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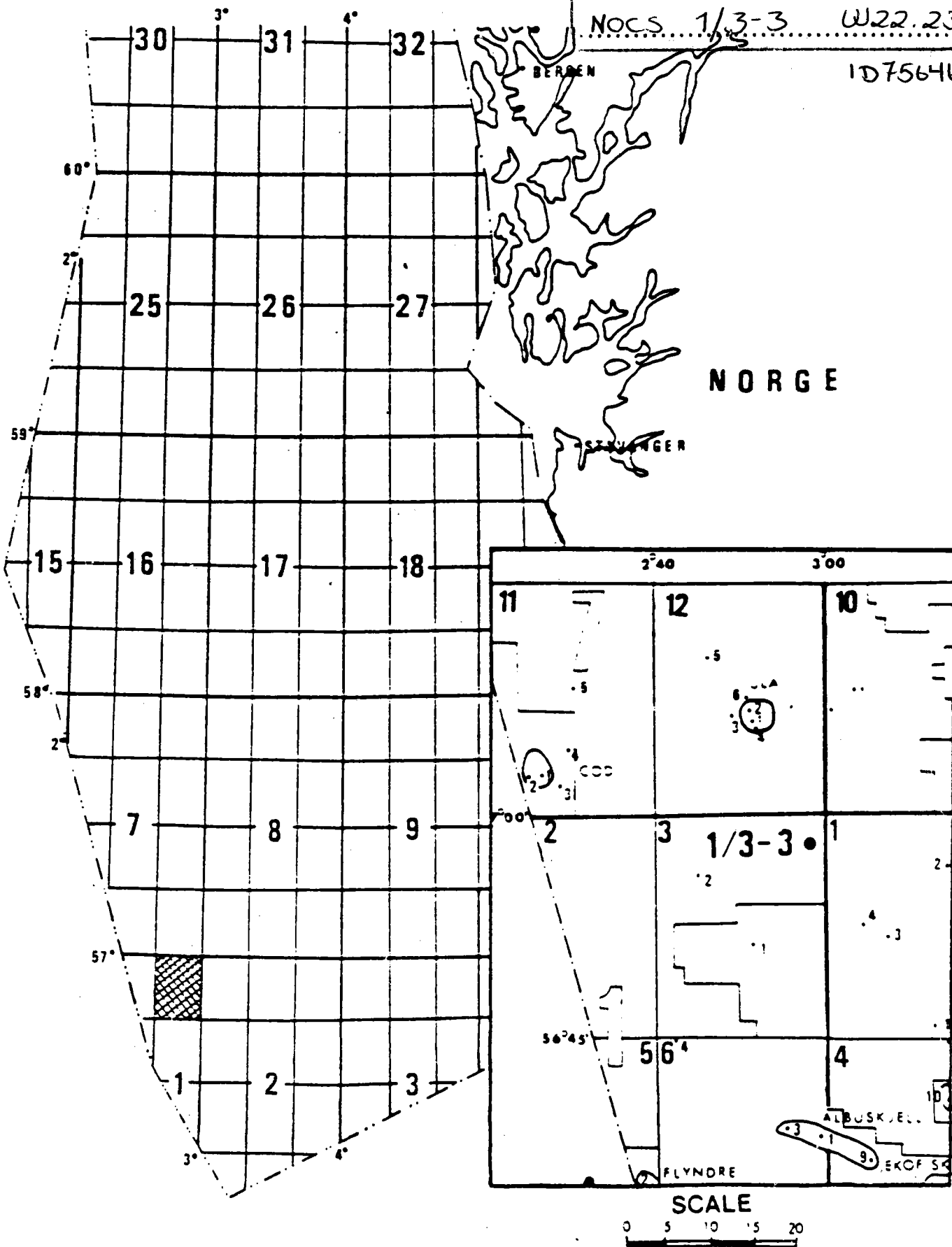


Fig. 1 - LOCATION MAP OF WELL 1/3-3

ELF

1 - BIOSTRATIGRAPHY1.1 - MICROPALAEONTOLOGY1.1.1 - INTRODUCTION

The micropaleontological study of well 1/3-3, carried out on the interval 3810-4867 m, deals with series, ranging from the Upper Cretaceous to the Jurassic.

Sampling

Free microfauna was observed in cutting samples and composite cutting samples, collected at about 10 metre intervals and from cores 1 to 6.

