trilobatus, Cicatricosisporites australiensis, Contignisporites cooksonii, Densoisporites perinatus* (common), *Lanterna sportula.*

6980-7553': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Epiplosphaera reticulospinosa, Gonyaulacysta sp., *Leptolepidites psarosus, Parvocavatus tuberosus, Senoniasphaera jurassica, Systematophora* cf. *S. areolata, S. orbifera.*

7580-8545': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Adnatosphaeridium caulleryi, Ctenidodinium sp., *Endosporites jurassicus,* Gen. et sp. 2 Gocht, 1970 (one specimen at 8545ft), *Gonyaulacysta cladophora* subsp. *cladophora, G. granulata, G. jurassica, Hystrichogonyaulax nealei, Leptodinium egemenii, Leptolepidites major, Staplinisporites* sp., *Systematophora fasciculigera, Tenua rioultii.*

8580-9426': *Valensiella vermiculata* Zone (Callovian)

Circularesporites cerebroides, Ctenidodinium ornatum, C. pachydermum, C. aff. *C. tenellum, sensu* Gocht, 1970, *Endoscrinium eisenackii, sensu* Gocht, 1970, Gen. et sp. 2 Gocht, 1970 (common), *Gonyaulacysta jurassica* (base), *Hystrichogonyaulax cornigera, Lithodinia jurassica, Polystephanephorus sarjeantii* (base), *Systematophora areolata* (base), *S. orbifera* (base), *S.* cf. *S. orbifera, Tenua* sp., *Trilobosporites jurassicus, Valensiella ovula, V. vermiculata.*

9440-9720': late Bathonian?-Callovian

Callialasporites dampieri (abundant at 9440ft), Gen. et sp. 2 Gocht, 1970 (present).

* * * * *

GRAND BANKS

The 26 wells analyzed from the Grand Banks are:

Bittern M-62	(11)
Bonavista C-99	(26)
Bonnition H-32	(18)
Carey J-34	(6)
Coot K-56	(8)
Cormorant N-83	(20)
Cumberland B-55	(25)
Dominion O-23	(24)
Egret K-36	(22)
Eider M-75	(9)
Flying Foam I-13	(23)
Gannet O-54	(5)
Hermine E-94	(1)
Heron H-73	(13)
Jaeger A-49	(15)
Kittiwake P-11	(3)
Murre G-67	(21)
Osprey H-84	(16)
Pelican J-49	(7)
Petrel A-62	(4)
Puffin B-90	(2)
Sandpiper 2-J-77	(10)
Skua E-41	(17)
Spoonbill C-30	(19)
Tors Cove D-52	(12)
Twillick G-49	(14)

The geographic locations are shown in Fig. 6. A comparison of the palynological ages of rocks dated in each well is illustrated in Fig. 7. Details of individual zone thicknesses and taxa occurrences are given below for each well.

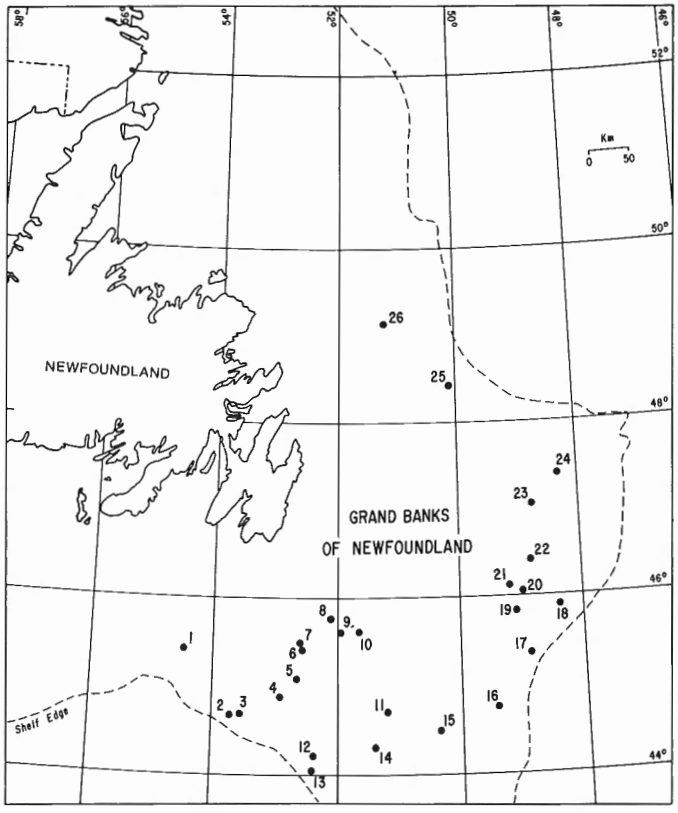

Figure 6: Well locations, Grand Banks.

Amoco-Imp
BITTERN M-62

GSC locality: D76

Location: 44°41'55.85"N; 51°10'14.29"W

RT elevation: 98' Water depth: 226'

Casing set at: 488, 848, 2520, and 9000'

Total depth: 15683' Interval studied: 870-15566'

Analyzed by: G.L. Williams

Palynological analysis of 121 sidewall core and 150 cuttings samples from the well indicates the following age determinations and biostratigraphic zonation:

870- 900'	*C. dispersum* Zone (middle-late Oligocene)
960- 1620'	*D. heterophlycta* Zone (early Oligocene)
1680- 2070'	*D. colligerum* Zone (late Eocene)
2130- 2160'	*A. reticulense* Zone (middle Eocene)
2200- 2220'	*A. senonensis* Zone (early Eocene)
2220- 2340'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
2400- 2430'	*D. euclaensis* Zone (Maastrichtian)
2490- 2950'	*O. operculata* Zone (Campanian)
2680- 2950'	*T. castaneum* subzone (early Campanian)
2950- 3700'	*C. truncigerum* Zone (Santonian)
3760- 3790'	*O. pulcherrimum* Zone (Coniacian)
3850- 4688'	*G. cladophora* Zone (Kimmeridgian)
4700- 5230'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
4962- 5230'	*C. costatum* subzone (early Oxfordian)
5262- 6584'	*V. vermiculata* Zone (Callovian)
5262- 6170'	*S. scarburghense* subzone (late Callovian)
6200- 6584'	*C. tribuliferum* subzone (early Callovian)
6600- 8230'	*G. filapicata* Zone (Bathonian)
8296- 8958'	*M. semitabulatum* Zone (Aalenian-Bajocian)
9052- 9830'	*N. gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)
9900-10130'	Pliensbachian
10198-12920'	Lias, (?Pliensbachian)
12990-15131'	Hettangian-Sinemurian
15500-15566'	Triassic

There is a major unconformity between 3850 and 3790ft with Kimmeridgian rocks immediately overlain by Santonian sediments. The cuttings sample at 2220-2250ft contains early Paleocene and early Eocene dinoflagellates. The absence of late Paleocene taxa is taken to indicate that sediments of this age are absent.

Most of the organic fraction in the Triassic and Lower Jurassic section is carbonised. The presence of Upper Triassic sediments in Bittern M-62 cannot be determined because of the absence of palynomorphs in the interval 15 500-15 131ft.

The Middle Triassic-Pliensbachian(?) (15 566-10 198ft) is predominantly, if not exclusively, non-marine, only one dinoflagellate specimen being recorded in a sidewall core sample at 12 920ft. The algal genus *Pediastrum*, present at 12 990, 13 085, 13 200 and 13 398ft, is known primarily from non-marine sediments. However, the genus has not been recorded previously from Lower Jurassic sediments and may be a contaminant. In the Pliensbachian (10 130-9900ft), there is a very weak marine incursion; non-marine conditions return at 9830ft and persist throughout most of the Toarcian to 9300ft. A predominantly inner neritic environment

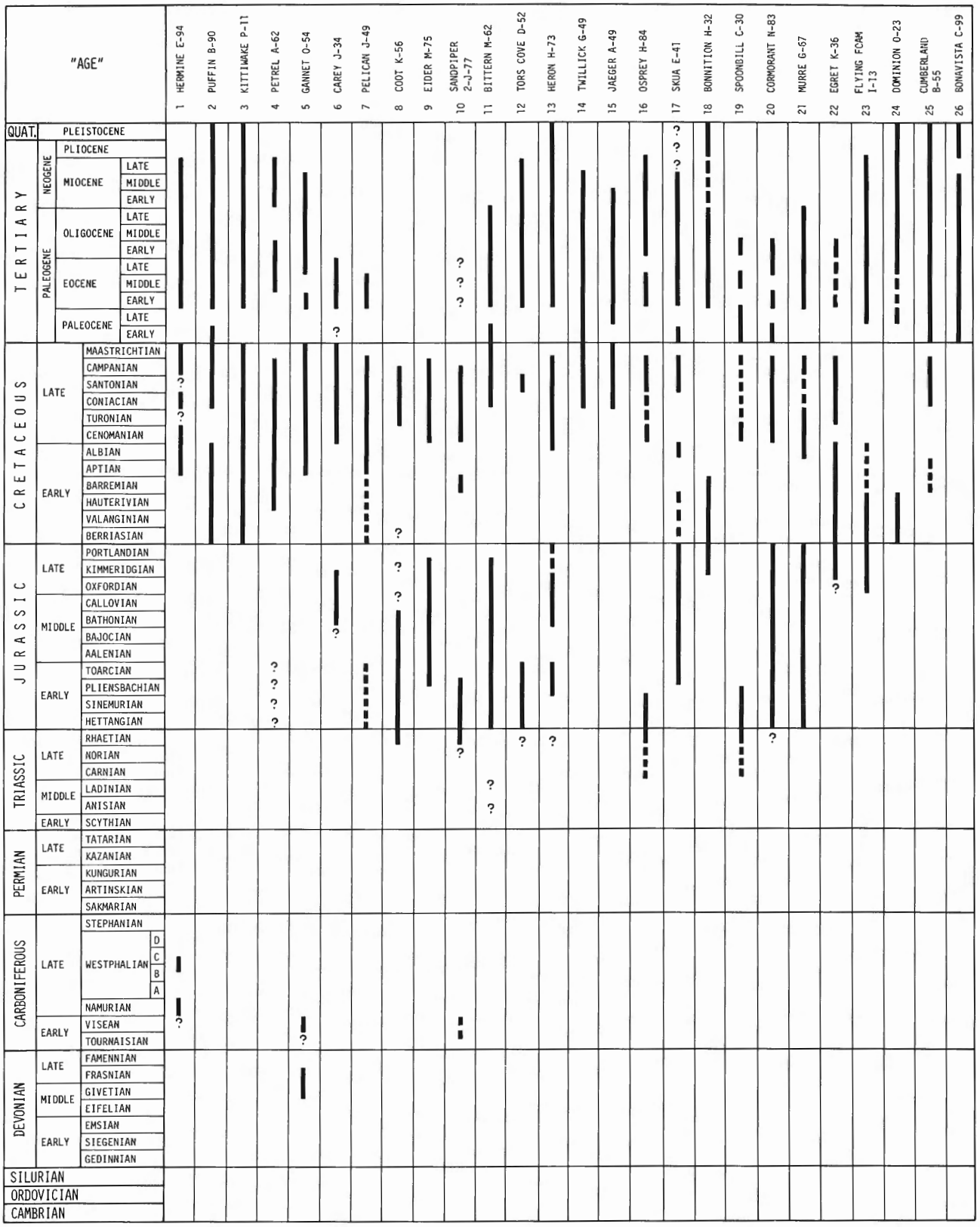

Figure 7: Palynological ages of sediments in Grand Banks wells.

existed in the vicinity of Bittern throughout the Middle and Late Jurassic (excluding the Portlandian), with dinoflagellates being abundant in the Callovian, Oxfordian and Kimmeridgian.

The Upper Cretaceous sediments are exclusively marine. The presence of reworked Albian species in the Santonian indicates that erosion and transportation of Albian sediments was occurring during this Age. The Paleogene was deposited in a neritic or possibly deeper water environment.

Selected palynomorphs

870-900': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Epicephalopyxis indentata, Tanyosphaeridium sp. A Williams and Brideaux, 1975.

960-1620': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, A. multicornutum, Chiropteridium aspinatum, C. lobospinosum, Cordosphaeridium cantharellum, C. funiculatum, Cyclonephelium intricatum, C. pastielsi, C. sp. B Williams and Brideaux, 1975, *Cyclopsiella vieta, Deflandrea phosphoritica, D. spinulosa, Distatodinium ellipticum, Eocladopyxis peniculatum, Gonyaulacysta* cf. *G. granulata, sensu* Benedek, 1972, *Kisselovia coleothrypta, Operculodinium* cf. *O. hirsutum, sensu* Gocht, 1969, *Pentadinium laticinctum* subsp. *granulatum, Phthanoperidinium amoenum, P. comatum, Thalassiphora pelagica, Tubidermodinium sulcatum, Wetzeliella* sp. A Williams and Bujak, 1977b.

1680-2070': *Diphyes colligerum* Zone (late Eocene)

Cyclonephelium sp. C Williams and Brideaux, 1975, *Diphyes colligerum.*

2130-2160': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium reticulense, Cordosphaeridium gracile, Samlandia chlamydophora, Wetzeliella articulata.

2200-2220': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum, Areoligera senonensis, sensu Gocht, 1969, *Cordosphaeridium fibrospinosum, Cyclonephelium divaricatum, Deflandrea hialina, Hemicystodinium zoharyi, Hystrichosphaeridium tubiferum, Lanternosphaeridium axiale.*

2220-2340': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Lejeunia magnifica, Palaeoperidinium pyrophorum, Spiniferites septatus.

2400-2430': *Dinogymnium euclaensis* Zone (Maastrichtian)

Hystrichodinium pulchrum.

2490-2950': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, Cyclonephelium distinctum, Isabelidinium belfastense, Oligosphaeridium complex, Xenascus ceratioides.

2680-2950': *Trichodinium castaneum* subzone (early Campanian)

Alterbia acuminata, Callaiosphaeridium asymmetricum, Cannosphaeropsis utinensis, Chatangiella vnigri, Dorocysta sp. A Bujak and Williams, 1978, *Exochosphaeridium bifidum,* Forma P Evitt, 1961, *Hystrichosphaeridium bowerbankii, Kleithriasphaeridium loffrense, K. readei, Odontochitina costata, Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Trichodinium castaneum.*

2950-3700': *Cordosphaeridium truncigerum* Zone (Santonian)

Canningia reticulata, Cordosphaeridium truncigerum, Coronifera oceanica, Dinogymnium euclaensis, Senoniasphaera rotundata, Spinidinium cf. *S. echinoideum, Spiniferites cingulatus, Surculosphaeridium longifurcatum, Triblastula utinensis.*

The following reworked Albian species were also present: *Callialasporites dampieri, Cyclonephelium vannophorum* (3220-3250ft), *Gonyaulacysta tenuicornuta, Pterodinium perforatum, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975.

3760-3790': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978.

3850-4688': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Aequitriradites spinulosus, Callialasporites dampieri (common), *Classopollis classoides, Contignisporites cooksonii, Densoisporites perinatus, Exesipollenites tumulus, Gonyaulacysta ambigua, G.* cf. *G. cladophora* (4558ft), *Klukisporites pseudoreticulatus, Leptolepidites psarosus, Pareodinia ceratophora* (4558ft), *Perinopollenites elatoides, Staplinisporites caminus, Systematophora orbifera, Tenua rioultii, Trilobosporites jurassicus.*

4700-5230': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Cerebropollenites mesozoicus, Gonyaulacysta jurassica, Polystephanephorus sarjeantii, Scriniocassis dictyotus, Systematophora areolata.

4962-5230': *Compositosphaeridium costatum* subzone (early Oxfordian)

Compositosphaeridium costatum, Hystrichogonyaulax nealei, Parvocavatus tuberosus, Stephanelytron redcliffense, Systematophora cf. *S. orbifera, Tenua* sp.

5262-6584': *Valensiella vermiculata* Zone (Callovian)

5262-6170': *Stephanelytron scarburghense* subzone (late Callovian)

Adnatosphaeridium aemulum, A. caulleryi, Ctenidodinium ornatum, Endoscrinium eisenackii, sensu Gocht, 1970, Gen. et sp. 2 Gocht, 1970, *Gonyaulacysta aldorfensis, Lithodinia jurassica, Polystephanephorus paracalathus, Senoniasphaera jurassica, Stephanelytron scarburghense* (restricted to this zone), *Tenua* sp., *Valensiella vermiculata.*

6200-6584': *Cleistosphaeridium tribuliferum* subzone (early Callovian)

Adnatosphaeridium caulleryi (common), *Cleistosphaeridium tribuliferum, Ctenidodinium continuum, C. ornatum, Gonyaulacysta jurassica* (base), *Polystephanephorus paracalathus* (base), *Scriniodinium crystallinum.*

6600-8230': *Gonyaulacysta filapicata* Zone (Bathonian)

Circularesporites cerebroides, Compositosphaeridium costatum (base), *Ctenidodinium ornatum* (base), *C. pachydermum, C.* aff. *C. tenellum, sensu* Gocht, 1970, *Endoscrinium eisenackii* (base), *Gonyaulacysta filapicata, Leptodinium regale, Systematophora* cf. *S. areolata.*

8296-8958': *Mancodinium semitabulatum* Zone (Aalenian-Bajocian)

Callialasporites dampieri (base), *Ctenidodinium* aff. *C. tenellum* (base), *Gonyaulacysta filapicata* (base), *Perinopollenites elatoides* (common).

9052-9830': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Camerosporites secatus, Kraeuselisporites reissingeri.

9900-10130': Pliensbachian

Luehndea spinosa.

10198-12920': Lias, (?Pliensbachian)

Classopollis classoides (common), *Mancodinium semitabulatum* (base).

12990-15131': Hettangian-Sinemurian

Annapiculatisporites sp., *Classopollis classoides* (base), *Pediastrum* spp.

15500-15566': Triassic (dated Middle Triassic by W.A.M. Jenkins pers. comm.)

Alisporites grauvogelii, Enzonalasporites sp., *Klausipollenites* sp., *Vallasporites* sp.

* * * * *

BP-Columbia
BONAVISTA C-99

GSC locality: D135

Location: 49°08'05.98"N; 51°14'24.47"W

RT elevation: 40' Water depth: 1080'

Casing set at: 1341, 2268, 3393, and 8164'

Total depth: 12398' Interval studied: 1500-12040'

Analyzed by: G.L. Williams

Palynological analysis of six conventional core and 75 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1500- 2850'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1500- 2400'	*S. scabratus* Subzone (Pleistocene)
2460- 2850'	*H. choanophorum* Subzone (Pliocene)
2910- 3930'	*P. laticinctum* Zone (middle Miocene)
3990- 4410'	*Apteodinium* sp. B Zone (early Miocene)
5010- 6690'	*C. dispersum* Zone (middle-late Oligocene)
6930- 8529'	*D. heterophlycta* Zone (early Oligocene)
8531-10930'	*D. colligerum* Zone (late Eocene)
11000-11740'	*A. reticulense* Zone (middle Eocene)
11810-11840'	*A. senonensis* Zone (early Eocene)
11910-11940'	*C. speciosa* Zone (late Paleocene)
12010-12040'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)

There is a very thick more or less complete marine Tertiary succession in the BP-Columbia Bonavista C-99 well. The condensed Paleocene-lower Eocene sediments are overlain by an unusually thick middle Eocene-Miocene sequence extending from 11 740 to 2910ft. Upper Miocene sediments may be absent or represented by a condensed sequence.

Paleoecological interpretations have not been attempted since sidewall cores were not available for study.

Selected palynomorphs

1500-2850': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

1500-2400': *Spiniferites scabratus* Subzone (Pleistocene)

Pinus spp., *Tsugaepollenites igniculus.* Reworked species occur throughout. They include: *Apectodinium homomorphum, Densoisporites* sp., *Wetzeliella ovalis. Apectodinium homomorphum* and *Wetzeliella ovalis* are common in the Eocene.

2460-2850': *Hystrichosphaeridium choanophorum* Subzone (Pliocene)

Leptodinium patulum, Sumatradinium sp.

2910-3930': *Pentadinium laticinctum* Zone (middle Miocene)

Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Hystrichokolpoma rigaudiae, Impletosphaeridium transfodum, Lingulodinium machaerophorum, Operculodinium centrocarpum, Palaeocystodinium golzowense, Perisseiasphaeridium* sp., *Polysphaeridium pastielsi, Spiniferites crassipellis, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

3990-4410': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium conjunctum, sensu Benedek, 1972, *A.* sp. B Williams and Brideaux, 1975, *Tanyosphaeridium* sp. A Williams and Brideaux, 1975 (common).

5010-6690': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Chiropteridium aspinatum, C. dispersum, Cordosphaeridium cantharellum, Deflandrea phosphoritica, D. spinulosa, Pentadinium laticinctum, Phthanoperidinium amoenum, P. comatum.*

6930-8529': *Deflandrea heterophlycta* Zone (early Oligocene)

Cyclonephelium sp. C Williams and Brideaux, 1975, *Deflandrea* sp. C Williams and Bujak, 1977b, *Thalassiphora pelagica, Vozzhennikovia tenella.*

Throughout this interval and particularly in the lower 200ft reworked Senonian species occur. These include *Chatangiella victoriensis* and *C. vnigri.* Whether these were originally reworked into the early Oligocene or represent caving from the Pleistocene sequence cannot be determined since only cuttings samples are available from this interval.

8531-10930': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium reticulense, sensu Gocht, 1969, *Areoligera senonensis, sensu* Gocht, 1969, *Cyclonephelium* sp. B Williams and Brideaux, 1975, *Deflandrea hialina, Diphyes* cf. *D. colligerum, Gonyaulacysta giuseppei, Homotryblium tenuispinosum, Wetzeliella articulata, W. lunaris, W. symmetrica.*

11000-11740': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium reticulense (common), *Apectodinium homomorphum, Areosphaeridium multicornutum, Cyclonephelium ordinatum, Diphyes colligerum, Eocladopyxis peniculatum, Homotryblium tenuispinosum* (common), *Kisselovia coleothrypta, Membranilarnacia ursulae, Muratodinium fimbriatum, Pyxidiella* sp., *Rhombodinium condylos, R.* cf. *R. condylos* Williams and Bujak, 1977b, *Schematophora speciosa, Wetzeliella edwardsi.*

11810-11840': *Areoligera senonensis* Zone (early Eocene)

Deflandrea oebisfeldensis, Rottnestia borussica.

11910-11940': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis speciosa, Hystrichosphaeridium tubiferum, Palaeocystodinium benjaminii.

12010-12040': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Lejeunia magnifica, Palaeoperidinium pyrophorum.

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Mobil Gulf
BONNITION H-32

GSC locality: D120

Location: 45°51'26.79"N; 48°19'31.76"W

RT elevation: 98' Water depth: 334'

Casing set at: 598, 948, and 3672'

Total depth: 10000' Interval studied: 990-9980'

Analyzed by: G.L. Williams

Palynological analysis of 91 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

990- 1020'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1080- 1410'	Miocene
1470- 1500'	*C. dispersum* Zone (?middle-late Oligocene)
1570- 2400'	*D. heterophlycta* Zone (early Oligocene)
2460- 3420'	*D. colligerum* Zone (late Eocene)
3480- 4230'	*A. reticulense* Zone (middle Eocene)
4230- 4290'	*A. senonensis* Zone (early Eocene)
4290- 6280'	*D. anaphrissa* Zone (Barremian)
6350- 7280'	*C. elegantulum* Zone (Hauterivian)
7350- 7780'	*P. neocomica* Zone (Berriasian-Valanginian)
7850- 8280'	*C. panneum* Zone (Portlandian)
8350- 9980'	*G. cladophora* Zone (Kimmeridgian)

Mobil-Gulf Bonnition H-32 appears to bottom in upper Kimmeridgian rocks at 10 000ft. The relatively thick Kimmeridgian-Portlandian section extending from 9980 to 7850ft contains numerous dinocysts and several spores. In the overlying Neocomian sediments spores tend to predominate over dinocysts. The presence of a major hiatus is postulated between 4290 and 4230ft where lower Eocene sediments appear to immediately overlie the Barremian.

The thin lower Eocene sequence is sequentially overlain by middle and upper Eocene, Oligocene, Miocene and Plio-Pleistocene sediments. The total thickness of the middle and upper Eocene and lower Oligocene sediments is over 2600ft. The interval 1500-1470ft is questionably Oligocene. Subdivision of the Miocene is not possible, although the assemblages appear to be middle to late Miocene. There are no early Miocene zonal index species present.

Paleoenvironmental determinations cannot be made with any degree of certainty due to the unavailability of sidewall and conventional core samples. The cuttings do, however, yield rich dinocyst assemblages in the Kimmeridgian suggesting shelf deposition. The Berriasian-Barremian samples contain dinocysts, but rarely in abundance and spores tend to predominate. The environment of deposition was presumably shallow neritic to non-marine. The Tertiary samples contain rich dinocyst assemblages, particularly in the Eocene and early Oligocene. The depositional environment in the vicinity of Bonnition during the Tertiary is therefore interpreted as neritic.

Selected palynomorphs

990-1020': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Pinus spp., *Spiniferites scabratus, Tsugaepollenites igniculus.*

1080-1410': Miocene

Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Lingulodinium machaerophorum, Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, *Systematophora ancyrea, Tuberculodinium vancampoae.*

1470-1500': *Chiropteridium dispersum* Zone (?middle-late Oligocene)

Chiropteridium dispersum.

1570-2400': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium cf. *A. arcuatum, Bombacacidites* sp. A Williams and Brideaux, 1975, *Chiropteridium aspinatum, Cordosphaeridium cantharellum, Deflandrea spinulosa, Deflandrea* sp. C Williams and Bujak, 1977b, *Eocladopyxis peniculatum, Epicephalopyxis indentata, Gonyaulacysta giuseppei, Heteraulacacysta campanula, Polysphaeridium pastielsi, Samlandia chlamydophora.*

2460-3420': *Diphyes colligerum* Zone (late Eocene)

Achomosphaera alcicornu, Areosphaeridium diktyoplokus, A. multicornutum, Cordosphaeridium exilimurum, C. funiculatum, Dinopterygium sp. A Williams and Bujak, 1977a, *Kisselovia coleothrypta, Leptodinium incompositum, Operculodinium* cf. *C. hirsutum, sensu* Gocht, 1969, *Pentadinium taeniagerum, Perisseiasphaeridium* sp., *Phthanoperidinium amoenum, P. comatum, Tectatodinium* sp., *Thalassiphora pelagica, Tubidermodinium sulcatum, Wetzeliella* sp.

3480-4230': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium multispinosum, Areoligera coronata, sensu Gocht, 1969, *A. medusettiformis, sensu* Gocht, 1969, *Baltisphaeridium* sp., *Cyclonephelium* sp. B Williams and Brideaux, 1975, *Deflandrea eocenica, D. hialina, Diphyes colligerum, Kisselovia tenuivirgula* subsp. *crassiramosa, Pyxidiella* sp.

4230-4290': *Areoligera senonensis* Peak Zone (early Eocene)

Apectodinium homomorphum, Areoligera senonensis, sensu Gocht, 1970 (common).

4290-6280': *Tenua anaphrissa* Zone (Barremian)

Callialasporites dampieri, C. trilobatus, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, C. hughesi, Classopollis classoides, Cribroperidinium orthoceras, Densoisporites velatus, Eucommiidites minor, Hemicystodinium sp., *Hystrichodinium pulchrum, Muderongia simplex, Perinopollenites elatoides, Pseudoceratium pelliferum, Vitreisporites pallidus.*

Two specimens of *Ctenidodinium elegantulum* and three specimens of *Phoberocysta neocomica* were recorded from the cuttings sample at 4290-4320ft. These specimens, all colourless, are presumed to be reworked.

6350-7280': *Ctenidodinium elegantulum* Zone (Hauterivian)

Alisporites grandis, Contignisporites cooksonii, Endoscrinium campanulum, Lanterna sp., *Muderongia perforata, Pareodinia ceratophora* (with kalyptra), *Systematophora turonica, Tenua* sp.

7350-7780': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Classopollis echinatus, Ellipsoidictyum cinctum, Occisucysta sp. A Bujak and Williams, 1978.

7850-8280': *Ctenidodinium panneum* Zone (Portlandian)

Amphorula sp., *Callialasporites trilobatus* (common), *Coronatispora valdensis, Epiplosphaera reticulospinosa, Pareodinia kondratjevii, Lanterna sportula, Systematophora schindewolfii, Trilobosporites jurassicus.*

8350-9980': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Adnatosphaeridium caulleryi, Epiplosphaera reticulospinosa (common), *Klukisporites pseudoreticulatus, Leptodinium* sp., *Parvocavatus tuberosus, Phthanoperidinium* sp., *Senoniasphaera jurassica, Systematophora orbifera.*

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Amoco-Imp-Skelly
CAREY J-34

GSC locality: D124

Location: 45°23'32.42"N; 52°35'02.67"W

RT elevation: 98' Water depth: 330'

Casing set at: 595, 957, 3780, and 10000'

Total depth: 12104' Interval studied: 1040-12090'

Analyzed by: J.P. Bujak

Palynological analysis of 61 sidewall core and 114 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1040- 1070' *D. colligerum* Zone (late Eocene)
1130- 1340' *A. reticulense* Zone (middle Eocene)
1400- 1520' *A. senonensis* Zone (early Eocene)
1580- 1700' Maastrichtian or early Paleocene
1760- 1880' *D. euclaensis* Zone (Maastrichtian)
1940- 2540' *O. operculata* Zone (Campanian)
2600- 2990' *C. truncigerum* Zone (Santonian)
3050- 3560' *O. pulcherrimum* Zone (Coniacian)
3620- 3650' *S. longifurcatum* Zone (Turonian)
3710- 4190' *C. polypes* Zone (Cenomanian)
4250- 4700' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
4760- 7490' *V. vermiculata* Zone (Callovian)
4760- 6890' *S. scarburghense* subzone (late Callovian)
6960- 7490' *C. tribuliferum* subzone (early Callovian)
7500-12090' Bajocian?-Bathonian

Jurassic strata in the well include a Bajocian?-Bathonian interval approximately 4600ft thick, which is overlain by about 2700ft of Callovian and 500ft of Oxfordian to lower Kimmeridgian sediments. Dinoflagellates and spores are generally common throughout the Jurassic section. Diversity of spores is low, but the diversity of dinoflagellates is fairly high in the Oxfordian to lower Kimmeridgian, and decreases somewhat in older strata, indicating reduced marine influence in the deeper sediments.

The Avalon Unconformity occurs at 4260ft (J. Wade, pers. comm.) and the Jurassic section is unconformably overlain by approximately 2500ft of Upper Cretaceous strata. Much of the Cretaceous interval is dominated by caved Paleogene dinoflagellates. *In situ* assemblages contain dinoflagellates throughout with spores also being common in the Cenomanian, indicating marine deposition.

Maastrichtian or lower Paleocene strata (1580-1700ft) are overlain by an Eocene section between 1520 and 1040ft. Dinoflagellate diversity is high in the middle-upper Eocene indicating marine deposition. The presence of the dinoflagellate *Chiropteridium dispersum* in the upper Eocene suggests that Oligocene strata are caved from the interval above the highest cuttings sample at 1040-1070ft.

Selected palynomorphs

1040-1070': *Diphyes colligerum* Zone (late Eocene)

Araneosphaera araneosa, Areosphaeridium diktyoplokus, A. fenestratum, A. multicornutum, Chiropteridium aspinatum, C. dispersum, Cordosphaeridium inodes, Dinopterygium cladoides, sensu Morgenroth, 1966a, *Gonyaulacysta giuseppei, Hystrichokolpoma rigaudiae, Kisselovia coleothrypta, Lingulodinium machaerophorum, Phthanoperidinium comatum, Spiniferites monilis, S. pseudofurcatus, S. ramosus, Thalassiphora pelagica, Wetzeliella articulata.*

The highest sample available for palynological analysis, from cuttings at 1040-1070ft contains a diverse assemblage of dinoflagellates indicative of upper Eocene strata deposited in a marine environment. The presence of *Chiropteridium dispersum* indicates the occurrence of caved Oligocene from higher in the well.

1130-1340': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Areosphaeridium arcuatum, Cordosphaeridium cantharellum, C. funiculatum, C. gracile, Deflandrea phosphoritica, Dinopterygium sp. A Williams and Bujak, 1977a, *Rhombodinium glabrum, R. rhomboideum, Homotryblium pallidum, Polysphaeridium pastielsii, P. simplex, Systematophora placacantha.*

Assemblages from this interval include several species caved from upper Eocene or younger strata. These are *Cordosphaeridium cantharellum, C. funiculatum, Dinopterygium* sp. A Williams and Bujak, 1977a.

1400-1520': *Areoligera senonensis* Zone (early Eocene)

Adnatosphaeridium multispinosum, Apectodinium homomorphum (common), *Areoligera senonensis, sensu* Gocht, 1969 (abundant), *Hystrichokolpoma eisenackii, Polysphaeridium subtile.*

1580-1700': Maastrichtian or early Paleocene

Isabelidinium bakeri, Oligosphaeridium complex, Epicephalopyxis indentata.

Assemblages from this interval are dominated by caved Eocene palynomorphs.

1760-1880': *Dinogymnium euclaensis* Zone (Maastrichtian)

Dinogymnium euclaensis, Isabelidinium cooksoniae, Spongodinium delitiense, Trithyrodinium evittii.

Assemblages from this interval are dominated by caved Eocene palynomorphs, including *Diphyes colligerum* which was not observed higher in the well.

1940-2540': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, Cyclonephelium distinctum, Dinogymnium acuminatum, Dinopterygium cladoides, Hystrichodinium pulchrum, Isabelidinium belfastensis, Lejeunia magnifica, Odontochitina operculata, Spinidinium sverdrupianum, Trichodinium castaneum.

2600-2990': *Cordosphaeridium truncigerum* Zone (Santonian)

Cannosphaeropsis utinensis, Odontochitina costata, Palaeohystrichophora infusorioides, Senoniasphaera protrusa, S. rotundata, Spinidinium echinoideum, Stephodinium coronatum, Trigonopyxidia sp.

Assemblages from this interval contain common caved Paleogene dinoflagellates, including the species *Rhombodinium perforatum*, not observed higher in the well.

3050-3560': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Fromea amphora, Oligosphaeridium pulcherrimum, Palaeostomocystis fragilis, Surculosphaeridium longifurcatum.

Assemblages from this interval include two caved species, not observed higher in the well. These are the Eocene-Oligocene species *Rhombodinium draco* and the Upper Cretaceous-lower Paleocene species *Ceratiopsis diebelii.*

3620-3650': *Surculosphaeridium longifurcatum* Zone (Turonian)

Callaiosphaeridium asymmetricum, Palaeoperidinium cretaceum, Palambages sp., *Rugubivesiculites rugosus, Xenascus ceratioides.*

3710-4190': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus, Camarozonosporites insignis, Cicatricosisporites hallei, C. hughesi, Cleistosphaeridium polypes, Cribroperidinium orthoceras, Cyclonephelium vannophorum, Klukisporites foveolatus, K. pseudoreticulatus, Liliacidites dividuus, Oligosphaeridium prolixispinosum, O. totum, Schizosporis reticulatus, Spinidinium vestitum, S. cf. *S. vestitum, sensu* Williams, 1975 (rare).

4250-4700': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Callialasporites dampieri, C. segmentatus, C. trilobatus, Cerebropollenites mesozoicus, Cicatricosisporites spp. (base), *Classopollis classoides, Ctenidodinium culmulum, C. panneum, C. schizoblatum, Endoscrinium eisenackii, Foveotriletes subtriangularis, Epiplosphaera reticulospinosa, Gonyaulacysta cladophora, G. granulata, G. jurassica, Pareodinia ceratophora, Senoniasphaera jurassica, Systematophora fasciculigera, S. orbifera, Tenua* sp. (rare), *Tubotuberella apatela.*

4760-7490': *Valensiella vermiculata* Zone (Callovian)

4760-6890': *Stephanelytron scarburghense* subzone (late Callovian)

Circularaesporites cerebroides, Ctenidodinium ornatum, C. pachydermum, Densoisporites velatus, Leptodinium subtile, Leptolepidites psarosus, Lithodinia jurassica, Pareodinia kondratjevii, Tenua sp. (common), *Valensiella vermiculata.*

6960-7490': *Cleistosphaeridium tribuliferum* subzone (early Callovian)

Chytroeisphaeridia chytroeides, sensu Gocht, 1970, *Ctenidodinium continuum, Cycadopites nitidus, Gonyaulacysta aldorfensis.*

7500-12090': Bajocian?-Bathonian

Chytroeisphaeridia chytroeides, Classopollis itunensis, Gonyaulacysta filapicata, Nannoceratopsis pellucida (rare), *Porcellispora* cf. *P. longdonensis, Tasmanites* sp. (rare), *Valensiella ovula.*

The lowest sidewall core sample from the well, at 12 040ft, contains the following dinoflagellate species: *Ctenidodinium panneum, C. pachydermum, Endoscrinium eisenackii, Epiplosphaera reticulospinosa, Gonyaulacysta aldorfensis, Pareodinia kondratjevii, Systematophora orbifera, Tenua* sp., *Valensiella ovula.* This indicates that the well probably does not include Bajocian strata.

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Amoco-Imp-Skelly
COOT K-56

GSC locality: D119

Location: 45°45'41.52"N; 52°08'32.13"W

RT elevation: 98' Water depth: 262'

Casing set at: 526, 919, 2435, and 7403'

Total depth: 11600' Interval studied: 1000-11600'

Analyzed by: J.P. Bujak

Palynological analysis of 34 sidewall core and 95 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1000- 1030'	early Campanian
1090- 1510'	*C. truncigerum* Zone (Santonian)
1630- 1900'	?Coniacian
1960- 1990'	*O. pulcherrimum* Zone (Coniacian)
2050- 2440'	*S. longifurcatum* Zone (Turonian)
2500- 2620'	Jurassic or Early Cretaceous
2680- 2980'	Jurassic undifferentiated
3040- 5330'	Bajocian-Bathonian
5400- 5730'	*N. gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)
5800- 7230'	*E.* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)
7300-10630'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)
10878-11600'	*C. meyeriana* Zone (Rhaetian-early Hettangian)

There appears to be a fairly continuous Rhaetian to Bathonian succession from 11 600 to 3040ft. Dinoflagellates have their lowest occurrence in the *N. gracilis*

Zone and become common in the upper part of the Bajocian-Bathonian (3040-3700ft) indicating increasing marine influence in younger strata. The Rhaetian to Bathonian section is overlain by an interval from 2980 to 2500ft of probable Jurassic age which may in part be Late Jurassic. Lower Cretaceous strata also may occur between 2620 and 2500ft. The interval 2980-2500ft contains few palynomorphs so that more precise dating was not possible using palynomorphs, but the Avalon Unconformity occurs at 2527ft (J. Wade, pers. comm.). A Turonian to lower Campanian succession occurs at 2440-1000ft and contains common dinoflagellates indicating neritic depositional environments.

Selected palynomorphs

1000-1030': early Campanian

Chatangiella victoriensis, Dinogymnium digitus, Exochosphaeridium bifidum, Hystrichodinium pulchrum, Odontochitina costata, Oligosphaeridium complex, Palaeohystrichophora infusorioides, Spinidinium sverdrupianum.

1090-1510': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella tripartita, Chlamydophorella discreta, C. nyei, Cordosphaeridium truncigerum, Hystrichosphaeridium difficile, H. paracostatum, Kleithriasphaeridium loffrense, Odontochitina operculata, Rugubivesiculites reductus, R. rugosus, Senoniasphaera protrusa, S. rotundata, Stephodinium coronatum, Surculosphaeridium longifurcatum, Trigonopyxidia sp., *Xenascus ceratioides.*

1630-1900': ?Coniacian

Cyclonephelium distinctum, Dinopterygium cladoides, Silicisphaera ferox, Surculosphaeridium longifurcatum (common).

1960-1990': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Oligosphaeridium pulcherrimum.

2050-2440': *Surculosphaeridium longifurcatum* Zone (Turonian)

Endoscrinium campanulum, Florentinia mantellii, Odontochitina porifera, Palaeostomocystis fragilis, Trichodinium castaneum.

Also present in this interval are rare specimens of the species *Epelidosphaeridia spinosa, Spinidinium vestitum,* and *Trilobosporites apiverrucatus.* These species may be reworked.

2500-2620': Jurassic or Early Cretaceous

Classopollis classoides.

Palynomorphs are rare in this interval and include *Classopollis classoides,* possibly indicating a Jurassic age. However, the presence of a single specimen of the Hauterivian to Aptian species *Aptea attadalica* in the cuttings sample at 2770-2800ft may represent caving from the interval 2500-2620ft suggesting the possible presence of Lower Cretaceous strata between 2500 and 2620ft.

2680-2980': Jurassic undifferentiated

Callialasporites dampieri, C. trilobatus, Cycadopites nitidus, Ctenidodinium panneum, Klukisporites foveolatus, Verrucosisporites spp.

Palynomorphs are rare in this interval, but the presence of *Ctenidodinium panneum* indicates an age no younger than Portlandian and the overall assemblage suggests a Portlandian age.

3040-5330': Bajocian-Bathonian

Cerebropollenites mesozoicus (common), *Chytroeisphaeridia chytroeides* (frequent), *Circularaesporites cerebroides* (common), *Classopollis itunensis* (abundant), *Ctenidodinium pachydermum, Densoisporites velatus, Klukisporites pseudoreticulatus, Leptolepidites psarosus, Pareodinia ceratophora* (with kalyptra), *P. kondratjevii, Porcellispora* sp. (top at 4120-50ft), *Tenua* spp.

The palynological assemblages show little variation through this interval and it was not possible to differentiate Bajocian from Bathonian strata.

5400-5730': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Luehndia spinosa, Nannoceratopsis gracilis.

5800-7230': *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Cerebropollenites mesozoicus (base at 7200ft), *Classopollis meyeriana, Convolutispora klukiforma, Kraeuselisporites reissingeri.*

A specimen of *Aquilapollenites* in the cuttings sample at 6900-6930ft is probably a mud contaminant.

7300-10630': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Araucariacites punctatus, Classopollis classoides (abundant), *Echinitosporites* sp. A Bujak and Williams, 1977.

10878-11600': *Classopollis meyeriana* Zone (Rhaetian-early Hettangian)

Classopollis meyeriana (abundant).

The lowest sidewall core sample, at 11 590ft, contains the species *Classopollis classoides* and *C. meyeriana* indicating that the sample is no older than Rhaetian.

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Amoco-Imp
CORMORANT N-83

GSC locality: D83

Location: 46°02'45.43"N; 48°58'02.07"W

RT elevation: 98' Water depth: 216'

Casing set at: 480, 840, 2510, and 9753'

Total depth: 10369' Interval studied: 870-10310'

Analyzed by: G.L. Williams

Palynological analysis of 40 sidewall core, 100 cuttings and ten conventional core samples indicates the following age determinations and biostratigraphic zonation:

870- 1080'	*D. heterophlycta* Zone (early Oligocene)
1240- 1260'	*D. colligerum* Zone (late Eocene)
?1260- 1320'	*A. senonensis* Zone (early Eocene)
1320- 1530'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
1560- 1590'	*O. operculata* Zone (Campanian)
1620- 2100'	*C. truncigerum* Zone (Santonian)
2160- 2190'	*O. pulcherrimum* Zone (Coniacian)

2530- 2550' *S. longifurcatum* Zone (Turonian)
2600' *C. polypes* Zone (Cenomanian)
2730- 2890' *C. panneum* Zone (Portlandian)
3060- 3090' *G. cladophora* Zone (Kimmeridgian)
3125' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
3150- 3770' *V. vermiculata* Zone (Callovian)
3780- 4350' *G. filapicata* Zone (Bathonian)
4410- 5070' *M. semitabulatum* Zone (Aalenian-Bajocian)
5100- 6415' *N. gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)
6535- 7735' Pliensbachian
7771- 9790' Hettangian-Sinemurian
9820-10310' ?Rhaetian

The Avalon Unconformity occurs at 2720ft in Cormorant N-83, where the Portlandian is overlain by Cenomanian sediments. It is possible that the Maastrichtian, which appears to be absent, is present between 1530 and 1560ft, since a few caved Maastrichtian dinocysts are present in the cuttings sample at 1620-1650ft. The lower Eocene interval is inferred from the presence of early Eocene dinocysts in the lower Paleocene sample at 1320-1350ft.

The environment of deposition in the ?Rhaetian-Sinemurian was possibly non-marine since only spores have been recorded from this interval. The Pliensbachian-Toarcian sediments appear to have been deposited predominantly in a shallow marine environment with some non-marine episodes. The presence of species of *Micrhystridium* at 6780, 6000, and 5100ft is taken to denote shallow water conditions. The unavailability of sidewall cores between 5100 and 3770ft precludes definite environmental interpretations for the Bajocian-Bathonian stages. Dinoflagellates are common in the cuttings samples however between 5070 and 3780ft indicating a neritic environment for at least part of this interval. Dinocysts are abundant throughout the Callovian. In the upper Jurassic dinocysts are rare and above 2890ft are absent. The sidewall core at 2730ft contains spores only and is taken to be indicative of a non-marine environment. The Cenomanian contains a rich dinocyst assemblage. The only samples available for examination from the Turonian-Oligocene interval are cuttings. However, the abundance of dinoflagellates suggests a marine environment of unknown water depths.

Selected palynomorphs

870-1080': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, Deflandrea wardenensis, Epicephalopyxis indentata, Samlandia chlamydophora, Systematophora ancyrea, Tanyosphaeridium sp. A Williams and Brideaux, 1975, *Tubidermodinium sulcatum.*

1240-1260': *Diphyes colligerum* Zone (late Eocene)

Cordosphaeridium cracenospinosum, Phthanoperidinium sp.

