Technical Service Report

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PALEONTOLOGICAL AND GEOCHEMICAL STUDY OF THE WELL ESSO 16/7-2, OFFSHORE NORWAY

BY

R. JAN DU CHENE, M. PONS AND N.S. IOANNIDES

EPR-E.WA5.82

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INTRODUCTION

For the paleontological investigation of the Esso 16/7-2 well, 65 cutting samples, 28 sidewall cores and 15 core samples were processed for palynology, and 47 cutting samples and 5 core samples were examined for micropaleontology. In addition, 5 sidewall cores were analyzed geochemically, as requested by Esso Norway (Table 1). Significantly, most of the samples below core 4 (core 4: 2675-2690,75m) and down to the Permo-Triassic section have proved barren and only a couple of SWC's yielded a dinocyst association certainly not older than Jurassic. Evidently, there exists the possibility of mud contamination but until there is proof to the contrary the proposed interpretation seems the best possible at present.

The stratigraphic tops are:

Depth (in m)	Age	Palynology	Micropaleontology
600	Pleistocene-Pliocene		*Elphidium incertum, E. clavatum, Cassidulina laevigata*
700	Pliocene		*Cibicides lobatulus grossa*
1100	Miocene	Good dinos association	

Depth (in m)	Age	Palynology	Micropaleontology
1400	Late to Middle Oligocene	Zone IX	*Cyclammina* aff. *placenta*
1700	Early Oligocene (?)	Zone VII (?)	
1990	Early Oligocene to Late Eocene	Zone VII	
2020	Middle Eocene	Zone VI	
2080	Early Eocene	Zone IV	
2170		Zone III	*Coscinodiscus* sp. 1
2235	Late to Middle Paleocene	Zone IB	
2270			*Bolivinopsis spectabilis*
2300		Zone IB-IA2	
2315	Middle to Early Paleocene	Zone IA2	
2338			*Globorotalia compressa*, *Globigerina* spp.
2424	Early Paleocene	Zone IAI	
2479	Early Maastrichtian		Assemblage of *Arkhangelskiella cymbiformis*, *Prediscosphaera cretacea*, *Micula staurophora*
2539	Early Maastrichtian to Late Campanian		*Arkhangelskiella cymbiformis* and *Reinhardtites anthophorus*

Depth (in m)	Age	Palynology	Micropaleontology
2560	Campanian to Santonian		*Eiffellithus eximius* and *Reinhardtites anthophorus*
2587	Early Kimmeridgian to Oxfordian		
2675	Callovian		
2690.75	Jurassic (?), not older than Callovian		
2975	Permo-Triassic		
3013	Permian		

STRATIGRAPHY

At 600m: Pleistocene-Pliocene

A - Palynology

This level is barren for palynology.

B - Micropaleontology

This sample is characterized by the presence of such forams as *Elphidium incertum, E. clavatum* and *Cassidulina laevigata.*

From 700 to 1000m: Pliocene

A - Palynology

Palynomorphs recorded in this interval are not diagnostic.

B - Micropaleontology

The presence of *Cibicides lobatulus grossa* at 700m indicates a Pliocene age.

Elphidium sp. 16, *Ammonia beccarii, Nonion pompilioides* are additionally observed in this interval.

From 1100 to 1300m: Miocene

A - Palynology

Good dinoflagellate assemblages are recorded throughout this interval: *Operculodinium crassum*, *"Hystrichosphaeridium" choanophorum*, *Tectatodinium pellitum*, *Hystrichokolpoma rigaudae*, *Palaeocystodinium golzowense*, *Hystrichosphaeropsis ovum*, *H. obscurum*, *Apteodinium spiridioides*, *Pentadinium taeniagerum*, *Millioudodinium tenuitabulatum*, *Tuberculodinium van campoae*, *Cyclopsiella elliptica*, *Andalusiella* sp., etc...

B - Micropaleontology

A Miocene foram assemblage is present at 1300m. *Asterigerina staeschei* and *A. gürichi* are the most prominent species ; they are accompanied by *Globorotalia scitula* and *Gr. obesa*.

From 1400 to 1600m: Late to Middle Oligocene

A - Palynology

At 1500m the first occurrence of *Deflandrea phosphoritica*, *Deflandrea heterophlycta* and *Wetzeliella* spp. indicates a Late to Middle Oligocene age (Zone IX).

At 1600m, we recorded *Rhombodinium draco*, *Wetzeliella symmetrica* and *Tanyosphaeridium paradoxum* which characterize zone VIII.

