

## STRATIGRAPHIC CORRELATION OF THE VLIELAND AND DELFLAND UNITS IN THE DUTCH OFFSHORE, BASED ON PALYNOLOGY<sup>1</sup>

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### ABSTRACT

Dunay, R.E. & A.J. Dronkers 1983 Stratigraphic correlation of the Vlieland and Delfland units in the Dutch offshore, based on palynology. In: J. P. H. Kaasschieter & T. J. A. Reijers (eds.): Petroleum geology of the southeastern North Sea and the adjacent onshore areas (The Hague, 1982) – Geol. Mijnbouw 62: 131-134.

A palynostratigraphic examination of the Early Cretaceous Vlieland and Delfland units was undertaken. The Vlieland Sandstone and the overlying Vlieland Shale in all locations contained among others, the dinoflagellates *Broomea/Batioladinium*, *Spiniferites dentatus*, *Hystriochodinium furcatum* and *Lithodinia pertusa*. Furthermore, recycled Triassic taxa were found in the Vlieland Sandstone in the southwestern portion of the study area.

The underlying Delfland sediments usually exhibited a typical Early Cretaceous, probably Valanginian, terrestrial palynoflora. The P/6-2 well was, however, anomalous in that it contained an extremely thick shale sequence exhibiting such Early Cretaceous dinoflagellates as *Subtilisphaera*.

### INTRODUCTION

Throughout the past 15 years exploration activity in the Dutch offshore was focused on the gas-bearing sandstones of Permo-Triassic age, primarily resulting from the discovery of the large Groningen gasfield onshore, in the northeastern part of the country. Recently, however, in a second phase of exploration, industry has been seeking new target zones offshore, especially with regard to oil exploration. In most wells drilled for Permo-Triassic reservoirs in the P/quadrant, shallower sandstones with good reservoir quality were encountered, usually overlying a paralic sequence of sandstones, shales and coals. These sandstones, considered to be late Jurassic to early Cretaceous in age were, as early as 1943, known to be good oil and gas producers in the Dutch onshore, as well as in England (Wealden Basin) and Germany (Lower Saxony Basin). As a result, lately attention was focused on the prospectivity of these sandstones which are well developed

also in Mobil's acreage. It became therefore important to ascertain:

1. The specific ages of the units in question, particularly of the sandstones;
2. The nature of the contact between the transgressive sandstones (called the Vlieland Sandstone Member) and the underlying paralic facies (called the Delfland Group), e.g. whether the contact is erosional with a time hiatus, or onlap;
3. The provenance of the sandstones, if possible. If the sand source could be located, predictions of sand thickness throughout the acreage could be estimated.

In the area of investigation, seven wells of Mobil Producing Netherlands Inc. which penetrated one or the other of the relevant units, were selected for analysis (Fig. 1).

Unfortunately, the palynological study was hindered by a complete lack of core material, both conventional and sidewall, from all but one well. This is understandable as, with the one exception, all wells were drilled for Triassic objectives. As a result, only cuttings samples were available for examination. The problems associated with examining only cuttings, in particular in view of the possible contamination with material from shallower depths in the borehole, precluded any greatly detailed stratigraphic and palaeo-environmental study. Such a study can only be realistically under-

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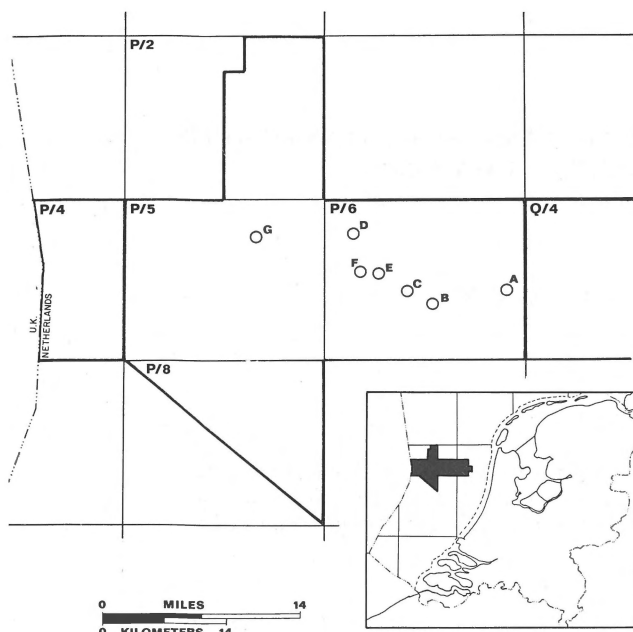


Fig. 1  
Index map studied wells of A, B, C, D, E, F, & G.

taken when sufficient core material is available. However, despite the obvious disadvantages inherent to only cuttings samples being available for study, certain significant stratigraphic conclusions could be drawn and were incorporated into a cohesive geological model for the area.