?1260-1320': *Areoligera senonensis* Zone (early Eocene)

1320-1530': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Areoligera medusettiformis, A. cf. *A. medusettiformis, A. senonensis, Ceratiopsis speciosa, Danea mutabilis, Extratriporopollenites* sp., *Palaeoperidinium pyrophorum.* The presence of *Cyclonephelium ordinatum* and *C. divaricatum* in this assemblage indicate Early Eocene between ?1260-1320ft.

1560-1590': *Odontochitina operculata* Zone (Campanian)

Chatangiella vnigri, Spinidinium cf. *S. echinoideum.*

1620-2100': *Cordosphaeridium truncigerum* Zone (Santonian)

Cordosphaeridium truncigerum, Surculosphaeridium longifurcatum.

2160-2190': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Chlamydophorella nyei.

2530-2550': *Surculosphaeridium longifurcatum* Zone (Turonian)

Classopollis classoides, Cleistosphaeridium polypes subsp. A, *sensu* Williams, 1975 (one specimen).

2600': *Cleistosphaeridium polypes* Zone (Cenomanian)

Callaiosphaeridium asymmetricum, Cyclonephelium membraniphorum, Exochosphaeridium bifidum, Microdinium setosum, Odontochitina costata, Oligosphaeridium complex, Spiniferites cingulatus (common), *Xenascus ceratioides, Xiphophoridium alatum.*

2730-2890': *Ctenidodinium panneum* Zone (Portlandian)

Aequitriradites spinulosus, Callialasporites dampieri, Ctenidodinium culmulum, Densoisporites perinatus, Exesipollenites tumulus, Klukisporites pseudoreticulatus, Lanterna sp., *Tenua* sp.

3060-3090': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Ellipsoidictyum cinctum, Gonyaulacysta ehrenbergii.

3125': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Alisporites grandis, Foraminisporis wonthaggiensis, Gonyaulacysta cladophora, Hystrichogonyaulax nealei, Lycopodiacidites cerniidites, Perinopollenites elatoides.

3150-3770': *Valensiella vermiculata* Zone (Callovian)

Cerebropollenites mesozoicus, Comasphaeridium sp., *Ctenidodinium pachydermum,* Gen. et sp. 2 Gocht, 1970, *Endoscrinium eisenackii, Leptodinium subtile* subsp. *pectinigerum, Pareodinia ceratophora, P. ceratophora* (with kalyptra), *Tenua hystrix, T. rioultii, T.* spp., *Valensiella ampulla.*

3780-4350': *Gonyaulacysta filapicata* Zone (Bathonian)

Ctenidodinium ornatum (common), *Gonyaulacysta* cf. *G. filapicata, Nannoceratopsis gracilis* (one specimen), *Tenua* spp. (common), *Valensiella vermiculata.*

4410-5070': *Mancodinium semitabulatum* Zone (Aalenian-Bajocian)

Ctenidodinium pachydermum (base), *Meiourogonyaulax* sp. Gocht, 1970, *Mendicodinium* sp.

5100-6415': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Araucariacites fissus, Baltisphaeridium debilispinum, Contignisporites cooksonii (base), *Cerebropollenites mesozoicus* (common), *Kraeuselisporites reissingeri, Leptolepidites* cf. *L. psarosus, Luehndea spinosa, Mancodinium semitabulatum, Maturodinium inornatum, Mendicodinium* sp., *Micrhystridium lymensis, Nannoceratopsis gracilis* (common), *Pediastrum* sp., *Tasmanites* sp.

6535-7735': Pliensbachian

Camarozonosporites rudis, Classopollis simplex, Cycadopites subgranulosus (7510ft), *Luehndea spinosa* (base),

Mancodinium semitabulatum (base), *Nannoceratopsis gracilis* (base), *Pareodinia ceratophora* (with kalyptra, base).

The species *Callialasporites dampieri*, not previously recorded from the Pliensbachian is present in the sidewall core samples at 6535, 6990, 7200, 7360, 7680, and 7735ft. This indicates either contamination of the sidewall cores or possibly a longer stratigraphic range for the species than was previously believed.

7771-9790': Hettangian-Sinemurian

Cerebropollenites mesozoicus (base), *Classopollis classoides*, *C. simplex* (base), *Ellipsovelatisporites plicatus*, *Ovalipollis* sp.

9820-10310': ?Rhaetian

Lycopodiacidites rhaeticus, *Lycopodiumsporites austroclavatidites*.

* * * * *

Mobil Gulf Imperial
CUMBERLAND B-55

GSC locality: D149

Location: 48°24'12.57"N; 50°07'58.13"W

RT elevation: 98' Water depth: 639'

Casing set at: 904, 1345, 4238, and 10483'

Total depth: 13571' Interval studied: 1380-13560'

Analyzed by: G.L. Williams

Palynological analysis of 127 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1380- 1860'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1920- 2400'	*Cannosphaeropsis* sp. A Zone (late Miocene)
2550- 3210'	*P. laticinctum* Zone (middle Miocene)
3260- 4110'	*Apteodinium* sp. B Zone (early Miocene)
4170- 4650'	*C. dispersum* Zone (middle-late Oligocene)
4710- 6540'	*D. heterophlycta* Zone (early Oligocene)
6600-10350'	*D. colligerum* Zone (late Eocene)
10440-11660'	*A. reticulense* Zone (middle Eocene)
11730-11760'	*A. senonensis* Zone (early Eocene)
11830-11860'	possibly *C. speciosa* Zone (late Paleocene)
11930-12060'	*P. pyrophorum-C. diebelii* Zone (early Paleocene)
12130-12160'	Senonian
?12160-?12230'	Barremian-Aptian
12230-13560'	Lower Paleozoic

The oldest datable sediments in Cumberland B-55 are Lower Paleozoic (D. Umpleby, personal communication) and extend from 13 560 to 12 230ft. The cuttings samples in this interval contain predominantly caved Paleocene-Eocene palynomorphs, with only one possible Paleozoic microfossil being observed. The Paleozoic rocks may be overlain by Barremian-Aptian sediments from ?12 230 to ?12 160ft since the two cuttings samples at 12 330-12 360 and 12 230-12 260ft respectively, contain spores and dinocysts of this age. The single sample at 12 130-12 160ft is herein dated Senonian and may be immediately overlain by lower Paleocene rocks, since diagnostic Maastrichtian palynomorphs have not been observed.

The thick more or less complete Tertiary section extends from 12 060 to possibly 1380ft. The Paleocene and lower Eocene sediments are sequentially succeeded by approximately 1200ft of middle Eocene, 3750ft of upper Eocene, 2370ft of Oligocene, and 2190ft of Miocene with about 1860ft being Plio-Pleistocene. The greatly expanded upper Eocene-Oligocene section is similar to that found in the BP Bonavista C-99 well to the northwest, which is located in the same sedimentary basin.

Paleoenvironmental interpretations are difficult since only cuttings samples were available for examination. Certain generalizations can however be made. The Barremian-Aptian if present and not merely reflecting reworked material must have been shallow water marine. The Paleocene palynomorphs show a marked colour change from the overlying assemblages, presumably reflecting somewhat different environmental conditions. Early Eocene dinocysts are very abundant with species of *Apectodinium* and *Wetzeliella* predominating between 11 760 and 11 630ft. This generally indicates an inner neritic environment. The rich middle Eocene dinocyst assemblages are taken to reflect shelf deposition. The very thick upper Eocene, initially deposited in a neritic environment, contains few dinocysts between 7140 and 6600ft suggesting shallowing. This is substantiated by the very low species diversity in the lower Oligocene from 6540 to 4710ft where the dominant dinocyst taxa are *Epicephalopyxis* and species of *Phthanoperidinium*. Also present are *Pediastrum* and several pollen taxa. Elsik (1975) has noted that *E. indentata* is common in marginal marine to marine environments. Bujak (pers. comm.) suggested that although the species had a wide range of salinity tolerance, it showed a preference for lower salinities. Williams and Bujak (1977b) interpreted sediments on the Labrador Shelf with concentrations of *E. indentata* as being deposited in shallow water marine environments. The lower Oligocene sediments in Cumberland B-55 are accordingly interpreted as being deposited in very shallow marine to estuarine environments. Miocene and younger sediments appear to represent shelf deposition with considerable reworking of Late Cretaceous and early Tertiary dinocysts. The middle Miocene assemblages include several Late Cretaceous taxa, previously known only from Arctic Canada and Bylot Island. This indicates that the East Newfoundland Basin was receiving both clastic sediments from the north and locally derived sediments in the Miocene. Although reworking continued into the Plio-Pleistocene the northerly sourced dinocysts are absent.

Selected palynomorphs

1380-1860': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Alnipollenites verus, *Cingutriletes* sp., *Pinus* spp., *Tsugaepollenites igniculus*.

Reworked species include *Classopollis classoides*.

1920-2400': *Cannosphaeropsis* sp. A Zone (late Miocene)

Apteodinium sp. Gocht, 1969, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Ganningia* sp., *Caryapollenites simplex*, *Hystrichokolpoma rigaudiae*, *Lingulodinium machaerophorum*, *Operculodinium centrocarpum*, *Osmundacidites* sp. A Williams and Bujak, 1977a, *Palaeocystodinium golzowense*, *Spiniferites scabratus*, *Systematophora placacantha*.

Reworked species include *Areoligera medusettiformis*, *Chatangiella tripartita*, *Cicatricosisporites australiensis*, *Hystrichokolpoma eisenackii*, *Isabelidinium belfastense*, and *Odontochitina operculata*.

2550-3210': *Pentadinium laticinctum* Zone (middle Miocene)

Epicephalopyxis indentata, Hemicystodinium sp. Williams, 1975, *Hystrichosphaeropsis obscura, Ilexpollenites* sp., *Impletosphaeridium transfodum, Maduradinium spatiosum, Operculodinium israelianum, Polysphaeridium pastielsii, Pterodinium circumsutum, Spiniferites crassipellis, S. pseudofurcatus, Tuberculodinium rossignoliae, T. vancampoae, Ulmipollenites* sp.

Reworked species include *Apteodinium* sp. B Williams and Brideaux, 1975, *Areoligera senonensis, sensu* Gocht, 1969, *Cerebropollenites mesozoicus, Chatangiella decorosa, C. ditissima, Cordosphaeridium fibrospinosum, Coronatispora valdensis, Heteraulacacysta campanula, Horologinella* sp., *Hystrichosphaeridium difficile, Luxadinium propatulum, Oligosphaeridium complex, Ovoidinium verrucosum, Trilobosporites trioreticulosus,* and *Wetzeliella meckelfeldensis.*

3260-4110': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B, *Ascostomocystis potane, Cordosphaeridium cantharellum, Epicephalopyxis indentata, Heteraulacacysta campanula, Homotryblium plectilum, Hystrichosphaeridium choanophorum, Pentadinium laticinctum, Spiniferites* cf. *S. crassipellis, S. membranaceus, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

Reworked species include *Callialasporites obrutus, Chatangiella decorosa, C. ditissima, Chiropteridium dispersum, Cyclonephelium membraniphorum, Deflandrea spinulosa, Extratriporopollenites* sp., *Spinidinium styloniferum,* and *Trichodinium castaneum.*

4170-4650': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Deflandrea spinulosa, Diacrocanthidium sp., *Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Hystrichokolpoma eisenackii, Svalbardella cooksoniae.*

4710-6540': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium multicornutum, Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Deflandrea* cf. *D. heterophlycta, Nyssapollenites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium* cf. *P. alectrolophum, P. amoenum, P.* cf. *P. echinatum, Thalassiphora pelagica.*

Reworked species include *Chatangiella decorosa.*

6600-10350': *Diphyes colligerum* Zone (late Eocene)

Areosphaeridium arcuatum, Cyclonephelium exuberans, C. sp. B Williams and Brideaux, 1975, *Deflandrea eocenica, D. granulosa, D. leptodermata, D.* sp. C Williams and Bujak, 1977b, *Diphyes colligerum, Distatodinium ellipticum, Kisselovia coleothrypta, K. tenuivirgula* subsp. *crassiramosa, Lejeunia hyalina, Phthanoperidinium comatum, Polysphaeridium simplex, Rhombodinium draco, R.* sp. A Williams and Bujak, 1977a, *Schematophora speciosa, Veryhachium* sp., *Wetzeliella ovalis, W. symmetrica.*

Reworked species include *Chatangiella decorosa, C. tripartita, Hystrichosphaeridium difficile, Kleithriasphaeridium loffrense, Kraeuselisporites reissingeri, Systematophora turonica,* and *Trilobosporites purverulentus.*

10440-11660': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Achilleodinium biformoides, Adnatosphaeridium reticulense, sensu Gocht, 1969, *A. vittatum, Araneosphaera araneosa, Areoligera senonensis, sensu* Gocht, 1969, *Areosphaeridium diktyoplokus, Baltisphaeridium* sp., *Cordosphaeridium gracile, Cyclonephelium ordinatum, Deflandrea denticulata, Eocladopyxis peniculata, Gonyaulacysta giuseppei, Homotryblium oceanicum, H. pallidum, H. tenuispinosum, Hystrichokolpoma* cf. *H. cinctum, Impletosphaeridium* cf. *I. transfodum, Leptodinium victorianum, Membranilarnacia ursulae, Rhombodinium condylos, R. intermedium, Spiniferites cornutus, Tectatodinium pellitum, Tubidermodinium sulcatum, Wetzeliella articulata, W.* cf. *W. edwardsii, W. varielongituda, W.* sp. A Williams and Bujak, 1977b, *Wilsonidium echinosuturatum.*

11730-11760': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (common), *Homotryblium tenuispinosum* (common), *Hystrichosphaeridium tubiferum, Wilsonidium lineidentatum.*

11830-11860': possibly *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis sp.

11930-12060': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Aireiana verrucosa, Areoligera medusettiformis (common), *Ceratiopsis speciosa, Eisenackia circumtabulata, Oligosphaeridium complex, Palaeoperidinium pyrophorum, Palambages* sp., *Turbiosphaera magnifica.*

12130-12160': Senonian

Isabelidinium cretaceum, Surculosphaeridium longifurcatum.

?12160-?12230': Barremian-Aptian

Alisporites grandis, Cicatricosisporites australiensis and *Cribroperidinium orthoceras* occur in cutting samples from 12 230 to 12 360ft.

12230-13560': Lower Paleozoic

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Mobil-Gulf
DOMINION O-23

GSC locality: D139

Location: 47°22'49.14"N; 48°18'27.90"W

RT elevation: 98' Water depth: 530'

Casing set at: 793, 1223, 4133, and 9748'

Total depth: 13116' Interval studied: 1200-13116'

Analyzed by: J.P. Bujak

Palynological analysis of 124 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1200- 1681' *Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1740- 1770' *Cannosphaeropsis* sp. A Zone (late Miocene)
1830- 2580' *P. laticinctum* Zone (middle Miocene)
2670- 3210' *Apteodinium* sp. B Zone (early Miocene)
3300- 3600' *C. dispersum* Zone (middle-late Oligocene)
3660- 4320' *D. heterophlycta* Zone (early Oligocene)
4380- 5130' late Eocene-early Oligocene
5190-10000' Eocene
10070-10410' *C. speciosa* Zone (late Paleocene)
10480-11020' *C. elegantulum* Zone (Hauterivian)
11090-13116' *P. neocomica* Zone (Berriasian-Valanginian)

The oldest strata in the well are Berriasian to Hauterivian between 13 116 and 10 480ft, the Avalon Unconformity occurring at 10 410ft (J. Wade, pers. comm.). These are overlain by a marine upper Paleocene to Plio-Pleistocene succession between 10 410 and 1200ft. The greater part of the Tertiary consists of Eocene sediments with a thickness of more than 4800ft. The paucity of palynomorphs in the Eocene sediments probably reflects their rapid accumulation.

Reworked palynomorphs are common. Jurassic dinoflagellates are present in the Lower Cretaceous, and Upper and Lower Cretaceous species occur throughout the Tertiary interval. Eocene and Paleocene dinoflagellates were noted in lower Miocene sediments.

Selected palynomorphs

1200-1681': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Ambrosia sp. Williams, 1975, *Caryapollenites simplex, Hystrichosphaeridium choanophorum, Operculodinium centrocarpum, O. israelianum, Retitricolpites* sp. M Williams and Brideaux, 1975, *Spiniferites ramosus, Tectatodinium pellitum, Tsugaepollenites* sp.

Dinoflagellates have their highest occurrence at 1470ft. Also present in this interval are reworked specimens of the species *Apectodinium homomorphum, Concavissimisporites punctatus, Isabelidinium belfastense, Oligosphaeridium complex,* and *Spinidinium vestitum.*

1740-1770': *Cannosphaeropsis* sp. A Zone (late Miocene)

Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Operculodinium giganteum, Spiniferites scabratus.

Also present in this interval are reworked specimens of the species *Camarozonosporites insignis, Chatangiella tripartita,* and *Cyathidites australis.*

1830-2580': *Pentadinium laticinctum* Zone (middle Miocene)
(middle Miocene)

Apteodinium sp. A Williams and Brideaux, 1975, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Gonyaulacysta giuseppei, Lejeunia* sp., *Leptodinium sphaericum, Nematosphaeropsis balcombiana, Palaeocystodinium golzowense, Pentadinium laticinctum, P. laticinctum* subsp. *granulatum, Polysphaeridium pastielsii, Selenopemphyx nephroides, Spiniferites crassipellis, S. membranaceus, S. monilis, S. pseudofurcatus, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Tuberculodinium vancampoae.*

Also present in this interval are reworked specimens of the species *Callialasporites dampieri, Chatangiella victoriensis, Contignisporites cooksonii, Isabelidinium cooksoniae, Odontochitina operculata, Palaeoperidinium cretaceum,* and *Trilobosporites apiverrucatus.*

2670-3210': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux, 1975, *Araneosphaera ananeosa, Chytroeisphaeridia* sp., *Cordosphaeridium cantharellum, Distatodinium paradoxum, Epicephalopyxis indentata, Pediastrum boryanum, Thalassiphora delicata.*

Also present in this interval are reworked specimens of the species *Eisenacki ornata, Concavissimisporites punctatus, Homotryblium tenuispinosum, Hystrichokolpoma eisenackii, Inversidinium exilimurum,* and *Palaeoperidinium cretaceum.*

3300-3600': *Chiropteridium dispersum* Zone
(middle-late Oligocene)

Areosphaeridium arcuatum (large form), *A. multicornutum* (large form), *Chiropteridium dispersum, C. lobospinosum, Deflandrea phosphoritica, Hystrichosphaeropsis* sp. A Williams and Brideaux, 1975, *Lejeunia fallax.*

Also present in this interval are reworked specimens of the species *Chatangiella victoriensis.*

3660-4320': *Deflandrea heterophlycta* Zone
(early Oligocene)

Areosphaeridium arcuatum (large form) (common), *A. multicornutum* (large form) (common), *Chiropteridium aspinatum, Cyclonephelium intricatum, Deflandrea heterophlycta, D. spinulosa, Polysphaeridium simplex, Systematophora placacantha, Thalassiphora pelagica, Wetzeliella articulata, W. lunaris, Wetzeliella* sp. A Williams and Bujak, 1977b.

Also present in this interval are reworked specimens of the species *Callialasporites dampieri, Chatangiella victoriensis, Cyclonephelium distinctum, Foveotriletes subtriangularis, Spinidinium sverdrupianum,* and *S. vestitum.*

4380-5130': late Eocene-early Oligocene

Areosphaeridium multicornutum, Cordosphaeridium inodes, Deflandrea phosphoritica, Homotryblium plectilum, H. tenuispinosum, Hystrichokolpoma salacia, Epicephalopyxis indentata (common between 4470 and 4650ft).

Also present in this interval are reworked specimens of the species *Contignisporites cooksonii, Isabelidium belfastense,* and *Odontochitina operculata.*

5190-10000': Eocene

Areosphaeridium fenestratum, Cordosphaeridium gracile, Cyclonephelium exuberans subsp. *ellipsoidale, C. ordinatum, C. textum, Deflandrea wetzelii, Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Heteraulacacysta leptalea, Homotryblium oceanicum, Kisselovia coleothrypta, K. reticulata, Lejeunia hyalina, Pediastrum boryanum* (present at 6900 and 7570ft), *Phthanoperidinium alectrolophum, P. comatum, Rhombodinium draco.*

Also present in this interval are reworked specimens of the Cretaceous species *Chatangiella victoriensis, Cribroperidinium orthoceras, Isabelidinium cooksoniae, Muderongia simplex, Spinidinium sverdrupianum, S. vestitum,* and *Trilobosporites apiverrucatus.*

10070-10410': *Ceratiopsis speciosa* Zone (late Paleocene)

Deflandrea sp. A Drugg, 1967, *Ceratiopsis leptoderma.*

10480-11020': *Ctenidodinium elegantulum* Zone
(Hauterivian)

Appendicisporites problematicus, Aptea attadalica, A. polymorpha, Callialasporites trilobatus, Cicatricosisporites annulatus, C. hughesi, Cribroperidinium orthoceras, Cyclonephelium distinctum, Dingodinium cerviculum, Gonyaulacysta serrata, Hystrichodinium pulchrum, Muderongia tetracantha, Occisucysta sp., *Odontochitina operculata, Oligosphaeridium complex, O. asterigerum, Pareodinia ceratophora, Phoberocysta* sp., *Prolixosphaeridium xanthiopyxides, Pseudoceratium pelliferum, Subtilisphaera pirnaensis, Trilobosporites apiverrucatus, Vitreisporites pallidus, Xenascus ceratioides.*

11090-13116': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Batioladinium jaegeri, Callialasporites dampieri, Classopollis classoides, Costatoperforosporites foveolatus, Ctenidodinium elegantulum, Endoscrinium campanulum, Gonyaulacysta spp., *Kraeuselisporites linearis, Lycopodiumsporites crassimacerius, Phoberocysta neocomica, Pilosisporites trichopapillosus, Polystephanophorus sarjeantii, Systematophora complicata.*

Also present in this interval are reworked specimens of the Jurassic species *Gonyaulacysta cladophora, Gonyaulacysta granulata, Systematophora fasciculigera,* and *Taeniophora iunctispina.*

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Amoco-Imp-Skelly
EGRET K-36

GSC locality: D108

Location: 46°25'37"N; 48°50'22"W

RT elevation: 98' Water depth: 223'

Casing set at: 486, 856, 2453, and 5424'

Total depth: 11000' Interval studied: 1240-11000'

Analysed by: G.L. Williams

Palynological analysis of 48 sidewall cores and 71 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1240- 2180'	*D. heterophlycta* Zone (early Oligocene)
2330- 2540'	Eocene
2600- 2630'	*O. operculata* Zone (Campanian)
2690- 3645'	*C. truncigerum* Zone (Santonian)
3745- 3890'	*O. pulcherrimum* Zone (Coniacian)
3950- 4335'	*S. longifurcatum* Zone (Turonian)
4425- 4730'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
4750- 4830'	*S. perlucida-S. schindewolfii* Zone (Aptian)
4900- 5550'	*D. anaphrissa* Zone (Barremian)
5600- 6420'	*C. elegantulum* Zone (Hauterivian)
6500- 7286'	*P. neocomica* Zone (Berriasian-Valanginian)
7300- 8142'	*C. panneum* Zone (Portlandian)
8237- 8448'	*G. cladophora* Zone (Kimmeridgian)
8448-10955'	presumed Oxfordian-Kimmeridgian
10955-11000'	Oxfordian

The sidewall core sample from 10 955ft contains two dinoflagellate species which are not known from pre-Oxfordian sediments. No Callovian taxa were observed in the cuttings sample at 11 000-10 970ft, therefore, Egret K-36 appears to bottom in Oxfordian.

There appears to be a more or less unbroken depositional record in Egret K-36 from the Oxfordian to the Albian, although part of the Aptian may be absent. The Cenomanian has not been recognised, the Albian apparently being overlain by the Turonian. The remainder of the upper Cretaceous is complete with the possible exception of the Maastrichtian. The Paleocene if present must be condensed, since the Campanian extends to within 60ft of Eocene sediments.

The depositional environment has shown considerable fluctuations in the vicinity of Egret K-36. In the Kimmeridgian-Portlandian the sediments were deposited predominantly in a shallow marine environment. The Berriasian-Hauterivian is inner neritic to littoral. The Barremian-Albian is non-marine, with occasional marginal marine episodes. Cenomanian sediments have not been identified, although they may be present between 4425 and 4335ft.

The Turonian marked the onset of a marine transgression which persisted into the Oligocene. The absence of the Maastrichtian-lower Paleocene may be apparent rather than real since caved dinoflagellates of this age occur in cuttings from 2630 to 2600ft. It is possible therefore that Maastrichtian-Paleocene sediments are present between 2600 and 2540ft. The lower Oligocene is particularly rich in dinoflagellates, perhaps denoting inner neritic deposition.

Selected palynomorphs

1240-2180': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, Chiropteridium aspinatum, C. dispersum, Cordosphaeridium cantharellum, C. funiculatum, Cyclonephelium sp. B Williams and Brideaux, 1975, *Deflandrea heterophlycta, D. phosphoritica, Gonyaulacysta* cf. *G. granulata, sensu* Benedek, 1972, *Homotryblium plectilum, Hystrichokolpoma rigaudiae, Kisselovia* cf. *K. coleothrypta, Thalassiphora pelagica, Tiliaepollenites* sp., *Tsugaepollenites igniculus, Tubidermodinium sulcatum, Wetzeliella articulata.*

2330-2540': Eocene

Cyclonephelium ordinatum, Hystrichosphaeropsis ovum, Systematophora ancyrea.

2600-2630': *Odontochitina operculata* Zone (Campanian)

Ceratiopsis diebelii (interpreted as caved Maastrichtian-early Paleocene), *Chatangiella victoriensis, Lejeunia* cf. *L. magnifica* (interpreted as caved Maastrichtian-Paleocene), *Vozzhennikovia rotunda* (interpreted as caved Paleocene).

2690-3645': *Cordosphaeridium truncigerum* Zone (Santonian)

Oligosphaeridium complex, Palaeohystrichophora infusorioides, Rugubivesiculites convolutus, Surculosphaeridium longifurcatum.

Specimens of reworked Early Cretaceous species occur in the sidewall core at 3645ft. Such species include the dinoflagellates *Muderongia perforata* and *Palaeoperidinium pyrophorum,* and the spores *Alisporites grandis, Callialasporites dampieri, C. trilobatus, Cerebropollenites mesozoicus,* and *Classopollis classoides.*

3745-3890': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Chlamydophorella nyei, Cyclonephelium distinctum, Kleithriasphaeridium loffrense, Oligosphaeridium pulcherrimum, Spinidinium cf. *S. echinoideum, Trichodinium castaneum, Xenascus ceratioides.*

3950-4335': *Surculosphaeridium longifurcatum* Zone (Turonian)

Callaiosphaeridium asymmetricum, Canningia reticulata, Odontochitina costata, Senoniasphaera rotundata, Silicisphaera ferox, Spiniferites cingulatus, Surculosphaeridium longifurcatum (common), *Tenua* sp.

4425-4730': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites potomacensis, Cicatricosisporites pseudotripartitus, Classopollis classoides,

Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Coronatispora valdensis, Cribroperidinium orthoceras, Deltoidospora juncta, Eucommiidites minor, E. troedssonii, Hystrichosphaeridium bowerbankii, Rugubivesiculites rugosus* (base at 4425ft).

4750-4830': *Subtilisphaera perlucida-Systematophora schindewolfi* Zone (Aptian)

Appendicisporites bifurcatus, Callialasporites dampieri, Cerebropollenites mesozoicus, Surculosphaeridium cf. *S. longifurcatum, sensu* Williams, 1975.

4900-5550': *Tenua anaphrissa* Zone (Barremian)

Aequitriradites spinulosus, Appendicisporites bilateralis, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, C. subrotundus, Densoisporites perinatus, Exesipollenites tumulus, Klukisporites pseudoreticulatus, Perinopollenites elatoides, Pseudoceratium pelliferum.

5600-6420': *Ctenidodinium elegantulum* Zone (Hauterivian)

Callialasporites trilobatus, Concavissimisporites variverrucatus, Coronatispora valdensis, Dictyophyllidites equiexinus, Foraminisporis wonthaggiensis, Muderongia perforata, M. simplex, Osmundacidites wellmanii, Plicatella abaca, Schizosporis parvus, Trilobosporites apiverrucatus, T. bernissartensis.

6500-7286': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Classopollis echinatus, Dingodinium cerviculum, Endoscrinium campanulum, Gonyaulacysta ambigua (two specimens, one at 6593ft; one at 6600-6630ft), *G. granulata* (two specimens, one at 7000-7030ft; one at 7100-7130ft), *Hystrichodinium pulchrum, Lanterna sportula, Leptodinium* sp., *Occisucysta* sp. A Bujak and Williams, 1978, *Pareodinia ceratophora, P. ceratophora* (with kalyptra), *P. kondratjevii, Perinopollenites elatoides* (common), *Pilosisporites trichopapillosus, Systematophora schindewolfii, Trilobosporites domitus.*

7300-8142': *Ctenidodinium panneum* Zone (Portlandian)

Amphorula metaelliptica, Classopollis classoides (abundant), *Contignisporites cooksonii, Leptolepidites psarosus, Pareodinia kondratjevii* (common), *P. villosa, Systematophora turonica, Tasmanites* sp.

8237-8448': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Contignisporites cooksonii (common), *Gonyaulacysta granulata, Ischyosporites crateris* (common), *Leptolepidites psarosus* (base), *Senoniasphaera jurassica, Systematophora orbifera, Tenua* sp.

8448-10955': presumed Oxfordian-Kimmeridgian

10955-11000': Oxfordian

Muderongia simplex, Parvocavatus tuberosus.

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Amoco-IOE
EIDER M-75

GSC locality: D28

Location: 45°34'57.97"N, 51°56'41.52"W

RT elevation: 98' Water depth: 255'

Casing set at: 424, 877, 2175, and 6990'

Total depth: 11582' Interval studied: 900-11580'

Analyzed by: G.L. Williams

Palynological analysis of 168 sidewall cores and 43 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

900- 1290'	*O. operculata* Zone (Campanian)
1440- 2010'	*C. truncigerum* Zone (Santonian)
2080'	*O. pulcherrimum* Zone (Coniacian)
2160- 2370'	*S. longifurcatum* Zone (Turonian)
2520- 2616'	*C. polypes* Zone (Cenomanian)
2700- 3004'	*G. cladophora* Zone (Kimmeridgian)
3060- 4090'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
4114- 6258'	*V. vermiculata* Zone (Callovian)
6330- 8505'	*G. filapicata* Zone (Bathonian)
8545-10240'	*M. semitabulatum* Zone (Aalenian-Bajocian)
10320-11580'	*N. gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

The Avalon Unconformity occurs at 2724ft in Amoco IOE Eider M-75, with Cenomanian immediately overlying Kimmeridgian rocks. Below and above this hiatus the section dated is more or less complete. The presence of upper Paleocene-lower Eocene sediments above 900ft is postulated from the presence of caved upper Paleocene-lower Eocene dinocysts in the cuttings sample from 900 to 930ft.

The environment of deposition throughout the Toarcian and the Bajocian below 9465ft is neritic. The interval 9140-8545ft contains very few dinoflagellates and occasional microforaminifers. The absence of sidewall cores between 8505 and 7775ft prevents meaningful interpretation of the depositional environment. The sidewall core from 7775ft indicates a strong marine transgression. In sidewall cores from 7030 and 7110ft the organic material is carbonized. From 7445 to 4264ft, the sediments appear to be predominantly nonmarine or brackish water with marine intercalations at 7445, 6484, 6330, 4818, and 4350ft.

The section represented by the sidewall core from 2616ft contains only two palynomorphs. Whether they are *in situ* is debatable. Above 2550ft the upper Cretaceous is marine.

Selected palynomorphs

900-1290': *Odontochitina operculata* Zone (Campanian)

Chatangiella vnigri, Exochosphaeridium striolatum, Hystrichodinium pulchrum, Hystrichosphaeridium bowerbankii, Spinidinium cf. *S. echinoideum, Xenascus ceratioides.*

Adnatosphaeridium reticulense, Apectodinium homomorphum, and *Thalassiphora pelagica* present as caved species from 900 to 1290ft, probably denoted the occurrence of upper Paleocene-lower Eocene sediments above 900ft.

1440-2010': *Cordosphaeridium truncigerum* Zone (Santonian)

Camarozonosporites insignis, Chatangiella victoriensis, Cicatricosisporites hallei, Cordosphaeridium truncigerum, Rugubivesiculites rugosus, Surculosphaeridium longifurcatum.

2080': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Callaiosphaeridium asymmetricum, Chlamydophorella nyei, Cleistosphaeridium huguonioti, Cyclonephelium vannophorum, Exochosphaeridium bifidum, Oligosphaeridium complex, Oligosphaeridium cf. *O. pulcherrimum.*

2160-2370': *Surculosphaeridium longifurcatum* Zone (Turonian)

Classopollis classoides, Epelidosphaeridia spinosa (common), *Kleithriasphaeridium loffrense, Polysphaeridium laminaspinosum, Surculosphaeridium longifurcatum* (common).

2520-2616': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium polypes subsp. A Williams, 1975, *Dinopterygium cladoides, Oligosphaeridium complex, Stephodinium coronatum.*

2700-3004': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Callialasporites dampieri, Cerebropollenites mesozoicus, Coronatispora valdensis, Densoisporites perinatus, Ellipsoidictyum cinctum, Endoscrinium eisenackii, Gonyaulacysta cladophora, G. jurassica, Lanterna sportula, Pareodinia ceratophora (with kalyptra), *Perinopollenites elatoides, Systematophora fasciculigera, S. orbifera* (common at 2856ft), *Tubotuberella apatela.*

3060-4090': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Ctenidodinium ornatum, Endoscrinium luridum, Endosporites jurassicus, Gen. et sp. 2 Gocht, 1970, *Hystrichogonyaulax cornigera, Klukisporites pseudoreticulatus, Leptodinium egemenii, Systematophora areolata.*

4114-6258': *Valensiella vermiculata* Zone (Callovian)

Adnatosphaeridium caulleryi, Ctenidodinium pachydermum, Gonyaulacysta jurassica (base), *Leptodinium regale, L. subtile* subsp. *pectinigerum, Lithodinia jurassica, Pareodinia ceratophora* (rugulate phragma), *Valensiella vermiculata.*

6330-8505': *Gonyaulacysta filapicata* Zone (Bathonian)

Baculatisporites sp., *Couperisporites jurassicus, Ctenidodinium ornatum* (base, common), *Gonyaulacysta filapicata, Leptodinium subtile* subsp. *pectinigerum* (base), *Meiourogonyaulax* sp., *Podocarpidites multicinus* (common), *Tenua* sp., *Valensiella ovula.*

8545-10240': *Mancodinium semitabulatum* Zone (Aalenian-Bajocian)

Antulisporties varigranulatus, Ctenidodinium pachydermum (base), *Leptodinium* cf. *L. regale, Mancodinium semitabulatum,* Megaspore, *Meiourogonyaulax* sp., *Pareodinia ceratophora, P. ceratophora* (with kalyptra).

10320-11580': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Callialasporites dampieri (base), *Camarozonosporites rudis, Contignisporites cooksonii, Nannoceratopsis gracilis.*

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Mobil-Gulf
FLYING FOAM I-13

GSC locality: D117

Location: 47°02'41.96"N; 48°46'30.98"W

RT elevation: 98' Water depth: 298'

Casing set at: 566, 946, 3915, and 8478'

Total depth: 12084' Interval studied: 990-12080'

Analyzed by: J.P. Bujak

Palynological analysis of 118 cuttings samples indicates the following age determinations and biostratigraphic zonation:

990- 1020'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1080- 1470'	*P. laticinctum* Zone (middle Miocene)
1530- 1830'	*Apteodinium* sp. B Zone (early Miocene)
1890- 1980'	*C. dispersum* Zone (middle-late Oligocene)
2070- 3000'	*D. heterophlycta* Zone (early Oligocene)
3060- 3630'	late Eocene-early Oligocene
3690- 6690'	Eocene
6750- 6970'	*C. speciosa* Zone (late Paleocene)
7040- 7270'	Early Cretaceous
7340- 9680'	Valanginian?-Hauterivian
9750-10380'	Portlandian-Valanginian
10450-11280'	*G. cladophora* Zone (Kimmeridgian)
11350-12080'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)

An Upper Jurassic to Lower Cretaceous succession occurs from 12 080 to 7040ft and includes dinoflagellate cysts that are particularly diverse in the Kimmeridgian indicating neritic depositional environments. The Avalon Unconformity occurs at 6949ft (J. Wade, pers. comm.), Lower Cretaceous strata being overlain by an upper Paleocene to upper Miocene succession. Eocene strata comprise 3000ft or more of the Tertiary sediments. Dinoflagellate cysts are common throughout the Tertiary indicating marine deposition in neritic environments.

Reworked palynomorphs were noted mainly in the Lower Cretaceous and primarily include Jurassic species. Reworking of species is less common in the Tertiary interval, only comprising a few Upper Cretaceous and Lower Tertiary specimens.

Selected palynomorphs

990-1020': *Cannosphaeropsis* sp. A Zone (late Miocene)

Alnipollenites verus, Carpinipites sp., *Caryapollenites simplex, Palaeocystodinium golzowense, Pinus* sp. (abundant), *Psilatricolporites* sp., *Tectatodinium pellitum, Tsugaepollenites* sp.

1080-1470': *Pentadinium laticinctum* Zone (middle Miocene)

Achomosphaera ramulifera, Bombacacidites sp. A Williams and Brideaux, 1975, *Lingulodinium machaerophorum, Operculodinium israelianum, Spiniferites pseudofurcatus, S. ramosus, Tuberculodinium vancampoae.*

Also present in this interval is a reworked specimen of the species *Deflandrea spinulosa.*

1530-1830': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux, 1975, *A.* sp. Gocht, 1969, *Cordosphaeridium cantharellum, Epicephalopyxis indentata, Homotryblium plectilum, Hystrichokolpoma rigaudiae, Operculodinium centrocarpum, Polysphaeridium pastielsii, P. simplex, Selenopemphyx* sp., *Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

1890-1980': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Pentadinium laticinctum subsp. *granulatum.*

2070-3000': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum (large form), *A. multicornutum* (large form), *Chiropteridium lobospinosum, Deflandrea phosphoritica, D. spinulosa, Gonyaulacysta giuseppei, Phthanoperidinium comatum, Wetzeliella lunaris.*

3060-3630': late Eocene-early Oligocene

Deflandrea heterophlycta, Distatodinium paradoxum, Eocladopyxis peniculatum, Hystrichokolpoma eisenackii, Leptodinium cf. *L. maculatum, Pentadinium laticinctum, Phthanoperidinium alectrolophum, Spiniferites crassipellis.*

Also present in this interval is a reworked specimen of the Late Cretaceous species *Isabelidinium cooksoniae.*

3690-6690': Eocene

Adnatosphaeridium multispinosum, Areoligera medusettiformis, A. cf. *A. senonensis, Cordosphaeridium gracile, C. inodes, Cyclonephelium intricatum, C. ordinatum, C.* cf. *C. retiintextum, C.* sp. A Williams and Brideaux, 1975, *Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Diphyes colligerum, Hemicystodinium zoharyi, Heteraulacacysta leptalea, Homotryblium tenuispinosum, Kisselovia coleothrypta, Phthanoperidinium* sp., *Rhombodinium draco, Systematophora placacantha, Wetzeliella* sp. A Williams and Bujak, 1977b.

6750-6970': *Ceratiopsis speciosa* Zone (late Paleocene)

Ceratiopsis leptoderma, Cordosphaeridium fibrospinosum, Deflandrea wetzeli, D. sp. A Drugg, 1967, *Turbiosphaera filosa.*

7040-7270': Early Cretaceous

Cribroperidinium orthoceras, Cyclonephelium distinctum, Gonyaulacysta episoma, Oligosphaeridium complex.

7340-9680': Valanginian?-Hauterivian

Appendicisporites problematicus, Batioladinium jaegeri, Biretisporites potoniae, Callialasporites dampieri, C. trilobatus, Cicatricosisporites spp., *Contignisporites cooksonii, Coronatispora valdensis, Dingodinium cerviculum, Endoscrinium campanulum, Foveotriletes subtriangularis, Gardodinium trabeculosum, Gonyaulacysta helicoidea, G. serrata, Hystrichodinium pulchrum, Ischyosporites disjunctus, Kraeuselisporites linearis, Leptolepidites psarosus, Lithodinia stoveri, Muderongia simplex, M. tetracantha, Occisucysta* sp., *Oligosphaeridium asterigerum, Pareodinia ceratophora, Phoberocysta* sp., *Pseudoceratium pelliferum, Systematophora complicata* (common), *S.* cf. *S. fasciculigera, S.* cf. *S. orbifera, Tanyosphaeridium* cf. *T. variecalamum.*

Also present within this interval are reworked specimens of the Jurassic species *Endoscrinium eisenackii, Gonyaulacysta granulata, Gonyaulacysta jurassica,* and *Tenua hystrix.*

9750-10380': Portlandian-Valanginian

Achomosphaera neptuni, Densoisporites perinatus, Muderongia sp., *Pareodinia kondratjevii, Phoberocysta neocomica* (common between 9850 and 9980ft).

Also present within this interval is a reworked specimen of *Wanaea fimbriata.*

10450-11280': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Apteodinium granulatum, Cerebropollenites mesozoicus, Dictyopyxis sp. Gitmez, 1970, *Epiplosphaera reticulospinosa, Gonyaulacysta cladophora, G. granulata, G. granuligera, G. longicornis, G.* cf. *G. mammilifera, G.* sp. F Gitmez and Sarjeant, 1972, *Hystrichosphaeridium petilum, Lanterna pattei, Leptodinium* cf. *L. arcuatum, Pareodinia ceratophora, P. dasyforma, Prolixosphaeridium mixtispinosum, Scriniodinium* cf. *S. crystallinum, Systematophora fasciculigera, S. orbifera, S. turonica, Tenua verrucosa.*

11350-12080': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Adnatosphaeridium caulleryi, Ctenidodinium schizoblatum, Eodoscrinium luridum, Gonyaulacysta jurassica, Systematophora areolata.

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Amoco-Imp
GANNET O-54

GSC locality: D78

Location: 45°03'54.56"N; 52°38'09.72"W

RT elevation: 98' Water depth: 328'

Casing set at: 593, 936, 2399, and 6509'

Total depth: 10000' Interval studied: 960-10000'

Analyzed by: M.S. Barss and G.L. Williams

Palynological analysis of 39 sidewall cores and 91 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

960- 990'	*P. laticinctum* Zone (middle Miocene)
1050- 1260'	*Apteodinium* sp. B Zone (early Miocene)
1320- 1350'	*C. dispersum* Zone (middle-late Oligocene)
1410- 1590'	*D. heterophlycta* Zone (early Oligocene)
1650- 2580'	*D. colligerum* Zone (late Eocene)
2640- 2940'	*A. senonensis* Zone (early Eocene)
3000- 3120'	*D. euclaensis* Zone (Maastrichtian)
3180- 3750'	*O. operculata* Zone (Campanian)
3810- 4290'	*C. truncigerum* Zone (Santonian)
4350- 5070'	*O. pulcherrimum* (Coniacian)
5120- 5430'	*S. longifurcatum* Zone (Turonian)
5470- 5670'	*C. polypes* Zone (Cenomanian)
5720- 6150'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
6210- 6500'	*S. perlucida-S. schindewolfii* Zone (Aptian)
6540- 7300'	Viséan
7300- 7830'	Viséan-?late Tournaisian
7855'	Frasnian
7900- 9690'	Frasnian-Givetian
9690-10000'	indeterminate

Amoco-Imp Gannet apparently bottoms in Paleozoic rocks at 10 000ft. Some color change in the fossils occurs at 7300ft and a major change takes place below 7800ft. This approximately coincides with the change in age from Viséan-?late Tournaisian to Devonian. Caving of younger fossils occurs in all of the Paleozoic samples. Above 6500ft there is more or less continuous deposition from Aptian through to the Maastrichtian. The Upper Cretaceous is approximately 2700ft thick. The Paleocene appears to be absent, lower Eocene sediments being present 60ft above the top

of the Maastrichtian. Within the thick Eocene section, there seems to be a hiatus between 2580 and 2640ft, since middle Eocene dinoflagellate assemblages are absent. It may however be a reflection of environmental control. There is a more or less complete development of Eocene to middle Miocene sediments.

Environmental interpretations are difficult to make, in view of the scarcity of dinocysts in many of the sidewall core samples. Since spores are present, but in low numbers, between 6210 and 5470ft, deposition may have been inner neritic, nearshore, or much deeper water because of the frequency of species of *Spiniferites*. From 5470 to 4650ft dinoflagellates are common, possibly denoting an outer neritic environment. Above 4650ft sidewall cores are not available. The cuttings samples from the Coniacian-Maastrichtian are usually dominated by caved Eocene species, the low number of indigenous specimens precluding environmental interpretations. The rich Eocene-Miocene assemblages are interpreted to indicate deposition in a neritic environment, with local shallowing indicated in the early Eocene.

Selected palynomorphs

960-990': *Pentadinium laticinctum* Zone (middle Miocene)

Apteodinium sp. Gocht, 1969, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Lingulodinium machaerophorum, Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, *Pterodinium circumsutum, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975, *Tuberculodinium vancampoae.*

1050-1260': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux, 1975, *Cordosphaeridium cantharellum, C.* cf. *C. multispinosum, Cyclopsiella elliptica, Epicephalopyxis indentata, Hystrichosphaeridium choanophorum, Hystrichosphaeropsis obscura, Impletosphaeridium transfodum, Palaeocystodinium golzowense, Polysphaeridium pastielsii.*

1320-1350': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, C. lobospinosum, Distatodinium paradoxum, Spiniferites crassipellis.