Other dinocysts present in these samples are: *Chiropteridium dispersum*, *Ch. aspinatum*, *Heteraulacacysta* sp., *Palaeocystodinium golzowense*, *Andalusiella* sp., *Cordosphaeridium cantharellum*, *Thalassiphora pelagica*.

B - Micropaleontology

At 1400m, the presence of arenaceous foraminifera with *Cyclammina* aff. *placenta* suggest an Oligocene age.

Radiolarians and rare *Turrilina alsatica* are also observed in this interval.

From 1700 to 1990m: Early Oligocene to Late Eocene

A - Palynology

This assemblage is characterized by the presence of *Areosphaeridium arcuatum, A. diktyoplokus* and *Kisselovia coleothrypta* (Zone VII). A single specimen of *Eatonicysta ursulae* (Zone V) is recorded at 1900m and considered reworked.

B - Micropaleontology

The microfauna is represented by *Cyclammina* aff. *cancellata, C. placenta, Ammodiscus incertus, Bathysiphon discreta, Trochammina globigeriniformis* and other arenaceous foraminifera.

Glomospira charoides is observed from 1900m downwards.

From 2020 to 2050m: Middle Eocene

A - Palynology

The first occurrence of *Wetzeliella articulata* at 2020m indicates a Middle Eocene age, (Zone VI). *Wetzeliella pachyderma* and *Eatonicysta ursulae* which characterize zone V, are absent from this interval.

B - Micropaleontology

Foraminiferal assemblages are dominated by arenaceous forams. *Incertae sedis* organism A is present at 2020m and below. A single specimen of *Coscinodiscus* sp. 1 is observed at 2050m, but considered reworked.

From 2080 to 2230m: Early Eocene

A - Palynology

The association *W. pachyderma* and *Kisselovia* aff. *clathrata* present from 2080 to 2140m characterizes the zone IV.

Deflandrea speciosa which indicates the zone III, is abundant at 2170 m and persists down section. The ratio of pollen is increasing in this zone: disaccate pollen, Carya type, Taxodiaceae type.

B - Micropaleontology

At 2170m, *Coscinodiscus* sp. 1 is recorded together with rare *Globigerina linaperta*.

The microfaunal assemblage is always represented by arenaceous foraminifera.

From 2235 to 2315m: Late to Middle Paleocene

A - Palynology

Alisocysta circumtabulata is consistently present from 2235m, and indicates the IB zone. Zone II seems to be absent.

Other dinoflagellates characterizing this interval are: *Thalassiphora delicata, Cordosphaeridium fibrospinosum, C. inodes, Achomosphaera sagena, A. alcicornu, A. crassipellis, Hystrichosphaeridium tubiferum, Oligosphaeridium* sp., *Areoligera senonensis, Spiniferites* spp., *Caligodinium* sp.

A few specimens of *Palaeoperidinium pyrophorum* are considered reworked. From 2300 to 2315m, *P. pyrophorum* is still rare but occurs consistently. This interval may represent a transition zone between IB and IA2.

B - Micropaleontology

Bolivinopsis spectabilis is observed at 2240m and the microfauna is the same as above.

From 2315 to 2378.8m: Middle to Early Paleocene

A - Palynology

The regular occurrence of *Palaeoperidinium pyrophorum* characterizes this interval and defines the zone IA2. Other dinocysts are: *Palaeocystodinium benjaminii, H. tubiferum, T. delicata, A. sagena*, etc... The fragment of *E. crassibulata* recorded at 2424m, is considered reworked.

B - Micropaleontology

Arenaceous foraminifera are again present. At 2338m, *Globorotalia compressa* and *Globigerina* spp. appear. These forms indicate a Middle to Early Paleocene age. The core 3 at 2375m.50 is barren of microfossils.

From 2424m to 2425.7m: Early Paleocene

Palynology

The occurrence of abundant *Eisenackia crassitabulata* indicates the zone IA1.

From 2479 to 2539m: Early Maastrichtian

A - Palynology

One specimen of *Litosphaeridium* cf. *arundum* is present in sample 2485m, indicating a generalized Middle to Late Cretaceous age.

B - Micropaleontology

At 2479m the presence of *Arkhangelskiella cymbiformis, Predicosphaera cretacea, Kamptnerius magnificus, Cretarhabdus crenulatus, Micula staurophora* suggests an Early Maastrichtian age.

From 2539 to 2560m : Early Maastrichtian to Late Campanian

Micropaleontology

At 2539m, the association of *Arkhangelskiella cymbiformis* and *Reinhardtites anthophorus* indicates an Early Maastrichtian to Late Campanian age.