## RESULTS

Of the seven wells, six penetrated the sandstone at the base of the Vlieland Formation. The seventh went directly from Cenozoic sediments into a complex sequence of paralic type facies and restricted marine clays. In four of these six wells, the Vlieland rests directly on the Delfland. In well G the Vlieland unconformably overlies Jurassic strata and in well D the base of the Vlieland is marked by a fault. In all of these wells, the basal sandstone is overlain by marine Vlieland siltstones and shales.

### Age correlation of the Vlieland Sandstone Member

The siltstones and shales immediately above the Vlieland Sandstone all contained a dinoflagellate flora of Early Hauterivian aspect, as outlined in Table I.

Analysis of the sandstones proper in those wells for which only cuttings samples were available was equivocal. The floras in the cuttings from the sandstone interval were often poor, and as no new taxa appeared downhole in the sandstones, it was impossible to determine the extent and influence of caving from the overlying silts and shales. However, in well G, the cored Vlieland Sandstone contained a similar, albeit sparse dinoflagellate flora. The sandstone cores contained a

Table I

Principal dinoflagellate constituents of the shales and sandstones immediately above the Vlieland Sandstone in MPNI wells.

<i>Broomea longicornutum</i>	<i>Gonyaulacysta</i> spp.
<i>Cyclonephelium distinctum</i>	<i>Kleithrisphaeridium corrugatum</i>
<i>C. distinctum brevispinatum</i>	<i>Kleithrisphaeridium</i> spp.
<i>Cassiculosphaeridium magna</i>	<i>Muderongia simplex</i>
<i>Cribroperidinium sepimentum</i>	<i>M. cf. tetracantha</i>
<i>C. edwardsii</i>	<i>Muderongia</i> spp.
<i>Ctenidodinium elegantulum</i>	<i>Oligosphaeridium</i> spp.
<i>Dingodinium cerviculum</i>	<i>Phoberocysta neocomica</i>
<i>Endoscrinium campanulum</i>	<i>Pseudoceratium pelliferum</i>
<i>Gonyaulacysta teicha</i>	<i>Spiniferites</i> cf. <i>S. dentatus</i>
<i>G. cf. G. cladophora</i>	<i>Subtilisphaera perlucida</i>
<i>G. cf. G. episoma</i>	<i>S. cf. S. perlucida</i>
<i>G. serrata</i>	

Table II

Principal palynological constituents of the Vlieland Sandstone.

<i>Broomea longicornutum</i>	<i>Kleithrisphaeridium corrugatum</i>
<i>Cyclonephelium distinctum</i>	<i>Kleithrisphaeridium</i> spp.
<i>C. distinctum brevispinatum</i>	<i>Lithodinia pertusa</i>
<i>Cassiculosphaeridium magna</i>	<i>Muderongia simplex</i>
<i>Cribroperidinium sepimentum</i>	<i>M. cf. M. tetracantha</i>
<i>C. edwardsii</i>	<i>Muderongia</i> spp.
<i>Ctenidodinium elegantulum</i>	<i>Oligosphaeridium asterigerum</i>
<i>Dingodinium cerviculum</i>	<i>Oligosphaeridium</i> spp.
<i>Endoscrinium campanulum</i>	<i>Pareodinia ceratophora</i>
<i>Gonyaulacysta teicha</i>	<i>Pseudoceratium pelliferum</i>
<i>G. cf. G. cladophora</i>	<i>Spiniferites</i> cf. <i>S. dentatus</i>
<i>G. cf. G. episoma</i>	<i>Subtilisphaera perlucida</i>
<i>G. serrata</i>	<i>S. cf. S. perlucida</i>
<i>Gonyaulacysta</i> spp.	(Pollen recycled from the Triassic):
<i>Hystrichosphaeridium furcatum</i>	<i>Lunatisporites</i> cf. <i>L. noviaulensis</i>

similar dinoflagellate flora to that above, as listed in Table II.

This flora likewise suggests an Early Hauterivian (to perhaps Late Valanginian) age. The dinoflagellate taxa which typify Early Valanginian and Ryazanian assemblages, such as *Endoscrinium pharo*, are not present in these cores.

It is furthermore significant that Triassic species occur in the Early Cretaceous sandstones of well G. Well G was drilled near the platform area to the southwest where Jurassic sediments are eroded and the Triassic subcrops below the Cretaceous (Fig. 2). The presence of similar assemblages in the silts and shales above the Vlieland Sandstone in all the wells suggests that the sandstones in the area of investigation are broadly isochronous and correlatable (Fig. 3).