1410-1590': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium multicornutum, Cordosphaeridium funiculatum, Deflandrea phosphoritica, Deflandrea sp. C Williams and Bujak, 1977b, *Dinopterygium* sp. A Williams and Bujak, 1977a, *Kisselovia* cf. *K. coleothrypta, K. tenuivergula* subsp. *crassiramosa, Thalassiphora pelagica.*

1650-2580': *Diphyes colligerum* Zone (late Eocene)

Areosphaeridium diktyoplokus, Cyclonephelium sp. A Williams and Brideaux, 1975, *C.* sp. B Williams and Brideaux, 1975, *C.* sp. C Williams and Brideaux, 1975, *Deflandrea hialina, Diphyes colligerum, Gonyaulacysta giuseppei, Pentadinium laticinctum* subsp. *granulatum, P. taeniagerum, Perisseiasphaeridium* sp., *Phthanoperidinium comatum, Polysphaeridium simplex, Rhombodinium perforatum, Rottnestia borussica, Samlandia chlamydophora, Tubidermodinium sulcatum, Wetzeliella ovalis.*

2640-2940': *Areoligera senonensis* Zone (early Eocene)

Achilleodinium biformoides, Adnatosphaeridium reticulense, Apectodinium homomorphum, Areoligera medusettiformis, sensu Gocht, 1970, *A. senonensis, sensu* Gocht, 1970 (common), *Cordosphaeridium cracenospinosum, C. gracile, Deflandrea granulosa, D. leptodermata, Homotryblium tenuispinosum, Hystrichokolpoma eisenackii, Hystrichosphaeridium pseudorecurvatum, H. tubiferum, Lanternosphaeridium axiale, Muratodinium fimbriatum, Rhombodinium draco, Wetzeliella symmetrica, W. varielongituda.*

3000-3120': *Dinogymnium euclaensis* Zone (Maastrichtian)

Cannosphaeropsis utinensis, Isbelidinium belfastense.

3180-3750': *Odontochitina operculata* Zone (Campanian)

Alterbia balmei, A. macrocysta, Ceratiopsis diebelii (caved), *Chatangiella victoriensis, C. vnigri, Dinogymnium acuminatum, D. undulosum, Dorocysta* sp. A Bujak and Williams, 1978, *Gardodinium deflandrei, Hystrichodinium pulchrum, Hystrichosphaeridium bowerbankii, Lejeunia tricuspis, Odontochitina costata, Palaeohystrichophora infusorioides, Palaeoperidinium pyrophorum, Palaeotetradinium silicorum, Spiniferites wetzelii, Spongodinium delitiense, Tanyosphaeridium variecalamum, Triblastula utinensis, Trichodinium* sp., *Xanascus ceratioides.*

3810-4290': *Cordosphaeridium truncigerum* Zone (Santonian)

Chlamydophorella nyei, Cordosphaeridium truncigerum, Coronifera oceanica (one specimen at 4170-4200ft), *Dinogymnium digitus, Exochosphaeridium bifidum, E. striolatum, Hystrichosphaeridium paracostatum, Kleithriasphaeridium loffrense, Impletosphaeridium whitei, Oligosphaeridium pulcherrimum* (3990-4020ft), *O.* cf. *O. pulcherrimum, Silicisphaera ferox, Surculosphaeridium longifurcatum, Trichodinium castaneum.*

4350-5070': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A. Bujak and Williams, 1978, *Canningia reticulata, Chatangiella tripartita, Dinogymnium westralium, Florentinia mantellii, F. resex, Fromea amphora, Hystrichosphaeropsis ovum, Odontochitina porifera, Senoniasphaera protrusa, S. rotundata.*

In addition reworked specimens of the species *Callialasporites dampieri* and *Classopollis classoides* are present in the sidewall core at 5000ft.

5120-5430': *Surculosphaeridium longifurcatum* Zone (Turonian)

Callaiosphaeridium asymmetricum, Dinogymnium westralium (base), *Dinopterygium cladoides, Eisenackia* sp., *Endoscrinium campanulum, Kleithriasphaeridium readei, Spiniferites cingulatus, Surculosphaeridium longifurcatum* (common), *Xiphophoridium alatum.*

5470-5670': *Cleistosphaeridium polypes* Zone (Cenomanian)

Camarozonosporites insignis, Cicatricosisporites hallei, Classopollis classoides, Cleistosphaeridium polypes subsp. A Williams, 1975, *Cyclonephelium vannophorum, Oligosphaeridium totum.*

5720-6150': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Concentricistes sp., *Cribroperidinium orthoceras, Eucommiidites minor, Vitreisporites* sp. Singh, 1971.

6210-6500': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites bifurcatus, Appendicisporites tricornitatus, Cicatricosisporites subrotundus, Coronatispora valdensis, Densoisporites velatus.

Carboniferous types belonging to *Calamospora, Chomotriletes, Cirratriradites, Convolutispora, Cyclogranisporites, Deltoidospora, Endosporites, Punctatisporites, Retusotriletes,* and *Spelaeotriletes* occur in the interval from 5720-6500ft

6540-7300': Viséan

Convolutispora florida, Cyclogranisporites sp., *Deltoidospora* sp., *Densosporites* sp., *Discernisporites irregularis, Grandispora conspicua, G. uncata, Granulatisporites* sp., *Knoxisporites literatus, K.* cf. *K. seniradiatus, K. triradiatus, Lycospora pusilla, Murospora* sp., *Punctatisporites planus, Proprisporites* sp., *Remysporites* cf. *R. magnus, Retusotriletes* cf. *R. avonensis, R. incohatus, Rugospora* cf. *R. corporata, R. minuta, Secarisporites* sp., *Spelaeotriletes* spp., *Stenozonotriletes* sp., *Triquitrites* cf. *T. comptus, Vallatisporites ciliaris, Velamisporites* cf. *V. magnus, V. perinatus, Verrucosisporites* cf. *V. congestus.* Many of the fossils are corroded. Caved Cretaceous fossils occur throughout this interval.

7300-7830': Viséan-?late Tournaisian

Some change in color of the fossils occurs in the interval 7300-7330ft. The spores are very corroded and remained quite dark, even after oxidation. A specimen resembling *Pustulatisporites pretiosus* suggests a possible late Tournaisian age.

Two assemblages are present in the 7330-7830ft interval - one composed of well preserved, yellow colored fossils, and one composed of badly corroded brown colored fossils. It is possible that the dark corroded fossils are reworked.

A very good Viséan assemblage, similar to that listed above, occurs in the interval from 7600-7630ft. Included in this assemblage are: *Anapiculatisporites* cf. *A. ampullaceous, Knoxisporites hederatus, Pustulatisporites* cf. *P. pretiosus, Vallatisporites* cf. *V. torulosa, V. vallatus.* These species lend weight to a possible late Tournaisian age.

Devonian spores occur in the sidewall core sample at 7500ft. These are as follows: *Ancyrospora* sp., *Apiculiretusispora* sp., *Geminospora? lemurata, G.* sp., *Rhabdosporites* sp., *Verrucosisporites* sp.

The company log states that the shale chips in the samples are definitely round as if transported by water. This and the fact that the sample occurs in the anhydrite zone, assigned to Windsor Group rocks (Viséan age), would suggest that the material has been reworked.

7855': Frasnian

Ancyrospora cf. *A. furcula, A.* spp., *Calamospora* cf. *C. atava, Geminospora* sp., *Grandispora* cf. *G. velata, Retusotriletes* sp., *Samarisporites ?euglyptus,* cf. *Verruciretusispora robusta, Verrucosisporites* sp., *Velamisporites* sp.

7900-9690': Frasnian-Givetian

Ancyrospora furcula, A. langii, A. involucra, Aneurospora cf. *A. goensis, Apiculiretusispora* sp., *Calyptosporites* sp., *Contagisporites optivus, Emphanisporites* sp., *Grandispora? naumovii, Hystricosporites* sp., *Lophozonotriletes? grumosus, Raistrickia clavata, Retusotriletes* spp., *Rhabdosporites langii, Samarisporites* sp.

D.C. McGregor, Geological Survey of Canada, examined samples from sidewall cores 7500 and 7855ft, and cuttings samples from 8100-8130, 8200-8230, 8300-8330, and 9460-9490ft and confirmed many of the Devonian identifications.

9690-10000': indeterminate

Devonian spores are present; it cannot be determined if these are caved or in place.

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ELF
HERMINE E-94

GSC locality: D38

Location: 45°23'29.30"N; 54°29'54.71"W

RT elevation: 85' Water depth: 271'

Casing set at: 1087, 3237, and 6004'

Total depth: 10720' Interval studied: 1100-10720'

Analyzed by: M.S. Barss and G.L. Williams

Palynological analysis of 97 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1100- 1400' *Cannosphaeropsis* sp. A Zone (late Miocene)
1490- 1580' *P. laticinctum* Zone (middle Miocene)
1670- 1700' *Apteodinium* sp. B Zone (early Miocene)
1760- 1790' *C. dispersum* Zone (middle-Late Oligocene)
1850- 2060' *D. heterophlycta* Zone (early Oligocene)
2120- 2510' *D. colligerum* Zone (late Eocene)
2570- 2600' *A. reticulense* Zone (middle Eocene)
2660- 2780' early to middle Eocene
2840- 2960' *A. senonensis* Zone (early Eocene)
3020- 3230' *D. euclaensis* Zone (Maastrichtian)
3290- 3330' *O. operculata* Zone (Campanian)
3390- 3510' barren
3570- 3780' Late Cretaceous
3840- 3870' barren
3930- 4050' *O. pulcherrimum* Zone (Coniacian)
4110- 4140' ?Turonian
4210- 4250' *C. polypes* Zone (Cenomanian)
4310- 5040' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
5200-?5400' *S. perlucida-S. schindewolfii* Zone (Aptian)
?5240-?5400': *A. attadalica* Subzone (early Aptian)
5400- 5800' Westphalian
5800- 5830' *Vestispora* Zone (late Westphalian B-early Westphalian C)
5830- 7630' late Viséan?-Namurian
7630-10720' indeterminate (assumed Paleozoic)

The Paleozoic interval is marked by a distinct change in color of the fossils. This change increases in intensity at depth, being particularly marked from 7500ft down.

In the interval 10 720-5400ft cavings created some problems in delineating the assemblages representative for each interval. Further difficulty resulted from reworked (probably Lower Carboniferous) spores occurring in certain intervals.

There are two major hiatuses in Elf Hermine E-94. According to palynology the lower is at 5400ft where Westphalian rocks are immediately overlain by Aptian rocks. However from well logs the unconformity occurs at 5364ft. The second break is between 3020 and 2960ft where the Maastrichtian appears to be immediately overlain by lower Eocene sediments.

The unavailability of sidewall core samples for analysis does not permit definitive paleoenvironmental conclusions to be drawn. Dinocysts are common in the Aptian and lower part of the Albian. The upper Cretaceous samples contain very low counts of dinocysts or spores. The diverse assemblages of the Paleogene are succeeded by Miocene sediments containing few palynomorphs. The tropical species *Hemicystodinium zoharyi* is restricted to the Eocene. This may indicate that cooler water conditions existed in the vicinity of Hermine E-94 in the early Oligocene.

Selected palynomorphs

1100-1400': *Cannosphaeropsis* sp. A Zone (late Miocene)

Alnipollenites verus, Carpinipites sp. A Williams and Brideaux, 1975, *Operculodinium centrocarpum, Spiniferites ramosus.*

Specimens of *Aquilapollenites* were present in the samples from 1280-1310 and 1370-1400ft respectively.

1490-1580': *Pentadinium laticinctum* Zone (middle Miocene)

Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Osmundacidites sp. A Williams and Bujak, 1977b, *Psilatricolporites* sp. Z Williams and Brideaux, 1975, *Tsugaepollenites igniculus, Ulmipollenites* sp.

1670-1700': *Apteodinium* sp. B Zone (early Miocene)

Betulaepollenites sp. A Williams and Brideaux, 1975, *Chiropteridium partispinatum, Epicephalopyxis indentata, Polysphaeridium* sp.

1760-1790': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Deflandrea phosphoritica, Leptodinium incompositum, Pentadinium laticinctum, Polysphaeridium pastielsii, Systematophora ancyrea.

1850-2060': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium aspinatum, Cordosphaeridium cantharellum, C. fibrospinosum, Impletosphaeridium transfodum, Phthanoperidinium comatum, Spiniferites pseudofurcatus, Thalassiphora pelagica, Tubidermodinium sulcatum, Wetzeliella sp. B Williams and Brideaux, 1975.

2120-2510': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium reticulense, Areoligera senonensis, sensu Gocht 1969, *Areosphaeridium diktyoplokus, A. multicornutum, Cordosphaeridium gracile, Cyclonephelium pastielsii, Diphyes colligerum, Hemicystodinium zoharyi, Homotryblium tenuispinosum, Hystrichosphaeridium pseudorecurvatum, Polystephanephorus* sp. A Williams and Brideaux, 1975, *Samlandia chlamydophora, Wetzeliella ovalis.*

2570-2600': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Lanternosphaeridium sp., *Muratodinium fimbriatum, Wetzeliella varielongituda.*

2660-2780': early to middle Eocene

Achilleodinium biformoides, Deflandrea oebisfeldensis, Hystrichokolpoma cinctum, Leptodinium cf. *L. incompositum.*

2840-2960': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum, Homotryblium tenuispinosum (common), *Wilsonidium echinosuturatum.*

3020-3230': *Dinogymnium euclaensis* Zone (Maastrichtian)

Chatangiella vnigri, Dinogymnium sp.

3290-3330': *Odontochitina operculata* Zone (Campanian)

Xenascus ceratioides.

3390-3510': barren

3570-3780': Late Cretaceous

Hexagonifera sp., *Palaeohystrichophora infusorioides, Rugubivesiculites convolutus, Spiniferites ramosus.*

3840-3870': barren

3930-4050': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Chlamydophorella nyei, Exochosphaeridium bifidum, Surculosphaeridium longifurcatum.

4110-4140': ?Turonian

Odontochitina costata, Oligosphaeridium complex, Spiniferites cingulatus.

4210-4250': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus.

4310-5040': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Alisporites grandis, Apteodinium sp., *Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Cicatricosisporites imbricatus, Cleistosphaeridium polypes, Cleistosphaeridium polypes* subsp. A Williams, 1975, *Coronifera oceanica, Cribroperidinium orthoceras, Cyclonephelium paucispinum, Endoscrinium campanulum, Eucommiidites minor, Gonyaulacysta episoma, Hystrichosphaeridium cooksoniae, H.* sp. A Bujak and Williams, 1978, *Neoraistrickia truncata, Ovoidinium verrucosum, Protoellipsodinium spinosum, Senoniasphaera microreticulata, Spinidinium vestitum, S.* cf. *S. vestitum, sensu* Williams, 1975, *Surculosphaeridium* cf. *S. longifurcatum, Trilobosporites apiverrucatus, Vitreisporites pallidus.*

5200-?5400': *Subtilisphaera perlucida-Systematophora schindewolfi* Zone (Aptian)

Subtilisphaera perlucida.

?5240-?5400': *Aptea attadalica* Subzone (early Aptian)

Aptea attadalica, Callialasporites dampieri, Cribroperidinium sepimentum, Doidyx anaphrissa and *Systematophora schindewolfii* occur in the cuttings sample 5400-5430ft and are presumed to be caved.

5400-5800': Westphalian

Lycospora pusilla (common), *Densosporites* sp., *Florinites* sp., *Punctatisporites* sp., *Verrucosisporites* sp.

Also present are reworked spores of possible Tournaisian age.

5800-5830': *Vestispora* Zone (late Westphalian B-early Westphalian C)

Apiculatisporis sp., *Calamospora minuta, C. microrugosa, Cirratriradites* sp., *Convolutispora* sp., *Crassispora kosankei, Cyclogranisporites* sp., *Deltoidospora* sp., *Dictyotriletes* sp., *Endosporites* sp., *Florinites pumicosus, F. similis, F. visendus, Savitrisporites nux, Vestispora costata.*

Also present are reworked spores of possible Tournaisian age.

5830-7630': late Viséan?-Namurian

Apiculatisporis aculeatus, A. setulosus, Auroraspora solisortus, Calamospora pallida, Cirratriradites sp., *Convolutispora florida, C. mellita, C. vermiformis,*

Costatascyclus crenatus, *Crassispora* sp., *Deltoidospora* sp., *Dictyotriletes clatriformis*, *D.* cf. *D. fragmentimurus*, *Discernisporites* sp., *Endosporites* sp., *Florinites* sp., *Foveosporites* sp., *Grandispora spinosa*, *Knoxisporites stephanephorus*, *K. triradiatus*, *Lophotriletes pseudoaculeatus*, *Lycospora noctuina* var. *noctuina*, *Microreticulatisporites* sp., *Punctatisporites planus*, *Retusotriletes incohatus*, *Schopfipollenites ellipsoides*, *Schopfites claviger*, *Spelaeotriletes* sp., *Vallatisporites ciliaris*, cf. *Velamisporites magnus*.

Spores are poorly preserved and rather scarce except in a few intervals.

7630-10720': indeterminate (assumed Paleozoic)

Spores are generally too highly carbonized and poorly preserved for identification. A few types identified as *Dictyotriletes* sp., *Punctatisporites* sp., and *Velamisporites* sp. from 8210-8220ft provide no additional information concerning the age.

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Amoco-Imp
HERON H-73

GSC locality: D82

Location: 44°02'26.65"N; 52°25'40.58"W

RT elevation: 85' Water depth: 346'

Casing set at: 625, 965, and 3000'

Total depth: 12000' Interval studied: 970-11910'

Analyzed by: G.L. Williams

Palynological analysis of 75 sidewall core and 98 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

970- 1180'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1240- 1450'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1510- 3280'	*P. laticinctum* Zone (middle Miocene)
3340- 4090'	*Apteodinium* sp. B Zone (early Miocene)
3400'	Senonian
4150- 4900'	*C. dispersum* Zone (middle-late Oligocene)
4960- 5389'	*D. heterophlycta* Zone (early Oligocene)
4960- 5170'	*C. funiculatum* subzone (late early Oligocene)
5230- 5389'	*A. arcuatum* subzone (early early Oligocene)
5500- 5620'	*D. colligerum* Zone (late Eocene)
5680- 5710'	*A. reticulense* Zone (middle Eocene)
5785'	*A. senonensis* Zone (early Eocene)
5790- 6200'	*O. operculata* Zone (Campanian)
6250- 7110'	*C. truncigerum* Zone (Santonian)
7200- 7450'	*O. pulcherrimum* Zone (Coniacian)
7490- 7572'	*S. longifurcatum* Zone (Turonian)
7590- 7690'	*C. polypes* Zone (Cenomanian)
7750'	late Albian-Cenomanian
7790'	Coniacian-Santonian
7830- 7930'	?late Albian
7995'	Late Jurassic
8105'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
8113- 8135'	Coniacian-early Santonian (probably caved)
8145'	Coniacian-Santonian (probably caved)
8285'	Senonian (probably caved)
8400'	Coniacian-early Santonian (probably caved)
8500'	*V. vermiculata* Zone (Callovian)
8615- 8860'	Coniacian-early Santonian (probably caved)
9090'	*V. vermiculata* Zone (Callovian)
9110'	*G. filapicata* Zone (Bathonian)
9140'	Coniacian-Santonian (probably caved)
9330- 9450'	Coniacian-Santonian (probably caved)
9515'	Bathonian with Coniacian-Santonian contaminants
9575'	Coniacian-Santonian (probably caved)
9640- 9790'	Late Cretaceous (probably caved)
9860- 9990'	*G. filapicata* Zone (Bathonian)
10060-10860'	Pliensbachian-Toarcian
10930-11360'	Pliensbachian
11430-11910'	?Rhaetian

The Senonian assemblage in the sidewall core from 3400ft and the repetition of Coniacian-early Santonian assemblages in the sidewall cores between 9575 and 7790ft can either be explained by salt movement, mislabelling, mixing, or contamination of the sidewall cores, or drilling mud contamination. The interval 9450-7490ft is predominantly limestone. Dinocyst recovery from calcareous lithologies is often extremely sparse. Thus any contaminants might tend to mask the indigenous species as in the sidewall core at 9515ft. The foraminifers have yielded essentially the same results as the dinocysts for this interval. The absence of cuttings samples between 9640 and 7600ft prevents confirmation of any one theory. The cuttings sample at 9890-9860ft contains a mixed Bathonian-Coniacian/Santonian assemblage possibly suggesting that salt tectonism has produced a melange, which extends from 9575 to 7790ft. Alternatively if it is assumed that all the Coniacian-Santonian specimens are caved then the interval from 9090 to 8500ft must be Callovian, and from 9990 to 9110ft Bathonian.

The Avalon Unconformity occurs at 8036ft in Heron H-73 where Upper Jurassic rocks are immediately overlain by Albian sediments. At 5790ft Campanian sediments immediately underly the lower Eocene, with the Maastrichtian and Paleocene being absent. Comparison of the Lower and Middle Jurassic with coeval rocks in Cormorant N-83 indicates that the Hettangian, Sinemurian and Bajocian stages are absent or very condensed. The interval 12 000-11 500ft in Heron was logged as salt. This is tentatively dated Rhaetian.

The environment of deposition in the Pliensbachian-Toarcian was probably inner neritic. The Middle Jurassic assemblages are too sparse for meaningful interpretations of environment. The Late Cretaceous and Tertiary contain rich dinocyst assemblages, indicative of a neritic environment. The tropical species *Homotryblium plectilum*, which became extinct in the early Oligocene in Puffin B-90 ranges up into the middle to late Oligocene in Heron. This suggests that in the vicinity of Heron, warmer water conditions persisted until almost Miocene time. This could be a result of Heron lying within the path of the proto-Gulf Stream.

Selected palynomorphs

970-1180': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

Spiniferites pseudofurcatus, *S. ramosus*, *S. scabratus*, *Sumatradinium* sp., *Tsugaepollenites igniculus*.

1240-1450': *Cannosphaeropsis* sp. A Zone (late Miocene)

Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Leptodinium patulum*, *Lingulodinium machaerophorum*, *Operculodinium centrocarpum*, *O. giganteum*, *O. israelianum*, *Thalassiphora delicata*.

1510-3280': *Pentadinium laticinctum* Zone (middle Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Cyclopsiella elliptica, C.* cf. *C. elliptica, Epicephalopyxis indentata, Hystrichokolpoma rigaudiae, Hystrichosphaeridium choanophorum, Hystrichosphaeropsis obscura, Ilexpollenites* sp., *Impletosphaeridium transfodum, Lejeunia fallax, L. paratenella, L. psilodora, Maduradinium spatiosum, Nematosphaeropsis* sp. A Williams and Brideaux, 1975, *Osmundacidites* sp. A Williams and Bujak, 1977b, *Pentadinium laticinctum, P. laticinctum* subsp. *granulatum, Polysphaeridium pastielsii, Pterodinium circumsutum, Spiniferites bentorii, S. crassipellis, Tuberculodinium rossignoliae, Vozzhennikovia tenella.*

Specimens of reworked Santonian-Campanian species are present at 1690-1720, 2020-2050, 2505, 2710-2740, and 2980-3010ft.

3340-4090': *Apteodinium* sp. B Zone (early Miocene)

Alnipollenites verus, Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Engelhardtioipollenites* sp. B Williams and Brideaux, 1975, *Heteraulacacysta* sp., *Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

3400': Senonian

Dinogymnium heterocostatum, Odontochitina costata, Senoniasphaera protrusa, Spinidinium cf. *S. echinoideum.*

4150-4900': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Cordosphaeridium cantharellum, Eocladopyxis peniculatum, Gonyaulacysta sp., *Homotryblium plectilum, Palaeocystodinium golzowense, Thalassiphora pelagica, ?Wilsonidium aechmophorum.*

4960-5389': *Deflandrea heterophlycta* Zone (early Oligocene)

4960-5170': *Cordosphaeridium funiculatum* subzone (late early Oligocene)

Areosphaeridium arcuatum, A. multicornutum, Chiropteridium aspinatum, Cyclonephelium sp., *Deflandrea phosphoritica, D. spinulosa, Dinopterygium cladoides, sensu* Morgenroth, 1966, *Kisselovia* cf. *K. coleothrypta, Phthanoperidinium coreoideum, Wetzeliella* sp. B Williams and Brideaux, 1975.

5230-5389': *Areosphaeridium arcuatum* subzone (early early Oligocene)

Cyclonephelium intricatum, Deflandrea heterophlycta, Polysphaeridium cf. *P. pastielsii, Samlandia chlamydophora, Tubidermodinium sulcatum.*

5500-5620': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium reticulense, Cordosphaeridium funiculatum, C. gracile, Cyclonephelium pastielsii, Hystrichokolpoma eisenackii, Hystrichosphaeridium pseudorecurvatum, Perisseiasphaeridium sp.

5680-5710': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Deflandrea oebisfeldensis, Diphyes colligerum, Duosphaeridium rugosum, Homotryblium tenuispinosum, Hystrichokolpoma cinctum, Membranilarnacia ursulae, Muratodinium fimbriatum.

5785': *Areoligera senonensis* Zone (early Eocene)

Areoligera cf. *A. medusettiformis, A. senonensis, sensu* Gocht, 1969, *Cordosphaeridium exilimurum, C. inodes, Lanternosphaeridium* sp. 2 Gocht, 1969.

5790-6200': *Odontochitina operculata* Zone (Campanian)

Alterbia acuminata, Chatangiella tripartita, C. victoriensis, C. vnigri, Dinogymnium acuminatum, Dorocysta sp. A Bujak and Williams, 1978, *Exochosphaeridium bifidum, E. striolatum, Hystrichodinium pulchrum, Hystrichosphaeridium bowerbankii, H. salpingophorum, Kleithriasphaeridium loffrense, Oligosphaeridium complex, Palaeohystrichophora infusorioides, Spinidinium* cf. *S. echinoideum, Trichodinium castaneum, Xenascus ceratioides.*

6250-7110': *Cordosphaeridium truncigerum* Zone (Santonian)

Cordosphaeridium truncigerum, Dinogymnium heterocostatum, Gonyaulacysta tenuiceras, Hystrichosphaeropsis ovum, Isabelidinium cooksoniae, Microdinium irregulare, Odontochitina porifera, Oligosphaeridium anthophorum, Pterospermopsis spinosa, Senoniasphaera protrusa, Spiniferites cingulatus, Surculosphaeridium longifurcatum, Triblastula utinensis.

Sidewall core at 6594ft contains Eocene dinocysts only.

7200-7450': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978, *Chatangiella victoriensis* (base), *Cordosphaeridium truncigerum* (base), *Dinogymnium heterocostatum* (base), *Endoscrinium campanulum, Exochosphaeridium* sp., *Florentinia radiculata, Gardodinium* cf. *G. deflandrei, Hystrichosphaeridium paracostatum, Hystrichosphaeropsis ovum* (base), *Odontochitina porifera* (common), *Triblastula utinensis* (base).

7490-7572': *Surculosphaeridium longifurcatum* Zone (Turonian)

Chlamydophorella nyei, Cleistosphaeridium huguoniotii, Dinopterygium cladoides, Psaligonyaulax deflandrei.

7590-7690': *Cleistosphaeridium polypes* Zone (Cenomanian)

Callaiosphaeridium asymmetricum, Litosphaeridium siphoniphorum, Subtilisphaera pontis-mariae.

7750': late Albian-Cenomanian

Spinidinium vestitum.

7790': Coniacian-Santonian

Dinogymnium acuminatum, D. heterocostatum, Gardodinium cf. *G. deflandrei, Hystrichosphaeridium paracostatum, Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Spinidinium* cf. *S. echinoideum, Triblastula utinensis.*

7830-7930': ?late Albian

Appendicisporites problematicus, Eucommiidites sp.

7995': Late Jurassic

Distalanulisporites sp.

8105': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Cicatricosisporites australiensis, Ctenidodinium ornatum, Hystrichogonyaulax nealei.

8113-8135': Coniacian-early Santonian (probably caved)

Dinogymnium heterocostatum, Odontochitina porifera, Palaeohystrichophora infusorioides, Triblastula utinensis.

8145': Coniacian-Santonian (probably caved)

Chatangiella victoriensis, Gardodinium cf. *G. deflandrei, Palaeohystrichophora infusorioides, Senoniasphaera protrusa.*

8285': Senonian (probably caved)

Only one species, *Spinidinium* cf. *S. echinoideum*, is present in this sample.

8400': Coniacian-early Santonian (probably caved)

Dinogymnium euclaensis, D. heterocostatum, Spinidinium cf. *S. echinoideum, Triblastula utinensis.*

8500': *Valensiella vermiculata* Zone (Callovian)

Adnatosphaeridium cf. *A. caulleryi, Leptodinium subtile* subsp. *pectinigerum.*

8615-8860': Coniacian-early Santonian (probably caved)

Chatangiella victoriensis, C. vnigri, Exochosphaeridium striolatum, Odontochitina porifera, Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Xenascus ceratioides.

9090': Callovian

The only dinocyst taxon present is *Leptodinium subtile* subsp. *pectinigerum.*

9110': *Gonyaulacysta filapicata* Zone (Bathonian)

Gonyaulacysta cf. *G. aldorfensis, G. filapicata.*

9140': Coniacian-Santonian (probably caved)

Exochosphaeridium bifidum, Hystrichosphaeridium paracostatum, Palaeohystrichophora infusorioides, Triblastula utinensis.

9330-9450': Coniacian-Santonian (probably caved)

Hystrichosphaeridium paracostatum, Hystrichosphaeropsis ovum, Odontochitina porifera, Palaeohystrichophora infusorioides, Triblastula utinensis.

9515': Bathonian with Coniacian-Santonian contaminants

Cordosphaeridium truncigerum, Dinogymnium microgranulosum, Leptodinium subtile subsp. *pectinigerum, Odontochitina porifera, Xenascus ceratioides.*

9575': Coniacian-Santonian (probably caved)

Dinogymnium euclaensis, Hystrichosphaeridium paracostatum, Odontochitina porifera, Palaeohystrichophora infusorioides.

9640-9790': cuttings samples containing Late Cretaceous taxa (probably caved)

Palaeohystrichophora infusorioides, Spinidinium cf. *S. echinoideum.*

9860-9990': *Gonyaulacysta filapicata* Zone (Bathonian)

Ctenidodinium ornatum, Leptodinium subtile subsp. *pectinigerum, Taeniophora iunctispina.*

10060-10860': Pliensbachian-Toarcian

Classopollis simplex, Kraeuselisporites reissingeri, Luehndea spinosa.

10930-11360': Pliensbachian

Cadargasporites verrucosus, Tasmanites sp.

11430-11910': ?Rhaetian

Alisporites sp., *Classopollis* sp.

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Amoco-Imp
JAEGER A-49

GSC locality: D84

Location: 44°28'01.51"N; 50°21'00.65"W

RT elevation: 98' Water depth: 190'

Casing set at: 453, 791, 902, and 2000'

Total depth: 3079' Interval studied: 900-3079'

Analyzed by: G.L. Williams

Palynological analysis of 3 sidewall core and 26 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

900- 930'	*Apteodinium* sp. B Zone (early Miocene)
990- 1020'	*C. dispersum* Zone (middle-late Oligocene)
1080- 1450'	*D. heterophlycta* Zone (early Oligocene)
1510- 1810'	*D. colligerum* Zone (late Eocene)
1870- 1990'	*A. reticulense* Zone (middle Eocene)
2050- 2080'	*A. senonensis* Zone (early Eocene)
2140- 2260'	*C. speciosa* Zone (late Paleocene)
2320- 2350'	*D. euclaensis* Zone (Maastrichtian)
2410- 2530'	*O. operculata* Zone (Campanian)
2500- 2530'	*T. castaneum* subzone (early Campanian)
2590- 2890'	*C. truncigerum* Zone (Santonian)
2890- 2930'	*O. pulcherrimum* Zone (Coniacian)
2930- 3079'	"basement"

The Coniacian-lower Miocene sequence in Jaeger A-49 is more or less complete with the exception of the lower Paleocene. Since, however this is a condensed section the possibility of the presence of sediments of this age between 2320 and 2260ft cannot be ruled out. The sediments throughout are marine. Present in a sidewall core at 3045ft, which is from "basement", is the taxon *Gonyaulacysta* cf. *G. cladophora*, previously known only from the Kimmeridgian of Amoco-Imp Bittern M-62. This suggests that material from the Kimmeridgian in the vicinity of Bittern was redeposited in the vicinity of Jaeger prior to or during the Coniacian. Additionally, Aptian-Albian rocks were being eroded, accounting for the presence of spores of this age in the Santonian of Jaeger.

Selected palynomorphs

900-930': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969, *Cordosphaeridium cantharellum, Cyclopsiella elliptica, Operculodinium centrocarpum, Tsugaepollenites igniculus.*

990-1020': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Deflandrea phosphoritica.

1080-1450': *Deflandrea heterophlycta* Zone (early Oligocene)

Apteodinium sp. B Williams and Brideaux, 1975, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Chiropteridium aspinatum, C. dispersum, C. lobospinosum, Cyclonephelium* spp., *Deflandrea heterophlycta, D. spinulosa, Hemicystodinium zoharyi* (one specimen at 1170-1200ft), *Hystrichokolpoma rigaudiae, Operculodinium* cf. *O. hirsutum, sensu* Gocht, 1969 (one specimen at 1320-1360ft), *Osmundacidites* sp. A Williams and Bujak, 1977b, *Pentadinium laticinctum, P. laticinctum* subsp. *granulatum, Polysphaeridium pastielsii, Systematophora ancyrea, Thalassiphora pelagica, Wetzeliella symmetrica, sensu* Gocht, 1969, *W.* sp. B Williams and Brideaux, 1975.

1510-1810': *Diphyes colligerum* Zone (late Eocene)

Adnatosphaeridium reticulense, Apectodinium homomorphum, Areosphaeridium arcuatum, A. multicornutum, Cordosphaeridium funiculatum, Deflandrea oebisfeldensis (one specimen at 1600-1630ft), *D. wardenensis, Dinopterygium* sp. A Williams and Bujak, 1977a, *Distatodinium ellipticum, Eocladopyxis peniculatum, Gonyaulacysta giuseppei, Kisselovia coleothrypta, K. reticulata, Perisseiasphaeridium* sp., *Phthanoperidinium* sp., *Pyxidiella* sp., *Spiniferites crassipellis, Tubidermodinium sulcatum, Wetzeliella ovalis.*

1870-1990': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Achilleodinium biformoides, Achomosphaera alcicornu, Cordosphaeridium gracile, Muratodinium fimbriatum, Pentadinium taeniagerum, Rhombodinium draco, Samlandia chlamydophora, Tectatodinium sp.

2050-2080': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (common), *Cordosphaeridium inodes, Diphyes colligerum.*

2140-2260': *Ceratiopsis speciosa* Zone (late Paleocene)

Areoligera medusettiformis, sensu Gocht, 1969, *A. senonensis, sensu* Gocht, 1969, *Palaeocystodinium australinum, Spinidinium styloniferum.*

2320-2350': *Dinogymnium euclaensis* Zone (Maastrichtian)

Ceratiopsis diebelii, Hystrichodinium pulchrum, Palaeoperidinium pyrophorum.

2410-2530': *Odontochitina operculata* Zone (Campanian)

Chatangiella vnigri, Cyclonephelium distinctum, Xenascus ceratioides.

2500-2530': *Trichodinium castaneum* subzone (early Campanian)

Fromea amphora, Isabelidinium cooksoniae, Odontochitina operculata, Palaeohystrichophora infusorioides, Trichodinium sp.

2590-2890': *Cordosphaeridium truncigerum* Zone (Santonian)

Achomosphaera ramulifera, Cordosphaeridium truncigerum, Dinogymnium acuminatum, Forma P Evitt, 1961, *Gardodinium deflandrei, Microdinium ornatum, Oligosphaeridium complex, O. pulcherrimum, Senoniasphaera protrusa, Surculosphaeridium longifurcatum, Trichodinium castaneum.*

Throughout this interval are reworked Aptian-Albian palynomorphs. These include *Appendicisporites tricuspidatus* and *Camarozonosporites insignis.*

2890-2930': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Although "basement" is picked from logs at 2930ft, the sidewall cores from 3045 and 2960ft contain the Coniacian contaminant *Cyclonephelium vannophorum* and also *Triblastula utinensis.* The interval 2930-2890ft is therefore taken to be Coniacian.

2930-3079': "basement"

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Amoco-Imp
KITTIWAKE P-11

GSC locality: D79

Location: 44°40'49.43"N; 53°31'45.65"W

RT elevation: 85' Water depth: 314'

Casing set at: 559, 915, 2505, and 7376'

Total depth: 11647' Interval studied: 1150-11647'

Analyzed by: G.L. Williams

Palynological analysis of 66 sidewall core and 110 cuttings samples indicates the following age determinations and biostratigraphic zonation:

1150- 1450'	*Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1150- 1180'	*S. scabratus* Subzone (Pleistocene)
1240- 1450'	*H. choanophorum* Subzone (Pliocene)
1510- 2860'	*Cannosphaeropsis* sp. A Zone (late Miocene)
3010- 3220'	*P. laticinctum* Zone (middle Miocene)
3460- 3790'	*Apteodinium* sp. B Zone (early Miocene)
3850- 3880'	*C. dispersum* Zone (middle-late Oligocene)
3940- 4780'	*D. heterophlycta* Zone (early Oligocene)
4840- 5332'	*D. colligerum* Zone (late Eocene)
5380- 5500'	*A. reticulense* Zone (middle Eocene)
5530- 5590'	*A. senonensis* Zone (early Eocene)
5650- 5780'	*D. euclaensis* Zone (Maastrichtian)
5900- 6228'	*O. operculata* Zone (Campanian)
6440- 6762'	*C. truncigerum* Zone (Santonian)
6840- 6870'	*O. pulcherrimum* Zone (Coniacian)
7095'	*S. longifurcatum* Zone (Turonian)
7156'	*C. polypes* Zone (Cenomanian)
7270'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
7440- 7662'	*S. perlucida-S. schindewolfii* Zone (Aptian)
7765- 7940'	*D. anaphrissa* Zone (Barremian)
8023- 8770'	*C. elegantulum* Zone (Hauterivian)
8783- 9952'	*P. neocomica* Zone (Berriasian-Valanginian)
9952-11647'	age indeterminate

Kittiwake P-11 bottomed at 11 647ft in the Argo Formation. Sidewall cores below 10 000ft are generally barren, containing only black carbonaceous matter.

Cuttings below this depth however have abundant microfossils, which indicate that the orderly stratigraphic succession has been broken up by salt tectonism.

Between 11 647 and 10 389ft, Late Jurassic and Early Cretaceous organic microfossil assemblages occur mixed together. They contain *Aequitriradites spinulosus, Cerebropollenites mesozoicus, Cribroperidinium* sp., *Ctenidodinium* sp., *Gonyaulacysta nuciformis, Lanterna* sp., *Muderongia simplex, Oligosphaeridium anthophorum, Pareodinia ceratophora, Phoberocysta neocomica, Pseudoceratium pelliferum, Subtilisphaera* cf. *S. perlucida, Systematophora* cf. *S. complex,* and *Tenua rioultii.*

A sidewall core from 10 389ft contains a dark, opaque, exclusively terrigenous organic residue of *Classopollis* spp., which, in this area, is recognized as being confined to the continental or marginal marine deposits of Early Jurassic age. The cuttings sample 10 240-10 370ft contains a Jurassic species of *Acanthaulax, Cribroperidinium* sp., and *?Diconodinium* sp., in addition to *Muderongia simplex, Oligosphaeridium complex, O. perforatum,* and *Phoberocysta neocomica* (a Cretaceous species unknown in the Jurassic), *Systematophora areolata* (a Jurassic species not known in the Cretaceous), and a Late Jurassic species of *Gonyaulacysta.* Those assemblages are a mixture of Early and Late Jurassic and Early Cretaceous fossils and may be representative of a cap rock facies overlying the salt, however the Early Cretaceous fossils may be caved.

Deposition during the Cretaceous and Tertiary appears to have been more or less continuous with only the Paleocene apparently being absent.

Paleoenvironmental interpretations are based primarily on cuttings so are somewhat speculative. The Berriasian-Barremian rocks were deposited in an inner neritic to littoral environment, with more open marine conditions existing in the Barremian. The Aptian-Albian rocks (7270-7662ft) are nearshore marine to nonmarine. During the Late Cretaceous and Paleogene the Kittiwake area was probably located in the outer neritic zone.

Selected palynomorphs

1150-1450': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

1150-1180': *Spiniferites scabratus* Subzone (Pleistocene)

Spiniferites membranaceus, S. ramosus, Sumatradinium sp.

1240-1450': *Hystrichosphaeridium choanophorum* Subzone (Pliocene)

Achomosphaera alcicornu, Spiniferites furcatus, sensu Wall, 1967, *Thalassiphora delicata.*

1510-2860': *Cannosphaeropsis* sp. A Zone (late Miocene)

Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Cyclopsiella* sp. A Williams and Brideaux, 1975, *Hystrichosphaeridium choanophorum, Lingulodinium machaerophorum, Operculodinium centrocarpum, O.* cf. *O. israelianum, Tsugaepollenites igniculus* (abundant), *Tuberculodinium vancampoae.*

3010-3220': *Pentadinium laticinctum* Zone (middle Miocene)

Hystrichokolpoma rigaudiae, Lingulodinium sp. A Williams and Brideaux, 1975, *Palaeocystodinium golzowense, Pentadinium laticinctum, Spiniferites pseudofurcatus, Tiliaepollenites* sp.

3460-3790': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Cyclopsiella elliptica, Hystrichosphaeropsis obscura, Lejeunia* spp., *Selenopemphix* sp., *Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

3850-3880': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Deflandrea phosphoritica, D. spinulosa, Pentadinium laticinctum subsp. *granulatum, Samlandia chlamydophora.*

3940-4780': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, Cordosphaeridium cantharellum, Cyclonephelium sp. B Williams and Brideaux, 1975, *Deflandrea heterophlycta, Dinopterygium* sp. A Williams and Bujak, 1977a, *Eocladopyxis peniculatum, Pentadinium taeniagerum, Phthanoperidinium comatum.*

4840-5332': *Diphyes colligerum* Zone (late Eocene)

Areosphaeridium diktyoplokus, Cordosphaeridium inodes, Cyclonephelium sp. C Williams and Brideaux, 1975, *Kisselovia tenuivirgula* subsp. *crassiramosa, Perisseiasphaeridium* sp., *Pyxidiella* sp., *Tubidermodinium sulcatum.*

5380-5500': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Achilleodinium biformoides, Adnatosphaeridium reticulense, sensu Gocht, 1969, *Apectodinium homomorphum, Areoligera senonensis, sensu* Gocht, 1969, *Cordosphaeridium gracile, Wetzeliella varielongituda.*

5530-5590': *Areoligera senonensis* Zone (early Eocene)

Comasphaeridium cf. *C. cometes, sensu* Williams and Brideaux, 1975, *Deflandrea leptodermata, D. phosphoritica* (base), *Kisselovia coleothrypta* (base).

5650-5780': *Dinogymnium euclaensis* Zone (Maastrichtian)

Alterbia acuminata, Ceratiopsis diebelii, Diconodinium cf. *D. rhombiformis, Dinogymnium microgranulosum, Exochosphaeridium bifidum, Gillinia hymenophora, Hystrichodinium pulchrum, Isabelidinium belfastense, I. cooksoniae.*

5900-6228': *Odontochitina operculata* Zone (Campanian)

Chatangiella vnigri, Dinogymnium heterocostatum, D. undulosum, Gardodinium deflandrei, Hystrichosphaeridium sp. A Williams and Bujak, 1977b, *Hystrichosphaeropsis ovum, Kleithriasphaeridium loffrense, Odontochitina operculata, O. costata, Palaeohystrichophora infusorioides, Spinidinium* cf. *S. styloniferum, Xenascus ceratioides.*

6440-6762': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis, Cordosphaeridium truncigerum, Gardodinium deflandrei, Hystrichosphaeropsis ovum (base), *Odontochitina porifera, Rugubivesiculites reductus, R. rugosus, Senoniasphaera protrusa, Spinidinium* cf. *S. styloniferum* (base), *Surculosphaeridium longifurcatum.*

6840-6870': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Oligosphaeridium pulcherrimum.

7095': *Surculosphaeridium longifurcatum* Zone (Turonian)

Chlamydophorella nyei, Cleistosphaeridium huguoniotii, Cyclonephelium paucispinum, C. vannophorum, Exochosphaeridium striolatum, Litosphaeridium siphoniphorum, Surculosphaeridium longifurcatum (common), *Tanyosphaeridium magdalium, Xiphophoridium alatum.*

7156': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium polypes, Epelidosphaeridia spinosa, Gonyaulacysta cassidata, Palaeohystrichophora infusorioides (abundant).

7270': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites jansonii, A. problematicus, Cicatricosisporites hallei, Classopollis classoides, Cribroperidinium orthoceras, Ovoidinium sp., *Palaeoperidinium pyrophorum, Senoniasphaera microreticulata, Triloborites apiverrucatus, T. trioreticulosus.*

7440-7662': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aptea attadalica, Callialasporites dampieri, Contignisporites cooksonii, Eucommiidites minor, Vitreisporites pallidus.

7765-7940': *Doidyx anaphrissa* Zone (Barremian)

Canningia colliveri, Cerebropollenites mesozoicus, Cribroperidinium sepimentum, Dingodinium cerviculum, Eopseudoceratium gochtii, Muderongia simplex, Oligosphaeridium reniforme, Pareodinia ceratophora (with kalyptra), *Pseudoceratium pelliferum, Subtilisphaera perlucida.*

8023-8770': *Ctenidodinium elegantulum* Zone (Hauterivian)

Batioladinium cf. *B. exiguum, B.* sp. A Bujak and Williams, 1978, *Ctenidodinium* sp., *Oligosphaeridium perforatum, Polystephanephorus* cf. *P. calathus, Systematophora complicata, Systematophora schindewolfii.*

8783-9952': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, Aequitriradites spinulosus, Biorbifera johnewingii, Cicatricosisporites australiensis, Diacanthum sp., *Dictyotriletes crateris, Klukisporites pseudoreticulatus, Phoberocysta neocomica, Polystephanephorus sarjeantii, Subtilisphaera* cf. *S. perlucida.*

9952-11647': age indeterminate.