At 2560m: Campanian to Santonian

Micropaleontology

At 2560m, it is difficult to assign more precise age to this sample than Campanian to Santonian. *Eiffellithus eximius* is observed in association with *Reinhardtites anthophorus*.

From 2587 (as high as 2581m) to 2675m: Early Kimmeridgian to Oxfordian

Palynology

Although a drastic change in organic matter (from woody into an abundance of amorphous) occurs at 2581m, the first positively identified Jurassic palynomorphs are observed at 2587m and become more diversified below but always badly diluted by the organic matter. These include *Gonyaulacysta jurassica*, *Scriniodinium luridum*, *Scriniodinium* cf. *galleritum*, *Sirmiodinium grossii*, *Acanthaulax* sp. and a variety of *Millioudodinium* spp. An early Kimmeridgian to Oxfordian age may be suggested.

It is worth noting that in sample at 2587m *Palaeohystrichophora infusoroides*, and *Criboperidinium* spp. are present; they are almost certainly caved from higher in the section and indicate that Campanian (or older) rocks were penetrated. The remote possibility of having a Cretaceous sequence with reworked Jurassic should be born in mind.

From 2675 to 2683m: Callovian

Palynology

A highly distinctive assemblage was extracted from the upper half of core 4 which spans the above interval. In addition to

Gonyaulacysta jurassica and *Sirmiodinium grossii*, it contains common *Ctenidodinium tenellum/stauromatos*, *Lithodinia* spp, *Pareodinia ceratophora*, *Ellipsoidictyrum* sp., *Meiourogonyaulax sellwoodii*, and *Tubotuberella eisenacki* subsp. *oligodentata*. Rare reworked striate pollen are also present. A Callovian age is indicated.

From 2683 to 2975m: Tentatively Jurassic (not older than Callovian ?)

Palynology

The samples prepared from this interval are barren or poor in recovery. *Millioudodinium* is seen scarcely, and it is associated with *Scriniodinium crystallinum* and *Scriniodinium? luridum*. A level of reference may be considered the SWC at 2903m which contains *Gonyaulacysta jurassica*, *Meiourogonyaulax* cf. *valensi*, *Leptodinium* cf. *subtile* and *S.? luridum*.

On the basis of the above assemblage an age not older than Callovian is tentatively suggested. However, the penetration of red beds in this interval, generally indicative of an older age (Triassic), would require further evidence for substantiating the *in situ* occurrence of the forementioned palynomorphs. It should be emphasized here that problems of this nature may only be solved by the use of conventional cores.

It is of interest that a similar situation occurred in the 16/9-1 well (1968) where a possibly comparable interval was not differentiated at that time despite the presence of *Gonyaulacysta jurassica* (recycling may have then been suspected too). One of us rapidly re-examined some of the SWC's between 7750' and 8070' in 16/9-1. *Millioudodinium* and other elements not older than Jurassic were also observed. Unfortunately a core proved barren of microfossils (core 2: approx. 7860'-7867').

From 2975 to 3003m: Permo-Triassic

Palynology

Striate pollen are consistently encountered in this interval. A Permo-Triassic age is suggested.

From 3003 to 3146m: Permo-Triassic

Palynology

Questionable *Lueckisporites virkkiae* is present at 3003m, accompanied by other striate bisaccate pollen. Monosaccate pollen attributable to *Potoneisporites* and *Florinites* are commonly represented. A Permian age is indicated.

GEOCHEMISTRY

It is of interest to note that the sample at 2581m is considerably richer in organic matter than the underlying four samples. Although thermally immature, the type of organic matter (predominantly type I) enhances its value as a source rock. The four samples between 2975.20m and 3033m fall within the oil window despite the limited, and essentially gaz prone organic matter (predominently type III).

RJDC/MP/NSI/pd/gp
June 9, 1982

SAMPLES STUDIED FOR PALYNOLOGY

Depth (m)	Sample		Age
600	cutt.	Barren	
700	cutt.	Very poor, non diagnostic	
800	cutt.	a.a.	
900	cutt.	a.a.	
1000	cutt.	a.a.	
1100	cutt.	Good dino. assemblage: *Operculodinium crassum*, *O.* sp., *"Hystrichosphaeridium" choanophorum*, *Tectatodinium pellitum* etc...	Miocene
1200	cutt.	*Hystrichokolpoma rigaudae*, *Palaeocystodinium golzowense*, *Hystrichosphaeropsis ovum*, *H. obscurum*, *Apteodinium spiridioides*, etc...	Miocene (middle)
1300	cutt.	a.a. + *Pentadinium taeniagerum*, *M. tenuitabulatum*, *Tuberculodinium van campoae*, *Cyclopsiella* cf. *elliptica*, *Andalusiella* sp.	Zone X
1500	cutt.	*Deflandrea phosphoritica*, *D. heterophlycta*, *Wetzeliellaceae*, *Heteralacaucysta* sp., *Cordosphaeridium cantharellum* etc...	Zone IX