Summary of results

Poorly preserved microfauna suggests an Upper Cretaceous age for the interval 3810-3870 m. A mixture of Upper and Lower Aptian foraminifera appears between 3875 and 3885 m. Barremian to Hauterivian series seem to have been encountered between 3885 and 3960 m. From 3960 m down to 4000 m, some species suggest a Valanginian age. The Portlandian to Upper Kimmeridgian interval is well characterized between 4050 and 4181,53 m. Early Kimmeridgian (to Oxfordian ?) markers only appear at 4360 m. From 4380 m down to 4867 m, the interval is probably devoid of any in situ microfauna.

1.1.2 - ZONATION AND STRATIGRAPHICAL COMMENTS (Pl. 1). Interval 3810-3870 m : UPPER CRETACEOUS

The dominantly planktonic microfauna includes some poorly preserved species such as *Rotalipora* sp. (3825 m) and *Hedbergella hoelzli* (3860 m). The latter suggests a basal Coniacian to uppermost Cenomanian age for the base of the series. But some cavings are suspected.

Ecology : probably outer neritic to upper bathyal environment.

. Interval 3875-3885 m : UPPER AND LOWER APTIAN

A break in the fauna occurs at the top of this interval : the composite cutting samples yielded a rich assemblage of small planktonic (*H. gargasiana*) and benthic foraminifera (*O. utaturensis*, *Valvulineria* ? *Gyroidinoides* ? sp., *G.* sp. ex. gr. *intermedia*, *S.* aff. *neocomiana*, etc...), characteristic of the Upper Aptian age, associated with a few Lower Aptian foraminifera (*H. aptiana*).