### Age correlation of the Delfland Group

The Delfland Group encountered is generally thin, except well P/6-2 (well A). The Delfland floras, as exemplified in all the wells except P/6-2, contained only terrestrial species with the occasional dinoflagellate. The constituents of these assemblages are outlined in Table III and are broadly consistent with a Valanginian age.

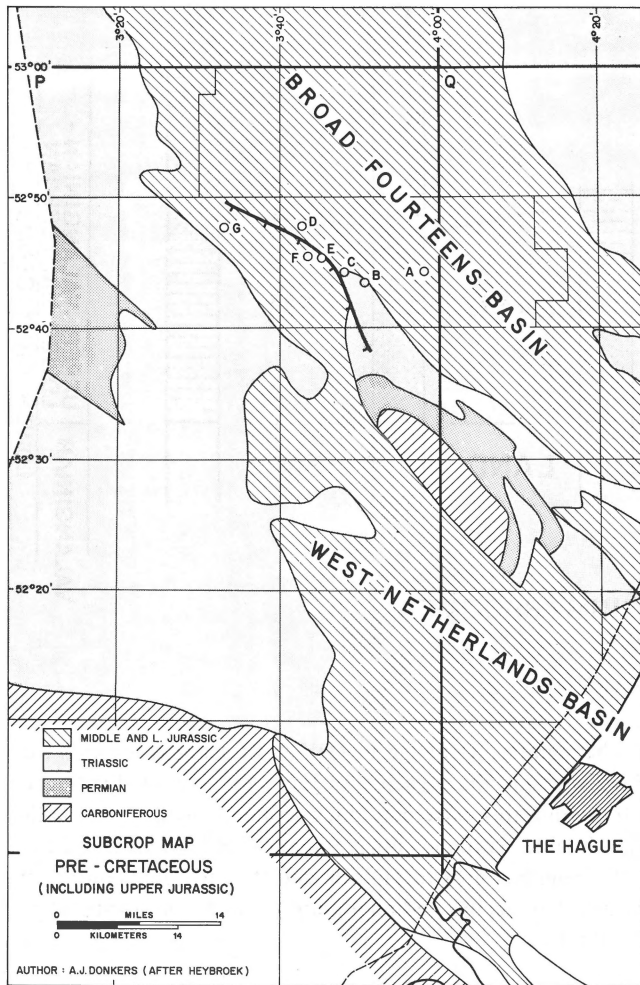


Fig. 2  
Subcrop map, pre-Cretaceous (including Upper Jurassic).

In the P/6-2 well, a sandy, shaly, probably delta-plain sedimentary sequence with a typical terrestrial flora (Table III), is underlain by a thick shale sequence. The floras from this shale are dominated by the *Circumpolles*. However, it also contains typical Early Cretaceous dinoflagellates, such as *Systematophora schindewolfii* and *Subtilisphaera perlucida*, the latter occurring in sediments no older than Valanginian, as well as the Early Cretaceous/Jurassic species *Pareodinia ceratophora* (Fig. 4).

## DISCUSSION AND CONCLUSIONS

This study was undertaken in order to date and correlate the oldest Cretaceous sands which were initially encountered by Mobil Producing Netherlands Inc. whilst drilling for deeper targets. Despite the paucity of data, the palynological investigation suggests that the Vlieland Sandstone Member in all the MPNI wells drilled to date is earliest Hauterivian to

Table III  
Principal palynological constituents of the Delfland Group.

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<i>Appendicisporites</i> spp.
<i>Callialasporites dampieri</i>
<i>Callialasporites turbatus</i>
<i>Deltoidospora</i> spp.
<i>Dictyophyllidites</i> spp.
<i>Cerebropollenites mesozoicus</i>
<i>Cicatricosisporites australiensis</i>
<i>Cicatricosisporites hallei</i>
<i>Cicatricosisporites</i> spp.
<i>Circumpolles</i> tetrads
<i>Classopollis</i> spp.
<i>Contignisporites cooksonae</i>
<i>Lycopodiumsporites</i> spp.
<i>Osmundacidites wellmanii</i>
<i>Pilososporites trichopapillosus</i>
<i>Pilososporites</i> spp.
<i>Trilobosporites variverrucatus</i>
<i>Trilobosporites</i> spp.
Indeterminate bisaccates
<i>Botryococcus</i>