1600	cutt.	a.a. + *Rhombodinium draco, Chiropteridium* spp., *Taniasphaeridium paradoxum, W. symmetrica*	Zone VIII
1700	cutt.	a.a. + rare *Kisselovia coleothrypta*	Zone VII?
1800	cutt.	a.a. but no *Kisselovia coleothrypta*	?
1900	cutt.	*Areosphaeridium arcuatum, A. dictyoplokus, K. coleothrypta,* abundant scolecodonts, one specimen of *A. ursulae*	Zone VII
1930	cutt.	a.a. no VI index species	Zone VII
1960	cutt.	a.a.	Zone VII
1990	cutt.	a.a.	Zone VII
2020	cutt.	*Wetzeliella articulata, Achomosphaera alcicornu*	Zone VI
2050	cutt.	a.a.	Zone VI
2080	cutt.	*Kisselovia* aff. *clathrata, W. pachyderma* + a.a.	Zone IV
2110	cutt.	*Kisselovia* aff. *clathrata* + a.a.	Zone IV
2140	cutt.	a.a. + cf. *D. speciosa*	Zone IV
2170	cutt.	*D. speciosa* very abundant	Zone III
2200	cutt.	*D. speciosa*, pollen abundant	Zone III

2230	cutt.	a.a.	Zone III
2235	cutt.	*Alisocysta circumtabulata*	Zone IB
2240	cutt.	a.a. + ?*Palaeoperidinium pyrophorum*	Zone IB
2245	cutt.	*Alisocysta circumtabulata*	Zone IB
2250	cutt.	a.a.	Zone IB
2255	cutt.	a.a.	Zone IB
2260	cutt.	a.a.	Zone IB
2290	cutt.	a.a.	Zone IB
2295	SWC	rare *Palaeoperidinium pyrophorum*	Zone IB-IA2
2300	cutt.	a.a.	Zone IB-IA2
2300.60	core	a.a.	Zone IB-IA2
2301.20	core	a.a.	Zone IB-IA2
2304	SWC	Barren	
2310	SWC	Barren	
2311	cutt.	*P. pyrophorum* rare	Zone IB-IA2
2311	SWC	no *P. pyrophorum*	Zone IB-IA2

2315	SWC	a.a.	Zone IB-IA2
2317	SWC	*P. pyrophorum* present	Zone IA2
2320	SWC	*P. pyrophorum* very common	Zone IA2
2320	cutt.	a.a.	Zone IA2
2326 A	SWC	*Senegalinium obscurum* abundant	
2326 B	SWC	a.a.	
2329	cutt.	*P. pyrophorum* abundant	Zone IA2
2338	cutt.	a.a.	Zone IA2
2339	SWC	No diagnostic species	
2347	cutt.	*P. pyrophorum* abundant	Zone IA2
2359	cutt.	a.a., cavings abundant	Zone IA2
2363.5	cutt.	*P. pyrophorum* abundant	Zone IA2
2366.5	cutt.	a.a.	Zone IA2
2375.5	cutt.	a.a., one fragment of *E. crassitabulata*	Zone IA2
2378.8	SWC	no diagnostic species	
2424	SWC	*E. crassitabulata* abundant	Zone IA1
2425.7	SWC	a.a.	Zone IA1
2455	cutt.	Virtually barren	

2485	cutt.	*Litosphaeridium* cf. *arundum*	Middle-Late Cretaceous
2515	cutt.	Caved Tertiary palynomorphs	
2545	cutt.	a.a.	
2575	cutt.	Rare long-ranging dinocysts	Cretaceous
2581	SWC	Incoming of Amorphous	Jurassic?
2587	cutt.	*Gonyaulacysta jurassica*, etc... Caved Cretaceous present	Early Kimmeridgian-Oxfordian
2593	SWC	a.a.	
2596	cutt.	a.a.	
2605	cutt.	a.a.	
2610	SWC	a.a.	
2626	cutt.	a.a.	
2635	cutt.	Rare, corroded unidentified dinocysts	
2645	SWC	a.a.	
2665	cutt.	a.a.	
2675.00	Core 4	*Meiourogonyaulax* cf. *valensi*, *Ctenidodinium tenellum/stauromatos*	Callovian
2675.48	Core 4	a.a.	
2678.98-2679	Core 4	*Ctenidodinium*, *Sirmiodinium*	

2680.98-
2681 Core 4 A rich Callovian association

2682.98-
2683 Core 4 a.a. Callovian

2684.99-
2685 Core 4 Barren

2687.04 Core 4 Rare sporomorphs

2687.60 Core 4 a.a.

2687.98-
2688 Core 4 Barren

2689.20 Core 4 a.a.

2689-
2689.06 Core 4 a.a.