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Amoco-IOE
MURRE G-67

GSC locality: D31

Location: 46°06'20.42"N; 49°09'38.07"W

RT elevation: 98' Water depth: 212'

Casing set at: 477, 835, 2305, and 7782'

Total depth: 10949' Interval studied: 900-9541'

Analyzed by: G.L. Williams

Palynological analysis of 105 sidewall cores, 48 cuttings and one tricore from the subject well indicates the following age determinations and biostratigraphic zonation:

900-	930'	*C. dispersum* Zone (middle-late Oligocene)
1080-	1110'	*D. heterophlycta* Zone (early Oligocene)
1470-	1500'	*D. colligerum* Zone (late Eocene)
1650-	1680'	*A. reticulense* Zone (middle Eocene)
1830-	1860'	*A. senonensis* Zone (early Eocene)
2190-	2370'	*O. operculata* Zone (Campanian)
2380-	2440'	Coniacian-Santonian
2510-	2691'	*S. longifurcatum* Zone (Turonian)
2760-	2876'	*C. polypes* Zone (Cenomanian)
	2945'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
3114-	3624'	Kimmeridgian-Portlandian
3650-	4058'	*G. cladophora* Zone (Kimmeridgian)
4070-	4419'	*G. jurassica* Zone (Oxfordian-early Kimmeridgian)
4445-	5260'	*V. vermiculata* Zone (Callovian)
5270-	5900'	*G. filapicata* Zone (Bathonian)
5992-	6355'	*M. semitabulatum* Zone (Aalenian-Bajocian)
6450-	7223'	*N. gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)
7330-	8766'	Pliensbachian
8781-	9541'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)

Amoco-IOE Murre G-67 was drilled to a total depth of 10 949ft, with the bottom 600ft being chlorite-grade metamorphic rocks. These have been dated Middle-Late Devonian in Jansa *et al.* (1976). The overlying red beds which extend to 9590ft, are unfossiliferous, although Jansa and Wade (1975) have suggested they may be Triassic. These are overlain by the Iroquois Formation which is palynologically dated as Hettangian to Pliensbachian. There is then a more or less complete Jurassic section extending to 2975ft, as determined from lithological data, where rocks of probable Portlandian age are overlain by Albian sediments.

The youngest dated Upper Cretaceous sediments are Campanian in a cuttings sample from 2190-2220ft. Above this at 1830-1860ft are lower Eocene sediments. A single specimen of the Danian species *Danea mutabilis*, has been recorded from 2190-2220ft. It is therefore possible that both Maastrichtian and Paleocene sediments occur between 2190 and 1860ft.

The environment of deposition in the Hettangian-early Pliensbachian was possibly non-marine since only spores have been recorded from this interval. The upper Pliensbachian to Bajocian sediments appear to have been deposited predominantly in a shallow marine environment. The Bathonian to Kimmeridgian sediments contain too few dinocysts to permit paleoenvironmental interpretations. The Portlandian sediments are predominantly non-marine and are overlain by non-marine Albian and Cenomanian sediments which are in turn overlain by marine Cenomanian to Campanian. The only samples from the Tertiary sequences are cuttings. However, the abundance of dinocysts suggests a marine environment of unknown water depths.

Selected palynomorphs

900-930': *Chiropteridium dispersum* Zone (middle-Late Oligocene)

Chiropteridium aspinatum, Deflandrea spinulosa, Impletosphaeridium transfodum, Polysphaeridium pastielsii, Tanyosphaeridium sp. A Williams and Brideaux, 1975, *Tubidermodinium sulcatum.*

1080-1110': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, Gonyaulacysta cf. *G. granulata, sensu* Benedek, 1972, *Kisselovia* cf. *K. coleothrypta, Phthanoperidinium* sp., *Vozzhennikovia tenella.*

1470-1500': *Diphyes colligerum* Zone (late Eocene)

Areoligera cf. *A. senonensis, Cyclonephelium* cf. *C. ordinatum, Wetzeliella varielongituda.*

1650-1680': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium vittatum, Apectodinium homomorphum, Areoligera senonensis, sensu Gocht, 1969, *Cordosphaeridium cracenospinosum, Diphyes colligerum, Homotryblium tenuispinosum, Lanternosphaeridium axiale.*

1830-1860': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (common), *Comasphaeridium* cf. *C. cometes, sensu* Williams and Brideaux, 1975.

2190-2370': *Odontochitina operculata* Zone (Campanian)

Chatangiella victoriensis, Dinogymnium euclaensis, Hystrichosphaeridium bowerbankii, Rugubivesiculites convolutus, Spinidinium cf. *S. echinoideum.*

2380-2440': Coniacian-Santonian

Palaeohystrichophora infusorioides, Rugubivesiculites rugosus, Spiniferites cingulatus, Surculosphaeridium longifurcatum.

2510-2691': *Surculosphaeridium longifurcatum* Zone (Turonian)

Appendicisporites bilateralis, Canningia colliveri, Camarozonosporites insignis, Chlamydophorella nyei, Cicatricosisporites hallei, Classopollis classoides, Trichodinium castaneum.

2760-2876': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium polypes subsp. A Williams, 1975, *Cyclonephelium vannophorum, Litosphaeridium siphoniphorum.*

2945': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites jansonii, A. problematicus, Callialasporites dampieri, Costatoperforosporites fistulosus, Liliacidites peroreticulatus, Retitricolpites virgeus.

3114-3624': Kimmeridgian-Portlandian

Alisporites grandis, Callialasporites dampieri (common), *C. trilobatus, Densoisporites perinatus, Dictyotriletes crateris, Foraminisporis wonthaggiensis, Klukisporites pseudoreticulatus, Leptolepidites psarosus, Vitreisporites pallidus.*

3650-4058': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Contignisporites fornicatus, Endoscrinium eisenackii, Exesipollenites tumulus, Gen. et sp. 2 Gocht, 1970, *Gonyaulacysta cladophora, Lanterna sportula, Wanaea spectabilis.*

4070-4419': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Gonyaulacysta jurassica.

4445-5260': *Valensiella vermiculata* Zone (Callovian)

Cerebropollenites mesozoicus, Contignisporites cooksonii, Couperisporites jurassicus, Dictyopyxidia sp., *Gonyaulacysta aldorfensis, Meiourogonyaulax* sp., *Pareodinia ceratophora, Tenua rioultii, Valensiella ovula.*

5270-5900': *Gonyaulacysta filapicata* Zone (Bathonian)

Gonyaulacysta filapicata, Leptodinium subtile subsp. *pectinigerum, Micrhystridium lymensis, Pareodinia ceratophora* (with kalyptra), *Rubinella major.*

5992-6355': *Mancodinium semitabulatum* Zone (Aalenian-Bajocian)

Contignisporites cooksonii (base), *Ctenidodinium pachydermum, Leptodinium regale, Tenua rioultii* (base).

6450-7223': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Callialasporites dampieri (base at 6450ft), *Contignisporites problematicus, Mancodinium semitabulatum, Mendicodinium* sp., *Nannoceratopsis gracilis, Pareodinia ceratophora* (base).

7330-8766': Pliensbachian

Cerebropollenites mesozoicus, Circularisporites cerebroides, Classopollis simplex, Tasmanites sp., *Veryhachium reductum.*

8781-9541': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Classopollis classoides (abundant), *Kraeuselisporites reissingeri.*

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Amoco-Imp-Skelly
OSPREY H-84

GSC locality: D105

Location: 44°43'28.79"N; 49°27'22.92"W

RT elevation: 85' Water depth: 200'

Casing set at: 455, 797, 2700, and 8001'

Total depth: 11397' Interval studied: 830-11390'

Analyzed by: J.P. Bujak and G.L. Williams

Palynological analysis of 89 sidewall core samples and 78 cuttings samples indicates the following age determinations and biostratigraphic zonation:

830- 860'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1010- 1040'	*P. laticinctum* Zone (middle Miocene)
1100- 1130'	*Apteodinium* sp. B Zone (early Miocene)
1190- 1400'	*C. dispersum* Zone (middle-late Oligocene)
1460- 1940'	*D. heterophlycta* Zone (early Oligocene)
2450- 2570'	early-middle Eocene
2630- 2660'	*A. senonensis* Zone (early Eocene)
2720- 3320'	Santonian-Campanian
3370'	Turonian-Coniacian
3470'	*C. polypes* Zone (Cenomanian)
3620- 4460'	Hettangian-Sinemurian
4497- 5350'	Rhaetian
5390- 6076'	age indeterminate
6290- 8900'	Carnian-Norian
8930- 9650'	age indeterminate (presumed Carnian-Norian
9680-11390'	Carnian-Norian

The geology of Osprey H-84 has been described by

Jansa *et al.* (1977). Between 11 390 and 3620ft there is a succession of Upper Triassic-Lower Liassic strata with no palynological evidence for sediments in the well older than Late Triassic. Age dating is based on the comparison of spores from described European and North American (Texas, Virginia, New England) assemblages. Spore assemblages from the well have low diversity, typically with single species or genus dominance.

The oldest sediments in Osprey H-84 are the Kettle red beds which extend from 11 397 to 10 846ft and are Carnian-Norian. Most of the overlying salt sequence (10 846-4108ft) is Late Triassic, and older than the Argo Formation of the Scotian Shelf. The sequence has been informally named the Osprey evaporites by Jansa *et al.* (1977). The overlying Murre carbonate (4108-3460ft) is generally older than the Iroquois Formation of the Scotian Basin.

At approximately 3500ft, the Lower Jurassic Murre carbonate is unconformably overlain by the Dawson Canyon Formation of Cenomanian-Coniacian age. Detailed palynological subdivision of the overlying Upper Cretaceous and Tertiary sediments is not possible because of poor recovery of palynomorphs.

Downhole caving and mud contamination is common in the examined samples and, although predominantly noted in cuttings samples, is sometimes present in sidewall core samples. Drilling mud contamination can be distinguished from downhole cavings by the nature of the organic material. The former includes genera such as *Aquilapollenites*, not known from strata of offshore eastern Canada.

Selected palynomorphs

830-860': *Cannosphaeropsis* sp. A Zone (late Miocene)

Alnipollenites verus, Lingulodinium machaerophorum, Osmundacidites sp. A Williams and Bujak 1977a.

1010-1040': *Pentadinium laticinctum* Zone (middle Miocene)

Maduradinium spatiosum.

1100-1130: *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux 1975, *Operculodinium centrocarpum, Systematophora ancyrea.*

1190-1400': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum.

1460-1940': *Deflandrea heterophlycta* Zone (early Oligocene)

Deflandrea heterophlycta, D. phosphoritica, D. spinulosa, Kisselovia cf. *K. coleothrypta, Tubidermodinium sulcatum.*

2450-2570': early-middle Eocene

Deflandrea wetzelii, Rhombodinium condylos, R. cf. *R. condylos, sensu* Williams and Bujak 1977b, *Wetzeliella ovalis.*

2630-2660': *Areoligera senonensis* Zone (early Eocene)

Adnatosphaeridium reticulense, Apectodinium homomorphum, Cordosphaeridium gracile, Deflandrea leptodermata, Muratodinium fimbriatum.

2720-3320': Santonian-Campanian

Chatangiella tripartita, Dinogymnium undulosum, Odontochitina costata, Palaeohystrichophora infusorioides, Xenascus ceratioides.

Ceratiopsis speciosa the late Paleocene zonal index species and *Extratriporopollenites* sp. are present in the interval 2720-2750ft. This suggests that there are Paleocene sediments between 2720 and 2660ft. It is even possible that there is no hiatus between the Campanian and lower Eocene rocks, but rather a condensed sequence. Also caved but lower down, in the cuttings sample 2990-3020ft, is *Membranilarnacia ursulae*. This has a restricted stratigraphic range of early Eocene to middle Eocene.

3370': Turonian-Coniacian

Kleithriasphaeridium loffrense, Silicisphaera ferox.

3470': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium huguoniotii, Epelidosphaeridia spinosa, Litosphaeridium siphoniphorum.

3620-4460': Hettangian-Sinemurian

Araucariacites punctatus, Classopollis classoides, C. itunensis, C. meyeriana, Cycadopites nitidus, Porcellispora longdonensis.

This interval probably correlates with the *Cycadopites subgranulosus* Zone of the Scotian Shelf (Bujak and Williams, 1977). The Hettangian-Sinemurian age of this interval in Osprey H-84 is indicated by the dominance of striate *Classopollis* species and absence of post-Sinemurian species noted in nearby Grand Banks wells.

Caved palynomorphs include *Adnatosphaeridium multispinosum, Apectodinium homomorphum, Chlamydophorella nyei, Cordosphaeridium inodes, Cyclonephelium distinctum, C. ordinatum, Spiniferites ramosus.*

4497-5350': Rhaetian

Araucariacites punctatus, Classopollis classoides, C. itunensis, C. meyeriana, Kraeuselisporites reissingeri.

The predominance of non-striate *Classopollis* at 4497ft indicates the presence of Rhaetian strata, even though striate species sometimes predominate in samples below 4497ft. This interval probably correlates with the *Classopollis meyeriana* Zone (Bujak and Williams, 1977).

Caved palynomorphs include *Apectodinium homomorphum, Areoligera* cf. *A. senonensis, Cyclonephelium ordinatum, Odontochitina costata, Spiniferites ramosus.*

5390-6076': age indeterminate

In situ palynomorphs were not observed in the four sidewall core samples and one cuttings sample examined from this interval. Caved Cenozoic dinocysts are in the cuttings sample at 5390-5420ft.

6290-8900': Carnian-Norian

Disaccates probably attributable to *Alisporites, Patinasporites densus* (2 specimens at 6830-6860ft), *Porcellispora longdonensis* (frequent and often dominating the assemblages), *Pseudenzonalasporites* sp. (1 specimen at 6830-6860ft).

Except for rare, possibly caved, specimens of *Classopollis meyeriana* at 6830-6860ft, *Classopollis* is absent from this interval. Assemblages are typically dominated by *Porcellispora longdonensis*, with rare *Patinasporites densus* at 6830-6860ft. The absence of *Classopollis* from the interval indicates a pre-Rhaetian age and *P. densus* appears to be restricted to Carnian-

Norian strata. The dominance of *P. longdonensis* is probably of paleoecologic rather than biostratigraphic significance.

Caved palynomorphs include *Apectodinium homomorphum*.

The presence of *Aquilapollenites* in the cuttings samples from 6830 to 6860ft and 8480 to 8510ft indicates drilling mud contamination.

8930-9650': age indeterminate (presumed Carnian-Norian)

In situ palynomorphs were not observed in the seven sidewall core samples and two cuttings samples examined from this interval.

9680-11390': Carnian-Norian

Camerosporites cf. *C. secatus* (differs from *C. secatus* in having smaller verrucae), *?Cucillispora* sp., Dinoflagellate, gen. et sp. indet. (2 specimens at 11 060-11 090ft), Disaccate pollen (possibly *Alisporites*, common at 10 850-10 880 and 11 060-11 090ft), *Discisporites* cf. *D. niger*, *Ovalipollis ovalis*, *Paracirculina quadruplicis*, *Patinasporites densus* (common at 9680, 10 850-10 880, and 11 060-11 090 ft), *Porcellispora longdonensis* (one specimen at 11 060-11 090ft may be caved).

Assemblages from this interval include either common *Patinasporites densus* or common disaccate pollen (without triletes) tentatively assigned to *Alisporites*. In contrast to the interval from 6290 to 8900ft, *Porcellispora longdonensis* is rare or absent. Below 11 060ft, specimens of spores noted are difficult to identify because of darkening and corrosion. The interval is therefore primarily dated on the occurrence of *Patinasporites densus*. No palynological evidence of older strata in the well was found.

Caved palynomorphs include *Apectodinium homomorphum*.

Drilling mud contamination is indicated in the sidewall core samples taken at 10 236 and 10 919ft by the presence of *Aquilapollenites*.

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Amoco-Imp-Skelly
PELICAN J-49

GSC locality: D113

Location: 45°28'35.17"N; 52°36'41.71"W

RT elevation: 98' Water depth: 300'

Casing set at: 562, 918, and 2510'

Total depth: 4260' Interval studied: 950-4230'

Analyzed by: G.L. Williams

Palynological analysis of 58 sidewall cores and 37 cuttings samples indicates the following age determinations and biostratigraphic zonation:

950- 980' early-middle Eocene
1040- 1250' *A. senonensis* Zone (early Eocene)
1310- 1520' *O. operculata* Zone (Campanian)
1490- 1520' *T. castaneum* subzone (early Campanian)
1580- 1790' *C. truncigerum* Zone (Santonian)
1850- 2330' *O. pulcherrimum* Zone (Coniacian)
2390- 2590' *S. longifurcatum* Zone (Turonian)
2600- 2790' *C. polypes* Zone (Cenomanian)
2820- 3060' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
2820- 2970' *R. rugosus* Subzone (late Albian)
3020- 3060' early Albian
3100- 3220' *S. perlucida-S. schindewolfii* Zone (Aptian)
3240' Berriasian-?Barremian
3270- 3530' Berriasian-Barremian
3705- 4230' Early Jurassic

Amoco-Imp-Skelly Pelican J-49 encountered salt at 3795ft. The well was subsequently abandoned at 4260ft while still in the Argo Formation, which contains a relatively diverse Early Jurassic assemblage. The overlying siltstone, anhydrite, shale and dolomite sequence cannot be dated palynologically. From 3530 to 3270ft can only be dated as Early Cretaceous, but cannot be younger than Barremian. The overlying Aptian (3220-3100ft) is succeeded by approximately 250ft of Albian.

Upper Cretaceous sediments first appear at 2790ft and extend to 1310ft with all stages apart from the Maastrichtian being recognized. The Tertiary section is incomplete with only Eocene sediments being recognized up to the highest sample at 980-950ft.

In Pelican J-49 dinocysts first appear at 3180ft within the Albian and presumably denote the first occurence of marine conditions. They do not however occur in any abundance until 2880ft. Throughout the remainder of the Late Cretaceous and in the Eocene they are common to abundant, with particularly rich assemblages being present in the Eocene. The environment is interpreted as open marine, neritic or possibly deeper water.

Selected palynomorphs

950-980': early-middle Eocene

Achilleodinium biformoides, *Areoligera medusettiformis*, *Areosphaeridium arcuatum*, *Cordosphaeridium inodes*, *Cyclonephelium ordinatum*, *Dinopterygium* sp. A Williams and Bujak, 1977a, *Kisselovia* cf. *K. tenuivirgula* subsp. *crassiramosa*, *Lingulodinium machaerophorum*, *Rhombodinium condylos*, *Thalassiphora pelagica*, *Tubidermodinium sulcatum*, *Wetzeliella articulata*.

1040-1250': *Areoligera senonensis* Zone (early Eocene)

Adnatosphaeridium patulum, *A. reticulense*, *sensu* Gocht, 1969, *Apectodinium homomorphum*, *Areoligera medusettiformis* (common), *A. senonensis*, *Areosphaeridium* cf. *A. multicornutum*, *Cordosphaeridium cracenospinosum*, *C. fibrospinosum*, *C. gracile*, *Deflandrea denticulata*, *D. oebisfeldensis*, *Diphyes colligerum*, *Gonyaulacysta giuseppei*, *Hystrichosphaeridium tubiferum*, *Kisselovia coleothrypta*, *Muratodinium fimbriatum*, *Operculodinium* cf. *O. hirsutum*, *sensu* Gocht, 1969, *Rottnestia borussica*, *Spiniferites crassipellis*, *Wetzeliella symmetrica*.

1310-1520': *Odontochitina operculata* Zone (Campanian)

Chatangiella tripartita, *Dinogymnium microgranulosum*, *Hystrichodinium pulchrum*, *Hystrichosphaeridium bowerbankii*, *Isabelidinium cooksoniae*, *Kleithriasphaeridium loffrense* (one specimen at 1400-1430ft), *Spiniferites cingulatus*.

1490-1520': *Trichodinium castaneum* subzone (early Campanian)

Alterbia macrocysta, *Chatangiella victoriensis*, *C. vnigri*, *Dorocysta* sp. A Bujak and Williams, 1978, *Exochosphaeridium striolatum*, *Palaeohystrichophora infusorioides*, *Tanyosphaeridium variecalamum*, *Trichodinium castaneum*.

1580-1790': *Cordosphaeridium truncigerum* Zone (Santonian)

Canningia reticulata, Cannosphaeropsis utinensis, Chlamydophorella nyei (one specimen at 1760-1790ft), *Cordosphaeridium truncigerum, Cyclonephelium eisenackii* (one speciman at 1670-1700ft), *Exochosphaeridium bifidum, Florentinia laciniata, F. mantellii, Gardodinium deflandrei, Hystrichosphaeridium paracostatum, Odontochitina costata, Oligosphaeridium pulcherrimum, Triblastula utinensis, Trithyrodinium suspectum, Xenascus ceratioides.*

1850-2330': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Alterbia balmei, Camarozonosporites insignis, Cyclonephelium hughesii, C. membraniphorum, Eisenackia crassitabulata, sensu Clarke and Verdier, 1967, *Fromea amphora, Gonyaulacysta exilicristata, Oligosphaeridium complex, Rugubivesiculites rugosus, Senoniasphaera protrusa, S. rotundata, Spiniferites porosus, S. wetzelii, Surculosphaeridium longifurcatum, Trigonopyxidia ginella, Valensiella ovula, sensu* Clarke and Verdier, 1967.

2390-2590': *Surculosphaeridium longifurcatum* Zone (Turonian)

Callaiosphaeridium asymmetricum, Cribroperidinium sp., *Endoscrinium campanulum, Microdinium ornatum, Oligosphaeridium anthophorum, Palaeoperidinium cretaceum, Xenascus ceratioides* (common).

2600-2790': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cicatricosisporites hallei, Cleistosphaeridium cf. *C. polypes, C. polypes* subsp. A Williams, 1975, *Cyclonephelium vannophorum, Epelidosphaeridia spinosa, Litosphaeridium siphoniphorum, Palaeohystrichophora infusorioides* (abundant), *Pterospermopsis helios, Tricolpites micromunus, Tricolpites parvus, Xiphophoridium alatum.*

2820-3060': *Spinidinium* cf. *S. vestitum-Systematophora schindewolfii* Zone (Albian)

2820-2970': *Rugubivesiculites rugosus* Subzone (late Albian)

Alisporites grandis, Appendicisporites jansonii, A. potomacensis, Costatoperforosporites foveolatus, Hystrichosphaeridium cooksoniae, Oligosphaeridium totum, Podocarpidites sp., *Schizosporis parvus, Spinidinium* cf. *S. vestitum, sensu* Williams, 1975.

Reworked species include *Callialasporites dampieri, Cerebropollenites mesozoicus,* and *Subtilisphaera perlucida.*

3020-3060': early Albian

Pterodinium magnoserratum.

3100-3220': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Callialasporites dampieri, Canninginopsis tabulata, Cicatricosisporites augustus, Spiniferites speciosus, Subtilisphaera cf. *S. perlucida, sensu* Bujak and Williams, 1978.

3240': Berriasian-?Barremian

Cerebropollenites mesozoicus, Perinopollenites elatoides.

3270-3530': Berriasian-Barremian

Appendicisporites bifurcatus, A. jansonii, A. problematicus, Callialasporites dampieri, Camarozonosporites insignis, Cerebropollenites mesozoicus, Cicatricosisporites hallei, C. hughesi, Classopollis classoides, Equisetosporites sp.

3705-4230': Early Jurassic

Classopollis classoides (common), *Kraeuselisporites reissingeri, Staplinisporites* sp. cf. *S. caminus, sensu* Reiser and Williams, 1969.

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Amoco-Imp
PETREL A-62

GSC locality: D71

Location: 44°51'06.29"N; 52°54'15.47"W

RT elevation: 98' Water depth: 282'

Casing set at: 550, 888, 2106, and 3902'

Total depth: 6384' Interval studied: 930-6384'

Analyzed by: G.L. Williams

Palynological analysis of 31 sidewall core and 60 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

930- 1050'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1110- 1230'	*P. laticinctum* (middle Miocene)
1290- 1410'	*Apteodinium* sp. B Zone (early Miocene)
1470- 2220'	*D. heterophlycta* Zone (early Oligocene)
2280-?2890'	*D. colligerum* Zone (late Eocene)
?2890- 2900'	*A. reticulense* Zone (middle Eocene)
2900- 3270'	*O. operculata* Zone (Campanian)
3150- 3270'	*T. castaneum* subzone (early Campanian)
3330- 3660'	*C. truncigerum* Zone (Santonian)
3730- 4230'	*O. pulcherrimum* Zone (Coniacian)
4277- 4330'	*S. longifurcatum* Zone (Turonian)
4350- 4400'	*C. polypes* Zone (Cenomanian)
4408- 4820'	*S.* cf. *S. vestitum-E. minor* Zone (Albian)
4888- 5130'	*S. perlucida-S. schindewolfii* Zone (Aptian)
5100- 5130'	*A. attadalica* Subzone (early Aptian)
5150- 5290'	*D. anaphrissa* Zone (Barremian)
5300- 5330'	*C. elegantulum* Zone (Hauterivian)
5350- 5570'	?Early Jurassic
5570- 6384'	no *in situ* palynomorphs

Below 5570ft in Amoco-IOE Petrel A-62 is salt. Present in a cuttings sample from 6100 to 6130ft is *Kraeuselisporites reissingeri* which has a known range of Rhaetian-Toarcian. This would possibly date the upper part of the salt, or more probably is caved from the cap rock, which is dated as Early Jurassic. Above the cap rock the oldest dated rocks are Hauterivian followed by a more or less complete section throughout the rest of the Cretaceous, although the Maastrichtian appears to be absent. In the Tertiary the Paleocene and lower Eocene are absent and the middle to upper Oligocene, if present, must be attenuated.

The Hauterivian and Barremian sediments appear to have been deposited in a very shallow marine environment. The Aptian-Albian is predominantly non-marine with very weak marine pulses. The abundance of

schizeaceous spores indicates a non-marine near-shore environment with a humid subtropical climate. The Upper Cretaceous sediments were deposited in a neritic environment, favorable to dinoflagellates. Marine conditions prevailed throughout the Tertiary, although there is an absence of dinocysts between 2800 and 2310ft. The lower Oligocene and lower Miocene sediments contain abundant dinocysts, denoting a neritic environment. The tropical species *Homotryblium plectilum* is present in the lower Oligocene and absent from the lower Miocene, presumably denoting cooler water conditions.

Selected palynomorphs

930-1050': *Cannosphaeropsis* sp. A Zone (late Miocene)

Alnipollenites verus, Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, *Sumatradinium* sp., *Tsugaepollenites igniculus, Tuberculodinium rossignoliae.*

1110-1230': *Pentadinium laticinctum* Zone (middle Miocene)

Epicephalopyxis indentata, Hemicystodinium sp. Williams, 1975, *Hystrichokolpoma rigaudiae, Maduradinium spatiosum, Palaeocystodinium golzowense.*

1290-1410': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium conjunctum, sensu Benedek, 1972, *A.* sp. B Williams and Brideaux, 1975, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Hystrichosphaeropsis obscura, Impletosphaeridium transfodum, Operculodinium giganteum, Pentadinium laticinctum, Systematophora ancyrea, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

1470-2220': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium lobospinosum, Cordosphaeridium cantharellum, C. funiculatum, Cyclonephelium semicirculatum, C. sp. B Williams and Brideaux, 1975, *Cyclopsiella vieta, Deflandrea spinulosa, Homotryblium plectilum, Kisselovia* cf. *K. coleothrypta, Pyxidiella* sp., *Rhombodinium draco, Thalassiphora pelagica, Tubidermodinium sulcatum, Wetzeliella* sp. B Williams and Brideaux, 1975.

2280-?2890': *Diphyes colligerum* Zone (late Eocene)

Apectodinium homomorphum, Areoligera medusettiformis, sensu Gocht, 1969, *Areosphaeridium multicornutum, Cordosphaeridium* cf. *C. gracile, sensu* Williams, 1975, *Cyclonephelium ordinatum, Deflandrea phosphoritica, Diphyes colligerum, Homotryblium tasmaniense, H. tenuispinosum, Operculodinium* cf. *O. hirsutum, sensu* Gocht, 1969, *Pentadinium taeniagerum, Spiniferites* cf. *S. pseudofurcatus.*

?2890-2900': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Hystrichokolpoma cinctum.

2900-3270': *Odontochitina operculata* Zone (Campanian)

Chatangiella vnigri, Cyclonephelium distinctum, Dinogymnium euclaensis, Hystrichodinium pulchrum, Hystrichosphaeridium salpingophorum, Spinidinium cf. *S. echinoideum, Subtilisphaera* cf. *S. perlucida, Triblastula utinensis.*

3150-3270': *Trichodinium castaneum* subzone (early Campanian)

Dinogymnium acuminatum, D. heterocostatum, Dorocysta sp. A Bujak and Williams, 1978, *Exochosphaeridium striolatum, Gardodinium deflandrei, Hystrichosphaeridium bowerbankii, Hystrichosphaeropsis ovum, Kleithriasphaeridium loffrense, Oligosphaeridium anthophorum, O. complex, Palaeohystrichophora infusorioides, Senoniasphaera rotundata, Spiniferites cingulatus, S. wetzelii, Trichodinium castaneum, Xenascus ceratioides.*

3330-3660': *Cordosphaeridium truncigerum* Zone (Santonian)

Canningia senonica, Cannosphaeropsis utinensis, Chatangiella victoriensis, Cordosphaeridium truncigerum, Cyclonephelium hughesii, Exochosphaeridium bifidum, Forma P Evitt, 1967, *Fromea amphora, Hystrichosphaeridium tubiferum* subsp. *brevispinum, Impletosphaeridium whitei, Isabelidinium cooksoniae, Kleithriasphaeridium readei, Odontochitina porifera, Oligosphaeridium* cf. *O. pulcherrimum, Polysphaeridium laminaspinosum, Rugubivesiculites rugosus, Senoniasphaera protrusa, Silicisphaera ferox, Tanyosphaeridium variecalamum, Trigonopyxidia ginella.*

3730-4230': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978, *Canningia reticulata, Coronifera oceanica, Dinogymnium microgranulosum, Dinopterygium cladoides, Endoscrinium campanulum, Exochosphaeridium* sp., *Hystrichosphaeridium paracostatum, Oligosphaeridium pulcherrimum, Palaeoperidinium cretaceum, Pterospermopsis spinosa, Senoniasphaera* cf. *S. rotundata, Surculosphaeridium longifurcatum.*

4277-4330': *Surculosphaeridium longifurcatum* Zone (Turonian)

Chlamydophorella nyei, Cleistosphaeridium huguoniotii, Subtilisphaera pirnaensis.

4350-4400': *Cleistosphaeridium polypes* Zone (Cenomanian)

Cleistosphaeridium polypes subsp. A Williams, 1975, *Epelidosphaeridia spinosa, Litosphaeridium siphoniphorum.*

4408-4820': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites potomacensis, A. problematicus, Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Cicatricosisporites augustus, C. hallei, Classopollis classoides, Cribroperidinium orthoceras, Cyclonephelium vannophorum, Eucommiidites minor, Florentinia radiculata, Gonyaulacysta cassidata, Oligosphaeridium complex (common), *Spinidinium* cf. *S. vestitum, Systematophora* sp. Davey and Verdier, 1971.

4888-5130': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Aequitriradites spinulosus, Appendicisporites bifurcatus, A. jansonii, A. unicus, Callialasporites dampieri, Cicatricosisporites hughesi, Concavissimisporites variverrucatus, Schizosporis reticulatus, Trilobosporites apiverrucatus, T. tribotrys, T. trioreticulosus.

5100-5130': *Aptea attadalica* Subzone (early Aptian)

Klukisporites pseudoreticulatus, Pilosisporites trichopapillosus, Trilobosporites purverulentus.

5150-5290': *Doidyx anaphrissa* Zone (Barremian)

Cerebropollenites mesozoicus, Oligosphaeridium asterigerum.

5300-5330': *Ctenidodinium elegantulum* Zone (Hauterivian)

Occisucysta sp. A Bujak and Williams, 1978.

5350-5570': Early Jurassic

Classopollis classoides (abundant).

5570-6384': no *in situ* palynomorphs

There appear to be no *in situ* palynomorphs. However present in the cuttings sample from 6100-6130ft, is the species *Kraeuselisporites reissingeri* which has a known range of late Rhaetian-Toarcian. If this is from the cap rock, it would conform to the age given above. If it is from the salt then this can be no older than Rhaetian in the upper part.

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Amoco-IOE
PUFFIN B-90

GSC locality: D35

Location: 44°39'12.73"N; 53°42'28.35"W

RT elevation: 98' Water depth: 350'

Casing set at: 528, 969, 2558, and 8856'

Total depth: 15425' Interval studied: 1030-15425'

Analyzed by: G.L. Williams

Palynological analysis of 154 cuttings samples and 100 sidewall cores indicates the following age determinations and biostratigraphic zonation:

1030- 1810' *Artemisia-Taraxacum* Zone (Plio-Pleistocene)
1030- 1060' *S. scabratus* Subzone (Pleistocene)
1150- 1810' *H. choanophorum* Subzone (Pliocene)
1870- 3610' *Cannosphaeropsis* sp. A Zone (late Miocene)
3670- 5140' *P. laticinctum* Zone (middle Miocene)
5200- 5500' *Apteodinium* sp. B Zone (early Miocene)
5560- 5590' *C. dispersum* Zone (middle-late Oligocene)
5620- 6545' *D. heterophlycta* Zone (early Oligocene)
5620- 5950' *C. funiculatum* subzone (late early Oligocene)
6025- 6545' *A. arcuatum* subzone (early early Oligocene)
6648- 7137' *D. colligerum* Zone (late Eocene)
7207' *A. reticulense* Zone (middle Eocene)
7246- 7300' *A. senonensis* Zone (early Eocene)
7390- 7473' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
7520' *D. euclaensis* Zone (Maastrichtian)
7521- 7900' *O. operculata* Zone (Campanian)
7770- 7900' *T. castaneum* subzone (early Campanian)
7950- 8590' *C. truncigerum* Zone (Santonian)
8660- 8890' *O. pulcherrimum* Zone (Coniacian)
8950- 9422' *S.* cf. *S. vestitum-E. minor* Zone (Albian)
9460- 9759' *S. perlucida-S. schindewolfii* Zone (Aptian)
9850-10700' *D. anaphrissa* Zone (Barremian)
10760-12090' *C. elegantulum* Zone (Hauterivian)
12160-15425' *P. neocomica* Zone (Berriasian-Valanginian)

The stratigraphy of Amoco-IOE Puffin B-90 has been presented in Jenkins *et al.* (1974). The well bottomed in presumably Berriasian-Valanginian sediments at 15 425ft, with the overlying 6500ft being included in the EArly Cretaceous. This is sequentially overlain by a more or less complete and thick Upper Cretaceous-Cenozoic sequence. The Cenomanian, which can be recognized in cuttings, must be attenuated. Above 8890ft is Coniacian, below 8950ft is Albian. The Cenomanian is therefore tentatively given a thickness of 30ft between 8900 and 8930ft. Upper Paleocene sediments appear to be absent. The Miocene attains its maximum known thickness for offshore eastern Canada in this well. The overall stratigraphy shows close comparison with Mobil Sable Island C-67, and the same lithostratigraphic units are present.

Considerable difficulty was experienced in age dating the bottom 3200ft of Puffin. The deepest sidewall core from a shale at 12 248ft contains an abundance of the species *Systematophora orbifera* which is generally taken to be a Late Jurassic form. There are also a few specimens of other Jurassic species, a few Neocomian taxa and some long ranging species. There are four plausible explanations. The first that the sample is Late Jurassic *in situ* is not supported by the analysis of the cuttings samples. From 13 590 to 12 760ft sporadic Jurassic species are recovered. Below 13 590ft however, the Neocomian assemblages dominate to the total exclusion of Jurassic species in the last few hundred feet. The second possibility is that the sidewall core represents a restricted environment which was particularly suited to the needs of the species *S. orbifera*. Thus we are seeing a local phenomenon. The presence of Neocomian species in the sample supports this hypothesis. The third possibility is that we have gouging, or mixing of material resulting from movement of the underlying diapir. The sidewall core may represent a fragment of Jurassic in a Neocomian succession. This is assuming that the sidewall from 12 248ft is Jurassic. Below 12 248ft down to 13 590ft the specimens of Jurassic species may be reworked. They are never in any abundance. The fourth possibility is reworking of Late Jurassic species. This is plausible for the specimens recorded from the cuttings samples but does not adequately explain the dominance of *S. orbifera* in the sidewall core at 12 248ft, since the species is also abundant in the cuttings sample from 12 260 to 12 290ft. This is more suggestive of a restricted environment.

Paleoenvironmental determinations, based on sidewall cores, are as follows: 12 248-12 045ft is shallow marine; 12 130-11 935ft is non-marine; 11 790-10 566ft is shallow marine; 10 528ft is very shallow marine; 10 442ft is non-marine; 10 183-9521ft is nearshore marine; 9422-9176ft appears to be brackish water to non-marine; 9138-8950ft is nearshore marine to brackish water; 8765ft is shallow marine, and 8453-7520ft is open marine but not deeper than outer shelf. Paleoenvironmental determinations have not been attempted above 7500ft in this well.

Selected palynomorphs

1030-1810': *Artemisia-Taraxacum* Zone (Plio-Pleistocene)

1030-1060': *Spiniferites scabratus* Subzone (Pleistocene)

Spiniferites membranaceus, S. scabratus, Tectatodinium pellitum.

1150-1810': *Hystrichosphaeridium choanophorum* Subzone (Pliocene)

Hystrichosphaeridium choanophorum, Operculodinium israelianum, Pterodinium circumsutum, Sumatradinium sp.

1870-3610': *Cannosphaeropsis* sp. A Zone (late Miocene)

Cannosphaeropsis sp. A Williams and Brideaux, 1975, *Cyclopsiella* sp. A Williams and Brideaux, 1975, *Leptodinium patulum, Lingulodinium machaerophorum, Nematosphaeropsis balcombiana, N.* sp. B Williams and Brideaux, 1975, *Operculodinium* cf. *O. israelianum, Spiniferites bentori, Tiliaepollenites* sp. A Williams and Brideaux, 1975, *Tuberculodinium vancampoae.*

3670-5140': *Pentadinium laticinctum* Zone (middle Miocene)

Epicephalopyxis indentata, Hemicystodinium sp. Williams, 1975, *Hystrichokolpoma rigaudiae, Hystrichosphaeropsis obscura, Lejeunia fallax, L. paratenella, Lingulodinium* sp. B. Williams and Brideaux, 1975, *Operculodinium giganteum, Palaeocystodinium golzowense, Pentadinium laticinctum, Polysphaeridium pastielsii, Spiniferites crassipellis, S. pseudofurcatus, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

5200-5500': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Cyclopsiella elliptica, ?Wilsonidium aechmophorum.*

5560-5590': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Cordosphaeridium cantharellum, Deflandrea phosphoritica, D. spinulosa.

5620-6545': *Deflandrea heterophlycta* Zone (early Oligocene)

5620-5950': *Cordosphaeridium funiculatum* subzone (late early Oligocene)

Areosphaeridium arcuatum, Ascostomocystis potane, Chiropteridium aspinatum, Cordosphaeridium funiculatum, Cyclonephelium exuberans, Deflandrea heterophlycta, Dinopterygium cladoides, sensu Morgenroth, 1966, *Eocladopyxis peniculata, Homotryblium plectilum, Kisselovia* cf. *coleothrypta, Perisseiasphaeridium* sp. A Williams and Brideaux, 1975, *Thalassiphora pelagica, Wetzeliella* sp. B Williams and Brideaux, 1975.

6025-6545': *Areosphaeridium arcuatum* subzone (early early Oligocene)

Adnatosphaeridium reticulense, Areosphaeridium arcuatum, Cordosphaeridium inodes, Cyclonephelium intricatum, Deflandrea sp. C Williams and Bujak, 1977b, *Samlandia chlamydophora, Wetzeliella ovalis.*

6648-7137': *Diphyes colligerum* Zone (late Eocene)

Areosphaeridium diktyoplokus, Diphyes colligerum, Leptodinium incompositum, Pentadinium laticinctum granulatum, P. taeniagerum, Phthanoperidinium sp., *Rhombodinium draco, Spiniferites cornutus.*

7207': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Cordosphaeridium gracile, Spiniferites sp.

7246-7300': *Areoligera senonensis* Zone (early Eocene)

Comasphaeridium cf. *C. cometes, Cordosphaeridium gracile* (peak abundance), *Wetzeliella symmetrica.*

7390-7473': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis diebelii, Deflandrea leptodermata, Exochosphaeridium bifidum, Forma P Evitt, 1967, *Microdinium* sp., *Palaeocystodinium australinum, Palaeoperidinium pyrophorum.*

7520': *Dinogymnium euclaensis* Zone (Maastrichtian)

Ceratiopsis diebelii, Dinogymnium acuminatum, D. euclaensis, Diphyes colligerum (base), *Gillinia hymenophora, Hystrichodinium voigtii, Hystrichosphaeridium bowerbankii, Microdinium veligerum, Odontochitina operculata, Palaeocystodinium australinum* (base), *Spiniferites wetzelii, Tanyosphaeridium magdalium, Trigonopyxidia ginella, Xenascus ceratioides* (one specimen).

7521-7900': *Odontochitina operculata* Zone (Campanian)

Cannosphaeropsis utinensis, Chatangiella tripartita, C. vnigri, Dinogymnium digitus, Gardodinium deflandrei, ?Hexagonifera chlamydata, Impletosphaeridium whitei, Kleithriasphaeridium loffrense, Microdinium veligerum, sensu Wilson, 1971, *Odontochitina operculata* (common), *Oligosphaeridium complex, Senoniasphaera rotundata, Xenascus ceratioides.*

7770-7900': *Trichodinium castaneum* subzone (early Campanian)

Chlamydophorella nyei, Dinogymnium undulosum, Exochosphaeridium striolatum, Odontochitina costata, Oligosphaeridium dictyophorum, Palaeohystrichophora infusorioides, Spinidinium cf. *S. echinoideum, Trichodinium castaneum.*

7950-8590': *Cordosphaeridium truncigerum* Zone (Santonian)

Cannosphaeropsis utinensis (base), *Cordosphaeridium truncigerum, Cyclonephelium distinctum, Dinogymnium acuminatum* (base), *D. heterocostatum, D. undulosum* (base), *Dinopterygium cladoides, Hystrichosphaeropsis ovum, Polysphaeridium laminaspinosum, Rugubivesiculites reductus, Senoniasphaera protrusa, Silicisphaera ferox, Stephodinium coronatum, Surculosphaeridium longifurcatum.*

8660-8890': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Areoligera sp. A Bujak and Williams, 1978, *Cyclonephelium vannophorum.*

8950-9422': *Spinidinium* cf. *S. vestitum-Eucommiidites minor* Zone (Albian)

Appendicisporites jansonii, A. problematicus, Cicatricosisporites augustus, C. hallei, Classopollis classoides, Cleistosphaeridium polypes, C. polypes subsp. A Williams, 1975, *Cribroperidinium intricatum, C. orthoceras, Eucommiidites minor, Oligosphaeridium albertense, Subtilisphaera pontis-mariae, Trilobosporites apiverrucatus, Vitreisporites pallidus.*

9460-9759': *Subtilisphaera perlucida-Systematophora schindewolfii* Zone (Aptian)

Appendicisporites unicus, Aptea attadalica, A. cf. *A. attadalica, sensu* Williams, 1975, *Callialasporites trilobatus, Canningia colliveri, Contignisporites*

cooksonii, *Doidyx anaphrissa* (at 9759ft), *Kleithriasphaeridium eoinodes*, *Palaeoperidinium cretaceum*, *Pareodinia ceratophora* (at 9759ft), *Pilosisporites trichopapillosus* (at 9759ft), *Subtilisphaera perlucida*, *S.* cf. *S. perlucida*, *sensu* Bujak and Williams, 1978.

9850-10700': *Doidyx anaphrissa* Zone (Barremian)

Cerebropollenites mesozoicus, *Concavissimisporites punctatus*, *Ctenidodinium* sp., *Dingodinium cerviculum*, *Pareodinia* sp., *Muderongia simplex* (common), *M. tomaszowensis*, *Pareodinia ceratophora* (with kalyptra), *Polystephanephorus sarjeantii*, *Pseudoceratium dettmanniae*, *P. pelliferum*, *Subtilisphaera perlucida* (common).

10760-12090': *Ctenidodinium elegantulum* Zone (Hauterivian)

Appendicisporites bifurcatus (base), *A. problematicus* (base), *Batioladinium jaegeri*, *B.* sp. A Bujak and Williams, 1978, *Cyclonephelium vannophorum* (base), *Gonyaulacysta serrata*, *Lanterna sportula*.

12160-15425': *Phoberocysta neocomica* Zone (Berriasian-Valanginian)

Achomosphaera neptuni, *Aequitriradites spinulosus*, *Appendicisporites potomacensis* (base at 12 216ft), *Biorbifera johnewingii*, *Cribroperidinium sepimentum*, *Endosporites jurassicus* (12 760-12 790ft), *Gonyaulacysta cladophora* (13 460-13 490ft), *Occisucysta* sp. A Bujak and Williams, 1978, *Oligosphaeridium anthophorum* (base at 12 216ft), *Phoberocysta neocomica*, *P.* sp. Bujak and Williams, 1978, *Prolixosphaeridium* sp., *Pseudoceratium nudum*, *Senoniasphaera jurassica*, *Spiniferites dentatus*, *Systematophora orbifera*.