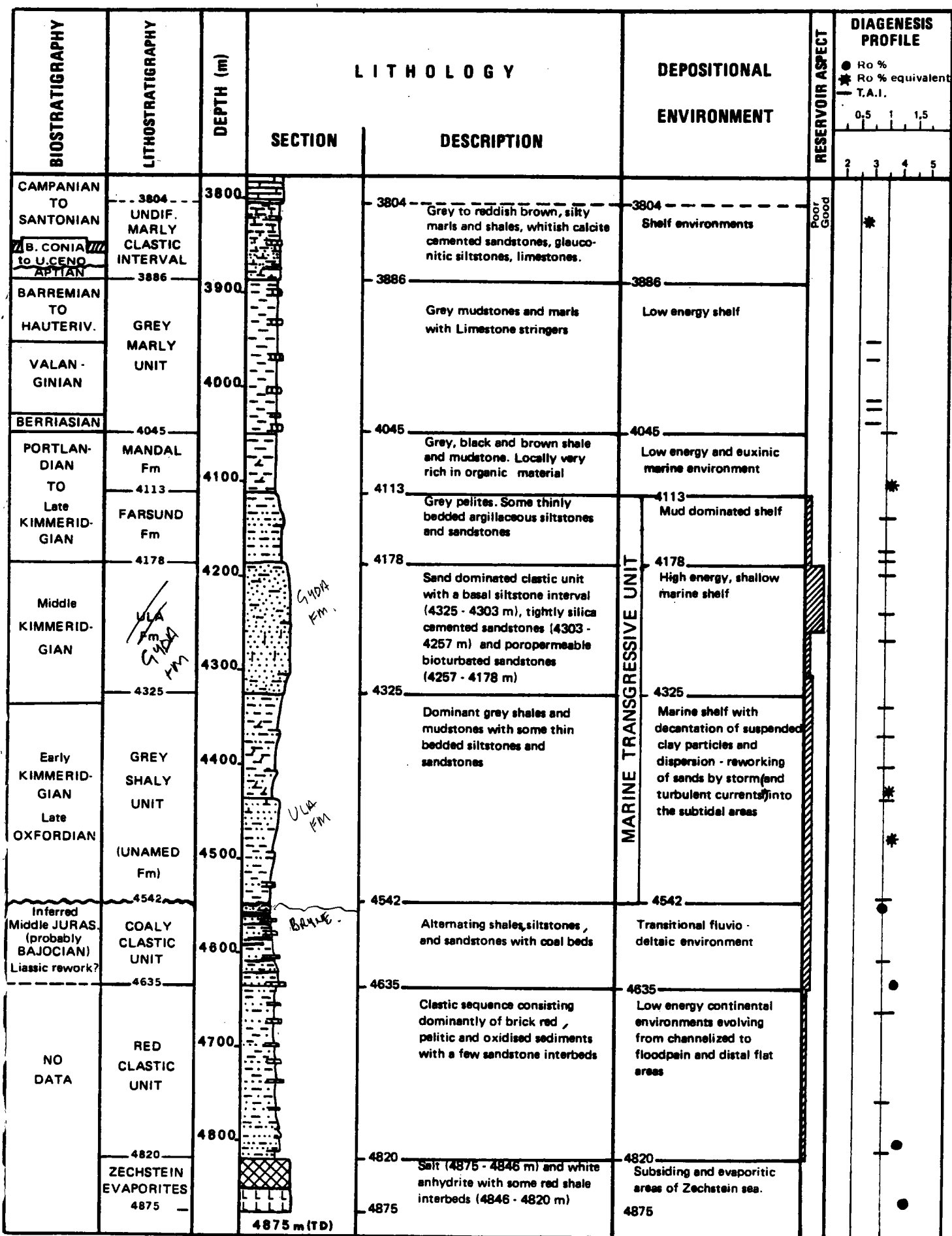


Fig. 2 - SYNTHETIC RESULTS ON THE PRE-CHALK SERIES OF WELL 1/3-3

Thus, both the presence of condensate Aptian strata just below the Upper Cretaceous series (provided that the foraminifera were in situ), and the lack of evidence of any Albian marker occurrence, suggest the existence of an unconformity at the top of the Lower Cretaceous.

Ecology : probably outer neritic.

. Interval 3885-3960 m : BARREMIAN TO HAUTERIVIAN (probably)

This interval only produced a few arenaceous foraminifera and smooth-walled Lenticulina of Barremian to Hauterivian age affinity, associated with the same species as those in the above interval and suspected of being caved.

Ecology : marine (probably outer or inner neritic).

. Interval 3960-4000 m : VALANGINIAN (?)

Very poor fauna, dominated by Lenticulina, especially Lenticulina (L.) cultrata, local marker of Valanginian and Hauterivian-Valanginian transition in the south of the North Sea.

Ecology : marine.

. Interval 4000-4050 m : No age assigned

Probably, no in place foraminifera and no diagnostic Ostracoda were found within this interval.

. Interval 4050-4181.53 m : PORTLANDIAN TO UPPER KIMMERIDGIAN

Microfauna more abundant, composed of various agglutinated foraminifera particularly H. ? infracallovienensis, C. canui, A. ? aff. braunsteini, A. coprolithiformis, etc..., associated with some Radiolaria such as Dictyomitra/Lithostrobos sp. characteristic of Portlandian to upper Kimmeridgian age (cf. offshore Netherlands).

Ecology : outer neritic.

. Interval 4181.53-4340 m : KIMMERIDGIAN

Interval devoid of any microfauna. Age inferred from nearby series.

. Samples 4360 m : LOWER KIMMERIDGIAN (TO OXFORDIAN ?)

Lenticulina (L.) varians, local marker of the Lower Kimmeridgian (to Oxfordian) strata from the offshore Netherlands, is the only species discovered in these samples.

Ecology : marine environment.

. Interval 4380-4867 m : No age assigned

Except for the presence of Kimmeridgian fauna, which were probably caved in the interval 4460-4500 m, and a few badly preserved foraminifera, perhaps of Liassic age, (between 4580 and 4620 m), this interval is virtually azoic.

1.2 - PALYNOLOGY

1.2.1 - INTRODUCTION

The palynological study was carried out between 3952 and 4825 m on Lower Cretaceous and Jurassic series. Forty seven (47) ~~samples~~ have been processed (16 sidewall core samples, 9 core samples and 22 cutting samples).

Between 3952 and 4247 m (base core 5), the microplanktonic assemblages are diagnostic and richly represented.

Between 4247 and 4825 m, the sidewall core samples were unfortunately of no use, due to the small quantities and contaminated material. In this interval, the analysis of the cutting samples has often been hampered by the poor preservation of the organic material and by cavings. Consequently, the analytical results may prove to be misleading.

The high degree of thermal alteration of the organic material is worth noting throughout the whole samples. The microfossils are strongly altered and diagenized.