2689.15 Core 4 a.a.

2689.20 Core 4 a.a.

2690.75 Core 4 a.a.

2691 SWC *Gonyaulacysta jurassica*

2695 cutt. Barren

2695 SWC a.a.

2725 cutt. a.a.

2725 SWC *Gonyaulacysta* cf. *cladophora*

2755	cutt.	*Leptodinium* sp.	
2785	cutt.	Poor	
2715	cutt.	a.a.	
2845	cutt.	Rare Jurassic dinocysts	
2875	SWC	Very poor	
2875	cutt.	Barren	
2903	SWC	A Jurassic association	
2905	cutt.	a.a.	
2935	cutt.	a.a.	
2955	cutt.	a.a.	
2930	SWC	No indication for a Triassic age	
2965	cutt.	a.a.	
2974	SWC	Tertiary mud contaminats	
2975.20	SWC	Striate pollen	Permo-Triassic
2995	cutt.	a.a.	
3003	SWC	*Lueckisporites virkkiae, Potonei-sporites/Florinites*	Permian
3013	SWC	a.a.	

3025	cutt.	a.a.
3033.20	SWC	a.a.
3055	cutt.	a.a.
3085	cutt.	a.a., poor
3115	cutt.	Poor
3146	cutt.	Poor

LIST OF CUTTINGS AND CORES STUDIED FOR MICROPALEONTOLOGY

(Foraminifera and Coccoliths)

600 cutting
700 cutting
800 cutting
900 cutting
1000 cutting
1100 cutting
1200 cutting
1300 cutting
1400 cutting
1500 cutting
1600 cutting
1700 cutting
1800 cutting
1900 cutting
1930 cutting
1960 cutting
1990 cutting
2020 cutting
2050 cutting
2080 cutting
2110 cutting
2140 cutting
2170 cutting
2200 cutting
2230 cutting
2235 cutting
2240 cutting
2245 cutting
2250 cutting
2255 cutting
2260 cutting
2290 cutting
2300 cutting
2300.60 Core 1
2301.20 Core 1
2311 cutting
2320 cutting
2329 cutting
2338 cutting
2347 cutting
2359 cutting
2363.50 Core 3
2365 cutting
2366.50 Core 3
2375.50 Core 3
2440 cutting
2461 cutting
2479 cutting
2500 cutting
2521 cutting
2539 cutting
2560 cutting
2581 cutting

WELL SECTION: 1617-2

SLIDES REC'D / /

STARTED / /

FINISHED / /

JOB NO:

STUDIED FOR:

STUDIED BY:

SAMPLE INTERVAL (M.)	T.O.C.	TAI POPULATION ANALYSIS* TAI VALUE	REL. ABUNDANCE (%)	TAI VALUE	REL. ABUNDANCE (%)	TAI VALUE	REL. ABUNDANCE (%)	CONFIDENCE Low-High (1-5)	Am ALGAL AMORPHOUS	BOTRYOCOCCUS	TASMANITES/LEIOSPHAERIDIA	TOTAL TYPE I	HERBACEOUS DINO-ACRITARCH	OTHER ALGAL	SPORE/POLLEN	HERBACEOUS	BIODEGRADED TERRESTRIAL	TOTAL TYPE II	W C OTHER WOODY III	COALY IV	INERT FINES	RESIN	FUNGAL	MICROFORAMS	CHITINOZOA	PYROBITUMENS	PYRITE	OTHER	MINERAL IMPRESSIONS	REMARKS
2581	3.80	1.5							60				2	12				22					1			3				
2975.20	0.26	1.5							20					9				70					1							
3003	0.40	2.5							20					10				70												
3013	0.26	2.5							15					35				50												
3033.2	0.42	2.5							5					15				80												Swc at 2667 missing
KEROGEN TYPE:									I				II					III	IV											

OMVS - ORGANIC MATTER VERY SPARCE

OMTS - ORGANIC MATTER TOO SPARCE TO EVALUATE

* CIRCLE TAI VALUE OF INDIGENOUS POPULATION WHEN POSSIBLE