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Amoco-Imp-Skelly
SANDPIPER 2-J-77

GSC locality: D109

Location: 45°36'39.31"N; 51°41'00.55"W

RT elevation: 98' Water depth: 297'

Casing set at: 429, 909, 2591, and 8954'

Total depth: 11566' Interval studied: 920-11560'

Analyzed by: M.S. Barss and J.P. Bujak

Palynological analysis of 53 sidewall core and 98 cuttings samples indicates the following age determinations and biostratigraphic zonation:

920- 1040'	probable Eocene
1100- 1130'	early Campanian
1190- 1760'	*C. truncigerum* Zone (Santonian)
1820- 1850'	*O. pulcherrimum* Zone (Coniacian)
1910- 2480'	*S. longifurcatum* Zone (Turonian)
2540- 2750'	*C. polypes* Zone (Cenomanian)
2815- 2840'	*D. anaphrissa* Zone (Barremian)
2848- 3094'	Pliensbachian
3129- 4000'	*E.* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)
4060- 8210'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)
7550- 8210'	Hettangian
8215- 8900'	*C. meyeriana* Zone (Rhaetian-early Hettangian)
8923- 9810'	possible Norian
9940-10470'	middle-late Viséan
10470-10660'	no samples
10660-11560'	*V. vallatus-P. pretiosus* Zone (late Tournaisian)

Sandpiper 2-J-77 bottomed in Tournaisian age sediments.

The assemblage recorded from 11 560 to 10 660ft compares closely with the *Vallatisporites vallatus-Pustulatisporites pretiosus* zone of Barss (in Hacquebard, 1972), from the Horton Group type section, which Howie and Barss (1975) consider to be late Tournaisian.

The assemblage occurring from 10 470 to 9940ft compares with assemblages recovered for rocks of the Windsor Group that have been dated as middle-late Viséan.

Both assemblages are composite assemblages, i.e., all of the types listed do not occur in all of the samples examined.

Between 9810 and 2848ft there is an Upper Triassic (?Norian-Rhaetian) to Pliensbachian succession. Spores predominate with species of *Classopollis* being dominant between 8900 and 2848ft. This pollen genus probably occupied upland slopes and lowlands near the coast and preferred well-drained soils and a warm climate (Srivastava, 1976). The oldest dinoflagellates reported from eastern Canada (*Cleistosphaeridium mojsisovicsii*) occur in this well in the sidewall core from 8215ft in Rhaetian strata and in cuttings samples between 7550 and 8010ft (*Dapcodinium priscum*), and indicate marine influence.

A thin sequence of Barremian strata (2840-2815ft), which is devoid of marine palynomorphs, overlies the Lower Jurassic beds. These strata are overlain by an Upper Cretaceous (Cenomanian to lower Campanian) succession from 2750 to 1100ft which contains mostly marine palynomorphs. The highest samples examined from the well, between 1040 and 920ft, contain rare palynomorphs including Eocene taxa and reworked Upper Cretaceous species.

Selected palynomorphs

920-1040': probable Eocene

Carpinus sp., *Operculodinium centrocarpum*, *Spiniferites ramosus*.

Palynomorphs are rare in this interval and a more detailed age determination is not possible using the species present. However, a small, undescribed dinoflagellate species present occurs in the Eocene of southern England (pers. obs.). The Late Cretaceous species *Spinidinium styloniferum* and *Spinidinium sverdrupianum* also occur.

1100-1130': early Campanian

Dinogymnium digitus, *D. euclaensis*, *Hystrichodinium pulchrum*, *Palaeohystrichophora infusorioides*, *Spinidinium styloniferum*.

Also present are reworked specimens of the species *Classopollis classoides*.

1190-1760': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella tripartita, *C. victoriensis*, *Cyclonephelium distinctum*, *Exochosphaeridium bifidum*, *Gonyaulacysta* cf. *G. obscura*, *Isabelidinium cooksoniae*, *Odontochitina costata*, *Oligosphaeridium complex*, *Epicephalopyxis indentata*, *Rugubivesiculites reductus*, *Senoniasphaera protrusa*, *S. rotundata*, *Surculosphaeridium longifurcatum* (rare), *Trichodinium castaneum*, *Xenascus ceratioides*.

1820-1850': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Hystrichosphaeridium stellatum, sensu Clarke and Verdier, 1967, *Surculosphaeridium longifurcatum* (common).

1910-2480': *Surculosphaeridium longifurcatum* Zone (Turonian)

Areoligera sp., *Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Chlamydophorella nyei, Cordosphaeridium truncigerum, Coronifera oceanica, Hystrichosphaeridium cooksoniae, H. difficile, H. paracostatum, Odontochitina operculata, Palaeoperidinium cretaceum, Palaeostomocystis fragilis, Rugubivesiculites rugosus, Stephodinium coronatum.*

The dinoflagellates *Cordosphaeridium truncigerum, Hystrichosphaeridium difficile,* and *H. paracostatum* may be caved in this interval. Also noted were probable reworked specimens of the species *Appendicisporites problematicus, Cerebropollenites mesozoicus, Spinidinium vestitum,* and *Subtilisphaera pirnaensis.*

2540-2750': *Cleistosphaeridium polypes* Zone (Cenomanian)

Appendicisporites problematicus, Cicatricosisporites spp., *Costatoperforosporites foveolatus, Cyclonephelium vannophorum, Endoscrinium campanulum, Oligosphaeridium pulcherrimum, Spinidinium vestitum.*

Also present is a reworked specimen of the species *Cicatricosisporites australiensis.*

2815-2840': *Doidyx anaphrissa* Zone (Barremian)

Aequitriradites spinulosus, Cicatricosisporites australiensis, C. hughesi, Concavissimisporites punctatus, Cyathidites australis, Klukisporites pseudoreticulatus, Trilobosporites apiverrucatus.

2848-3094': Pliensbachian

Classopollis classoides (abundant), *C. itunensis, Cycadopites deterius, C. nitidus, Micrhystridium fragile, Tasmanites* sp.

The presence of *Aquilapollenites* in the sidewall core at 2848ft indicates drilling mud contamination.

3129-4000': *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Kraeuselisporites reissingeri.

Assemblages from this interval are dominated by *Classopollis classoides* and *C. itunensis.*

4060-8210': *Cycadopites subgranulosus* Zone (Hettangian-early Sinemurian)

Araucariacites punctatus, Classopollis meyeriana, Convolutispora klukiforma, Cycadopites subgranulosus (7207ft), *Porcellispora longdonensis.*

7550-8210': Hettangian

Dapcodinium priscum.

The occurrence of *D. priscum* between 7550 and 8010ft indicates marine influence.

8215-8900': *Classopollis meyeriana* Zone (Rhaetian-early Hettangian)

C. meyeriana (common), *Cleistosphaeridium mojsisovicsii.*

Classopollis classoides occurs in the sidewall core at 8900ft indicating an age no older than Rhaetian.

8923-9810': possible Norian

Cingulizonates rhaeticus, Duplicisporites granulatus, Enzonalasporites manifestus, Ovalipollis minimus, O. ovalis, Paracirculina quadruplicis, P. scurrilis, Patinasporites densus, Praecirculina granifer.

9940-10470': middle-late Viséan

Calamospora sp., *Convolutispora* cf. *C. vermiformis, Cyclogranisporites* sp., *Densosporites variomarginatus, Discernisporites micromanifestus, D.* sp. Barss, 1967 pl. VI, fig. 9, *Endosporites* sp., *Grandispora* sp., *Knoxisporites stephanephorus, K. triradiatus, Punctatisporites planus, Retusotriletes* cf. *R. avonensis, R. incohatus, Rugospora* sp., *Spelaeotriletes* sp., *Stenozonotriletes* sp., *Vallatisporites ciliaris, V.* cf. *V. vallatus, V. verrucosus* (one specimen), *Velamisporites perinatus, Verrucosisporites nitidus* (one specimen).

10470-10660': no samples

10660-11560': *Vallatisporites vallatus-Pustulatisporites pretiosus* Zone (late Tournaisian)

Spores with an x are very possibly caved specimens.

Acanthotriletes hacquebardii, Anapiculatisporites ampullaceus, Apiculatisporis spp., *Camptotriletes verrucosus, Convolutispora* cf. *C. finis, C. flexuosa* forma *minor, C. vermiformis, Cristatisporites aculeatus, C. echinatus, Cyclogranisporites commodus, Densosporites* sp., *Dictyotriletes* cf. *D. sagenoformis, D. submarginatus, Grandispora conspicua, G. echinata, G. tenuispinosa, G. uncata, Gulisporites torpidus, Knoxisporites literatus, Leiozonotriletes insignitus, Orbisporis convolutus, Punctatisporites irrasus, P. limbatus,* x*Proprisporites undosus, Pustulatisporites gibberosus, P. pretiosus, Raistrickia abstrusa, R. baculosa, R. clavata, R. ponderosa,* xcf. *Remysporites* sp., *Reticulatisporites* sp., *Retusotriletes avonensis, R. incohatus,* x*Schopfites claviger, S. augustus,* x*Velam sporites magnus, V. perinatus, Vallatisporites torulosa, V. vallatus, V. verrucosus, Verrucosisporites congestus, V. nitidus, V. papulosus.*

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Amoco-Imp-Skelly
SKUA E-41

GSC locality: D132

Location: 45°20'23.23"N; 48°52'26.26"W

RT elevation: 98' Water depth: 272'

Casing set at: 539, 910, 2752, and 8004'

Total depth: 10626' Interval studied: 970-10595'

Analyzed by: J.P. Bujak

Palynological analysis of 99 cuttings samples and 64 sidewall core samples indicates the following age determinations and biostratigraphic zonation:

970- 1090'	Miocene or younger
1150- 1270'	*P. laticinctum* Zone (middle Miocene)
1390- 1510'	*Apteodinium* sp. B Zone (early Miocene)
1570- 1810'	*C. dispersum* Zone (middle-late Oligocene)
1930- 2200'	*D. heterophlycta* Zone (early Oligocene)

2260- 2650' late Eocene-early Oligocene
2705- 2975' *D. colligerum* Zone (late Eocene)
2980- 3190' *A. reticulense* Zone (middle Eocene)
3250- 3460' *A. senonensis* Zone (early Eocene)
3520- 3730' *P. pyrophorum-C. diebelii* Zone (early Paleocene)
3800- 4180' *O. operculata* Zone (Campanian)
4150- 4180' *T. castaneum* subzone (early Campanian)
4240- 4270' *C. truncigerum* Zone (Santonian)
4312' Albian/Santonian
4330- 4450' age indeterminate
4455- 4810' Neocomian (Hauterivian or older)
5050- 5130' *C. panneum* Zone (Portlandian)
5200- 6150' *G. cladophora* Zone (Kimmeridgian)
6200- 7230' *G. jurassica* Zone (Oxfordian-early Kimmeridgian)
7300- 7630' Callovian-Oxfordian
7700- 9240' Bajocian-Bathonian
9370-10595' *N. gracilis* Zone (late Pleinsbachian-Toarcian/Aalenian)

The oldest rocks dated palynologically in the well contain the dinoflagellate *Nannoceratopsis gracilis*, indicating a Toarcian/Aalenian or a late Pliensbachian age and some marine influence. These are overlain by a tentatively dated sequence of Bajocian to Oxfordian rocks (9240-7300ft) which contain marine palynomorphs. The succeeding interval 7230-5200ft contains sporadic but persistent individuals of *Gonyaulacysta jurassica* which, unless reworked, indicate an early Kimmeridgian or older age. The sidewall core sample from 5050ft contains an assemblage that is no younger than Portlandian.

Neocomian strata (Hauterivian or older) between 4810 and 4455ft are devoid of marine palynomorphs and are overlain by Albian at 4312ft and Upper Cretaceous strata from 4270 to 3800ft, probably comprising Santonian-Campanian strata only. These are overlain by lower Paleocene strata (3730-3520ft). Upper Paleocene strata were not seen, but all Scotian Shelf-Grand Banks palynomorph zones were noted from early Eocene to middle Miocene (3460-1150ft). The highest samples examined from the well (1090-970ft) contain a Miocene or younger assemblage.

The Upper Cretaceous-Tertiary succession contains mostly dinoflagellates, indicating marine deposition.

Reworking is common in the Tertiary section and includes Triassic, Jurassic and Cretaceous palynomorphs.

Selected palynomorphs

970-1090': Miocene or younger

Spiniferites ramosus, Tectatodinium pellitum, Thalassiphora delicata.

1150-1270': *Pentadinium laticinctum* Zone (middle Miocene)

Tanyosphaeridium sp. A Williams and Brideaux, 1975.

Also present are reworked specimens of the Cretaceous dinocyst species *Cyclonephelium distinctum* and *Oligosphaeridium pulcherrimum.*

1390-1510': *Apteodinium* sp. B Zone (early Miocene)

Cordosphaeridium cantharellum, Hystrichosphaeropsis obscura, Lingulodinium machaerophorum, Spiniferites pseudofurcatus, Systematophora ancyrea, Tuberculodinium vancampoae.

Also present are reworked specimens of the Mesozoic species *Classopollis classoides, Muderongia simplex,* and *Trilobosporites apiverrucatus.*

1570-1810': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Areosphaeridium multicornutum (large form), *Chiropteridium dispersum, Hystrichokolpoma rigaudiae.*

Also present are reworked specimens of the Mesozoic spores *Classopollis classoides* and *Converrucosisporites exquisitus.*

1930-2200': *Deflandrea heterophlycta* Zone (early Oligocene)

Chiropteridium aspinatum, C. dispersum, Deflandrea heterophlycta, D. phosphoritica, Gonyaulacysta giuseppei, Homotryblium tenuispinosum, Kisselovia coleothrypta, K. tenuivirgula, Pentadinium laticinctum, P. laticinctum subsp. *granulatum, Phthanoperidinium comatum, Systematophora placacantha, Wetzeliella articulata.*

Also present are reworked specimens of the species *Classopollis classoides.*

2260-2650': late Eocene-early Oligocene

Areoligera undulata, Areosphaeridium multicornutum, Cordosphaeridium funiculatum, C. gracile, Cyclonephelium exuberans subsp. *ellipsoidale, Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Heteraulacacysta leptalea, Homotryblium plectilum, Impletosphaeridium kroemmelbeinii.*

Also present are reworked specimens of the Triassic genus *Lunatisporites,* the Jurassic to Early Cretaceous species *Cicatricosisporites australiensis, C. hughesi, Classopollis classoides, Densoisporites velatus, Pareodinia ceratophora,* and the Cretaceous species *Chatangiella tripartita, Cyclonephelium distinctum, Isabelidinium cooksoniae,* and *Spinidinium vestitum.*

2705-2975': *Diphyes colligerum* Zone (late Eocene)

Areosphaeridium diktyoplokus, Cyclonephelium intricatum, C. textum, Deflandrea wetzelii, Distatodinium paradoxum, Hystrichokolpoma salacium, Hystrichosphaeridium pseudorecurvatum, Palaeocystodinium golzowense, Phthanoperidinium alectrolophum, Samlandia chlamydophora, Spiniferites monilis, Thalassiphora pelagica, Wetzeliella sp. A Williams and Bujak, 1977b.

2980-3190': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Achilleodinium biformoides, Adnatosphaeridium multispinosum (abundant at 3150ft), *A. vittatum, Apectodinium homomorphum, Areoligera medusettiformis, A.* cf. *A. senonensis, Cordosphaeridium inodes* (common), *Cyclonephelium retiintextum, Diphyes colligerum, Eisenackia ornata, Hystrichokolpoma eisenackii, Membranilarnacia ursulae, Turbiosphaera* cf. *T. filosa, Wetzeliella* spp.

3250-3460': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum (abundant), *Areoligera* cf. *A. senonensis* (abundant), *Cyclonephelium exuberans, C. ordinatum, Deflandrea dartmooria, Palaeocystodinium* cf. *P. australinum* (rare, poorly preserved, may be reworked).

Also present is a reworked specimen of the Jurassic-Early Cretaceous species *Pareodinia ceratophora.*

3520-3730': *Palaeoperidinium pyrophorum-Ceratiopsis diebelii* Zone (early Paleocene)

Ceratiopsis speciosa, Inversidinium exilimurum, Oligosphaeridium complex, Palaeocystodinium australinum, Palaeoperidinium pyrophorum, Spiniferites ramosus (large form).

3800-4180': *Odontochitina operculata* Zone (Campanian)

Ceratiopsis diebelii, Cyclonephelium distinctum, Hystrichodinium pulchrum, Isabelidinium belfastense, I. cooksoniae, Membranilarnacia sp. Wilson, 1971, *Odontochitina operculata* (common).

4150-4180': *Trichodinium castaneum* subzone (early Campanian)

Chlamydophorella nyei, Hystrichosphaeridium tubiferum, Palaeohystrichophora infusorioides, Trichodinium castaneum, Xenascus ceratioides.

4240-4270': *Cordosphaeridium truncigerum* Zone (Santonian)

Hystrichosphaeridium paracostatum, Odontochitina costata.

4312': Albian/Santonian

Albian assemblage: *Cicatricosisporites hallei, Costatoperforosporites foveolatus, Hystrichosphaeridium arundum, Litosphaeridium conispinum, L. siphoniphorum.* Santonian assemblage: *Hystrichosphaeridium difficile, Spinidinium styloniferum.*

4330-4450': age indeterminate

Cuttings samples with Late Cretaceous palynomorphs, probably caved.

4455-4810': Neocomian (Hauterivian or older)

Biretisporites potoniae, Callialasporites dampieri, Classopollis classoides, Contignisporites cooksonii, Ctenidodinium elegantulum, Densoisporites velatus, Klukisporites foveolatus, Trilobosporites apiverrucatus. Also present is a reworked specimen of the Jurassic species *Ctenidodinium ornatum.*

5050-5130': *Ctenidodinium panneum* Zone (Portlandian)

Ctenidodinium culmulum, C. panneum, Verrucosisporites spp. (frequent).

5200-6150': *Gonyaulacysta cladophora* Zone (Kimmeridgian)

Epiplosphaera bireticulata, Gen. et sp. 2, Gocht, 1970, *Gonyaulacysta cladophora, Lithodinia jurassica, Pareodinia ceratophora* (with kalyptra), *Scriniodinium crystallinum, Systematophora orbifera.*

Also present at 5200-5230ft and 5800-5830ft are probably reworked specimens of the species *Gonyaulacysta jurassica.*

6200-7230': *Gonyaulacysta jurassica* Zone (Oxfordian-early Kimmeridgian)

Ctenidodinium pachydermum, Gonyaulacysta granulata, G. jurassica, Leptodinium egemenii.

7300-7630': Callovian-Oxfordian

Compositosphaeridium costatum, Ctenidodinium ornatum, Endoscrinium eisenackii, Gonyaulacysta jurassica (common, base at 7600-7630ft), *Tenua* sp.

7700-9240': Bajocian-Bathonian

Callialasporites (abundant), *Ctenidodinium ornatum* (base at 8725ft), *Lithodinia jurassica* (base at 8725ft), *Tenua* sp. (base at 9240ft).

A probable reworked specimen of the species *Nannoceratopsis gracilis* occurs at 8680ft.

9370-10595': *Nannoceratopsis gracilis* Zone (late Pliensbachian-Toarcian/Aalenian)

Kraeuselisporites reissingeri, Nannoceratopsis gracilis (common).

The occurrence of the Sinemurian and older spore *Porcellispora longdonensis* at 10 540 and 10 595ft is attributed to reworking.

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Amoco-Imp-Skelly
SPOONBILL C-30

GSC locality: D111

Location: 45°49'06.47"N; 49°04'06.18"W

RT Elevation: 98' Water depth: 214'

Casing set at: 479, 830, 2800, and 8407'

Total depth: 9046' Interval studied: 940-9040'

Analyzed by: J.P. Bujak

Palynological analysis of 48 cuttings samples and 72 sidewall core samples indicates the following age determinations and biostratigraphic zonation:

940- 1090'	*D. heterophlycta* Zone (early Oligocene)
1420- 1450'	*A. reticulense* Zone (middle Eocene)
1510- 1780'	Paleocene
2020- 2050'	age indeterminate
2680- 2710'	Campanian or older
2850- 2920'	early Campanian or older
2940- 2971'	Cenomanian
3022- 3344'	*E.* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)
3390- 4402'	*C. subgranulosus* Zone (late Hettangian-early Sinemurian)
4460- 5160'	*C. meyeriana* Zone (Rhaetian-early Hettangian)
5210- 7951'	age indeterminate
7970- 8400'	Carnian-Norian
8405- 8756'	age indeterminate (presumed Carnian-Norian)
8770- 8800'	Carnian-Norian
8800- 9040'	age indeterminate

The lowest interval in the well (9049-8000ft) could not be dated as the samples are devoid of *in situ* palynomorphs. This is overlain by Carnian-Norian to late Sinemurian-early Pliensbachian strata from 8800 to 3022ft. Marine palynomorphs are absent from the Upper Triassic to Lower Jurassic succession and spore assemblages in the Rhaetian to Pliensbachian (5160-3022ft) are dominated by the genus *Classopollis,* a pollen that probably occupied upland slopes and lowlands near the coast and preferred well-drained soils and a warm climate (Srivastava, 1976).

The Avalon Unconformity at 2990ft (J. Wade, pers. comm.) separates Pliensbachian strata from Cenomanian sediments. The latter contain common dinoflagellate cysts indicating marine deposition. From 2920 to 940ft many of the Late Cretaceous to Oligocene palynological zones could not be recognized because of the poor recovery of fossils from the samples available. Campanian or older strata occur from 2920 to 2680ft and contain few palynomorphs, those present being mostly marine. The interval 2050-2020ft is devoid of *in situ* palynomorphs and is overlain by a Paleocene to lower

Oligocene succession from 1780 to 940ft containing diverse dinoflagellate assemblages indicating neritic depositional environments. Lower and Upper Eocene strata were not recognized, but may be present as condensed sections between sampled intervals.

Reworked Cretaceous palynomorphs were noted in the middle Eocene and lower Oligocene intervals.

Selected palynomorphs

940-1090': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum, A. arcuatum (large form), *A. multicornutum, Bombacacidites* sp. A Williams and Brideaux, 1975, *Chiropteridium aspinatum, Cordosphaeridium funiculatum, Cyclonephelium* sp. A Williams and Brideaux, 1975, *Deflandrea heterophlycta, D. phosphoritica, D. spinulosa, Eocladopyxis peniculatum, Gonyaulacysta giuseppei, Heteraulacacysta campanula, Homotryblium floripes, Hystrichokolpoma rigaudiae, Kisselovia coleothrypta, Lingulodinium machaerophorum, Operculodinium centrocarpum, Palaeocystodinium golzowense, Pentadinium laticinctum, Sumatradinium* sp., *Spiniferites pseudofurcatus, S. ramosus, Thalassiphora pelagica.*

Also present are reworked specimens of the species *Cicatricosisporites hallei* and *Rugubivesiculites rugosus.*

1420-1450': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium multispinosum, Areoligera cf. *A. senonensis, sensu* Gocht, 1969 (rare), *Areosphaeridium diktyoplokus, Cordosphaeridium gracile, C. inodes, Cyclonephelium* sp. C Williams and Brideaux, 1975, *Dracodinium* sp., *Homotryblium tenuispinosum, Phthanoperidinium comatum, Polysphaeridium simplex, P. subtile, Systematophora placacantha, Wetzeliella articulata.*

Also present at 1420-1450ft is a reworked specimen of the Cretaceous dinoflagellate *Spinidinium vestitum.*

There is no evidence of upper Eocene strata in the cuttings sample from this interval, but upper Eocene sediments may be present between 1090 and 1420ft.

1510-1780': Paleocene

Areoligera senonensis, sensu Gocht, 1969 (frequent), *Ceratiopsis* sp., *Deflandrea denticulata, Lejeunia magnifica* (rare), *Palaeocystodinium australinum, Trithyrodinium* sp.

There is no evidence of lower Eocene strata in the well.

2020-2050': age indeterminate

The sample from this interval contains only Paleogene species which are presumed to be caved on lithostratigraphic evidence.

2680-2710': Campanian or older

Xenascus ceratioides.

The sample at 2680-2710ft mostly includes Paleogene species that are presumed to be caved. The occurrence of *Xenascus ceratioides* indicates an age no younger than Campanian.

2850-2920': early Campanian or older

Exochosphaeridium bifidum, Palaeohystrichophora infusorioides (common), *Trichodinium castaneum.*

2940-2971': Cenomanian

Coronifera sp., *Cyclonephelium distinctum, Florentinia mantellii, Hystrichodinium pulchrum, Hystrichosphaeridium cooksoniae, Litosphaeridium siphoniphorum, Odontochitina costata, O. operculata, Oligosphaeridium complex, Surculosphaeridium longifurcatum.*

3022-3344': *Echinitosporites* cf. *E. iliacoides* Zone (late Sinemurian-early Pliensbachian)

Classopollis classoides, C. itunensis (frequent), *C. meyeriana* (common), *Cycadopites deterius, C. nitidus, Echinitosporites* sp. A Bujak and Williams, 1977, *Kraeuselisporites reissingeri, Porcellispora longdonensis.*

Assemblages from this interval are dominated mostly by the genus *Classopollis* with striate species predominating. Palynomorphs are well preserved and colourless to pale yellow.

3390-4402': *Cycadopites subgranulosus* Zone (late Hettangian-early Sinemurian)

Araucariacites punctatus, C. classoides (abundant), *C. itunensis* (frequent), *C. meyeriana* (common), *Cycadopites jansonii, C. subgranulosus, Kraeuselisporites reissingeri* (common at 4095ft).

Assemblages are similar to those in the overlying interval, being dominated by striate species of *Classopollis.* Palynomorphs are well preserved and colourless to pale yellow.

4460-5160': *Classopollis meyeriana* Zone (Rhaetian-early Hettangian)

C. meyeriana (abundant).

Assemblages are dominated by non-striate species of *Classopollis,* with striate species being generally less common. Palynomorphs have fair to good preservation and are colourless to pale yellow.

5210-7951': age indeterminate

The ten cuttings samples and 25 sidewall core samples examined from this salt interval do not appear to contain *in situ* palynomorphs. Rare specimens of *Classopollis* in cuttings samples are probably caved. Some sidewall core samples contain fungal spores and resinous organic material. These are considered to represent contamination, probably from the drilling mud.

7970-8400': Carnian-Norian

Camerosporites pseudoverrucatus (common at 8265ft), *C.* cf. *C. secatus, Ellipsovelatisporites* sp., *Paracirculina quadruplicis, Patinasporites densus, Porcellispora longdonensis, Protodiploxypinus* sp., *Triadispora* cf. *T. triradiata, Vallasporites* sp., *Enzonalasporites* sp.

Other than non-trilete disaccate pollen (*?Alisporites*), the species listed above are rare. Preservation of palynomorphs is fair with a generally brown to dark brown colour. Minor amounts of cavings were noted in the cuttings samples. Contaminants (fungal spores and resinous bodies) are present in several sidewall core samples.

In situ palynomorphs recorded from this interval are similar to Lower Keuper elements described by Scheuring (1970) from the Southern Jura. An undifferentiated Carnian-Norian age is proposed for the interval.

8405-8756': age indeterminate
(presumed Carnian-Norian)

In situ palynomorphs were not recorded from the single cuttings sample and 15 sidewall core samples examined from this interval. Several sidewall core samples (8550, 8592, and 8688ft) include mud contaminants as indicated by their colourless to yellow nature and occurrence of *Aquilapollenites* and *Betulaepollenites*.

8770-8800': Carnian-Norian

Disaccates (possibly *Alisporites*), *Vallasporites ignacii*.

8800-9040': age indeterminate

In situ palynomorphs were not recorded from the six samples examined from this interval. The presence of *Aquilapollenites* in the sidewall cores at 8919 and 8985ft indicates mud contamination.

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Pan Am-IOE
TORS COVE D-52

GSC locality: D25

Location: 44°11'14"N; 52°23'42"W

RT elevation: 31' Water depth: 293'

Casing set at: 378, 723, and 2115'

Total depth: 4834' Interval studied: 930-4812'

Analyzed by: G.L. Williams

Palynological analysis of 64 sidewall core and 108 cuttings samples from the subject well indicates the following age determinations and stratigraphic zonation:

930- 1400'	*Cannosphaeropsis* sp. A Zone (late Miocene)
1470- 2130'	*P. laticinctum* Zone (middle Miocene)
2183- 2860'	*Apteodinium* sp. B Zone (early Miocene)
2913'	*C. dispersum* Zone (middle-late Oligocene)
2960- 3090'	*D. heterophlycta* Zone (early Oligocene)
3105- 3360'	*D. colligerum* Zone (late Eocene)
3403'	Early Jurassic
3450- 3520'	late Eocene
3522- 3660'	*A. reticulense* Zone (middle Eocene)
3710'	*C. truncigerum* Zone (Santonian)
3720'	*A. senonensis* Zone (early Eocene)
3750- 3810'	*C. truncigerum* Zone (Santonian)
3840- 4210'	Pliensbachian-Toarcian
4285- 4812'	Rhaetian?-Sinemurian

Pan Am-IOE Tors Cove D-52 bottomed in salt which is herein dated Rhaetian?-Sinemurian. From 4210 to ?3810ft is a sequence of rocks which can be correlated with sediments of Pliensbachian-Toarcian age elsewhere on the Grand Banks.

This sequence is overlain by approximately 60ft (3810-3750ft) of Santonian sediments. There is thus a significant hiatus representing the Middle and Late Jurassic, the Early Cretaceous, and part of the Late Cretaceous (Cenomanian-Coniacian). The sample at 3720ft is dated early Eocene, indicating another hiatus in the well. There is some uncertainty regarding the sidewall cores since the sidewall at 3710ft contains a rich Santonian assemblage which in turn is overlain by middle Eocene sediments from 3660 to 3522ft. Possibly the tectonics associated with the salt intrusion have resulted in mixing of the overlying sediments. This might also explain the anomalous occurrence of the Early Jurassic assemblage in SWC 3403ft.

Subdivision of the Tertiary is difficult due to the high degree of reworking of both Upper Cretaceous and older Tertiary sediments. However reliance on high abundances only, permits a tentative subdivision of the Eocene, Oligocene and Miocene sediments. The Eocene contains several reworked specimens of Carboniferous spores and acritarchs. The Oligocene, as elsewhere on the Grand Banks, is a reduced sequence extending from 3090 to 2913ft only.

Paleoenvironmental data are obtained from sidewall cores. Marine palynomorphs are absent below 3980ft, indicating in part non-marine deposition. The presence of *Tasmanites* from 3980 to 3840ft may indicate shallow water marine deposition. The Santonian, taken here to extend from 3810 to 3750ft, is neritic with rich dinocyst assemblages. A marine environment prevailed throughout the Tertiary with dinocysts being abundant. Spores and pollen are most common in the Miocene, possibly denoting a shallower environment for this Epoch.

Selected palynomorphs

930-1400': *Cannosphaeropsis* sp. A Zone (late Miocene)

Ambrosia sp., *Artemisia* sp., *Caryapollenites simplex, Epicephalopyxis indentata, Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Liquidamberpollenites* sp., *Nyssapollenites* sp., *Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, *Pinus* spp., *Podocarpidites* sp., *Pterocaryapollenites* sp., *Pterodinium circumsutum, Spiniferites scabratus, Systematophora ancyrea, Taraxacum* sp., *Triorites* sp., *Tsugaepollenites igniculus*.

Reworked species include *Apectodinium homomorphum, Cerebropollenites mesozoicus, Chatangiella victoriensis,* and *Palaeoperidinium pyrophorum*.

1470-2130': *Pentadinium laticinctum* Zone
(middle Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Canningia* sp., *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, *Cyclopsiella elliptica, Hystrichosphaeridium choanophorum, Hystrichosphaeropsis obscura, Nematosphaeropsis balcombiana, Palaeocystodinium golzowense, Spiniferites mirabilis, Tuberculodinium vancampoae*.

Reworked species include *Apectodinium homomorphum, Cannosphaeropsis utinensis, Chatangiella vnigri, Dinogymnium heterocostatum, Gardodinium deflandrei, Phthanoperidinium comatum, Pistillipollenites mcgregorii, Rugubivesiculites rugosus, Tasmanites* sp., and *Veryhachium trispinosum*.

2183-2860': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. Gocht, 1969, *A.* sp. B Williams and Brideaux, 1975, *Cordosphaeridium minimum, C. multispinosum, Cyclopsiella vieta, Homotryblium plectilum, Impletosphaeridium transfodum, Leptodinium patulum, Pentadinium laticinctum, Polysphaeridium pastielsii, Spiniferites pseudofurcatus*.

Reworked species include *Chatangiella vnigri, Cordosphaeridium funiculatum, C. gracile,* and *Deflandrea spinulosa*.

2913': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, Cordosphaeridium cantharellum, Deflandrea spinulosa.

2960-3090': *Deflandrea heterophlycta* Zone (early Oligocene)

Cordosphaeridium funiculatum, Deflandrea phosphoritica, Gonyaulacysta giuseppei, Kisselovia cf. *K. coleothrypta, K. reticulata.*

Reworked species include *Appendicisporites problematicus, Deflandrea hialina, Dinopterygium* sp. A Williams and Bujak, 1977a.

3105-3360': *Diphyes colligerum* Zone (late Eocene)

Achomosphaera alcicornu, Areosphaeridium arcuatum, A. multicornutum, Cordosphaeridium fibrospinosum, Cyclonephelium sp. A Williams and Brideaux, 1975, *C.* sp. B Williams and Brideaux, 1975, *Deflandrea eocenica, D. heterophlycta, D.* sp. C Williams and Bujak, 1977b, *Dinopterygium* sp. A Williams and Bujak, 1977a., *Eocladopyxis peniculatum, Kisselovia tenuivirgula, Pentadinium taeniagerum, Sapotaceapollenites* sp., *Tectatodinium pellitum, Thalassiphora pelagica.*

Reworked species include *Triquitrites* sp. and *Veryhachium trispinosum.*

3403': Early Jurassic

Classopollis classoides.

3450-3520': *Diphyes colligerum* Zone (late Eocene)

Phthanoperidinium echinatum.

3522-3660': *Adnatosphaeridium reticulense* Zone (middle Eocene)

Adnatosphaeridium multispinosum, ?A. patulum, Anacolosidites sp., *Areosphaeridium diktyoplokus, Deflandrea hialina, Leptodinium incompositum, Phthanoperidinium amoenum, P. comatum, Rhombodinium* cf. *R. condylos, sensu* Williams and Bujak, 1977b, *Spiniferites cingulatus, Trigonopyxidia* sp., *Tubidermodinium sulcatum.*

Reworked species include *Densosporites* sp., *Ovoidinium verrucosum, Tripartites* sp., and *Veryhachium trispinosum.*

3710': *Cordosphaeridium truncigerum* Zone (Santonian)

Cordosphaeridium truncigerum, Dinogymnium westralium, Gardodinium deflandrei, Odontochitina operculata, O. porifera, Palaeohystrichophora infusorioides, Senoniasphaera protrusa, Spinidinium styloniferum, Triblastula utinensis.

3720': *Areoligera senonensis* Zone (early Eocene)

Deflandrea leptodermata, Leptodinium victorianum, Rottnestia borussica.

3750-3810': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis, Chlamydophorella discreta, Dinogymnium euclaensis, Hystrichosphaeridium difficile, Hystrichosphaeropsis ovum, Palaeostomocystis fragilis, Senoniasphaera rotundata, Xenascus ceratioides.

Caved species from higher in the well include *Achilleodinium biformoides, Duosphaeridium rugosum,* and *Hystrichokolpoma cinctum.*

3840-4210': Pliensbachian-Toarcian

Classopollis classoides (abundant), *C.* cf. *C. classoides* (abundant), *Perinopollenites elatoides, Tasmanites* sp.

4285-4812': Rhaetian?-Sinemurian

Classopollis classoides (abundant), *C.* cf. *C. classoides* (abundant), *C. meyeriana, Cycadopites daterius, Porcellispora longdonensis* (at 4531ft). May be Rhaetian below 4531ft.

* * * * *

Amoco-Imp-Skelly
TWILLICK G-49

GSC locality: D122

Location: 44°18'25.60"N; 51°21'32.10"W

RT elevation: 98' Water depth: 244'

Casing set at: 427, 848, and 2783'

Total depth: 4270' Interval studied: 880-4270'

Analyzed by: J.P. Bujak

Palynological analysis of 33 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

880- 910'	*P. laticinctum* Zone (middle Miocene)
970- 1300'	*Apteodinium* sp. B Zone (early Miocene)
1360- 1720'	*C. dispersum* Zone (middle-late Oligocene)
1870- 2080'	*D. heterophlycta* Zone (early Oligocene)
2140- 2620'	middle-late Eocene
2800- 2830'	*A. senonensis* Zone (early Eocene)
2890- 3100'	Paleocene
3160- 3280'	*D. euclaensis* Zone (Maastrichtian)
3310- 3520'	*O. operculata* Zone (Campanian)
3580- 3880'	*C. truncigerum* Zone (Santonian)
3940- 4170'	*O. pulcherrimum* Zone (Coniacian)
4240- 4270'	barren

The interval 4270-4240ft in this well corresponds to igneous basement. Coniacian to Maastrichtian strata occur from 4170 to 3160ft and contain mostly dinoflagellate cysts indicating marine deposition. This sequence is overlain by a Paleocene to middle Miocene succession often containing diverse dinoflagellate assemblages indicating marine, probably neritic, deposition.

Reworked palynomorphs are rare in the well, but include some specimens of Late Cretaceous-early Paleocene species in the Eocene and Late Jurassic-Early Cretaceous species in the Santonian and Campanian.

Selected palynomorphs

880-910': *Pentadinium laticinctum* Zone (middle Miocene)

Hystrichokolpoma rigaudiae, Operculodinium centrocarpum, Spiniferites pseudofurcatus, Systematophora ancyrea, Tectatodinium pellitum, Tsugaepollenites sp.

970-1300': *Apteodinium* sp. B Zone (early Miocene)

Apteodinium sp. B Williams and Brideaux, 1975, *A.* sp. Gocht, 1969, *Distatodinium paradoxum, Hystrichosphaeropsis obscura, Lingulodinium machaerophorum, Pentadinium laticinctum, Tanyosphaeridium* sp. A Williams and Brideaux, 1975.

1360-1720': *Chiropteridium dispersum* Zone (middle-late Oligocene)

Chiropteridium dispersum, C. lobospinosum, Deflandrea phosphoritica, Homotryblium plectilum, Palaeocystodinium golzowense.

1870-2080': *Deflandrea heterophlycta* Zone (early Oligocene)

Areosphaeridium arcuatum (large form), *Chiropteridium aspinatum, Cordosphaeridium cantharellum, Cyclonephelium intricatum, Deflandrea heterophlycta, D. spinulosa, Dinopterygium cladoides, sensu* Morgenroth, 1966a, *Lejeunia fallax, L. hyalina, Pentadinium laticinctum* subsp. *granulatum, P. laticinctum* subsp. *lophophorum, Polysphaeridium simplex, Systematophora placacantha* (abundant), *Thalassiphora pelagica, Wetzeliella articulata, W.* sp. A Williams and Bujak, 1977b.

2140-2620': middle-late Eocene

Areosphaeridium arcuatum, A. multicornutum, Cordosphaeridium funiculatum, C. gracile, C. exuberans subsp. *ellipsoidale, Cyclonephelium* sp. A Williams and Brideaux, 1975, *Homotryblium tenuispinosum, Kisselovia coleothrypta, K. tenuivirgula* var. *crassiramosa* (form with short horns).

2800-2830': *Areoligera senonensis* Zone (early Eocene)

Apectodinium homomorphum, Areoligera medusettiformis, A. cf. *A. senonensis, Cordosphaeridium inodes* (abundant), *Deflandrea* cf. *D. cygniformis.*

Also present in this interval are reworked specimens of the Late Cretaceous-early Paleocene species *Palaeoperidinium pyrophorum.*

2890-3100': Paleocene

Ceratiopsis speciosa (abundant at 2890ft), *Lejeunia magnifica, Palaeocystodinium australinum.*

3160-3280': *Dinogymnium euclaensis* Zone (Maastrichtian)

Chatangiella tripartita, Dinogymium digitus, Exochosphaeridium bifidum, Hystrichodinium pulchrum, Isabelidinium belfastense, Oligosphaeridium complex, Spiniferites ramosus (large form).

3310-3520': *Odontochitina operculata* Zone (Campanian)

Cannosphaeropsis utinensis, Chlamydophorella nyei, Cyclonephelium distinctum, ?Hexagonifera chlamydata, Hystrichosphaeropsis ovum, Oligosphaeridium cf. *O. pulcherrimum, Palaeohystrichophora infusorioides, Spinidinium sverdrupianum, Trithyrodinium suspectum, Xenascus ceratioides, X.* sp.

Also present within this interval are reworked specimens of the Late Jurassic-Early Cretaceous species *Muderongia simplex.*

3580-3880': *Cordosphaeridium truncigerum* Zone (Santonian)

Chatangiella victoriensis, Cordosphaeridium truncigerum, Dinogymnium heterocostatum, Gardodinium deflandrei, Isabelidinium cooksoniae, Odontochitina costata, O. operculata, O. porifera, Schizocystia laevigata, Senoniasphaera protrusa, S. rotundata, Silicisphaera ferox, Spinidinium styloniferum, Surculosphaeridium longifurcatum, Wallodinium anglicum, Xiphophoridium alatum.

3940-4170': *Oligosphaeridium pulcherrimum* Zone (Coniacian)

Surculosphaeridium longifurcatum (abundant).

4240-4270': barren

LABRADOR SHELF

The 11 wells analyzed from the Labrador Shelf are:

Bjarni H-81	(8)
Cartier D-70	(6)
Freydis B-87	(2)
Gudrid H-55	(7)
Herjolf M-92	(9)
Indian Harbour M-52	(3)
Karlsefni A-13	(11)
Leif E-38	(4)
Leif M-48	(5)
Snorri J-90	(10)
Verrazano L-77	(1)

The numbers in brackets refer to the geographic locations shown in Fig. 8. A comparison of the palynological ages of rocks dated in each well is illustrated in Fig. 9. Details of individual zone thicknesses and taxa occurrences are given below for each well.

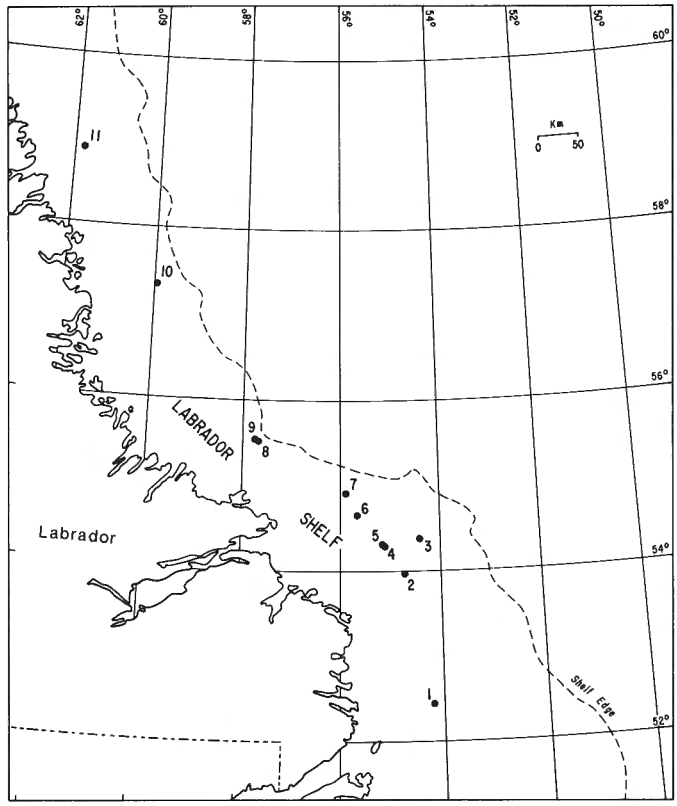

Figure 8: Well locations, Labrador Shelf.