The main palynological results can be summarized as follows :

- . 3952-4022 m - NC1a zone - Early VALANGINIAN
- . 4028-4034 m - Equivalent NCO Zone - BERRIASIAN (= boreal RYAZANIAN)
- . 4043-4076 m - NJ9 Zone - Late PORTLANDIAN (= boreal VOLGIAN)
- . 4143 m - NJ8 Zone - Late KIMMERIDGIAN - Early PORTLANDIAN (= boreal VOLGIAN)
- . 4181-4310/20 m - NJ7 Zone - Middle KIMMERIDGIAN (= boreal VOLGIAN)
- . 4335/40-4520/30 m - Equivalent NJ6 Zone - Late OXFORDIAN - Early KIMMERIDGIAN
- . 4555/65-4630/34 m - Inferred Middle JURASSIC (probably BAJOCIAN)
(Liassic reworking)
- . 4653/64-4815/25 m - No dating

1.2.2 - PALYNOLOGICAL ZONATION AND STRATIGRAPHICAL COMMENTS (See Plate 2). 3952-4022 m - NC1a Zone - Early VALANGINIAN

4 SWC samples.

A rich dinocyst assemblage has been recovered including the diagnostic markers *Diacanthum hollisteri*, *Glabridinium apatelum* and *Lagenorhitis delicatula*. The terrestrial assemblage contains mainly bisaccate pollen grains.

. 4028-4034 m - Equivalent NCO Zone - BERRIASIAN = boreal RYAZANIAN

2 SWC samples.

The dinocyst assemblage appears to be poorer than above. The general character of this assemblage shows Berriasian affinity (equivalent NCO Zone) despite the lack of NCO markers.

The terrestrial assemblage largely predominates and reveals significant records of Spores, related to *Cicatricosisporites*, *Trilobosporites* and *Concavisporites*.

. 4043-4076 m - NJ9 Zone - Late PORTLANDIAN (= boreal VOLGIAN)

4 SWC samples.

The dinocyst assemblage shows a diagnostic change and mainly includes *Dingodinium spinosum*, *Egmontodinium* sp. D 958 and *Chytroeisphaeridia chytroeides*. The occurrence of abundant amorphous material linked to abundant Tasmanean Algae (*Pterospermella aureolata*) is conspicuous in this interval.

The marine and terrestrial organisms are extremely altered. The terrestrial components are mainly represented by bisaccates and long ranging spores and pollen grains. These elements have not been plotted on Plate 2 due to their poor preservation and the consequent difficulties in clearly identifying them.

. 4143.85 m - NJ8 Zone - Late KIMMERIDGIAN - Early PORTLANDIAN (= boreal VOLGIAN)

1 core sample.

The dinocyst assemblage is characterized by *Glossodinium dimorphum*, *Adnatosphaeridium caulleryi* D 515d, *Gonyaulacysta longicornis*, *Ctenidodinium panneum* and *Hystrichodinium* aff. *pulchrum*.

The terrestrial microflora remains the same.

*Reservoir
Zone*

• 4181.50-4310/4320 m - NJ7 Zone - Middle KIMMERIDGIAN (= boreal VOLGIAN)

8 core samples.
2 cutting samples.

The NJ7 assemblages have been clearly recognized in the core samples between 4181.50 and 4246 m. The same microflora appears to occur down to 4310/20 m on cutting samples.

The dinocyst assemblage is characterized by the persistence of the above cited species and by the new occurrence of *Oligosphaeridium pulcherrimum* D 585.

The terrestrial microflora continues to be basically the same.

• 4335/4340 m - 4520/4530 m - Equivalent NJ6 Zone - Late OXFORDIAN - Early KIMMERIDGIAN

1 SWC sample (Barren).
7 cutting samples.

The NJ6 Zone is tentatively thought to occur between 4335/4340 m and 4430/4435 m on the basis of the occurrence of common *Hystrichogonyaulax* (cf. *cladophora* ?) and of the occurrence of a questionable specimen of *Scriniodinium crystallinum* at 4430/4435 m. Middle Kimmeridgian microfossils are observed in cavings.

The same marine microflora, always occurring with abundant insignificant terrestrial elements, is observed down to 4520/4530 m. No pre-late Oxfordian dinocysts have been identified.