Eastcan *et al.*
BJARNI H-81

GSC locality: D116

Location: 55°30'29.35"N; 57°42'05.52"W

RT elevation: 41' Water depth: 456'

Casing set at: 577, 1211, 4093, and 7065'

Total depth: 8251' Interval studied: 1250-7318'

Analyzed by: G.L. Williams

Palynological analysis of 120 cuttings samples, 16 sidewall core samples and six conventional core samples

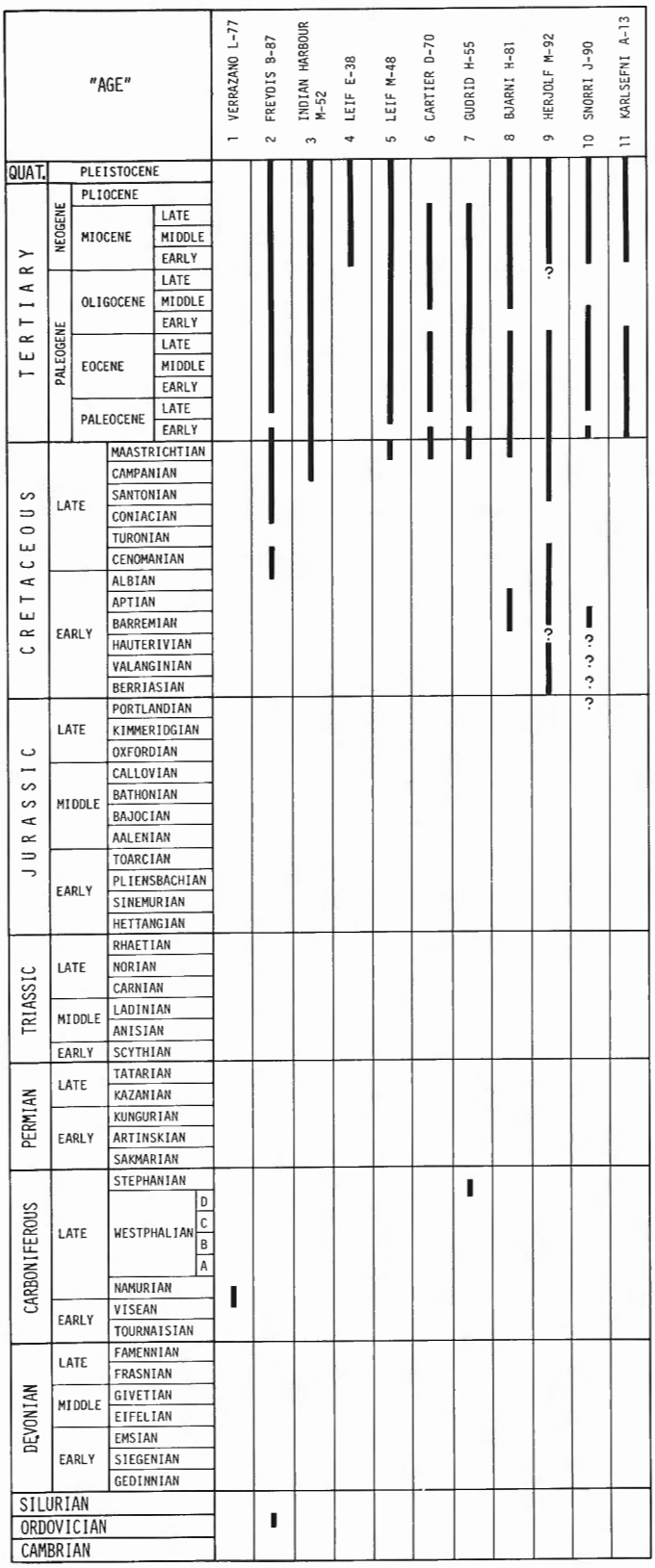

Figure 9: Palynological ages of sediments in Labrador Shelf wells.

indicates the following age determinations and biostratigraphic zonation:

1250- 2400' *T. igniculus* assemblage (Plio-Pleistocene)
2410- 2790' Miocene-Pliocene
2860- 3190' *O. centrocarpum* assemblage (middle-late Miocene)
3360- 4290' *E. indentata* assemblage (early Miocene)
4360- 4490' *C. fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)
4560- 5990' *W. lunaris* assemblage (middle-late Eocene)
6010- 6290' *A. senonensis* assemblage (early Eocene)
6360- 6390' *C. speciosa* assemblage (late Paleocene)
6460- 6690' *E. circumtabulata* assemblage (early-late Paleocene)
6740- 6770' *P. pyrophorum* assemblage (early Paleocene)
6860- 7020' *A. nucula-H. chlamydata* assemblage (Maastrichtian)
7074- 7318' *C. mesozoicus* assemblage (?Barremian-Aptian)

The Eastcan *et al.* Bjarni well encountered basalt at 7400ft. The oldest datable sediments (7318-7074ft) are tentatively dated Barremian-Aptian. Immediately overlying this unit are marine sediments which contain Maastrichtian dinocysts. There appears to be a more or less continuous Tertiary sequence, although lower Oligocene sediments have not been recognized. Subdivision of the Plio-Pleistocene is difficult because of the few species which appear to be indigenous and the high percentage of reworked material.

Selected palynomorphs

1250-2400': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Alnipollenites verus, Betulaepollenites sp., *Caryapollenites simplex, Pinus* spp., *Tsugaepollenites igniculus.*

Specimens of reworked species are present at 1480-1510ft (*Operculodinium centrocarpum, Systematophora ancyrea*), 1510-1600ft (*Perisseiasphaeridium* sp.), 1900-1930ft (*Chiropteridium* cf. *C. dispersum, Cordosphaeridium cantharellum, Deflandrea spinulosa*), 2110-2200ft (*Deflandrea* sp.), and 2310-2400ft (*Phthanoperidinium* sp.).

2410-2790': Miocene-Pliocene

Cordosphaeridium cantharellum, Distatodinium paradoxum, Epicephalopyxis indentata, Impletosphaeridium transfodum, Operculodinium centrocarpum, O. israelianum, Osmundacidites sp. A Williams and Bujak, 1977b, *Polysphaeridium* cf. *P. pastielsii, Spiniferites crassipellis, S. pseudofurcatus, Systematophora ancyrea, Wetzeliella* cf. *W. ovalis.*

There is so much caved and reworked material in this interval that the few specimens recorded of the above species, cannot be used as the basis for a reliable age call.

2860-3190': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Osmundacidites sp. A Williams and Bujak, 1977b, *Podocarpidites* sp. Williams and Bujak, 1977b.

3360-4290': *Epicephalopyxis indentata* assemblage (early Miocene)

Epicephalopyxis indentata, Lingulodinium machaerophorum, Phthanoperidinium sp. A Williams and Bujak, 1977b, *Tiliaepollenites* sp. Williams and Bujak, 1977b.

Specimens of reworked Late Cretaceous species occur sporadically. These include *Chatangiella tripartita, Cicatricosisporites* sp., *Classopollis classoides, Cyclonephelium distinctum, Densoisporites* sp., *Spinidinium* cf. *S. echinoideum, Surculosphaeridium longifurcatum.* Whether these were reworked in the early Miocene or represent caving from the Plio-Pleistocene cannot be determined since all the samples are cuttings samples.

4360-4490': *Cordosphaeridium fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)

Cordosphaeridium sp., *Cyclonephelium* sp., *Deflandrea* sp. C Williams and Bujak, 1977b, *Rhombodinium* sp.

4560-5990': *Wetzeliella lunaris* assemblage (middle-late Eocene)

Chiropteridium aspinatum, Cyclonephelium intricatum, Deflandrea phosphoritica, Diphyes colligerum, Kisselovia coleothrypta, Leptodinium incompositum, Lingulodinium machaerophorum (common), *Pterocaryapollenites* sp. A Williams and Bujak, 1977b, *Triatriopollenites* sp. A Williams and Bujak, 1977b, *Wetzeliella lunaris, W. varielongituda.*

6010-6290': *Areoligera senonensis* assemblage (early Eocene)

Apectodinium homomorphum, A. homomorphum subsp. *quinquelata, Areoligera senonensis, Kisselovia tenuivirgula, Rhombodinium condylos.*

6360-6390': *Ceratiopsis speciosa* assemblage (late Paleocene)

Ceratiopsis speciosa, Cyclonephelium ordinatum.

6460-6690': *Eisenackia circumtabulata* assemblage (early-late Paleocene)

Eisenackia circumtabulata, Hystrichosphaeridium sp. A, *Oligosphaeridium complex, Palaeocystodinium benjaminii.*

6740-6770': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Ceratiopsis diebelii, Lejeunia magnifica, Palaeoperidinium pyrophorum.

6860-7020': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Alterbia cf. *A. acuminata, ?Hexagonifera chlamydata.*

7074-7318': *Cerebropollenites mesozoicus* assemblage (?Barremian-Aptian)

Appendicisporites bifurcatus, Baculatisporites comaumensis, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, C. hallei, Classopollis classoides, Concavissimisporites variverrucatus, Contignisporites cooksonii, Trilobosporites purverulentus, Vitreisporites pallidus.

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Eastcan *et al.*
CARTIER D-70

GSC locality: D157

Location: 54°39'02.39"N; 55"40'29.90"W

RT elevation: 41' Water depth: 1017'

Casing set at: 1135, 1896, and 3867'

Total depth: 6322' Interval studied: 1940-6250'

Analyzed by: G.L. Williams

Palynological analysis of 45 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1940- 3690'	*O. centrocarpum* assemblage (middle-late Miocene)
3750- 3980'	*E. indentata* assemblage (early Miocene)
4170- 4190'	*C. fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)
4270- 5580'	*W. lunaris* assemblage (middle-late Eocene)
4270- 4780'	late Eocene
4860- 5580'	middle Eocene
5670- 5780'	*A. senonensis* assemblage (early Eocene)
5850- 6100'	*C. speciosa* assemblage (late Paleocene)
6170- 6180'	*P. pyrophorum* assemblage (early Paleocene)
6180- 6250'	*A. nucula-H. chlamydata* assemblage (Maastrichtian)

Eastcan *et al.* Cartier D-70 encountered basement at 6250ft. The cuttings sample at 6200-6170ft contains a mixed Maastrichtian-early Paleocene assemblage. The Cretaceous-Tertiary boundary is therefore tentatively placed at 6180ft. With the exception of a possible hiatus in the Paleocene (the *Eisenackia circumtabulata* assemblage being absent or not recognized) there appears to be a more or less complete Tertiary sequence up to the middle-upper Miocene. Sample coverage above 1940ft is lacking. The Paleocene and lower Eocene sediments have a combined thickness of 510ft. These are overlain by approximately 1500ft of middle to upper Eocene sediments. The very thin Oligocene is overlain by a thick Miocene sequence which is subdivided into lower and middle to upper Miocene.

Selected palynomorphs

1940-3690': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Alnipollenites verus, Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Osmundacidites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium comatum, Pinus* spp., *Polypodiumsporites* sp., *Podocarpidites* sp. Williams and Bujak, 1977b, *Rouseisporites* sp., *Systematophora ancyrea, Tsugaepollenites igniculus.*

Reworked species include *Cerebropollenites mesozoicus, Chatangiella tripartita, C. victoriensis, Cicatricosisporites augustus, Cyclonephelium vannophorum, Odontochitina costata,* and *Wetzeliella* sp. B Williams and Brideaux, 1975. These are predominantly Cretaceous taxa.

3750-3980': *Epicephalopyxis indentata* assemblage (early Miocene)

Cicatricososporites sp. (one specimen at 3950-3980ft), *Cordosphaeridium cantharellum, Epicephalopyxis indentata, Lingulodinium machaerophorum.*

4170-4190': *Cordosphaeridium fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)

Deflandrea sp. C Williams and Bujak, 1977b.

4270-5580': *Wetzeliella lunaris* assemblage (middle-late Eocene)

4270-4780': late Eocene

Baltisphaeridium sp., *Cordosphaeridium fibrospinosum*, *Cupaneidites* sp. A Williams and Bujak, 1977b, *Hystrichokolpoma* cf. *H. rigaudiae*, *Impletosphaeridium transfodum*, *Nyssapollenites* sp. A Williams and Bujak, 1977b, *Wetzeliella articulata*.

4860-5580': middle Eocene

Apectodinium homomorphum, *A. hyperacanthum*, *Cyclonephelium* sp., *Deflandrea wetzelii*, *Kisselovia coleothrypta*, *Pistillipollenites mcgregorii*, *Polysphaeridium* cf. *P. simplex*, *Systematophora* sp.

5670-5780': *Areoligera senonensis* assemblage (early Eocene)

Areosphaeridium sp., *Cyclonephelium divaricatum*, *Heteraulacacysta campanula*, *Homotryblium tenuispinosum*, *Membranilarnacia ursulae*, *Rhombodinium condylos*, *Spiniferites speciosus*.
Reworked species include *Luxadinium primulum*.

5850-6100': *Ceratiopsis speciosa* assemblage (late Paleocene)

Apectodinium parvum, *Areoligera medusettiformis*, *Ceratiopsis speciosa*, *Deflandrea* cf. *D. phosphoritica*, *Hystrichosphaeridium tubiferum*.
Reworked species include *Palaeoperidinium pyrophorum*.

6170-6180': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Ceratiopsis diebelii, *Palaeoperidinium pyrophorum*.

6180-6250': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Amphidiadema nucula, *Lejeunia tricuspis*, *Palaeocystodinium* sp., *Spiniferites scabrosus*, *Spongodinium delitiense*, *Trithyrodinium* sp.
Reworked species include *Cribroperidinium orthoceras*.

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Eastcan *et al.*
FREYDIS B-87

GSC locality: D148

Location: 53°56'13.31"N; 54°42'30.01"W

RT elevation: 40' Water depth: 575'

Casing set at: 697, 1424, and 3665'

Total depth: 7592' Interval studied: 1480-6700'

Analyzed by: G.L. Williams

Palynological analysis of 11 sidewall core and 59 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1480- 1690' *T. igniculus* assemblage (Plio-Pleistocene)
1780- 2700' *O. centrocarpum* assemblage (middle-late Miocene)
2760- 3400' *E. indentata* assemblage (early Miocene)
3430- 3460' *C. fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)
3500- 3535' *W. ovalis* assemblage (early Oligocene)
3600- 4390' *W. lunaris* assemblage (middle-late Eocene)
3600- 4250' late Eocene
4270- 4390' middle Eocene
4450- 4630' *A. senonensis* assemblage (early Eocene)
4690- 4810' *C. speciosa* assemblage (late Paleocene)
4870- 4900' *P. pyrophorum* assemblage (early Paleocene)
4960- 5320' *A. nucula-H. chlamydata* assemblage (Maastrichtian)
5350- 5440' Campanian
5560- 5680' Santonian
5710- 5860' Coniacian
5890- 5920' late Albian-Cenomanian
5950- 6235' late Albian
6340- 6700' Caradocian

The Eastcan *et al.* Freydis B-87 well bottomed in Lower Paleozoic rocks, the organic walled microfossils of which have been studied in some detail by W.A.M. Jenkins (pers. comm.). Overlying these older rocks are non-marine to very shallow marine, or littoral, Upper Albian and possibly Cenomanian sediments, containing several spores and occasional dinocysts. The transition from the Late Albian-Cenomanian assemblages in the cuttings sample at 5920-5890ft to the marine Coniacian assemblage occurs within 30ft. The sediments between 5890 and 5860ft may in part be assignable to the Turonian since species which "top" in this stage are present in the cuttings sample from 5920 to 5890ft. The Coniacian-Santonian assemblages compare favourably with an assemblage described by Manum and Cookson (1964) from Graham Island.

The Cretaceous-Paleogene rocks are interpreted to have been deposited in a neritic environment. There may be a hiatus within the Paleocene since the *Eisenackia circumtabulata* assemblage is absent or not recognized.

Environmental predictions concerning the Miocene-Pleistocene can only be speculative in view of the poor assemblages recovered. The presence of occasional dinocysts in the Miocene is taken to indicate an inner neritic environment. Specimens of reworked middle to late Eocene species are common in the Miocene. During the Plio-Pleistocene the percentages of reworked material reaches a peak and ranges in age from Albian(?) to Miocene.

Selected palynomorphs

1480-1690': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Alnipollenites verus, *Caryapollenites simplex*, *Ilexpollenites* sp., *Pinus* spp., *Tsugaepollenites igniculus*, *Ulmipollenites* sp.
Reworked species include *Areoligera medusettiformis*, *Deflandrea oebisfeldensis*, *D. spinulosa*, *Phthanoperidinium comatum*, and *Vitreisporites* sp. Singh, 1971.

1780-2700': *Operculodinium centrocarpum* assemblage (middle to late Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975,

Lingulodinium machaerophorum, Osmundacidites sp. A Williams and Bujak, 1977b, *Polypodiumsporites* sp., *Systematophora ancyrea.*

Reworked species include *Cupaneidites* sp. A Williams and Bujak, 1977b, *Deflandrea wetzelii, Kisselovia coleothrypta,* and *Pterocaryapollenites* sp. A Williams and Bujak, 1977b.

2760-3400': *Epicephalopyxis indentata* assemblage (early Miocene)

Epicephalopyxis indentata, Lingulodinium machaerophorum (common), *Phthanoperidinium* sp.

Reworked species include *Anacolosidites* sp., *Chatangiella victoriensis, Cupaneidites* sp. A Williams and Bujak, 1977b, *Cyclonephelium* sp. B Williams and Brideaux, 1975, and *Pistillipollenites mcgregorii.*

3430-3460': *Cordosphaeridium fibrospinosum-Deflandrea* sp. C Assemblage (Oligocene)

Leptodinium incompositum.

3500-3535': *Wetzeliella ovalis* assemblage (early Oligocene)

Wetzeliella similis.

3600-4390': *Wetzeliella lunaris* assemblage (middle-late Eocene)

3600-4250': late Eocene

Areosphaeridium cf. *A. multicornutum, Deflandrea spinulosa, Hemiplacophora semilunifera, Hystrichokolpoma rigaudiae, Nyssapollenites* sp. A Williams and Bujak, 1977b, *Pistillipollenites mcgregorii, Pterocaryapollenites* sp. A Williams and Bujak, 1977b, *Rhombodinium* cf. *R. condylos, sensu* Williams and Bujak, 1977b, *Wetzeliella ovalis.*

4270-4390': middle Eocene

Apectodinium homomorphum, Cyclonephelium ordinatum, Extratriporopollenites sp., *Hemicystodinium zoharyi, Heteraulacacysta campanula, Kisselovia coleothrypta, Myrtaceidites* sp., *Tubidermodinium sulcatum, Wilsonidium echinosuturatum.*

4450-4630': *Areoligera senonensis* assemblage (early Eocene)

Apectodinium homomorphum (abundant), *A. hyperacanthum, Areoligera medusettiformis, Cordosphaeridium craceno-spinosum, C. gracile, Deflandrea denticulata, D. oebisfeldensis, Gonyaulacysta giuseppei, Hystrichosphaeridium tubiferum, Leptodinium victorianum, Membranilarnacia ursulae, Rhombodinium condylos.*

4690-4810': *Ceratiopsis speciosa* assemblage (late Paleocene)

Ceratiopsis speciosa, Deflandrea dartmooria.

4870-4900': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Palaeoperidinium pyrophorum, Spongodinium delitiense.

4960-5320': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Amphidiadema nucula, A. rectangularis, Ceratiopsis diebelii, Cyclonephelium distinctum, Exochosphaeridium bifidum, Hystrichosphaeridium cf. *H. tubiferum, H.* sp. A Williams and Bujak, 1977b, *Isabelidinium belfastense, I. cretaceum, Microdinium ornatum, Oligosphaeridium anthophorum, Palambages* sp., *Spiniferites scabrosus, Tanyosphaeridium variecalamum.*

5350-5440': Campanian

Alterbia acuminata, Chatangiella vnigri, Cyclonephelium cf. *C. distinctum, Dorocysta* sp., *Isabelidinium cooksoniae, Kleithriasphaeridium loffrense, Oligosphaeridium complex, Palaeohystrichophora infusorioides, Xenascus ceratioides.*

5560-5680': Santonian

Chatangiella victoriensis, Chlamydophorella nyei, Epelidosphaeridia spinosa, Hystrichosphaeridium cf. *H. paracostatum, Stephodinium coronatum, Surculosphaeridium longifurcatum.*

5710-5860': Coniacian

Chlamydophorella grossa, Cordosphaeridium truncigerum, Coronifera oceanica, Hystrichosphaeridium difficile, H. paracostatum, Kleithriasphaeridium loffrense (common), *Oligosphaeridium pulcherrimum, Silicisphaera ferox, Spiniferites porosus, Trichodinium castaneum, Trithyrodinium suspectum, Xiphophoridium alatum.*

5890-5920': late Albian-Cenomanian

Cicatricosisporites hughesi, Endoscrinium campanulum, Impletosphaeridium whitei, Rugubivesiculites rugosus.

5950-6235'; late Albian

Appendicisporites bilateralis, A. problematicus, Callaiosphaeridium asymmetricum, Camarozonosporites insignis, Cicatricosisporites hallei, Cribroperidinium intricatum, Rugubivesiculites convolutus (base), *Vitreisporites* sp. Singh, 1971.

6340-6700': Caradocian

Dated on acritarchs and chitinozoa (W.A.M. Jenkins, pers. comm.).

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Eastcan *et al.*
GUDRID H-55

GSC locality: D133

Location: 54°54'30.02"N; 55°52'32.22"W

RT elevation: 40' Water depth: 982'

Casing set at: 1099, 1529, 3466, 7752, and 9260'

Total depth: 9311' Interval studied: 1660-8820'

Analyzed by: G.L. Williams and M.S. Barss

Palynological analysis of 72 cuttings and 2 conventional core samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1660- 2340' *O. centrocarpum* assemblage (middle-late Miocene)
2400- 2700' *E. indentata* assemblage (early Miocene)
2760- 4310' *C. fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)
4400- 5400' *W. ovalis* assemblage (early Oligocene)
5480- 6860' *W. lunaris* assemblage (middle-late Eocene)
5480- 6110' late Eocene
6170- 6860' middle Eocene
6920- 7310' *A. senonensis* assemblage (early Eocene)
7360- 7800' *C. speciosa* assemblage (late Paleocene)
7860- 7980' *P. pyrophorum* assemblage (early Paleocene)
8040- 8700' *A. nucula-H. chlamydata* assemblage (Maastrichtian)
8700- 8785.3' barren
8785.3-8785.6' Westphalian D-Stephanian
8786- 8820' barren

A conventional core sample from 8785.3-8785.6ft yielded a palynomorph assemblage that compares with assemblages described from Westphalian D-Stephanian rocks of eastern Canada. Overlying these rocks are marine Maastrichtian sediments which in turn are overlain by almost 6500ft of Tertiary, with only the *Eisnackia circumtabulata* assemblage not recognized. Recovery of dinocysts from the Maastrichtian-lower Eocene is good, middle Eocene-Oligocene poor and in the Miocene fair. The zonation within the Eocene-Oligocene is in part based on pollen.

Paleoecological interpretations have not been attempted since sidewall cores were not available for study.

Selected palynomorphs

1660-2340': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Alnipollenites verus, Caryapollenites simplex, Operculodinium centrocarpum, Osmundacidites sp. A Williams and Bujak, 1977b, *Systematophora ancyrea, Tsugaepollenites igniculus.*

2400-2700': *Epicephalopyxis indentata* assemblage (early Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Epicephalopyxis indentata, Lejeunia psilodora, Podocarpidites* sp. Williams and Bujak, 1977b, *Ulmipollenites* sp., *Vozzhennikovia tenella.*

2760-4310': *Cordosphaeridium fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)

Cyclonephelium semicirculatum, Dinopterygium sp., *Ilexpollenites* sp., *Phthanoperidinium* sp., *Pterocaryapollenites* sp. A Williams and Bujak, 1977b, *Triatriopollenites* sp. A Williams and Bujak, 1977b.

4400-5400': *Wetzeliella ovalis* assemblage (early Oligocene)

Osmundacidites sp. A Williams and Bujak, 1977b, *Phthanoperidinium echinatum, Wetzeliella* sp.

5480-6860': *Wetzeliella lunaris* assemblage (middle-late Eocene)

5480-6110': late Eocene

Baltisphaeridium sp., *Extratriporopollenites* sp., *Horologinella* sp., *Lingulodinium* cf. *L. machaerophorum, Operculodinium* cf. *O. hirsutum, sensu* Gocht, 1969.

6170-6860': middle Eocene

Deflandrea wardenensis, Momipites coryloides, Nyssapollenites sp. A Williams and Bujak, 1977b, *Pistillipollenites mcgregorii, Sequoiapollenites* sp.

6920-7310': *Areoligera senonensis* assemblage (early Eocene)

Adnatosphaeridium patulum, A. reticulense, sensu Gocht, 1969, *Apectodinium homomorphum, Deflandrea oebisfeldensis, Diphyes colligerum, Homotryblium* cf. *H. tenuispinosum, Kisselovia coleothrypta, Palaeocystodinium golzowense, Rhombodinium* cf. *R. condylos, sensu* Williams and Bujak, 1977b, *Wetzeliella symmetrica, Wilsonidium tabulatum.*

7360-7800': *Ceratiopsis speciosa* assemblage (late Paleocene)

Achilleodinium biformoides, Ceratiopsis cf. *C. speciosa, Gonyaulacysta giuseppei, Hystrichosphaeridium tubiferum, Spiniferites cingulatus.*

7860-7980': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Eisenackia circumtabulata, Lejeunia tricuspis, Palaeoperidinium pyrophorum.

8040-8700': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Amphidiadema nucula, A. rectangularis, Areoligera medusettiformis, Ceratiopsis diebelii, Isabelidinium cretaceum, Leptodinium sp., *Oligosphaeridium anthophorum, Spongodinium delitiense.*

8700-8785.3': barren

8785.3-8785.6': Westphalian D-Stephanian

Apiculatisporis cf. *A. verrucifer, Calamospora breviradiata, C. pallida, Deltoidospora* sp., *Laevigatosporites desmoinesensis, L. medius, L.* cf. *L. minimus, L.* cf. *L. perminutus, Latosporites* sp., *Lycospora pusilla, Punctatisporites* sp., *Punctatosporites minutus, Thymospora obscura, Triquitrites* cf. *T. bransonii, Verrucosisporites* cf. *V. donarii,* cf. *Vestispora laevigata.*

8786-8820' barren

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Eastcan *et al.*
HERJOLF M-92

GSC locality: D166

Location: 55°31'53.4"N; 57°44'52.9"W

RT elevation: 88' Water depth: 476'

Casing set at: 624, 1427, 4546, and 9035'

Total depth: 13406' Interval studied: 1490-12330'

Analyzed by: G.L. Williams

Palynological analysis of 119 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1600- 2630'	*T. igniculus* assemblage (Plio-Pleistocene)
2700- 3630'	*O. centrocarpum* assemblage (middle late Miocene)
3700- 4430'	*E. indentata* assemblage (early Miocene)
4500- 4530'	?Oligocene
4600- 5830'	*W. lunaris* assemblage (middle-late Eocene)
4600- 5530'	late Eocene
5600- 5830'	middle Eocene
5900- 7030'	*A. senonensis* assemblage (early Eocene)
7100- 7130'	*C. speciosa* assemblage (late Paleocene)
7200- 7230'	*E. circumtabulata* assemblage (early-late Paleocene)
7300- 7630'	*P. pyrophorum* assemblage (early Paleocene)
7700- 8130'	*A. nucula-H. chlamydata* assemblage (Maastrichtian)
8200- 8330'	Campanian
8400- 8430'	Santonian-Campanian
8500- 8830'	Albian-Cenomanian
8900- 9230'	Albian
9300-12130'	Barremian-Aptian
12200-12330'	?Neocomian

Eastcan *et al.* Herjolf M-92 encountered volcanics at 12 360ft and bottomed in granitic basement at 13 406 ft. The granite is overlain by basalt, which extends upwards to 12 360ft. Overlying this is a sandstone unit dated Barremian-Aptian between 12 130 and 9300ft and Albian-Cenomanian between 9230 and 8500ft. This reveals the presence of a more complete Bjarni Formation section at Herjolf when compared to Bjarni H-81.

The presence of spores and the absence of dinocysts indicates non-marine deposition, although a marine incursion between 8830-8700ft is suggested by the occurrence of the dinocyst *Cribroperidinium orthoceras* in this interval.

Marine Santonian to Maastrichtian sediments occur from 8430 to 7700ft. These contain dinocysts also present in coeval sediments in other Labrador Shelf and several Scotian Shelf wells. The cuttings sample from 8430-8400ft contains two specimens of dinocyst species believed to die out on the Grand Banks in the Santonian. Whether these also have a restricted range on the Labrador Shelf is at present uncertain. The thin but more or less complete Paleocene is overlain by almost 2500ft of Eocene sediments. The Paleocene dinocysts correlate with Scotian Shelf assemblages while the Eocene taxa are more provincial, comparing only with those recovered from other Labrador Shelf wells. This provincialism is also observable in the spores.

One sample, 4500-4530ft, has been questionably dated Oligocene. The overlying Miocene, which extends from 4430 to 2700ft, contains several reworked Late Cretaceous dinocysts. Reworked Carboniferous spores, Late Cretaceous dinocysts and Eocene, Oligocene and Miocene dinocysts occur throughout the Plio-Pleistocene, with the indigenous palynomorphs rarely being abundant.

The unavailability of sidewall cores prevents the generation of paleoenvironmental data.

Selected palynomorphs

1600-2630': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Abies sp., *Caryapollenites simplex*, *Pinus* sp., *Spiniferites ramosus*, *Tsugaepollenites igniculus*.

Reworked taxa include *Bombacacidites* sp. A Williams and Brideaux, 1975, *Chiropteridium dispersum*, *C. lobospinosum*, *C. partispinatum*, *Hystrichokolpoma eisenackii*, *H. rigaudiae*, *Lingulodinium machaerophorum*, *Nyssapollenites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium comatum*, *Spinidinium* cf. *S. vestitum*, *sensu* Williams, 1975, *Spiniferites pseudofurcatus*, *Svalbardella* sp., *Systematophora ancyrea*. Included also are reworked Carboniferous spores belonging to *Tripartites* and *Triquitrites* previously described from Mississippian sediments of Arctic Canada.

2700-3630': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Alnipollenites verus, *Bombacacidites* sp. A Williams and Brideaux, 1975, *Cingutriletes* sp., *Osmundacidites* sp. A Williams and Bujak, 1977b, *Podocarpidites* sp. Williams and Bujak, 1977b, *Polypodiumsporites* sp., *Rouseisporites* sp., *Systematophora ancyrea*.

Reworked taxa include *Areosphaeridium multifurcatum*, *Chiropteridium dispersum*, *Cordosphaeridium fibrospinosum*, *Deflandrea phosphoritica*, *Extratriporopollenites* sp., *Ovoidinium verrucosum*, *Rhombodinium* cf. *R. condylos*, *sensu* Williams and Bujak, 1977b.

3700-4430': *Epicephalopyxis indentata* assemblage (early Miocene)

Epicephalopyxis indentata, *Impletosphaeridium transfodum*, *Lingulodinium machaerophorum*, *Operculodinium centrocarpum*.

Reworked taxa include *Nyssapollenites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium* cf. *P. echinatum*, and *Surculosphaeridium* cf. *S. longifurcatum*.

4500-4530': ?Oligocene

Deflandrea sp., *Wetzeliella* sp.

4600-5830': *Wetzeliella lunaris* assemblage (middle-late Eocene)

4600-5630': late Eocene

Baltisphaeridium sp., *Chiropteridium* sp., *Cicatricosisporites dorogensis*, *Cupaneidites* sp. A Williams and Bujak, 1977b, *Deflandrea* sp. C Williams and Bujak, 1977b, *Diphyes colligerum*, *Extratriporopollenites* spp., *Hystrichokolpoma eisenackii*, *Kisselovia* cf. *K. tenuivirgula*, *Nyssapollenites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium echinatum*, *Platycaryapollenites* sp. A Williams and Bujak, 1977b, *Polysphaeridium pastielsii*, *Sequoiapollenites* sp., *Vitreisporites* sp., *Wetzeliella ovalis*.

Reworked taxa include *Ceratiopsis speciosa* and *Chatangiella vnigri*.

5600-5830': middle Eocene

Deflandrea sp. B Williams and Bujak, 1977b, *Eocladopyxis peniculata*, *Vitreisporites* sp. (abundant).

5900-7030': *Areoligera senonensis* assemblage (early Eocene)

Adnatosphaeridium reticulense, Apectodinium homomorphum, A. parvum, Areoligera medusettiformis, A. cf. *A. medusettiformis, A.* cf. *A. senonensis, Deflandrea* cf. *D. phosphoritica, sensu* Williams and Bujak, 1977b, *Deflandrea wardenensis, Diphyes* sp., *Homotryblium tenuispinosum, Hystrichokolpoma cinctum, Phthanoperidinium comatum, Polysphaeridium simplex, Rhombodinium condylos, R.* cf. *R. condylos, sensu* Williams and Bujak, 1977b, *Thalassiphora pelagica, Wetzeliella articulata.*

7100-7130': *Ceratiopsis speciosa* Zone (late Paleocene)

Apectodinium homomorphum (common), *A. hyperacanthum, Ceratiopsis speciosa.*

7200-7230': *Eisenackia circumtabulata* assemblage (early-late Paleocene)

Eisenackia circumtabulata.

7300-7630': *Palaeoperidinium pyrophorum* Zone (early Paleocene)

Ceratiopsis striata, Deflandrea cf. *D. denticulata, Palaeocystodinium australinum, Palaeoperidinium pyrophorum, Spongodinium delitiense.*

7700-8130': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Amphidiadema nucula, ?Hexagonifera chlamydata, Hystrichosphaeridium sp. A Williams and Bujak, 1977b, *Isabelidinium* cf. *I. cretaceum, Lejeunia magnifica, L. tricuspis, Leptodinium* sp., *Oligosphaeridium complex, Spiniferites scabrosus.*

8200-8330': Campanian

Achomosphaera ramulifera, Ceratiopsis diebelii, Chatangiella decorosa, Chlamydophorella grossa, Cordosphaeridium fibrospinosum, Cyclonephelium distinctum, Hystrichosphaeridium tubiferum, Oligosphaeridium sp.

8400-8430': Santonian-Campanian

Chatangiella vnigri, Dorocysta sp. A Bujak and Williams, 1978, *Odontochitina porifera, Rugubivesiculites rugosus, Surculosphaeridium* cf. *S. longifurcatum, Xiphophoridium alatum.*

8500-8830': Albian-Cenomanian

Cicatricosisporites hallei, C. hughesi, Cribroperidinium orthoceras, Osmundacidites wellmanii, Vitreisporites sp. Singh, 1971.

8900-9230': Albian

Alisporites grandis.

9300-12130': Barremian-Aptian

Alisporites sp., *Appendicisporites concentricus, Cerebropollenites mesozoicus, Contignisporites glebulentus, Pediastrum* sp., *Perinopollenites elatoides, Vitreisporites pallidus.*

12200-12330': ?Neocomian

Cicatricosisporites australiensis, C. hallei.

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BP-Columbia *et al.*
INDIAN HARBOUR M-52

GSC locality: D153

Location: 54°21'51.34"N; 54°23'51.81"W

RT elevation: 42.6' to 7783'; 98' to 12986'

Water depth: 649'

Casing set at: 1032, 1865, 5177 and 10328

Total depth: 12986' Interval studied: 1000-12982'

Analyzed by: G.L. Williams

Palynological analysis of 107 cuttings samples and one conventional core sample from the subject well indicates the following age determinations and biostratigraphic zonations:

1000- 1900' *T. igniculus* assemblage (Plio-Pleistocene)
1930- 3190' Miocene
3250- 4690' Oligocene
4750- 8170' *W. lunaris* assemblage (middle-late Eocene)
4750- 6910' late Eocene
6980- 8170' middle Eocene
8230- 9970' *A. senonensis* assemblage (early Eocene)
10030-10240' *C. speciosa* assemblage (late Paleocene)
10300-10330' *E. circumtabulata* assemblage (early-late Paleocene)
10390-10420' *P. pyrophorum* assemblage (early Paleocene)
10480-10600' *A. nucula-H. chlamydata* assemblage (Maastrichtian)
10660-?10686' Campanian
10686-12982' age indeterminate

BP Columbia *et al.* Indian Harbour M-52 was initially spudded August 21, 1975 by the drillship HAVDRILL, and drilled to 7808 feet before being suspended in October of the same year. In 1976 the Sedco J rig reentered the well and deepened it to 12 986ft. The well was then plugged and abandoned. According to the well history report Indian Harbour M-52 bottomed in dolomitic limestone of Paleozoic age. This is overlain by a volcanic sequence which extends from 12 982 to 10 686ft. The presence of the spores *Alisporites grandis* and *Cerebropollenites mesozoicus* in some of the cuttings samples from the volcanic interval suggests by comparison with other Labrador Shelf wells that Barremian-Aptian rocks occur immediately above this sequence. Caved specimens of the dinocyst taxa *Cordosphaeridium truncigerum, Hystrichosphaeridium difficile, Kleithriasphaeridium loffrense* and *Trichodinium* sp. are also present, probably indicating Santonian-lower Campanian sediments above 10 686ft. The oldest rocks presumably containing dinocysts in place are Campanian. These are sequentially overlain by Maastricatian sediments and a more or less complete Tertiary sequence. The a proximately 400ft of Paleocene includes all three assemblages which Williams and Bujak 1977b recognized in other Labrador Shelf wells. The Eocene which is over 5000ft thick is overlain by 1260ft of Oligocene, which may all be early Oligocene. The Miocene cannot be subdivided.

Paleoenvironmental interpretations are based solely on cuttings so must be regarded with some reservations. Dinocysts are common in the Campanian to early Paleocene. The interval from 10 060 to 4390 ft is rich in amorphogen with few dinocysts and some reworking. The environment is interpreted as deeper water. The change in organic matter, increasing phyrogen and hylogen in the Oligocene, suggests shallower water conditions. This is also accompanied by an increase in the relative abundance of spores and pollen to dinocysts which also persists throughout the

Neogene. There is considerable reworking throughout this part of the section.

Selected palynomorphs

1000-1900': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Abies sp., *Alnipollenites verus* (one specimen at 1780-1810ft), *Pinus* sp., *Tsugaepollenites igniculus*.

1930-3190': Miocene

Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Cordosphaeridium cantharellum, Hystrichokolpoma rigaudiae, Lingulodinium machaerophorum, Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, *Rouseisporites* sp., *Systematophora ancyrea*.

Reworked species include *Areosphaeridium multicornutum, Callialasporites dampieri, Cerebropollenites mesozoicus, Chiropteridium aspinatum, C. dispersum, Chatangiella victoriensis, Deflandrea dartmooria, Nyssapollenites* sp. A Williams and Bujak, 1977b and *Wetzeliella* sp. B Williams and Brideaux, 1975.

3250-4690': Oligocene

Chiropteridium aspinatum, C. dispersum, Cordosphaeridium multispinosum, Deflandrea spinulosa, Leptodinium incompositum, Phthanoperidinium comatum, Polysphaeridium pastielsii, Tanyosphaeridium sp. A Williams and Brideaux, 1975.

Reworked species include *Chatangiella victoriensis, Cicatricososporites* sp., *Cordosphaeridium gracile* and *Deflandrea eocenica*.

4750-8170': *Wetzeliella lunaris* assemblage (middle-late Eocene)

4750-6910': late Eocene

Baltisphaeridium sp., *Cyclonephelium exuberans, Deflandrea eocenica, Deflandrea* sp. C Williams and Bujak, 1977b, *Gonyaulacysta guiseppei, Lejeunia hyalina, Nyssapollenites* sp. A Williams and Bujak, 1977b, *Phthanoperidinium alectrolophum, P. echinatum, Systematophora* cf. *S. ancyrea, Thalassiphora pelagica, Tubidermodinium sulcatum*.

Reworked species include *Chatangiella victoriensis, Cicatricosisporites hallei, C. hughesi, Cyclonephelium paucispinum, C. vannophorum, Laciniadinium biconiculum, Odontochitina costata, Oligosphaeridium complex, Ovoidinium verrucosum, Palaeohystrichophora infusorioides,* and *Vitreisporites* sp. Singh, 1971.

6980-8170 middle Eocene

Apectodinium homomorphum, Areoligera medusettiformis, Cyclonephelium ordinatum, Deflandrea sp. B Williams and Bujak, 1977b, *Extratriporopollenites* sp., *Kisselovia tenuivirgula, Wetzeliella articulata, W. ovalis*.

Reworked species include *Hystrichosphaeridium tubiferum, Schizocystia rugosa, Spinidinium styloniferum, Veryhachium trispinosum* and *Wilsonidium echinosuturatum*.

8230-9970': *Areoligera senonensis* assemblage (early Eocene)

Adnatosphaeridium vittatum, Apectodinium homomorphum (common), *A. homomorphum* subsp. *quinquelatum, Areosphaeridium* sp., *Deflandrea oebisfeldensis, D. wardenensis, Eisenackia* sp., *Muratodinium fimbriatum, Rhombodinium condylos*.

10030-10240': *Ceratiopsis speciosa* assemblage (late Paleocene)

Ceratiopsis speciosa, Deflandrea dartmooria, Palaeocystodinium benjaminii.

10300-10330': *Eisenackia circumtabulata* assemblage (early-late Paleocene)

Eisenackia circumtabulata.

10390-10420': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Palaeoperidinium pyrophorum.

10480-10600': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Achomosphaera sagena, Amphidiadema rectangularis, Ceratiopsis diebelii, Isabelidinium cretaceum, Lejeunia tricuspis, Leptodinium sp., *Oligosphaeridium complex, Spongodinium delitiense*.

10660-?10686': Campanian

Cyclonephelium distinctum, Odontochitina operculata, Spiniferites cingulatus, Xenascus ceratioides.

10686-12982': age indeterminate

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Eastcan *et al.*
KARLSEFNI A-13

GSC locality: D156

Location: 58°52'15.03"N; 61°46'42.08"W

RT elevation: 41' Water depth: 573'

Casing set at: 690, 1650, 4823, and 10722'

Total depth: 13612' Interval studied: 1760-13480'

Analyzed by: G.L. Williams

Palynological analysis of 28 sidewall core and 103 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1760- 4080' *T. igniculus* assemblage (Plio-Pleistocene)
4150- 6290' *O. centrocarpum* assemblage (middle-late Miocene)
6374- 6590' *E. indentata* assemblage (early Miocene)
6720- 9080' *W. lunaris* assemblage (middle-late Eocene)
6720- 7280' late Eocene
7380- 8190' middle to late Eocene
8260- 9080' middle Eocene
9160-12382' *A. senonensis* assemblage (early Eocene)
12450-12880' *C. speciosa* assemblage (late Paleocene)
12950-13480' *P. pyrophorum* assemblage (early Paleocene)

The Cenozoic sequence recognised shows close similarity with that in Eastcan *et al.* Snorri J-90

except that the zones are somewhat thicker in Karlsefni. The Paleocene to Eocene is marine with dinocysts. The Oligocene has not been recognised. Subdivision of the Miocene to Pleistocene is primarily based on spores.

Considerable reworking occurs throughout the section. Some of the reworked material includes Cretaceous taxa which have previously been described only from the Arctic (McIntyre, 1975).

Selected palynomorphs

1760-4080': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Abies sp., *Pinus* spp., *Tsugaepollenites igniculus*.

Reworked taxa include *Areoligera medusettiformis, Baltisphaeridium* sp., *Bombacacidites* sp. A Williams and Brideaux, 1975, *Callialasporites dampieri, Cerebropollenites mesozoicus, Operculodinium centrocarpum, Osmundacidites* sp. A Williams and Bujak, 1977b, and *Systematophora ancyrea*.

4150-6290': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Alnipollenites verus, Bombacacidites sp. A. Williams and Brideaux, 1975, *Caryapollenites simplex, Osmundacidites* sp. A. Williams and Bujak, 1977b, *Rouseisporites* sp., *Ulmipollenites* sp. Williams and Brideaux, 1975.

Reworked taxa include *Chlamydophorella nyei, Cicatricosisporites hallei, Exesipollenites tumulus, Hystrichosphaeridium tubiferum, Spinidinium* cf. *S. vestitum*, and *Vitreisporites* sp. Singh, 1971.

6374-6590': *Epicephalopyxis indentata* assemblage (early Miocene)

Cyclopsiella vieta, Epicephalopyxis indentata, Polypodiumsporites sp.

6720-9080': *Wetzeliella lunaris* assemblage (middle-late Eocene)

6720-7280': late Eocene

Deflandrea wardenensis, Diphyes colligerum, Epicephalopyxis sp., *Lingulodinium machaerophorum, Nyssapollenites* sp. A Williams and Bujak, 1977b, *Spiniferites ramosus, Systematophora ancyrea*.

Reworked taxa include *Cerebropollenites mesozoicus, Cyclonephelium distinctum*.

7380-8190': middle to late Eocene

Adnatosphaeridium ?patulum (one specimen at 7380ft), *Baltisphaeridium* sp. (one specimen at 7514ft and one at 7972 ft), *Cyclonephelium* cf. *C. ordinatum, Polysphaeridium* cf. *P. simplex*.

The occurrence of middle Eocene taxa in the interval is sporadic. Whether they are in place cannot be determined.

8260-9080': middle Eocene

Achilleodinium biformoides (8860-8890ft), *Cicatricososporites* sp. (8460-8490ft), *Deflandrea* cf. *D. phosphoritica, sensu* Williams and Bujak, 1977b (8600ft), *D.* sp. B Williams and Bujak, 1977b (8660-8690ft), *Membranilarnacia* cf. *M. ursulae, Pistillipollenites mcgregorii, Polysphaeridium* cf. *P. simplex* (common at 8600ft), *Systematophora* sp., *Wetzeliella articulata* (9080ft).

9160-12382': *Areoligera senonensis* assemblage (early (early Eocene)

Apectodinium homomorphum, A. homomorphum subsp. *quinquelatum, A. parvum, Areoligera medusettiformis, A. medusettiformis, sensu* Gocht, 1969, *Azolla* sp., *Cordosphaeridium gracile, Cyclonephelium ordinatum, Deflandrea denticulata, D. oebisfeldensis, Eisenackia* sp., *Homotryblium* cf. *H. tenuispinosum, Platycaryapollenites* sp. A Williams and Bujak, 1977b, *Wilsonidium echinosuturatum*.

12450-12880': *Ceratiopsis speciosa* assemblage (late Paleocene)

Ceratiopsis speciosa, Deflandrea dartmooria, Hystrichosphaeridium tubiferum, Spinidinium sp.

12950-13480': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Eisenackia circumtabulata, Lejeunia magnifica, L. tricuspis, Palaeoperidinium pyrophorum.

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Tenneco *et al.*
LEIF E-38

GSC locality: D32

Location: 54°17'29.87"N; 55°05'52.17"W

RT elevation: 40' Water depth: 550'

Casing set at: 627, 1079, and 3128'

Total depth: 3557' Interval studied: 1130-3557'

Analyzed by: G.L. Williams

Palynological analysis of 25 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonations:

1130- 1920' *T. igniculus* assemblage (Plio-Pleistocene)
1990- 2870' *O. centrocarpum* assemblage (middle-late Miocene)
2920- 3557' *E. indentata* assemblage (early Miocene)

The above age assignments are tentative because of the extremely poor sample control in Leif E-38. The early Miocene assemblage is dominated by *Epicephalopyxis indentata*, previously recorded from the early Miocene of the Grand Banks as *Xenikoon* sp. A by Williams and Brideaux, 1975. The middle to late Miocene assemblages are extremely sparse with a low species diversity and few specimens. The Plio-Pleistocene contains reworked Senonian, Eocene and Miocene taxa.

Selected palynomorphs

1130-1920': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Alnipollenites verus, Caryapollenites simplex, Pinus sp., *Tsugaepollenites igniculus*.

Reworked specimens of pre-Pliocene species are present throughout. They are either Senonian, Eocene

or Miocene in age. Campanian species include *Aquilapollenites* sp., *Chatangiella victoriensis, Isabelidinium belfastense,* and *Rugubivesiculites convolutus.* Eocene species include *Cordosphaeridium gracile* and *Cyclonephelium* sp. Miocene species are *Bombacacidites* sp A Williams and Brideaux, 1975, *Hemicystodinium* sp. Williams, 1975, and *Palaeocystodinium golzowense.* The Miocene taxa occur throughout the Plio-Pleistocene sequence. The Eocene taxa first appear at 1410-1440ft and are common at 1500-1530ft and 1590-1620ft. The Campanian species appear at 1590-1620ft and are present at 1690-1720ft and 1790-1820ft.

1990-2870': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Lejeunia sp. Williams and Bujak, 1977b, *Lingulodinium machaerophorum, Spiniferites ramosus, Systematophora ancyrea.*

2920-3557': *Epicephalopyxis indentata* assemblage (early Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Epicephalopyxis indentata, Polysphaeridium pastielsii.*

Specimens of reworked Senonian and Eocene species are present in this interval. These include *Areoligera senonensis, sensu* Gocht, 1969, *Kisselovia coleothrypta,* and *Pentadinium laticinctum granulatum.*

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Eastcan *et al.*
LEIF M-48

GSC locality: D107

Location: 54°17'45.92"N; 55°07'20.17"W

RT elevation: 40' Water depth: 545'

Casing set at: 663, 1259, and 3706'

Total depth: 6165' Interval studied: 1290-6025'

Analyzed by: G.L. Williams

Palynological analysis of 54 cuttings samples and 23 sidewall cores from the Eastcan *et al.* Leif M-48 well indicates the following age determinations and biostratigraphic zonation:

1290- 1890'	*T. igniculus* assemblage (Plio-Pleistocene)
2000- 2390'	Miocene-Pliocene
2400- 2890'	*O. centrocarpum* assemblage (middle-late Miocene)
2890- 3790'	*E. indentata* assemblage (early Miocene)
3850- 3920'	*C. fibrospinosum-Deflandrea* sp. C. assemblage (middle-late Oligocene)
3940- 4060'	*W. ovalis* assemblage (early Oligocene)
4120- 4960'	*W. lunaris* assemblage (middle-late Eocene)
5010- 5650'	*A. senonensis* assemblage (early Eocene)
5712- 5750'	*C. speciosa* assemblage (late Paleocene)
5800'	*E. circumtabulata* assemblage (early-late Paleocene)
5876- 6025'	*A. nucula-H. chlamydata* assemblage (Maastrichtian)

The bottom 140ft of Leif M-48 (6025-6165ft) are volcanics dated Early Cretaceous by McWhae and Michel, (1975). The palynological zonation of this well is based on sidewall cores and cuttings. Sidewall cores containing diagnostic dinoflagellate assemblages have been examined at 5410, 5550, 5712, 5800, 5876, 5912, 5950, 6000, and 6025ft. These permit delineation of the Maastrichtian, the lower Paleocene and the upper Paleocene-lower Eocene contact. Verification of the Eocene-Oligocene top or the Miocene top is not possible at this time.

Selected palynomorphs

1290-1890': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Alnipollenites verus, Betulaepollenites, Caryapollenites simplex, Pinus sp., *Tsugaepollenites igniculus.*

Reworked specimens are common throughout this interval and are predominantly Senonian, Oligocene or Miocene species. Miocene species include *Apteodinium* sp. B Williams and Brideaux, 1975, *Cannosphaeropsis* sp. A Williams and Brideaux, 1975, and *Hemicystodinium* sp. Williams, 1975. These are present in the sidewall core from 1290ft and in the cuttings samples 1300-1330, 1400-1490, and 1600-1690ft. Oligocene species include *Chiropteridium lobospinosum* and *Deflandrea phosphoritica.* These occur in the sidewall core from 1290ft and the cuttings samples at 1300-1330 and 1400-1490ft. The most abundant reworked species are of Late Cretaceous age. These include *Aquilapollenites* sp., *Chatangiella tripartita, C. victoriensis, Dinogymnium euclaensis, Oligosphaeridium anthophorum,* and *Rugubivesiculites rugosus.* All of these species have been previously recorded from the Senonian. They are present in Leif M-48 in the sidewall core from 1290ft and the cuttings samples at 1326-1390, 1400-1490, 1600-1690, 1690-1720, 1700-1790, and 1800-1890ft.

2000-2390': Miocene-Pliocene

Lingulodinium sp.

2400-2890': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Bombacacidites sp. A Williams and Brideaux, 1975, *Lejeunia* sp. Williams and Brideaux, 1977b, *Osmundacidites* sp. A Williams and Bujak, 1977b, *Pediastrum* sp., *Systematophora ancyrea.*

Systematophora ancyrea does not extend into the uppermost Miocene in the Grand Banks sediments. It is therefore possible that part of the upper Miocene is absent in Leif M-48.

2890-3790': *Epicephalopyxis indentata* Zone (early Miocene)

Diatoms, Epicephalopyxis indentata, Phthanoperidinium sp. (3290-3310ft), *Polysphaeridium pastielsii* (3580-3610ft).

Down to 3590ft reworked Late Cretaceous species are common. Whether these were reworked in the lower Miocene or represent caving from the Pleistocene sequence cannot be determined since all the productive samples are cuttings samples.

3850-3920': *Cordosphaeridium fibrospinosum-Deflandrea* sp. C assemblage (middle-late Oligocene)

Cordosphaeridium fibrospinosum.

3940-4060': *Wetzeliella ovalis* assemblage (early Oligocene)

Cordosphaeridium cantharellum, Deflandrea sp. C Williams and Bujak, 1977b, *Thalassiphora pelagica, Wetzeliella ovalis.*

4120-4960': *Wetzeliella lunaris* assemblage (middle-late Eocene)

Achomosphaera alcicornu, Adnatosphaeridium reticulense, Baltisphaeridium sp., *Cordosphaeridium cracenospinosum, Cyclonephelium* cf. *C. pastielsii, Deflandrea phosphoritica, D.* sp. B Williams and Bujak, 1977b, *Diphyes colligerum, Kisselovia tenuivirgula, Pentadinium* sp., *Pterocaryapollenites* sp. A Williams and Bujak, 1977b, *Wetzeliella lunaris.*

5010-5650': *Areoligera senonensis* assemblage (early Eocene)

Apectodinium homomorphum, Areoligera senonensis, sensu Gocht, 1969, *Eocladopyxis peniculatum, Extratriporopollenites* sp., *Hystrichosphaeridium* cf. *H. tubiferum, Platycaryapollenites* sp. A Williams and Bujak, 1977b, *Rhombodinium condylos.*

5712-5750': *Ceratiopsis speciosa* assemblage (late Paleocene)

Ceratiopsis speciosa, Deflandrea dartmooria.

5800': *Eisenackia circumtabulata* assemblage (early-late Paleocene)

Eisenackia circumtabulata.

5876-6025': *Amphidiadema nucula-Hexagonifera chlamydata* assemblage (Maastrichtian)

Amphidiadema nucula, Ceratiopsis diebelii, Hystrichosphaeridium sp. A Williams and Bujak, 1977b, *Isabelidinium cretaceum, Spiniferites scabrosus.*

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Eastcan *et al.*
SNORRI J-90

GSC locality: D152

Location: 57°19'44.52"N; 59°57'44.37"W

RT elevation: 37' Water depth: 462'

Casing set at: 579, 1225, 3699, and 8845'

Total depth: 10531' Interval studied: 1260-10335'

Analyzed by: G.L. Williams

Palynological analysis of two conventional core, 20 sidewall core and 73 cuttings samples from the subject well indicates the following age determinations and biostratigraphic zonation:

1260- 4170' *T. igniculus* assemblage (Plio-Pleistocene)
4250- 4980' *O. centrocarpum* assemblage (middle-late Miocene)
5040- 5160' *E. indentata* assemblage (early Miocene)
5220- 5250' *W. ovalis* assemblage (early Oligocene)
5400- 7410' *W. lunaris* assemblage (middle-late Eocene)
5400- 6330' late Eocene
6390- 7410' middle Eocene
7525- 8194' *A. senonensis* assemblage (early Eocene)
8200- 9565' *C. speciosa* assemblage (late Paleocene)
9720- 9850' *P. pyrophorum* assemblage (early Paleocene)
9926- 9965' Barremian
10040-10250' no diagonistic fossils
10261' Jurassic?-Barremian
10270-10335' no diagonistic fossils

Eastcan *et al.* Snorri J-90 encountered basement at 10 335ft. A sidewall core from 10 261ft contains a sparse spore assemblage which can only be dated Jurassic? to Barremian. The two sidewall core samples from 9965 and 9926ft and both from the same sandstone, can be dated with some degree of confidence as Barremian. The abundance of spores, together with the absence of dinoflagellates, indicates non-marine deposition.

Overlying this are marine Paleocene sediments containing dinocysts which occur in coeval sediments in other Labrador Shelf and several Scotian Shelf wells. The *Eisenackia circumtabulata* assemblage is not recognized in these sediments indicating a possible hiatus. The Eocene dinoflagellates are more provincial, a trend also reflected by the spores. A thin unit of Oligocene is recognised between 5250 and 5220ft. Within the Miocene, reworked Cretaceous spores and dinocysts are commonly encountered. The thick Plio-Pleistocene section contains reworked Paleozoic acritarchs, and Late Cretaceous through Miocene dinocysts and spores. Paleoenvironmental determinations would be too speculative to have any meaning.

Selected palynomorphs

1260-4170': *Tsugaepollenites igniculus* assemblage (Plio-Pleistocene)

Abies sp., *Pinus* spp., *Tsugaepollenites igniculus.*

4250-4980': *Operculodinium centrocarpum* assemblage (middle-late Miocene)

Alnipollenites verus, Bombacacidites sp. A Williams and Brideaux, 1975, *Caryapollenites simplex, Osmundacidites* sp. A Williams and Bujak, 1977b, *Rouseisporites* sp., *Sequioapollenites* sp.

Reworked taxa include *Aquilapollenites* and *Chlamydophorella nyei.*

5040-5160': *Epicephalopyxis indentata* assemblage (early Miocene)

Epicephalopyxis indentata, Polypodiumsporites sp.

5220-5250': *Wetzeliella ovalis* assemblage (early Oligocene)

Operculodinium israelianum, Kisselovia cf. *K. coleothrypta.*

5400-7410': *Wetzeliella lunaris* assemblage (middle-late Eocene)

5400-6330': late Eocene

Cordosphaeridium fibrospinosum, Cyclonephelium sp. C Williams and Brideaux, 1975, *Hystrichokolpoma rigaudiae, Kisselovia coleothrypta, Lingulodinium machaerophorum, Nyssapollenites* sp. A Williams and Bujak, 1977b, *Rhombodinium intermedium.*

6390-7410': middle Eocene

Achilleodinium biformoides, Areosphaeridium diktyoplokus, Azolla sp. (7410ft), *Cicatricososporites* sp. (6480ft), *Deflandrea* cf. *D. phosphoritica, sensu* Williams and Bujak, 1977b (6800ft), *Homotryblium tenuispinosum* (7380ft),

Pistillipollenites mcgregorii, Platycaryapollenites sp. A Williams and Bujak, 1977b, *Polysphaeridium* cf. *P. simplex, Systematophora* sp. *Wetzeliella articulata, Wilsonidium echinosuturatum* (7380ft).

7525-8194': *Areoligera senonensis* assemblage (early Eocene)

Adnatosphaeridium patulum, Ceratiopsis cf. *C. speciosa, Cordosphaeridium gracile, Deflandrea denticulata, Leptodinium victorianum, Rhombodinium condylos, Rhombodinium glabrum.*

8200-9565': *Ceratiopsis speciosa* assemblage (late Paleocene)

Apectodinium homomorphum, A. hyperacanthum, Areoligera medusettiformis, Ceratiopsis speciosa, Deflandrea dartmooria, Oligosphaeridium complex, Palaeocystodinium benjaminii.

9720-9850': *Palaeoperidinium pyrophorum* assemblage (early Paleocene)

Eisenackia circumtabulata, Palaeoperidinium pyrophorum.

9926-9965': Barremian

Alisporites grandis, Appendicisporites cf. *A. jansonii, Callialasporites dampieri, Cerebropollenites mesozoicus, Cicatricosisporites australiensis, C. hallei, Vitreisporites* sp. Singh, 1971.

10040-10250': no diagonistic fossils

10261': Jurassic?-Barremian

Cerebropollenites mesozoicus, Perinopollenites elatoides.

10270-10335': no diagonistic fossils

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Eastcan *et al.*
VERRAZANO L-77

GSC locality: D167

Location: 52°26'36.5"N; 54°11'52.6"W

RT elevation: 42' Water depth: 600'

Casing set at: 680 and 1450'

Total depth: 1509' Interval studied: 690-1509'

Analyzed by: M.S. Barss

Nine cuttings samples were studied from the 690 to 1509ft interval. The samples are all palyniferous, although the samples from 780-810, 880-910, and 980-1010ft contain only a few palynomorphs. Cavings could not be recognized because of the similarity of the forms recognized in each sample.

The assemblage listed is a composite assemblage. All of the types listed did not occur in all of the samples studied. The assemblage compares closely with that reported by Neves and Belt, 1970 from the late Viséan-early Namurian of the Antigonish Basin, Nova Scotia. This occurrence considerably extends the known limits of sediments of this age in eastern Canada.

The following age determination has been made:

690- 1509' late Viséan-early Namurian

Selected palynomorphs

690-1509': late Viséan-early Namurian

Anaplanisporites globulus, Apiculatisporis sp., *Calamospora breviradiata, C. microrugosa, C. mutabilis, C. pallida, Camptotriletes* sp., *Cirratriradites* cf. *C. ornatus, Convolutispora ampla, C. pseudolunatus, C. vermiformis, Crassispora maculosa, Cyclogranisporites* spp., *Deltoidospora inerma, Densosporites triangularis, Dictyotriletes mediareticulatus, D.* sp. Barss, 1967, pl. XIII, fig. 15, *Discernisporites micromanifestus, Foveosporites* sp., *Grandispora spinosa, Granulatisporites tuberculatus, Ibrahimispores brevispinosus, Knoxisporites* cf. *K. cinctus, K. hederatus, K. inconspicuus, K. stephanephorus, K. triradiatus, Lophotriletes commissuralis, L. coniferus, Lycospora noctuina* var. *noctuina, L. pusilla, Phylothecotriletes* sp., *Punctatisporites heterofiliferus, Raistrickia ponderosa, ?Remysporites* sp., *Reticulatisporites decoratus, Retusotriletes incohatus, Rugospora corporata, R. minuta, Schopfipollenites ellipsoides, Schulzospora elongata, S. plicata, S. rara, Spelaeotriletes arenaceous, Triquitrites marginatus, Velamisporites magnus, V. perinatus, Verrucosisporites morulatus, V. verrucosus, V. microtuberosus, Waltzisporites politus.*

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AGE OF FORMATIONS

McIver (1972) was the first author to propose a formal terminology for the Mesozoic-Cenozoic stratigraphic units on the Scotian Shelf. He erected three groups, 12 formations and four members. Amoco and Imperial (1973), in a discussion of the regional geology of the Grand Banks, used informal designations for four units that they recognized. Swift *et al.* (1975) added one informal unit which they recognized on the Grand Banks. Jansa and Wade (1975) discussed the geology of the continental margin off Nova Scotia and Newfoundland. They recognized McIver's units with some modifications and defined one formation and two informal units. Hardy (1975) subdivided McIver's Banquereau Formation into four informal units. Jansa *et al.* (1976, 1977) defined a total of three informal units on the Grand Banks.

The palynologically defined ages for the type sections of the lithostratigraphic units, as defined in the above papers, are discussed below in alphabetical order.

Ages of lithostratigraphic units on the Labrador Shelf will be given by Umpleby (in press), who is proposing a formal terminology for the units recognized in the wells. All footages quoted are from rotary table.

Abenaki Formation

McIver (1972) defined the type section of the Abenaki Formation in Shell Oneida O-25 between 9460 and 12 620ft. Williams (1975) dated this interval as Middle Jurassic to Tithonian and stated "the top of the Abenaki Formation would lie very close to the Jurassic-Cretaceous boundary". The interval 9460-12 360ft is dated palynologically as Callovian to Berriasian-Valanginian? in this paper.

Argo Formation

McIver (1972) did not define the precise footage for the type section of the Argo Salt in Shell Argo F-38, although he stated that it comprised approximately 2500ft of relatively pure halite. Jansa and Wade (1975) referred to this unit as the Argo Formation, but also did not give the precise interval. J.A. Wade (pers. comm.) designates the interval 7563-10 122 ft in Shell Argo F-38 as the type section for the Argo Formation. The interval is dated palynologically as Rhaetian-early Hettangian to Early Jurassic.

Baccaro Member of the Abenaki Formation

McIver (1972) defined the type section of the Baccaro Member in Shell Oneida O-25 between 9460 and 12 040ft. This interval is dated palynologically as Oxfordian-early Kimmeridgian to Berriasian-Valanginian?.

Banquereau Formation

McIver (1972) defined the type section of the Banquereau Formation in Mobil Sable Island C-67 between 567 and 4472ft. This interval is dated palynologically as Campanian to Plio-Pleistocene. Williams (1975) dated the interval 875-4470ft in Sable Island C-67 as Maastrichtian to Miocene.

Dawson Canyon Formation

McIver (1972) defined the type section of the Dawson Canyon Shale in Shell Missisauga H-54 between 3420 and 4310ft. The interval is dated palynologically as Cenomanian to Santonian. Jansa and Wade (1975) referred to this unit as the Dawson Canyon Formation.

Eider Member of the Logan Canyon Formation

The informal term "Eider Unit" was introduced by Amoco and Imperial (1973) who stated that it consisted of "generally clean and porous, fine- to coarse-grained sands" and might correlate with the Logan Canyon Formation. They stated that the unit was up to 1000ft thick and their figs. 4 and 5 indicate its presence in Amoco-Imp Gannet O-54 and Petrel A-62, Amoco-IOE Eider M-75 and Puffin B-90, and Pan-Am IOE Grand Falls H-09.

Jansa and Wade (1975) referred to this unit as the Eider Member and stated that it "corresponds to the upper sandstone pulse of the Logan Canyon Formation in the Scotian Basin". Swift *et al.* (1975, fig. 11) indicated that the Eider Unit is present in Amoco-Imp Heron H-73 from 7780-8070ft. This interval is dated palynologically as Late Jurassic to late Albian-Cenomanian. Comparison with the resistivity log (Swift *et al.*, 1975, fig. 11) indicates that the top of the Jurassic is at 8070ft, so that the Eider unit is late Albian to Cenomanian.

Jansa *et al.* (1976) stated that the interval 2750-2975ft in Amoco-IOE Murre G-67 may be equivalent to the "Eider Unit". This interval is dated palynologically as Albian to Cenomanian.

Esperanto beds of the Banquereau Formation

The informal term Esperanto beds was introduced by Hardy (1975) who stated that a representative section occurs in Shell Oneida O-25 between 900 and 1620ft. This interval is dated palynologically as middle-late Oligocene to middle-late Miocene.

Eurydice Formation

Jansa and Wade (1975) defined the type section of the Eurydice Formation in Shell Eurydice P-36 between 7850 and 9728ft, the lower contact was not penetrated. This interval is dated palynologically as Rhaetian-early Hettangian to late Hettangian-early Sinemurian.

Heron Limestone

The informal term "Heron Limestone" was introduced by Swift *et al.* (1975) who stated that it was "a white to reddish-brown limestone of microcrystalline to medium grain (.25mm) size". They indicated (fig. 11) its presence in Amoco-Imp Heron H-73 between approximately 7634 and 7780ft. This interval is dated palynologically as late Albian-Cenomanian.

Iroquois Formation

McIver (1972) defined the type section of the Iroquois Formation in Shell Iroquois J-17 between 5922 and 6707ft. This interval is dated palynologically as late Hettangian-early Sinemurian to late Sinemurian-early Pliensbachian.

Kettle red beds

The informal term Kettle red beds was introduced by Jansa *et al.* (1977) for "a terrigenous sequence composed of interbedded reddish mudstone, sandstone and conglomerate" in Amoco-Imp-Skelly Osprey H-84 between 10 846 and 11 397ft. This interval is dated palynologically as Carnian-Norian.

Logan Canyon Formation

McIver (1972) defined the type section of the Logan Canyon Formation in Shell Cree E-35 between 4833 and 7903ft. This interval is dated palynologically as Aptian to early Cenomanian.

Manhasset beds of the Banquereau Formation

The informal term Manhasset beds was introduced by Hardy (1975) who stated that a representative section occurs in Mobil Sable Island C-67 between 1740 and 2490ft. This interval is dated palynologically as early Oligocene to middle-late Oligocene.

Maskonomet beds of the Banquereau Formation

The informal term Maskonomet beds was introduced by Hardy (1975) who stated that a representative section occurs in Shell Oneida O-25 between 2325 and 4000ft. This interval is dated palynologically as Campanian to early Paleocene.

Mic Mac Formation

McIver (1972) defined the type section of the Mic Mac Formation in Shell Mic Mac H-86 between 10 210 and 14 460ft. This well has not been analyzed by the present authors. A section partially equivalent to this occurs in the nearby well Shell Mic Mac J-77 between 10 062 and 12 750ft (T.D.) (J.A. Wade, pers. comm.). This interval is dated palynologically as Callovian to Kimmeridgian.

Misaine Member of the Abenaki Formation

McIver (1972) defined the type section of the Misaine Member in Shell Oneida O-25 between 12 040 and 12 277ft. This interval is dated palynologically as Callovian to Oxfordian-early Kimmeridgian.

Missisauga Formation

McIver (1972) described the Missisauga Formation as "a dominantly sandstone sequence occurring as thick, massive sand units in the updip and central basin regions and grading into thinner units downdip and towards the western shelf region". He defined the type updip section in Shell Missisauga H-54 between 7920 and 11 605ft, and the type downdip section in Shell Cree E-35 between 8473 and 12 303ft. These intervals are dated here as Berriasian-Valanginian to Barremian and Berriasian-Valanginian to Aptian respectively.

Mohawk Formation

McIver (1972) described the Mohawk Formation as "overlying the pre-Jurassic surface, or the Iroquois Formation where it is present, and underlying the Abenaki Formation" and defined the type section in Shell Mohawk B-93 between 5280 and 6930ft. This interval is dated palynologically as Bathonian to Berriasian-Valanginian.

Jansa and Wade (1975) suggested that the interval 14 892 to 15 700ft in Shell Mic Mac H-86 be designated as the new type section for the Mohawk Formation because they believed that "the interval 5280 to 6335ft in the Mohawk well is correlative to the Abenaki and equivalent formations".

Given (1977) redefined the Mohawk Formation, restricting it to "the texturally more mature sands found on the Western Shelf, which are better sorted and locally calcareous". She retained the type section for the redefined Mohawk Formation as designated by McIver (1972). Given (1977) erected the Mohican Formation for the "texturally less mature sands, which tend to be poorly sorted, dolomitic, silty, argillaceous, kaolinitic and locally interbedded with varicolored shale", which occur between the Iroquois Formation and the Scatarie Member of the Abenaki Formation.

Mohican Formation

Given (1977) defined the type section of the Mohican Formation in Shell Oneida O-25 between 12 680 and 13 483ft, with the basal contact not being penetrated. This interval was dated palynologically as Middle Jurassic by Williams (1975).

Murre Carbonate

The informal term Murre Carbonate was introduced by Amoco and Imperial (1973) who stated that this unit was 1120ft thick in the Amoco-IOE Murre G-67 well, where it is mostly micritic and dolomitized limestones. They did not give precise details of the footage of this unit.

Jansa and Wade (1975) considered that the Murre Carbonate interval from 8454 to 9590ft in the Murre G-67 well represented an extention of the Iroquois Formation beneath the Grand Banks. The interval 8454-9541ft is dated palynologically as late Hettangian-early Sinemurian to Pliensbachian.

Nashwauk beds of the Banquereau Formation

The informal term Naskwauk beds was introduced by Hardy (1975) who stated that a representative section occurs in Mobil-Tetco Esperanto K-78 between 1620 and 2360ft. This interval is dated palynologically as late Paleocene to middle Eocene.

Naskapi Member of the Logan Canyon Formation

McIver (1972) defined the type section of the Naskapi Shale, giving it formational status, in Shell Cree E-35 between 7903 and 8473ft. This interval is dated palynologically as Aptian.

Jansa and Wade (1975) referred to this unit as the Naskapi Member of the Logan Canyon Formation.

Osprey evaporites

The informal term Osprey evaporites was introduced by Jansa *et al.* (1977) for an evaporite sequence extending from 4108 to 10 846ft in Amoco-Imp-Skelly Osprey H-84. This interval is dated palynologically as Carnian-Norian to Hettangian-Sinemurian.

Petrel Member of the Dawson Canyon Formation

The informal term Petrel Limestone was introduced by Amoco and Imperial (1973) for an approximately 280ft marl and chalk interval in Amoco-Imp Gannet O-54. Precise footages were not given.

Swift *et al.* (1975) stated that "the Petrel Limestone most commonly consists of microcrystalline limestone of an apparent outer-shelf environment of deposition. It is locally more than 400ft (122m) thick". They indicated (fig. 11) its presence in Amoco-Imp Heron H-73 between 7230 and 7634ft. This interval is dated palynologically as Cenomanian to Coniacian. Swift *et al.* stated, "We do not proposed formal formation or member status for the Petrel Limestone in this paper but suggest that this should be considered at some future time when more well control has been obtained and released from confidential status".

Jansa and Wade (1975) stated "One regionally persistant limestone marker was described by McIver (1972). This marker correlates with a similar one on the western Grand Banks named the Petrel Limestone (Amoco Canada Petroleum Co. Ltd. and Imperial Oil Ltd., 1973). In this report these limestones, which are good regional seismic markers, are formally designated the Petrel Member of the Dawson Canyon Formation". Jansa and Wade did not specify a type section.

Red Shale Unit

The informal term Red Shale Unit was introduced by Amoco and Imperial (1973) for "a gypsiferous red shale or mudstone unit" in Amoco-IOE Murre G-67 where it is 745ft thick; the precise interval was not specified. According to Amoco and Imperial (1973), the unit is underlain by metamorphic basement rocks and overlain by Lower Jurassic carbonates.

Jansa and Wade (1975) identified a 760ft thick red bed sequence from 9590-10 350ft in Murre G-67 and tentatively correlated it with the Eurydice Formation.

Jansa *et al.* (1976) designated the interval 9590-10 350ft in Murre G-67 as "unnamed red beds". These are synonymous with the Red Shale Unit but have not been dated palynologically because of the absence of palynomorphs.

Sable Member of the Logan Canyon Formation

McIver (1972) defined the type section of the Sable Shale Member in Shell Cree E-35 between 5595 and 5838ft. This interval is dated palynologically as late Albian. Jansa and Wade (1975) referred to this unit as the Sable Member of the Logan Canyon Formation.

Scatarie Member of the Abenaki Formation

McIver (1972) defined the type section of the Scatarie Member in Shell Oneida O-25 between 12 277 and 12 620ft. The interval 12 277-12 360ft is dated palynologically as Callovian.

Shortland Shale

The informal term Shortland Shale was introduced by Jansa and Wade (1975). They hypothesized, "Seaward from the Logan Canyon Formation, there exists a predominantly shaly sequence herein informally designated the Shortland Shale". They could not designate a type section for the unit as it had not been drilled.

Given (1977) stated, "The term Shortland shale, proposed by Jansa and Wade (1975, p. 83) for the shale equivalent of the Logan Canyon Formation is unsatisfactory as it is a duplication of the Dawson Canyon Formation defined by McIver (1972, p. 66)...."

Verrill Canyon Formation

McIver (1972) defined the type section of the Verrill Canyon Shale in Shell Oneida O-25 between 8280 and 9460ft. Williams (1975) dated this interval Berriasian to early Aptian. The interval 8280-9430ft is now dated palynologically as Hauterivian to Aptian. Jansa and Wade (1975) referred to this unit as the Verrill Canyon Formation.

Whale Unit

The informal term Whale Unit was introduced by Jansa and Wade (1975). They stated that "The sequences encountered from 8612-11,582ft (2626-3531m) (T.D.) in the Eider well, 5960-8454ft (1817-2577m) in the Murre well, and 6580-11,360ft (2006-3463m) in the Bittern well are given the informal name "Whale Unit". The maximum palynological age range for these intervals is Pliensbachian to early Callovian (see well reports).

Jansa *et al.* (1976) assigned the interval 3740-8454ft in Amoco-IOE Murre G-67 to the Whale Unit. This interval is dated palynologically as Pliensbachian to Kimmeridgian.

Wyandot Formation

McIver (1972) defined the type section of the Wyandot Chalk in Shell Mic Mac H-86 between 2440 and 2730ft. Since 2440ft is exactly 100 feet below the top of the chalk in Mic Mac H-86 it is assumed that a typographical error occurs and the intended top is 2340ft. This well has not been analyzed by the present authors. A section equivalent to 2340-2730ft occurs in the nearby well Shell Mic Mac J-77 between 2132 and 2505ft (J.A. Wade, pers. comm.). This interval is dated palynologically as Campanian.

Jansa and Wade (1975) used the term Wyandot Formation and expanded its definition. They stated, "The occurrence of chalk or limestone strata interbedded with marl requires the expansion of the definition of the Wyandot Formation from the uppermost chalk bed described by McIver (1972), to a dominantly chalk formation with marl and calcareous shale interbeds, as represented by the interval 4700-6002ft (1433-1830m) in the Mobil-Tetco Dauntless D-35 well". This interval is dated palynologically as Campanian to Maastrichtian.

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APPENDIX

Spores and pollen

ABIES Miller

ACANTHOTRILETES Naumova
hacquebardii Playford
varispinosus Pocock

AEQUITRIRADITES Delcourt and Sprumont
spinulosus Cookson and Dettmann
verrucosus (Cookson and Dettmann) Cookson and Dettmann

AHRENSISPORITES Potonié and Kremp
guerickei (Horst) Potonié and Kremp

ALATISPORITES Ibrahim
hexalatus Kosanke
trialatus Kosanke

ALISPORITES Daugherty
grauvogelii Klaus
grandis (Cookson) Dettmann

ALNIPOLLENITES Potonié
verus (Potonié) ex Potonié

AMBROSIA Linnaeus
sp. Williams, 1975

ANACOLOSIDITES Cookson and Pike

ANAPICULATISPORITES Potonié and Kremp
ampullaceus (Hacquebard) Playford

ANAPLANISPORITES Jansonius
globulus Butterworth and Williams

ANCYROSPORA Richardson
furcula Owens
involucra Owens
langii (Taugourdeau-Lantz) Allen

ANEUROSPORA Streel
goensis Streel

ANTULISPORITES Archangelsky and Gamerro
varigranulatus (Levet and Carette) Reiser and Williams

APICULATASPORITES Ibrahim

APICULATISPORIS Potonié and Kremp
abditus (Loose) Potonié and Kremp
aculeatus Ibrahim
baccatus Hoffmeister, Staplin, and Malloy
grumosus (Ibrahim) Potonié and Kremp
imbricatus (Kosanke) Potonié and Kremp
irregularis (Kosanke) Potonié and Kremp
latigranifer (Loose) Potonié and Kremp
priscus (Kosanke) Potonié and Kremp
setulosus (Kosanke) Potonié and Kremp
spinulistratus (Loose) Potonié and Kremp
verrucifer (Kosanke) Potonié and Kremp

APICULIRETUSISPORA Streel

APPENDICISPORITES Weyland and Krieger
bifurcatus Singh
bilateralis Singh
concentricus Kemp
jansonii Pocock
potomacensis Brenner
problematicus (Burger) Singh
spinosus Pocock
tricornitatus Weyland and Greifeld
tricuspidatus Weyland and Greifeld
unicus (Markova) Singh

AQUILAPOLLENITES Rouse

ARAUCARIACITES Cookson ex Couper
australis Cookson
fissus Reiser and Williams
punctatus (Nilsson) Cornet and Traverse

ARCELLITES Miner
reticulatus (Cookson and Dettmann) Potter

ARCHAEOZONOTRILETES Naumova
variabilis Naumova

ARMATISPORITES Dybová and Jachowicz

ARTEMISIA Linnaeus

AURORASPORA Hoffmeister, Staplin, and Malloy
solisortus Hoffmeister, Staplin, and Malloy

BACULATISPORITES Pflug and Thomson
comaumensis (Cookson) Potonié

BETULAEPOLLENITES Potonié
sp. A Williams and Brideaux, 1975

BIRETISPORITES Delcourt and Sprumont
potoniae Delcourt and Sprumont

BOMBACACIDITES Couper
sp. A Williams and Brideaux, 1975

CADARGASPORITES de Jersey and Paten
verrucosus Reiser and Williams

CADIOSPORA Kosanke
magna Kosanke

CALAMOSPORA Schopf, Wilson, and Bentall
atava (Naumova) McGregor
aerarius Butterworth and Williams
breviradiata Kosanke
hartungiana Schopf
microrugosa (Ibrahim) Schopf, Wilson, and Bentall
minuta Bharadwaj
mutabilis (Loose) Schopf, Wilson, and Bentall
pallida (Loose) Schopf, Wilson, and Bentall
pedata Kosanke
perrugosa (Loose) Schopf, Wilson, and Bentall

CALLIALASPORITES Dev
dampieri (Balme) Dev
obrutus Norris
segmentatus (Balme) Dev
trilobatus (Balme) Dev

CALYPTOSPORITES Richardson

CAMAROZONOSPORITES Pant ex Potonié
insignis Norris
rudis (Leschik) Klaus

CAMEROSPORITES Leschik

pseudoverrucatus Scheuring
secatus Leschik

CAMPTOTRILETES Naumova ex Potonié and Kremp
bucculentus (Loose) Potonié and Kremp
superbus Neves
verrucosus Butterworth and Williams

CARPINIPITES Srivastava
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975

CARPINUS Linnaeus

CARYAPOLLENITES Raatz ex Potonié
simplex (Potonié) Raatz

CEREBROPOLLENITES Nilsson
mesozoicus (Couper) Nilsson

CHOMOTRILETES Naumova ex Naumova

CICATRICOSISPORITES Potonié and Gelletich
annulatus Archangelsky and Gamerro
augustus Archangelsky and Gamerro
australiensis (Cookson) Potonié
brevilaesuratus Couper
dorogensis Pontié and Gelletich
hallei Delcourt and Sprumont
hughesi Dettmann
imbricatus (Markova) Singh
pseudotripartitus (Bolkhovitina) Dettmann
purbeckensis Norris
subrotundus Brenner
venustus Deák

CICATRICOSOSPORITES Thomson and Pflug ex Krutzsch
auritus Singh

CINGULIZONATES Dybová and Jachowicz
rhaeticus (Reinhardt) Schulz

CINGUTRILETES Pierce

CIRCULARESPORITES Danzé and Laveine
cerebroides Danzé and Laveine

CIRRATRIRADITES Wilson and Coe
annulatus Kosanke and Brokaw
flabelliformis Wilson and Kosanke
foveatus Guennel
granulatipunctatus Hoffmeister, Staplin, and Malloy
ornatus Neves
saturni (Ibrahim) Schopf, Wilson, and Bentall
splendens Balme and Hennelly

CLASSOPOLLIS Pflug
classoides Pflug
echinatus Burger
itunensis Pocock
meyeriana (Klaus) de Jersey
simplex (Danzé, Corsin, and Laveine) Reiser and Williams

COLUMNISPORITES Peppers
ovalis Peppers
sp. 2 Peppers, 1964

COMPLEXISPORITES Jizba

CONCAVISSIMISPORITES Delcourt and Sprumont
minor (Pocock) Delcourt, Dettmann, and Hughes
punctatus (Delcourt and Sprumont) Brenner
southeyensis Pocock
variverrucatus (Couper) Brenner

CONTIGNISPORITES Dettmann
cooksonii (Balme) Dettmann
fornicatus Dettmann
glebulentus Dettmann
multimuratus Dettmann
problematicus (Cooper) Döring

CONTAGISPORITES Owens
optivus (Chibrikova) Owens

CONVERRUCOSISPORITES Potonié and Kremp
cameronii (de Jersey) Playford and Dettmann
exquisitus Singh
variverrucatus (Couper) Brenner

CONVOLUTISPORA Hoffmeister, Staplin, and Malloy
ampla Hoffmeister, Staplin, and Malloy
finis Love
flexuosa forma *minor* Hacquebard
florida Hoffmeister, Staplin, and Malloy
klukiforma (Nilsson) Schulz
mellita Hoffmeister, Staplin, and Malloy
pseudolunatus Sabry and Neves
sculptilis Felix and Burbridge
usitata Playford
varicosa Butterworth and Williams
vermiformis Hughes and Playford

COPTOSPORA Dettmann

CORDAITINA Samoilovich
triangularis (Mehta) Hart

CORONATISPORA Dettmann
valdensis (Couper) Dettmann

CORYLUS Linnaeus
tripollenites Rouse

COSTATASCYCLUS Felix and Burbridge
crenatus Felix and Burbridge

COSTATOPERFOROSPORITES Deák
fistulosus Deák
foveolatus Deák

COUPERISPORITES Pocock
jurassicus Pocock

CRASSISPORA Bharadwaj
kosankei (Potonié and Kremp) Bharadwaj
maculosa (Knox) Sullivan
plicata Peppers
trychera Neves and Ioannides
sp. A Neves and Belt, 1970

CRISTATISPORITES Potonié and Kremp
aculeatus (Hacquebard) Potonié
connexus Potonié and Kremp
echinatus Playford
solaris (Balme) Butterworth and Smith

CUCILLISPORA Scheuring

CUPANEIDITES Cookson and Pike
sp. A Williams and Bujak, 1977b

CYATHIDITES Couper
australis Couper
minor Couper

CYCADOPITES Wodehouse
deterius (Balme) Norris
jansonii Pocock
nitidus (Balme) Norris
subgranulosus (Couper) Bujak and Williams
?sp. A Bujak and Williams, 1977
?sp. B Bujak and Williams, 1977

CYCLOBACULISPORITES Bharadwaj
provectus (Kosanke) Potonié and Kremp

CYCLOGRANISPORITES Potonié and Kremp
aureus (Loose) Potonié and Kremp
commodus Playford
lasius (Waltz) Playford
micaceus (Imgrund) Potonié and Kremp
microgranus Bharadwaj
minutus Bharadwaj
orbicularis Kosanke
pergranulus Alpern
provectus (Kosanke) Potonié and Kremp

DECUSSOSPORITES Brenner
microreticulatus Brenner

DELTOIDOSPORA Miner
diaphana Wilson and Webster
hallii Miner
inerma (Waltz) Braman and Hills
juncta (Kara-Murza) Singh
psilostoma Rouse

DENSOISPORITES Weyland and Krieger
perinatus Couper
velatus Weyland and Krieger

DENSOSPORITES Berry
anulatus (Loose) Smith and Butterworth
aseki Potonié and Kremp
duriti Potonié and Kremp
intermedius Butterworth and Williams
pseudoannulatus Butterworth and Williams
rarispinosus Playford
sphaerotriangularis Kosanke
triangularis Kosanke
variomarginatus Playford

DICTYOPHYLLIDITES Couper
equiexinus (Couper) Dettmann
harrisii Couper

DICTYOTRILETES Naumova ex Ishchenko
bireticulatus (Ibrahim) Potonié and Kremp
clatriformis (Artüz) Sullivan
crateris (Balme) Pocock
fragmentimurus Neville
mediareticulatus (Ibrahim) Potonié and Kremp
reticulocingulum (Loose) Smith and Butterworth
sagenoformis Sullivan
submarginatus Playford
sp. Barss, 1967, pl. XIII, fig. 15
sp. Barss, 1967, pl. XIII, fig. 16

DISCERNISPORITES Neves
concentricus Neves
irregularis Neves
micromanifestus (Hacquebard) Neves and Owens
sp. A Neves and Belt, 1970
sp. Barss, 1967, pl. VI, fig. 9
sp. Barss, 1967, pl. VI, fig. 15

DISCISPORITES Leschik
niger Leschik

DISTALANULISPORITES Klaus

DISTALTRIANGULISPORITES Singh
perplexus (Singh) Singh

DUPLICISPORITES Leschik
granulatus Leschik

ECHINITOSPORITES Schulz and Krutzsch
iliacoides Schulz and Krutzsch
cf. *E. iliacoides, sensu* Bujak and Williams, 1977
sp. A Bujak and Williams, 1977

ELLIPSOVELATISPORITES Klaus
plicatus Klaus

EMPHANISPORITES McGregor

ENDOSPORITES Wilson and Coe
globiformis (Ibrahim) Schopf, Wilson, and Bentall
jurassicus Pocock
minutus Hoffmeister, Staplin, and Malloy
ornatus Wilson and Coe
pellucidus Wilson and Coe
zonalis (Loose) Knox
sp. Barss, 1967, pl. VI, fig. 4

ENGELHARDTIOIPOLLENITES Potonié
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975

ENTYLISSA Naumova ex Ishchenko

ENZONALASPORITES Leschik
manifestus Leschik

EPHEDRIA Linnaeus

EPHEDRIPITES Bolkhovitina ex Pontié

EQUISETOSPORITES Daugherty

EUCOMMIIDITES Erdtman ex Potonié
minor Groot and Penny
troedssonii Erdtman

EXESIPOLLENITES Balme
tumulus Balme

EXTRATRIPOROPOLLENITES Pflug
sp. C Williams and Brideaux, 1975

FLORINITES Schopf, Wilson, and Bentall
antiquus Schopf
circularis Bharadwaj
eremus Balme and Hennelly
junior Potonié and Kremp
mediapudens (Loose) Potonié and Kremp
millotti Butterworth and Williams
minutus Bharadwaj
parvus Dybová and Jachowicz
pumicosus (Ibrahim) Schopf, Wilson, and Bentall
similis Kosanke
triletus Kosanke
visendus (Ibrahim) Schopf, Wilson, and Bentall

FORAMINISPORIS Krutzsch
wonthaggiensis (Cookson and Dettmann) Dettmann

FOVEOSPORITES Danzé and Laveine
insculptus Playford
labiosus Singh

FOVEOTRILETES Potonié
subtriangularis Brenner

GEMINOSPORA Balme
lemurata Balme

GLEICHENIIDITES Ross
senonicus Ross

GONDISPORITES Bharadwaj

GRANDISPORA Hoffmeister, Staplin, and Malloy
balteata (Playford) Playford
conspicua (Playford) Playford
naumovii (Kedo) McGregor
procincta (Felix and Burbridge) Playford
spinosa Hoffmeister, Staplin, and Malloy
tenuispinosa (Hacquebard) Playford
uncata (Hacquebard) Playford
velata (Richardson) McGregor

GRANULATISPORITES Ibrahim
elegans Peppers
granulatus Ibrahim
guliferus Potonié and Kremp
minutus Potonié and Kremp
politus Hoffmeister, Staplin, and Malloy
tuberculatus Hoffmeister, Staplin, and Malloy

GRUMOSISPORITES Smith and Butterworth
varioreticulatus (Neves) Smith and Butterworth

GULISPORITES Imgrund
torpidus Playford

GUTHOERLISPORITES Bharadwaj
magnificus Bharadwaj
velensis Bharadwaj

HAMIAPOLLENITES Wilson
tractiferinus (Samoilovich) Jansonius

HAMULATISPORIS Krutzsch
amplus Stanley

HYSTRICHOSPORITES McGregor

IBRAHIMISPORES Artüz
brevispinosus Neves

ILEXPOLLENITES Thiergart ex Potonié
sp. A Williams and Brideaux, 1975

ILLINITES Kosanke
unicus Kosanke

INDOSPORA Bharadwaj

ISCHYOSPORITES Balme
crateris Balme
disjunctus Singh
punctatus Cookson and Dettmann

KLAUSIPOLLENITES Jansonius
reissingeri (Harris) Chaloner

KLUKISPORITES Couper
areolatus Singh
foveolatus Pocock
pseudoreticulatus Couper

KNOXISPORITES Potonié and Kremp
cinctus (Waltz) Butterworth and Williams
corpeus (Loose) Potonié and Kremp
dissidius Neves
hageni Potonié and Kremp
hederatus (Ishchenko) Playford
inconspicuus Felix and Burbridge
literatus (Waltz) Playford
rotatus Hoffmeister, Staplin, and Malloy
seniradiatus Neves
stephanephorus Love
triradiatus Hoffmeister, Staplin, and Malloy

KRAEUSELISPORITES Leschik
linearis (Cookson and Dettmann) Dettmann
reissingeri (Harris) Morbey

LAEVIGATOSPORITES Ibrahim
desmoinesensis (Wilson and Coe)
Schopf, Wilson, and Bentall
medius Kosanke
minimus Dybová and Jachowicz
perminutus Alpern
vulgaris Ibrahim

LATENSINA Alpern

LATOSPORITES Potonié and Kremp

LEIOTRILETES Naumova ex Ishchenko
adnatoides Potonié and Kremp
adnatus (Kosanke) Potonié and Kremp
sphaerotriangulus (Loose) Potonié and Kremp
tumidus Butterworth and Williams