• 4532-4630/4634 m

3 SWC samples.
4 cutting samples.

A change can be identified at 4532 m (SWC), 4542,50 m (SWC) and in the cutting samples between 4555/4565 m and 4630/4634 m due to the occurrence of an abundant coaly material which predominates throughout this interval, and down to 4815/4825 m.

The sidewall core samples are devoid of any microfossils. The assemblages recovered in the cutting samples contain scarce dinoflagellates which are thought to be caved from the Kimmeridgian series. The terrestrial microflora is abundant and diagnostic species have been recognized: *Quadraeculina anellaeformis*, *Eucommiidites subgranulosus*, *Chasmatosporites apertus*, *Classopollis/Circulina* spp., *Contignisporites problematicus* and *Monosulcites minimus*. In all the samples, the spores (*Cyathidites* group) are well represented.

The general composition of this assemblage and particularly the frequency of *Eucommiidites subgranulosus*, enables a resemblance to be envisaged with the Early Liassic of the North Sea. On the other hand, many of the above cited species are known to occur in Liassic and Bajocian sediments, and the occurrence of *Neoraistrickia gristhorpensis* below (4785/95 m) could suggest that Middle Jurassic (Bajocian-Bathonian) sediments have been penetrated in this well.

It is difficult to give an accurate palynostratigraphical dating for this interval. In view of the available data and the regional knowledge of these series, this microflora could be of Middle Jurassic (probably Bajocian) age with eventual reworking of Liassic sediments.

. 4653/4664 m - 4815/4825 m - Uncharacterized

2 SWC samples.
9 cutting samples.

The sidewall core samples are devoid of any microfossils. The assemblages recovered from the cutting samples, remain similar to that of the previous interval. No evidence to indicate Triassic sediments has been encountered.

1.3 - NANNOFOSSIL STUDY

1.3.1 - INTRODUCTION

The study of the calcareous nannofossils has been carried out on the interval 3895-3178 m. For this work 28 samples were studied, most were cuttings, 11 were slab samples.

A photonic microscope was used to propose a stratigraphic scheme, whilst a scanning electron microscope was used to study the preservation of the nannofossils.

1.3.2 - STRATIGRAPHICAL SUMMARY

- . From 3178 to 3285 m
DANIAN, NP 1 to NP 3 Zones
- . From 3312 to 3640 m
UPPER MAASTRICHTIAN, L. quadratus Zone to N. frequens Zone
- . From 3664 to 3760 m
LOWER MAASTRICHTIAN, R. Levis Zone
- . From 3780 to 3820 m
CAMPANIAN to SANTONIAN

1.3.3 - STRATIGRAPHICAL ANALYSIS

- For details on species distribution, see Plate 3.
- The zonal scheme used here is (for the DANIAN) from MARTINI's (1971) zonation.

- The zonal scheme used for the Upper Cretaceous has been drawn from a comparison between two zonations proposed by Sissingh (1977) and Doeven (1983).

. From 3178 to 3265 m

Fairly rich to poor taphocoenosis were encountered. Apart from some specimens reworked from the Upper Cretaceous strata, Danian species were observed.

Neocrepidolithus dirimosus
 Neocrepidolithus neocrassus
 Placozygus sigmoides
 Cruciplacolithus tenuis
 Chiasmolithus consuetus
 Neochiastozygus concinnus
 Prinsius bisulcus
 Markalius apertus
 Markalius inversus
 etc...

Zonation : NP 2 to NP 3

Proposed age : DANIAN

Remark : the sample from 3265 m yielded a dominant species :

Prinsius rosenkrantzii.

The P. rosenkrantzii acme zone seems to be of great interest, for proposing biostratigraphical correlations.

. Sample 3285 m

Yielded a poor taphocoenosis composed of :

Thoracosphaera sp.
 Markalius inversus
 Cruciplacolithus primus
 Biscutum parvulum

Hence, we proposed between 3265 to 3312 m :

Zonation : NP 1

Age : Lower DANIAN

. From 3312 to 3640 m

Poor to very poor taphocoenosis were encountered, nannofossils species being :

Arkhangelskiella cymbiformis
Lithraphidites quadratus
Kamptnerius magnificus
Lucianorhabdus cayeuxii
Watznaueria barnesae
Micula decussata
etc...