LEIOZONOTRILETES Hacquebard
insignitus Hacquebard

LEPTOLEPIDITES Couper
major Couper
psarosus Norris

LILIACIDITES Couper
crassatus Singh
dividuus (Pierce) Brenner
peroreticulatus (Brenner) Singh
reticulatus (Brenner) Singh
textus Norris

LIMITISPORITES Leschik
monstruosus (Luber and Waltz) Hart
sp. Barss, 1967, pl. XXXIII, fig. 5

LIQUIDAMBARPOLLENITES Raatz ex Potonié

LOPHOTRILETES Naumova ex Ishchenko
babsae (Brenner) Singh
commissuralis (Kosanke) Potonié and Kremp
coniferus Hughes and Playford
gibbosus (Ibrahim) Potonié and Kremp
ibrahimi (Peppers) Pi-Radondy and Doubinger
microsaetosus (Loose) Potonié and Kremp
mosaicus Potonié and Kremp
pseudoaculeatus Potonié and Kremp

LOPHOZONOTRILETES Naumova
grumosus Naumova

LUECKISPORITES Potonié and Klaus

LUNATISPORITES Leschik

LYCOPODIACIDITES Couper
cerniidites (Ross) Krutzsch
rhaeticus Schulz

LYCOPODIUMSPORITES Thiergart ex Delcourt and Sprumont
austroclavatidites (Cookson) Potonié
crassatus Singh
crassimacerius Hedlund
expansus Singh
reticulumsporites (Rouse) Dettmann

LYCOSPORA Schopf, Wilson, and Bentall
noctuina var. *noctuina* Butterworth and Williams
pressoides (Potonié and Kremp) Bharadwaj
pusilla (Ibrahim) Schopf, Wilson, and Bentall
rotunda Bharadwaj

MATONISPORITES Couper
phlebopteroides Couper

MICRORETICULATISPORITES Knox
nobilis (Wicher) Knox
sulcatus (Wilson and Kosanke) Smith and Butterworth

MOMIPITES Wodehouse
coyrloides Wodehouse
tenuipolus Anderson

MOOREISPORITES Neves
inusitatus (Kosanke) Neves

MUROSPORA Somers
kosankei Somers
sp. Barss, 1967, pl. V, fig. 13

MYRTACEIDITES Cookson and Pike

NEORAISTRICKIA Potonié
elongata Reiser and Williams
robusta Brenner
truncata (Cookson) Potonié

NYSSAPOLLENITES Thiergart ex Potonié
sp. A Williams and Bujak, 1977b

ORBISPORIS Bharadwaj and Venkatachala
convolutus Butterworth and Spinner

OSMUNDACIDITES Couper
sp. A Williams and Bujak, 1977b
wellmannii Couper

OVALIPOLLIS Krutzsch
minimus Scheuring
ovalis Krutzsch

PARACIRCULINA Klaus
quadruplicis Scheuring
scurrilis Scheuring

PATINASPORITES Leschik
densus Leschik

PERINOPOLLENITES Couper
elatoides Couper

PERIPOROPOLLENITES Pflug and Thomson
sp. Z Williams and Brideaux, 1975

PHYLOTHECOTRILETES Luber ex Potonié

PICEAPOLLENITES Potonié

PILOSISPORITES Delcourt and Sprumont
notensis Cookson and Dettmann
trichopapillosus (Thiergart) Delcourt and Sprumont
trichopapillosus, sensu Norris, 1969
verus Delcourt and Sprumont
sp. A Bujak and Williams, 1977

PINUS Linnaeus

PISTILLIPOLLENITES Rouse
mcgregorii Rouse

PITYOSPORITES Seward

PLATYCARYAPOLLENITES Nagy
sp. A Williams and Bujak, 1977b

PLICATELLA Luber
abaca (Brenner) Norris

PODOCARPIDITES Cookson ex Couper
multicinus Pocock
sp. Williams and Bujak, 1977b

POLLENITES Potonié ex Potonié and Gelletich
pseudolaesus Potonié

POLYCINGULATISPORITES Simoncsics and Kedves
radiatus Singh

POLYPODIUMSPORITES Raatz

PORCELLISPORA Scheuring
longdonensis (Clarke) Scheuring

POTONIEISPORITES Bharadwaj
bhardwaji Remy and Remy
elegans (Wilson and Kosanke) Wilson and Venkatachala
novicus Bharadwaj
simplex Wilson

PRAECIRCULINA Klaus
granifer (Leschik) Klaus

PROPRISPORITES Neves
undosus Clayton

PROTODIPLOXYPINUS Samoilovich

PROTOHAPLOXYPINUS Samoilovich
globus (Hart) Hart
latissimus (Luber) Samoilovich

PSEUDENZONALASPORITES Scheuring

PSILATRICOLPORITES Van der Hammen ex Pierce
sp. Z Williams and Brideaux, 1975

PTEROCARYAPOLLENITES Raatz ex Potonié
sp. A Williams and Bujak, 1977b

PUNCTATOSPORITES Ibrahim
granifer Potonié and Kremp
minutus Ibrahim

PUNCTATISPORITES Ibrahim
aerarius Butterworth and Williams

compactus Peppers
discretus Gupta
glaber (Naumova) Playford
heterofiliferus Felix and Burbridge
incomptus Felix and Burbridge
irrasus Hacquebard
limbatus Hacquebard
minutus Kosanke
obliquus Kosanke
planus Hacquebard
punctatus Ibrahim
sinuatus (Artüz) Neves
solidus Hacquebard
trifidus Felix and Burbridge
validus Felix and Burbridge
sp. Barss, 1967, pl. V, fig. 10

PUSTULATISPORITES Potonié and Kremp
gibberosus (Hacquebard) Playford
pretiosus Playford

QUERCOIDITES Potonié, Thomson and Thiergart ex Potonié

RADIIZONATES Staplin and Jansonius

RAISTRICKIA Schopf, Wilson, and Bentall
abstrusa Playford
aculeata Kosanke
baculosa Hacquebard
clavata (Hacquebard) Playford
crinita Kosanke
crocea Kosanke
irregularis Kosanke
ponderosa Playford
protensa Kosanke
saetosa (Loose) Schopf, Wilson, and Bentall
superba (Ibrahim) Schopf, Wilson, and Bentall
vulgata Felix and Burbridge
sp. Barss, 1967, pl. XIII, fig. 1

REMYSPORITES Butterworth and Williams
magnificus (Horst) Butterworth and Williams

RETICULATISPORITES Ibrahim
annulatus Guennel
decoratus Hoffmeister, Staplin, and Malloy
muricatus Kosanke
polygonalis (Ibrahim) Loose
reticulatus (Ibrahim) Ibrahim

RETICULISPORITES Potonié and Kremp
vermiformis Kemp

RETITRICOLPITES (Van der Hammen) Pierce
geargensis Brenner
maximus Singh
virgeus (Groot, Penny, and Groot) Brenner
vulgaris Pierce
sp. M Williams and Brideaux, 1975

RETUSOTRILETES Naumova
avonensis Playford
incohatus Sullivan

RHABDOSPORITES Richardson
langii (Eisenack) Richardson

ROUSEISPORITES Pocock
reticulatus Pocock
triangularis Pocock

RUBINELLA Maljavkina
major (Couper) Norris

RUGOSPORA Neves and Owens
corporata var. *corporata* Neves and Owens
minuta Neves and Ioannides
polyptycha Neves and Ioannides
sp. Barss, 1967, pl. VI, fig. 15
sp. Barss, 1967, pl. VI, fig. 22
sp. Barss, 1967, pl. VI, fig. 25

RUGUBIVESICULITES Pierce
convolutus Pierce
reductus Pierce
rugosus Pierce

SAMARISPORITES Richardson
euglyptus Taugourdeau-Lantz

SAPOTACEOIPOLLENITES Potonié

SAVITRISPORITES Bharadwaj
nux (Butterworth and Williams) Sullivan

SCHIZOSPORIS Cookson and Dettmann
parvus Cookson and Dettmann
reticulatus Cookson and Dettmann

SCHOPFIPOLLENITES Potonié and Kremp
ellipsoides (Ibrahim) Potonié and Kremp

SCHOPFITES Kosanke
augustus Playford
claviger Sullivan
colchesterensis Kosanke
dimorphus Kosanke

SCHULZOSPORA Kosanke
elongata Hoffmeister, Staplin, and Malloy
plicata Butterworth and Williams
rara Kosanke

SECARISPORITES Neves
crenatus Peppers
remotus Neves

SEQUOIAPOLLENITES Thiergart

SPACKMANITES Habib
facierugosus (Loose) Habib

SPECIOSOSPORITES Potonié and Kremp
minutus Alpern
triletoides Alpern

SPELAEOTRILETES Neves and Owens
arenaceous Neves and Owens
sp. A Neves and Belt, 1970
sp. B Neves and Belt, 1970
sp. Barss, 1967, pl. XIV, fig. 11

SPINOSPORITES Alpern

STAPLINISPORITES Pocock
caminus (Balme) Pocock
cf. *caminus, sensu* Reiser and Williams, 1969

STENOZONOTRILETES Naumova ex Ishchenko

STEREISPORITES Pflug and Thomson
antiquasporites (Wilson and Webster) Dettmann
perforatus Leschik

STRIATOABIETITES Hart
sp. Barss, 1967, pl. XXXV, fig. 18

STRIATOMONOSACCITES Efremova

STRIATOPODOCARPITES Sedova

STRIATOPOLLIS Krutzsch
paraneus (Norris) Singh

TAENIAESPORITES Leschik

TARAXACUM Zinn

TAUROCUSPORITES Stover
segmentatus Stover

TAXODIACEAEPOLLENITES Kremp ex Potonié
hiatus (Potonié) Kremp

THYMOSPORA Wilson and Venkatachala
obscura (Kosanke) Wilson and Venkatachala
perverrucosa (Alpern) Wilson and Venkatachala
thiessenii (Kosanke) Wilson and Venkatachala
verrucosa (Alpern) Wilson and Venkatachala

TILIAEPOLLENITES Potonié
sp. A Williams and Brideaux, 1975
sp. Williams and Bujak, 1977b

TORISPORA Balme
securis (Balme) Alpern, Doubinger, and Horst
verrucosus Alpern

TRIADISPORA Klaus
triradiata Scheuring

TRIATRIOPOLLENITES Pflug
sp. A Williams and Brideaux, 1975
sp. A Williams and Bujak, 1977b

TRICIDARISPORITES Sullivan and Marshall
arcuatus Neville

TRICOLPITES Cookson
crassimurus (Groot and Penney) Singh
micromunus (Groot and Penney) Singh
parvus Stanley

TRICOLPORITES Erdtman
sp. D Williams and Brideaux, 1975

TRILOBOSPORITES Pant ex Potonié
apiverrucatus Couper
bernissartensis (Deflandre and Sprumont) Potonié
domitus Norris
jurassicus Pocock
marylandensis Brenner
purverulentus (Verbitskaya) Dettmann
tribotrys Dettmann
trioreticulosus Cookson and Dettmann

TRIORITES Erdtman ex Cookson

TRIPARTITES Schemel

TRIPORATE
Type M Williams and Brideaux, 1975
Type O Williams and Brideaux, 1975

TRIQUITRITES Wilson and Coe
additus Wilson and Hoffmeister
bransonii Wilson and Hoffmeister
comptus Williams
crassus Kosanke
marginatus Hoffmeister, Staplin, and Malloy
pulvinatus Kosanke
sculptilis Balme
spinosus Kosanke
trigonappendix (Loose) Potonié and Kremp

TRIVOLITES Peppers

TSUGAEPOLLENITES Potonié and Venitz ex Potonié
igniculus (Potonié) Potonié and Venitz

TUBERCULATOSPORITES Imgrund

ULMIPOLLENITES Wolff
sp. Williams and Brideaux, 1975

VALLASPORITES Leschik
ignacii Leschik

VALLATISPORITES Hacquebard
ciliaris (Luber) Sullivan
torulosa (Hacquebard) Somers
vallatus Hacquebard
verrucosus Hacquebard

VELAMISPORITES Bharadwaj and Venkatachala
magnus (Hughes and Playford) Playford
perinatus (Hughes and Playford) Playford

VERRUCIRETUSISPORA Owens
robusta Owens

VERRUCOSISPORITES Ibrahim
cheneyi Cornet and Traverse
congestus Playford
donarii Potonié and Kremp
grandiverrucosus (Kosanke)
Smith, Butterworth, Knox, and Love
microtuberosus (Loose) Smith and Butterworth
morulatus (Knox) Smith and Butterworth
nitidus Playford
papulosus Hacquebard
pergranulus Alpern
verrucosus (Ibrahim) Ibrahim
sifati (Ibrahim) Smith and Butterworth

VESICASPORA Schemel

VESTIGISPORITES Balme and Hennelly

VESTISPORA Wilson and Hoffmeister
colchesterensis Peppers
costata (Balme) Bharadwaj
fenestrata (Kosanke and Brokaw)
Wilson and Venkatachala
irregularis (Kosanke) Wilson and Venkatachala
laevigata Wilson and Venkatachala
magna (Butterworth and Williams)
Wilson and Venkatachala
profunda Wilson and Hoffmeister
pseudoreticulata Spode
tortuosa (Balme) Bharadwaj

VITREISPORITES Leschik
pallidus (Reissinger) Nilsson
sp. Singh, 1971

VITTATINA (Luber) Samoilovich ex Wilson
subsaccata Samoilovich
sp. Barss, 1967, pl. XXXVI, fig. 4

WALTZISPORA Staplin
politus (Hoffmeister, Staplin, and Malloy) Butterworth and Williams

WILSONITES Kosanke
delicatus Kosanke
kosankei Bharadwaj

Dinoflagellates

ACANTHAULAX Sarjeant

ACHILLEODINIUM Eaton
biformoides (Eisenack) Eaton

ACHOMOSPHAERA Evitt
alcicornu (Eisenack) Davey and Williams
neptuni (Eisenack) Davey and Williams
ramulifera (Deflandre) Evitt
sagena Davey and Williams

ADNATOSPHAERIDIUM Williams and Downie
aemulum (Deflandre) Williams and Downie
caulleryi (Deflandre) Williams and Downie
multispinosum Williams and Downie
?patulum Williams and Downie
reticulense (Pastiels) De Coninck
reticulense, sensu Gocht, 1969
vittatum Williams and Downie
sp. Wilson, 1971

AIORA Cookson and Eisenack
fenestrata (Deflandre and Cookson) Cookson and Eisenack

AIREIANA Cookson and Eisenack
verrucosa Cookson and Eisenack

ALTERBIA Lentin and Williams
acuminata (Cookson and Eisenack) Lentin and Williams
acuminata, sensu Clarke and Verdier, 1967
asymmetrica (Wilson) Lentin and Williams
balmei (Cookson and Eisenack) Lentin and Williams
macrocysta (Cookson and Eisenack) Lentin and Williams
microgranulata (Stanley) Lentin and Williams
minor (Alberti) Lentin and Williams
raijae (Kjellström) Lentin and Williams

AMPHIDIADEMA Cookson and Eisenack
nucula (Cookson and Eisenack) Lentin and Williams
rectangularis (Cookson and Eisenack) Lentin and Williams

AMPHORULA Dodekova
metaelliptica Dodekova

APECTODINIUM (Costa and Downie) Lentin and Williams
homomorphum (Deflandre and Cookson) Lentin and Williams
subsp. *quinquelatum* (Williams and Downie) Lentin and Williams
hyperacanthum (Cookson and Eisenack) Lentin and Williams
parvum (Alberti) Lentin and Williams

APTEA Eisenack
attadalica (Cookson and Eisenack) Davey and Verdier
cf. *A. attadalica, sensu* Williams, 1975
polymorpha Eisenack

APTEODINIUM Eisenack
conjunctum, Eisenack and Cookson, *sensu* Benedek, 1972
grande Cookson and Hughes
granulatum Eisenack
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975
sp. Gocht, 1969

ARANEOSPHAERA Eaton
araneosa Eaton

AREOLIGERA Lejeune-Carpentier
coronata (O. Wetzel) Lejeune-Carpentier, *sensu* Gocht, 1969
medusettiformis (O. Wetzel) Lejeune-Carpentier
medusettiformis, sensu Gocht, 1969
senonensis Lejeune-Carpentier
senonensis, sensu Gocht, 1969
sp. A Bujak and Williams, 1978
undulata Eaton

AREOSPHAERIDIUM Eaton
arcuatum Eaton
diktyoplokus (Klumpp) Eaton
fenestratum Bujak
multicornutum Eaton

ASCOSTOMOCYSTIS Drugg and Loeblich
potane Drugg and Loeblich

BATIACASPHAERA Drugg
compta Drugg

BATIOLADINIUM Brideaux
exiguum (Alberti) Brideaux
?gochtii (Alberti) Lentin and Williams
jaegeri (Alberti) Brideaux
sp. A Bujak and Williams, 1978

BIORBIFERA Habib
johnewingii Habib

CALIGODINIUM Drugg
aceras (Manum and Cookson) Lentin and Williams

CALLAIOSPHAERIDIUM Davey and Williams
asymmetricum (Deflandre and Courteville) Davey and Williams

CANNINGIA Cookson
colliveri Cookson and Eisenack
hirtella (Alberti) Millioud
reticulata Cookson and Eisenack
senonica Clarke and Verdier

CANNINGINOPSIS Cookson
tabulata (Davey and Verdier) Duxbury

CANNOSPHAEROPSIS O. Wetzel
utinensis O. Wetzel
sp. Wilson, 1971
sp. A Williams and Brideaux, 1975

CANTULODINIUM Alberti

CASSICULOSPHAERIDIA Davey
magna Davey

CERATIOPSIS Vozzhennikova
diebelii (Alberti) Vozzhennikova
leptoderma Vozzhennikova
pannucea (Stanley) Lentin and Williams
speciosa (Alberti) Lentin and Williams
striata (Drugg) Lentin and Williams

CHATANGIELLA Vozzhennikova
decorosa (McIntyre) Lentin and Williams
ditissima (McIntyre) Lentin and Williams
granulifera (Manum) Lentin and Williams
tripartita (Cookson and Eisenack) Lentin and Williams
tripartita, sensu Vozzhennikova, 1967
victoriensis (Cookson and Manum) Lentin and Williams
vnigri Vozzhennikova Lentin and Williams

CHIROPTERIDIUM Gocht
aspinatum (Gerlach) Brosius
dispersum Gocht
lobospinosum (Gocht) Gocht
partispinatum (Gerlach) Brosius

CHLAMYDOPHORELLA Cookson
discreta Clarke and Verdier
grossa Manum and Cookson
nyei Cookson and Eisenack
sp. A Bujak and Williams, 1978

CHYTROEISPHAERIDIA (Sarjeant) Downie and Sarjeant
chytroeides (Sarjeant) Downie and Sarjeant
chytroeides, sensu Gocht, 1970

CLEISTOSPHAERIDIUM Davey, Downie, Sarjeant, and Williams
huguoniotii (Valensi) Davey
mojsisovicsii Morbey
polypes (Cookson and Eisenack) Davey
subsp. A, *sensu* Williams, 1975
tribuliferum (Sarjeant)
Davey, Downie, Sarjeant and Williams
sp. Williams, 1978

COMPOSITOSPHAERIDIUM Dodekova
costatum (Davey and Williams) Dodekova

CORDOSPHAERIDIUM Eisenack
cantharellum (Brosius) Gocht
cracenospinosum Davey and Williams
exilimurum Davey and Williams
fibrospinosum Davey and Williams
funiculatum Morgenroth
gracile (Eisenack) Davey and Williams
cf. *C. gracile, sensu* Williams, 1975
inodes (Klumpp) Morgenroth
minimum (Morgenroth) Benedek
multispinosum Davey and Williams
truncigerum (Deflandre) De Coninck
sp. 2 Gocht, 1969

CORONIFERA Cookson and Eisenack
oceanica Cookson and Eisenack

CRIBROPERIDINIUM Neale and Sarjeant
edwardsii (Cookson and Eisenack) Davey
intricatum Davey
muderongense (Cookson and Eisenack) Davey
muderongense, sensu Habib, 1972
orthoceras (Eisenack) Davey
sepimentum Neale and Sarjeant
sp. Brideaux, 1971

CTENIDODINIUM Deflandre
continuum Gocht
culmulum (Norris) Lentin and Williams
elegantulum Millioud
ornatum (Eisenack) Deflandre
pachydermum (Deflandre) Gocht
panneum (Norris) Lentin and Williams
schizoblatum (Norris) Lentin and Williams
aff. *C. tenellum* Deflandre, *sensu* Gocht, 1970

CYCLONEPHELIUM Deflandre and Cookson
distinctum Deflandre and Cookson
subsp. *brevispinatum* (Millioud) Lentin and Williams
divaricatum Williams and Downie
eisenackii Davey
expansum Corradini
exuberans Deflandre and Cookson
subsp. *ellipsoidale* Weyns
hughesii Clarke and Verdier
intricatum Eaton
membraniphorum Cookson and Eisenack
ordinatum Williams and Downie
pastielsii Deflandre and Cookson
paucispinum Davey
retiintextum Cookson
semicirculatum Morgenroth
textum Bujak
vannophorum Davey
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975
sp. C Williams and Brideaux, 1975

CYCLOPSIELLA Drugg and Loeblich
elliptica Drugg and Loeblich
trematophora (Cookson and Eisenack)
Lentin and Williams
vieta Drugg and Loeblich
sp. A Williams and Brideaux, 1975

DANEA Morgenroth
mutabilis Morgenroth

DAPCODINIUM Evitt
priscum Evitt

DEFLANDREA Eisenack
cygniformis Pöthe de Baldis
dartmooria Cookson and Eisenack
delineata Cookson and Eisenack
denticulata Alberti
eocenica Baltes ex Lentin and Williams
granulosa Cookson and Eisenack
heterophlycta Deflandre and Cookson
hialina Baltes ex Lentin and Williams
leptodermata Cookson and Eisenack
oebisfeldensis Alberti
phosphoritica Eisenack
cf. *D. phosphoritica, sensu* Williams and Bujak, 1977b
spinulosa Alberti
wardenensis Williams and Downie
wetzelii Morgenroth
sp. A Drugg, 1967
sp. Wilson, 1971
sp. B Williams and Brideaux, 1975
sp. B Williams and Bujak, 1977b
sp. C Williams and Bujak, 1977b

DIACANTHUM Habib
hollisteri Habib

DICONODINIUM Eisenack and Cookson
arcticum Manum and Cookson
rhombiformis Vozzhennikova

DICTYOPYXIS Cookson and Eisenack
sp. Gitmez, 1970

DINGODINIUM Cookson and Eisenack
cerviculum Cookson and Eisenack

DINOGYMNIUM Evitt, Clarke, and Verdier
acuminatum Evitt, Clarke, and Verdier
cerviculum Cookson and Eisenack
curvatum (Vozzhennikova) Lentin and Williams
digitus (Deflandre) Evitt, Clarke, and Verdier
var. A Williams and Brideaux, 1975
euclaensis Cookson and Eisenack
heterocostatum (Deflandre) Evitt, Clarke, and Verdier
microgranulosum Clarke and Verdier
undulosum Cookson and Eisenack
westralium (Cookson and Eisenack)
Evitt, Clarke, and Verdier

DINOPTERYGIUM Deflandre
cladoides Deflandre
cladoides, sensu Morgenroth, 1966a
sp. A Williams and Bujak, 1977a

DIPHYES Cookson
colligerum (Deflandre and Cookson) Cookson

DISTATODINIUM Eaton
craterum Eaton
ellipticum (Cookson) Eaton
paradoxum (Brosius) Eaton
paradoxum, sensu Benedek, 1972

DOIDYX Sarjeant
anaphrissa Sarjeant

DOROCYSTA Davey
sp. A Williams and Bujak, 1978

DRACODINIUM Gocht

DUOSPHAERIDIUM Davey and Williams
nudum (Cookson) Loeblich and Loeblich
rugosum Drugg

EISENACKIA Deflandre and Cookson
circumtabulata Drugg
crassitabulata Deflandre and Cookson,
sensu Clarke and Verdier, 1967
ornata Cookson and Eisenack

ELLIPSOIDICTYUM Klement
cinctum Klement

ENDOSCRINIUM (Klement) Vozzhennikova
campanulum (Gocht) Vozzhennikova
eisenackii (Deflandre) Gocht
eisenackii, sensu Gocht, 1970
luridum (Deflandre) Gocht

EOCLADOPYXIS Morgenroth
peniculata Morgenroth

EOPSEUDOCERATIUM (Neale and Sarjeant)
Lentin and Williams
gochtii Neale and Sarjeant

EPELIDOSPHAERIDIA Davey
spinosa (Cookson and Hughes) Davey

EPICEPHALOPYXIS Deflandre
indentata Deflandre and Cookson

EPIPLOSPHAERA Klement
areolata Klement
bireticulata Klement
reticulospinosa Klement

EXOCHOSPHAERIDIUM Davey, Downie, Sarjeant, and Williams
bifidum (Clarke and Verdier)
Clarke, Davey, Sarjeant, and Verdier
striolatum (Deflandre) Davey

FIBRADINIUM Morgenroth
annetorpense Morgenroth
sp. A Williams and Brideaux, 1975

FLORENTINIA Davey and Verdier
laciniata Davey and Verdier
mantellii (Davey and Williams) Davey and Verdier
radiculata (Davey and Williams) Davey and Verdier
resex Davey and Verdier

FORMA P Evitt, 1967

FROMEA Cookson and Eisenack
amphora Cookson and Eisenack

GARDODINIUM Alberti
deflandrei Clarke and Verdier
trabeculosum (Gocht) Alberti

GEN. *et* sp. 1, Bujak and Williams, 1977
sp. 2, Bujak and Williams, 1977
sp. 1, Gocht, 1970
sp. 2, Gocht, 1970

GILLINIA Cookson and Eisenack
hymenophora Cookson and Eisenack

GINGINODINIUM Cookson and Eisenack
ornatum (Felix and Burbridge) Lentin and Williams

GONYAULACYSTA Deflandre ex Norris and Sarjeant
aculeata (Klement) Sarjeant
aldorfensis Gocht
ambigua (Deflandre) Sarjeant
angulosa Gitmez
cassidata (Eisenack and Cookson) Sarjeant
cladophora (Deflandre) Dodekova
ehrenbergii Gitmez
episoma Sarjeant
exilicristata Davey
filapicata Gocht
giuseppei (Morgenroth) Sarjeant
granulata (Klement) Sarjeant
cf. *G. granulata, sensu* Benedek, 1972
granuligera (Klement) Sarjeant
helicoidea (Eisenack and Cookson) Sarjeant
jurassica (Deflandre) Norris and Sarjeant
subsp. *longicornis* (Deflandre) Lentin and Williams
longicornis (Downie) Sarjeant
mamillifera (Deflandre) Sarjeant
nuciformis (Deflandre) Sarjeant
obscura (Lejeune-Carpentier) Sarjeant
perforans (Cookson and Eisenack) Sarjeant
pyra (Drugg) Sarjeant
serrata (Cookson and Eisenack) Sarjeant
?tenuiceras (Eisenack) Sarjeant

GONYAULACYSTA (con't)

tenuicornuta (Cookson and Eisenack) Sarjeant
tenuitabulata (Gerlach) De Coninck
wetzelii (Lejeune-Carpentier) Sarjeant
sp. F Gitmez and Sarjeant, 1972

HEMICYSTODINIUM Wall
zoharyi (Rossignol) Wall
sp. Williams, 1975

HEMIPLACOPHORA Cookson and Eisenack
semilunifera Cookson and Eisenack

HETERAULACACYSTA Drugg and Loeblich
campanula Drugg and Loeblich
leptalea Eaton

HETEROSPHAERIDIUM Cookson and Eisenack
heteracanthum (Deflandre and Cookson) Eisenack and Kjellström

HEXAGONIFERA Cookson and Eisenack
?chlamydata Cookson and Eisenack

HOMOTRYBLIUM Davey and Williams
oceanicum Eaton
pallidum Davey and Williams
plectilum Drugg and Loeblich
tasmaniense Cookson and Eisenack
tenuispinosum Davey and Williams

HOROLOGINELLA Cookson and Eisenack
apiculata Cookson and Eisenack
?extrema Cookson and Eisenack

HYSTRICHODINIUM Deflandre
pulchrum Deflandre
voigtii (Alberti) Davey

HYSTRICHOGONYAULAX Sarjeant
cornigera (Valensi) Sarjeant
nealei (Sarjeant) Sarjeant

HYSTRICHOKOLPOMA Klumpp
cinctum Klumpp
eisenackii Williams and Downie
rigaudiae Deflandre and Cookson
salacium Eaton
sequanaportus Deflandre and Deflandre-Rigaud

HYSTRICHOSPHAERIDIUM Deflandre
arundum Eisenack and Cookson
bowerbankii Davey and Williams
choanophorum Deflandre and Cookson
cooksoniae Singh
difficile Manum and Cookson
paracostatum Cookson and Eisenack
petilum Gitmez
pseudorecurvatum Morgenroth
recurvatum (White) Davey and Williams
salpingophorum Deflandre
tubiferum (Ehrenberg) Deflandre
subsp. *brevispinum* (Davey and Williams) Lentin and Williams
sp. A Williams and Bujak, 1977b
sp. A Bujak and Williams, 1978

HYSTRICHOSPHAEROPSIS Deflandre
obscura Habib
ovum Deflandre
sp. A Williams and Brideaux, 1975

IMPLETOSPHAERIDIUM Morgenroth
kroemmelbeinii Morgenroth
transfodum Morgenroth
whitei (Deflandre and Courteville) Morgenroth

INVERSIDINIUM McLean
exilimurum McLean

ISABELIDINIUM Lentin and Williams
bakeri (Deflandre and Cookson) Lentin and Williams
belfastense (Cookson and Eisenack) Lentin and Williams
cooksoniae (Alberti) Lentin and Williams
cf. *I. cooksoniae, sensu* Clarke and Verdier, 1967
cretaceum (Cookson) Lentin and Williams
korojonense (Cookson and Eisenack) Lentin and Williams

KALYPTEA Cookson and Eisenack
sp. A Brideaux, 1971

KISSELOVIA Vozzhennikova
coleothrypta (Williams and Downie) Lentin and Williams
reticulata (Williams and Downie) Lentin and Williams
tenuivirgula (Williams and Downie) Lentin and Williams
subsp. *crassiramosa* (Williams and Downie) Lentin and Williams

KLEITHRIASPHAERIDIUM Davey
eoinodes (Eisenack) Davey
fasciatum (Davey and Williams) Davey
loffrense Davey and Verdier
readei (Davey and Williams) Davey and Verdier

LACINIADINIUM McIntyre
biconiculum McIntyre

LANTERNA Dodekova
pattei (Valensi) Brideaux and Fisher
sportula Dodekova

LANTERNOSPHAERIDIUM Morgenroth
axiale (Eisenack) Morgenroth
lanosum Morgenroth
sp. 2 Gocht, 1969

LEJEUNIA Gerlach
fallax Morgenroth
hyalina Gerlach
magnifica (Stanley) Lentin and Williams
paratenella Benedek
psilodora Benedek
tricuspis (O. Wetzel) Gorka
sp. III Drugg, 1967
sp. Williams and Bujak, 1977b

LEPTODINIUM Klement
arcuatum Klement
egemenii Gitmez
incompositum (Drugg) Lentin and Williams
maculatum Cookson and Eisenack
patulum Wall
regale Gocht
sphaericum Wall
subtile Klement
subsp. *pectinigerum* Gocht
victorianum Cookson and Eisenack

LINGULODINIUM Wall
machaerophorum (Deflandre and Cookson) Wall
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975

LITHODINIA Eisenack
jurassica Eisenack
jurassica, sensu Gocht, 1970
stoveri (Millioud) Duxbury

LITOSPHAERIDIUM Davey and Williams
conispinum Davey and Verdier
siphoniphorum (Cookson and Eisenack) Davey and Williams
siphoniphorum, sensu Warren, 1967

LUEHNDEA Morgenroth
spinosa Morgenroth

LUXADINIUM Brideaux and McIntyre
primulum Brideaux and McIntyre
propatulum Brideaux and McIntyre

MADURADINIUM Cookson and Eisenack
spatiosum (Morgenroth) Lentin and Williams

MANCODINIUM Morgenroth
semitabulatum Morgenroth

MATURODINIUM Morgenroth
inornatum Morgenroth

MEIOUROGONYAULAX Sarjeant
sp. Gocht, 1970
sp. Williams, 1975

MEMBRANILARNACIA Eisenack
tenella Morgenroth
ursulae (Morgenroth) DeConinck
sp. Wilson, 1971

MEMBRANOSPHAERA Samoilovitch ex Norris and Sarjeant

MENDICODINIUM Morgenroth

MEMBRANILARNACIA sp. Wilson, 1971

MICRODINIUM Cookson and Eisenack
irregulare Clarke and Verdier
ornatum Cookson and Eisenack
saeptum Morgenroth
setosum Sarjeant
veligerum (Deflandre) Davey
veligerum, sensu Wilson, 1971

MUDERONGIA Cookson and Eisenack
perforata Alberti
simplex Alberti
staurota Sarjeant
tetracantha (Gocht) Alberti
tomaszowensis Alberti

MULTISPINULA Bradford
quanta Bradford

MURATODINIUM Drugg
fimbriatum (Cookson and Eisenack) Drugg

NANNOCERATOPSIS Deflandre
gracilis Alberti
pellucida Deflandre

NELSONIELLA Cookson and Eisenack
aceras Cookson and Eisenack

NEMATOSPHAEROPSIS Deflandre and Cookson
balcombiana Deflandre and Cookson
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975

OCCISUCYSTA Gitmez
sp. A Bujak and Williams, 1978

ODONTOCHITINA Deflandre
costata Alberti
operculata (O. Wetzel) Deflandre and Cookson
porifera Cookson

OLIGOSPHAERIDIUM Davey and Williams
albertense (Pocock) Davey and Williams
anthophorum (Cookson and Eisenack) Davey
asterigerum (Gocht) Davey and Williams
complex (White) Davey and Williams
cf. *O. complex, sensu* Williams, 1978
dictyophorum (Cookson and Eisenack) Davey and Williams
dividuum Williams
irregulare (Pocock) Davey and Williams
perforatum (Gocht) Davey and Williams
prolixispinosum Davey and Williams
pulcherrimum (Deflandre and Cookson) Davey and Williams
reniforme (Tasch) Davey
totum Brideaux
subsp. *minor* (Brideaux) Lentin and Williams
subsp. *totum* (Brideaux) Lentin and Williams
sp. A Williams and Brideaux, 1975

OPERCULODINIUM Wall
centrocarpum (Deflandre and Cookson) Wall
giganteum Wall
cf. *O. hirsutum* (Ehrenberg) Lentin and Williams, *sensu* Gocht, 1969
israelianum (Rossignol) Wall

OVOIDINIUM Davey
scabrosum (Cookson and Hughes) Davey
verrucosum (Cookson and Hughes) Davey

PALAEOCYSTODINIUM Alberti
australinum (Cookson) Lentin and Williams
benjaminii Drugg
golzowense Alberti

PALAEOHYSTRICHOPHORA Deflandre
infusorioides Deflandre

PALAEOPERIDINIUM Deflandre
cretaceum Pocock
pyrophorum (Ehrenberg) Sarjeant
sp. A Bujak and Williams, 1978

PALAEOSTOMOCYSTIS Deflandre
fragilis Cookson and Eisenack
laevigata Drugg

PALAEOTETRADINIUM Deflandre
silicorum Deflandre

PALYNODINIUM Gocht
grallator Gocht

PAREODINIA Deflandre
ceratophora Deflandre
ceratophora Deflandre (with kalyptra)
dasyforma Wiggins
kondratjevii (Vozzhennikova) Wiggins
villosa Tasch

PARVOCAVATUS Gitmez
tuberosus Gitmez

PENTADINIUM Gerlach
laticinctum Gerlach
subsp. *granulatum* Gocht
subsp. *lophophorum* Benedek
taeniagerum Gerlach

PERISSEIASPHAERIDIUM Davey and Williams
sp. A Williams and Brideaux, 1975

PHOBEROCYSTA Millioud
neocomica (Gocht) Millioud

PHTHANOPERIDINIUM Drugg and Loeblich
alectrolophum Eaton
amoenum Drugg and Loeblich
comatum (Morgenroth) Eisenack and Kjellström
coreoideum (Benedek) Lentin and Williams
echinatum Eaton
sp. A Williams and Bujak, 1977b

POLYSPHAERIDIUM Davey and Williams
laminaspinosum Davey and Williams
pastielsii Davey and Williams
simplex (White) Davey and Williams
subtile Davey and Williams

POLYSTEPHANEPHORUS Sarjeant
calathus (Sarjeant) Downie and Sarjeant
paracalathus (Sarjeant) Downie and Sarjeant
sarjeantii Gitmez
sp. A Williams and Brideaux, 1975

PROLIXOSPHAERIDIUM Davey, Downie, Sarjeant, and Williams
granulosum (Deflandre)
Davey, Downie, Sarjeant, and Williams
mixtispinosum (Klement)
Davey, Downie, Sarjeant, and Williams
parvispinum (Deflandre)
Davey, Downie, Sarjeant, and Williams
xanthiopyxides (O. Wetzel)
Davey, Downie, Sarjeant, and Williams

PROTOELLIPSODINIUM Davey and Verdier
spinosum Davey and Verdier

PSALIGONYAULAX Sarjeant
deflandrei Sarjeant

PSEUDOCERATIUM Gocht
dettmanniae Cookson and Hughes
expolitum Brideaux
nudum Gocht
pelliferum Gocht

PTERODINIUM Eisenack
circumsutum Morgenroth
magnoserratum Cookson and Eisenack
perforatum (Clarke and Verdier) Davey and Verdier

PYXIDIELLA Cookson and Eisenack
sp. Williams, 1975

RENIDINIUM Morgenroth
membraniferum Morgenroth

RHOMBODINIUM Gocht
condylos (Williams and Downie) Lentin and Williams
cf. *R. condylos, sensu* Williams and Bujak, 1977b
draco Gocht
glabrum (Cookson) Vozzhennikova
rhomboideum (Alberti) Lentin and Williams
sp. A Williams and Bujak, 1977a
intermedium (Cookson and Eisenack) Lentin and Williams
perforatum (Jan du Chene and Chateauneuf, 1975)
Lentin and Williams

ROTTNESTIA Cookson and Eisenack
borussica (Eisenack) Cookson and Eisenack

SAMLANDIA Eisenack
chlamydophora Eisenack

SCHEMATOPHORA Deflandre and Cookson
speciosa Deflandre and Cookson

SCHIZOCYSTIA Cookson and Eisenack
laevigata Cookson and Eisenack
rugosa Cookson and Eisenack

SCRINIOCASSIS Gocht
dictyotus (Cookson and Eisenack) Beju

SCRINIODINIUM Klement
crystallinum (Deflandre) Klement

SELENOPEMPHIX Benedek
nephroides Benedek

SENONIASPHAERA Clarke and Verdier
jurassica (Gitmez and Sarjeant) Lentin and Williams
microreticulata Brideaux and McIntyre
protrusa Clarke and Verdier
rotundata Clarke and Verdier

SILICISPHAERA Davey and Verdier
ferox (Deflandre) Davey and Verdier

SPINIDINIUM Cookson and Eisenack
densispinatum Stanley
echinoideum (Cookson and Eisenack) Lentin and Williams
styloniferum Cookson and Eisenack
sverdrupianum (Manum) Lentin and Williams
vestitum Brideaux
cf. *S. vestitum, sensu* Williams, 1975

SPINIFERITES Mantell
bentorii (Rossignol) Wall and Dale
cingulatus (O. Wetzel) Sarjeant
subsp. *cingulatus* (O. Wetzel) Lentin and Williams
cornutus (Gerlach) Sarjeant
crassipellis (Deflandre and Cookson) Sarjeant
?dentatus (Gocht, 1959) Lentin and Williams
furcatus (Ehrenberg), *sensu* Wall, 1967
membranaceus (Rossignol) Sarjeant
mirabilis (Rossignol) Sarjeant
monilis (Davey and Williams) Sarjeant
porosus (Manum and Cookson) Harland
pseudofurcatus (Klumpp) Sarjeant
ramosus (Ehrenberg) Loeblich and Loeblich
subsp. *multibrevis* (Davey and Williams)
Lentin and Williams
scabratus (Wall) Sarjeant
scabrosus (Clarke and Verdier) Lentin and Williams
septatus (Cookson and Eisenack) McLean
speciosus (Deflandre) Sarjeant
wetzelii (Deflandre) Sarjeant

SPONGODINIUM Deflandre
delitiense (Ehrenberg) Deflandre

STEPHANELYTRON Sarjeant
caytonense Sarjeant
redcliffense Sarjeant
scarburghense Sarjeant

STEPHODINIUM Deflandre
coronatum Deflandre

SUBTILIDINIUM Morgenroth
minutum Morgenroth

SUBTILISPHAERA Jain and Millepied
asymmetrica (Davey and Verdier) Lentin and Williams
perlucida (Alberti) Jain and Millepied
cf. *S. perlucida, sensu* Bujak and Williams, 1978
pirnaensis (Alberti) Jain and Millepied
pirnaensis, sensu Millioud, 1969
pontis-mariae (Deflandre) Lentin and Williams

SUMATRADINIUM Lentin and Williams

SURCULOSPHAERIDIUM Davey, Downie, Sarjeant, and Williams
longifurcatum Davey, Downie, Sarjeant, and Williams
cf. *S. longifurcatum, sensu* Williams, 1975

SVALBARDELLA Manum
cooksoniae Manum
sp. Wilson, 1971

SYSTEMATOPHORA Klement
ancyrea Cookson and Eisenack
areolata Klement
complicata Neale and Sarjeant
fasciculigera Klement
orbifera Klement
placacantha (Deflandre and Cookson)
Davey, Downie, Sarjeant, and Williams
schindewolfii (Alberti) Downie and Sarjeant
turonica (Alberti) Downie and Sarjeant
sp. Davey and Verdier, 1971

TAENIOPHORA Klement
iunctispina Klement

TANYOSPHAERIDIUM Davey and Williams
magdalium (Drugg) Heisecke
variecalamum Davey and Williams
sp. A Williams and Brideaux, 1975

TECTATODINIUM Wall
pellitum Wall
sp. Benedek, 1972

TENUA Eisenack
hystrix Eisenack
rioultii Sarjeant
verrucosa Sarjeant
villersensis Sarjeant

THALASSIPHORA Eisenack and Gocht
delicata Williams and Downie
pelagica (Eisenack) Eisenack and Gocht

TRIBLASTULA O. Wetzel
utinensis O. Wetzel

TRICHODINIUM Eisenack and Cookson
castaneum (Deflandre) Clarke and Verdier
ciliatum (Gocht) Eisenack

TRIGONOPYXIDIA Cookson and Eisenack
ginella (Cookson and Eisenack) Downie and Sarjeant

TRITHYRODINIUM Drugg
evittii Drugg
striatum Benson
suspectum (Manum and Cookson) Davey

TUBERCULODINIUM Wall
rossignoliae Drugg
vancampoae (Rossignol) Wall

TUBIDERMODINIUM Morgenroth
sulcatum Morgenroth

TUBOTUBERELLA Vozzhennikova
apatela (Cookson and Eisenack)
Ioannides, Stavrinos, and Downie

TURBIOSPHAERA Archangelsky
filosa (Wilson) Archangelsky
magnifica Eaton

VALENSIELLA Eisenack
ampulla Gocht
ovula (Deflandre) Eisenack
vermiculata Gocht

VOZZHENNIKOVIA Lentin and Williams
rotunda (Wilson) Lentin and Williams
tenella (Morgenroth) Lentin and Williams

WALLODINIUM Loeblich and Loeblich
anglicum (Cookson and Hughes) Lentin and Williams

WANAEA Cookson and Eisenack
fimbriata Sarjeant
spectabilis (Deflandre and Cookson)
Cookson and Eisenack

WETZELIELLA Eisenack
articulata Eisenack
edwardsii Wilson
lunaris Gocht
meckelfeldensis Gocht
ovalis Eisenack
pilata Stanley
similis Eisenack
symmetrica Weiler
symmetrica, sensu Gocht, 1969
varielongituda Williams and Downie
sp. A Williams and Brideaux, 1975
sp. B Williams and Brideaux, 1975
sp. A Williams and Bujak, 1977b

WILSONIDIUM Lentin and Williams
?aechmophorum (Benedek) Lentin and Williams
echinosuturatum (Wilson) Lentin and Williams
lineidentatum (Deflandre and Cookson)
Lentin and Williams
tabulatum (Wilson) Lentin and Williams

XENASCUS Cookson and Eisenack
ceratioides (Deflandre) Lentin and Williams

XIPHOPHORIDIUM Sarjeant
alatum (Cookson and Eisenack) Sarjeant

AZOLLA Lamarck

BALTISPHAERIDIUM Eisenack
debilispinum Wall and Downie

COMASPHAERIDIUM Staplin, Jansonius, and Pocock
cf. *C. cometes*, (Valensi) Staplin, Jansonius, and Pocock, *sensu* Williams and Brideaux, 1975

CONCENTRICYSTES Rossignol

INCERTAE SEDIS Neves and Belt, 1970

MICRHYSTRIDIUM Deflandre
fragile Deflandre
lymensis Wall
stellatum Deflandre

MULTIPLICISPHAERIDIUM Staplin

PALAMBAGES O. Wetzel

PEDIASTRUM Meyer
boryanum (Turpin) Meneghini

PTEROSPERMOPSIS Wetzel
helios Sarjeant
spinosa Clarke and Verdier

TASMANITES Newton

VERYHACHIUM Deunff
reductum Deunff
trispinosum (Eisenack) Deunff