Zonation : this assemblage enables us to assign this interval to the L. quadratus zone and to the N. frequens zone.

Proposed age : UPPER MAASTRICHTIAN

. From 3664 to 3760 m

Very poor taphocoenosis were observed; the same species as before, plus another important species : Reinhardtites levis which seems to be stratigraphically restricted from Upper Campanian to Lower Maastrichtian beds.

Zonation : R. levis zone

Proposed age : Lower MAASTRICHTIAN

. From 3780 to 3895 m : these samples yielded very poor taphocoenosis.

At 3780 m we observed the occurrence of Eiffelithus eximius, the top level of which is thought to be Campanian.

At 3820 m we observed the occurrence of Lithastrinus floralis : if this is the last occurrence of the species, this interval can be assigned to the Santonian.

Proposed age : Campanian to Santonian

Remark : Due to the poor preservation of the calcareous nannofossils, it seems difficult to propose a more precise zonation, for this interval.

1.3.4 - CONCLUSION

The stratigraphical analysis of the samples from 3178 to 3895 m enabled us to propose a biostratigraphical scheme between the Danian and the Upper Cretaceous.

1.4 - BIOSTRATIGRAPHICAL CONCLUSIONS AND ECOLOGICAL DATA

The biostratigraphical subdivisions of Jurassic Cretaceous and Tertiary deposits in well 1/3-3 have been made using micropaleontological (Foraminifera, Ostracods, Radiolaria, Nannofossils) and palynological (Dinoflagellates, Spores and pollen grains) methods.

A biostratigraphical summary is proposed in Figure 3 for the interval 4875-3810 m.

The sediments overlying the ZECHSTEIN Evaporites (top 4820 m) have not been characterized up to 4630 m due to the lack of reliable microplanktonic and microfaunistic data.

The coal bearing deposits are characterized up to 4532 m (SWC) by a coaly palynofacies and between 4630 and 4555 m (cuttings) by a dominated miospore assemblage of Middle Jurassic (Bajocian) and / or Liassic affinity. A poor foraminiferal assemblage of Liassic aspect has been encountered between 4620 and 4580 m. No accurate biostratigraphical dating appears to be possible. These series are tentatively thought to be of MIDDLE JURASSIC (probably Bajocian) age. Further investigations would enable this question to be resolved, so that there may be no doubt as to the stratigraphical interpretation of these deposits.

The coal-bearing deposits (top 4542 m) are unconformably overlain by the marine Late Jurassic sediments. The stratigraphical limit between Middle Jurassic and Late Oxfordian/Early Kimmeridgian sediments is tentatively set at about 4555 m (cutting).

The Late Jurassic series extent continuously throughout Late OXFORDIAN/Early KIMMERIDGIAN, KIMMERIDGIAN and PORTLANDIAN, and are characterized by rich microflora and microfauna. The palynological biozones NJ 6, NJ 7, NJ 8 and NJ 9 have been identified between 4555 and 4043 m. It is worth noting that no evidence of pre-Late Oxfordian sediments has been encountered in this well. Note also that the ULA Sandstones (4325-4178 m) are clearly characterized by the NJ 7 palynological zone of Middle Kimmeridgian age, and by agglutinating Foraminifera and Radiolaria indicating outer neritic conditions. The same environmental conditions prevail throughout the Late Kimmeridgian and Portlandian sequence.

The top of the Jurassic series is set at 4043 m (SWC) from palynological data. This limit (top NJ 9 zone) coincides with an influx of Tasmanian Algae occurring in a rich amorphous organic facies.

The Lower CRETACEOUS starts with a condensed BERRIASIAN sequence (4034-4028 m). VALANGINIAN deposits have been recognized between 4022 and 3952 m from microplanktonic evidence. Sediments of HAUTERIVIAN to BARREMIAN age are thought to be present up to 3885 m on the basis of arenaceous Foraminifera and Lagenidae. Condensed APTIAN strata occur up to 3875 m. The microfauna reflects marine (outer to inner neritic) conditions.

Uppermost CENOMANIAN to basal CONIACIAN deposits (3875-3860 m) lie unconformably upon the APTIAN deposits. The planktonic microfauna recovered between 3875 and 3810 m indicate an outer neritic to upper bathyal environment.

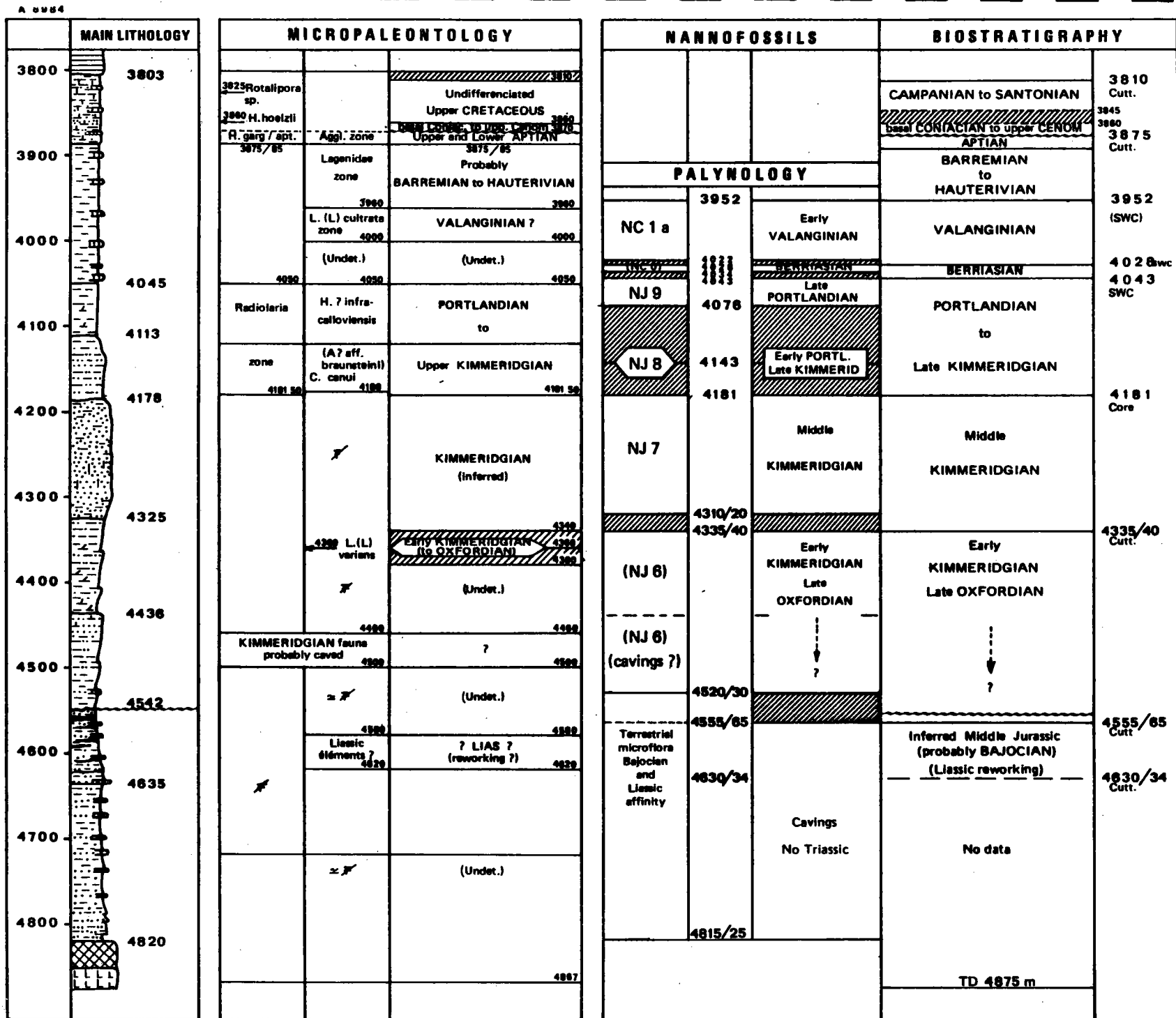


Fig. 3 - BIOSTRATIGRAPHICAL SUMMARY 3810 - 4875 m (TD)

Scale 1/4000ème

The calcareous nannofossils, therefore, lead us to date the overlying Upper Cretaceous to Tertiary sediments as follows : SANTONIAN TO CAMPANIAN (3860-3780 m), LOWER MAASTRICHTIAN (3760-3664 m), UPPER MAASTRICHTIAN (3640-3312 m) AND DANIAN (3312-3265 m).