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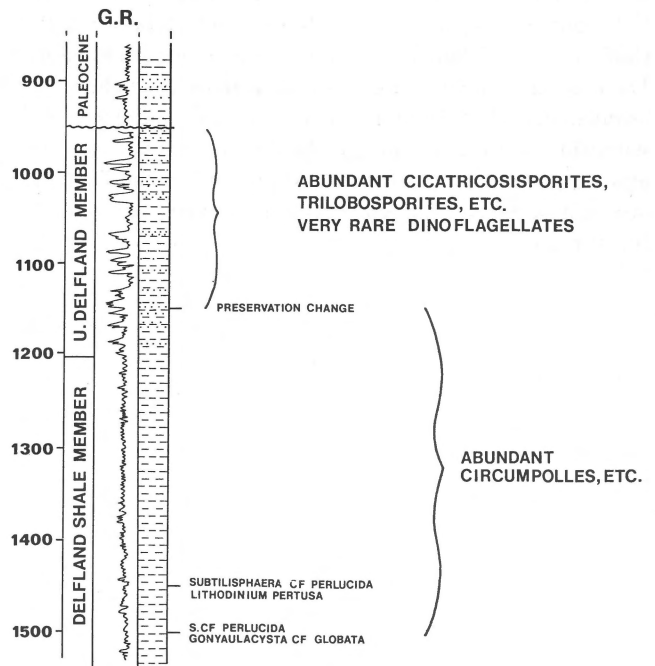


Fig. 3  
Well P/6-2A, Lower Cretaceous bio-stratigraphy.

perhaps latest Valanginian in age.

The presence of Triassic recycling in the Early Cretaceous sandstones of well G in the northeastern half of block P/5 suggests that, at least in part, these sandstones were sourced from Bunter Sandstones subcropping against the Cretaceous

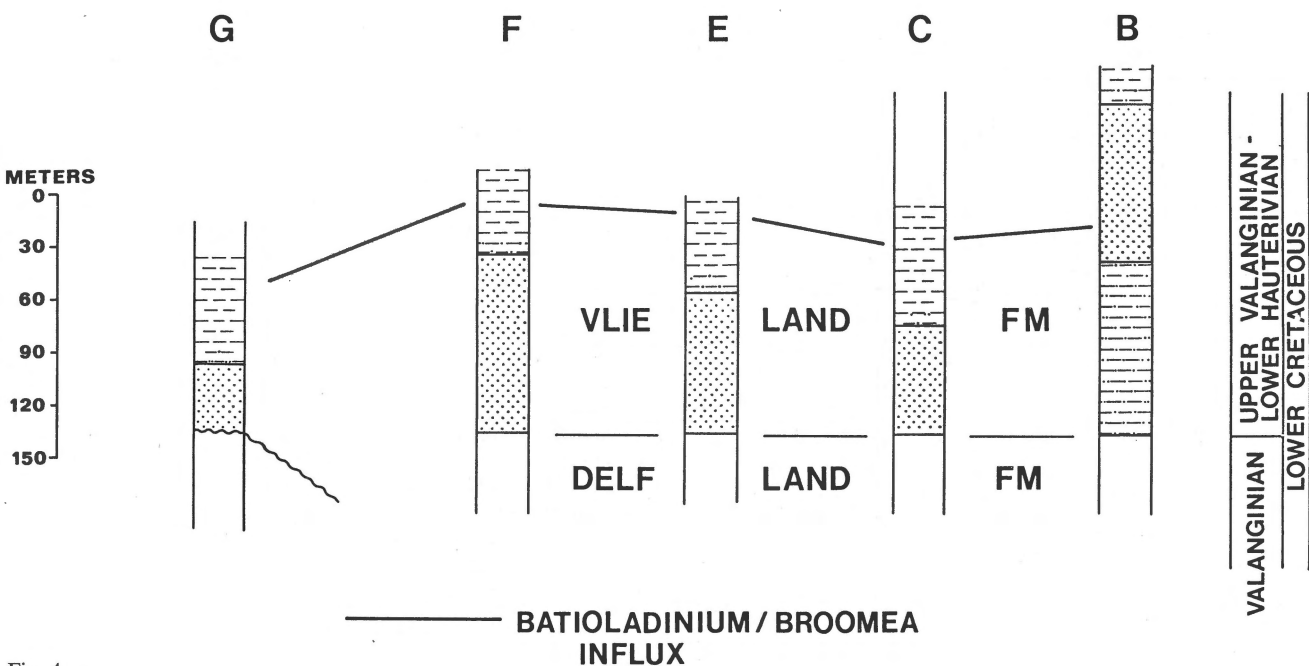


Fig. 4  
Correlation of biostratigraphic zones in wells B,C,E,F and G; MPNI acreage.

to the southwest. Furthermore, as the Delfland is also broadly Valanginian in age, the formational contact between the Delfland and Vlieland does not represent a significant hiatus. The contact between these two units is therefore believed to be onlap of earliest Hauterivian marine sands onto terrestrial sediments of Valanginian age. In the area around well G, however, a major hiatus is indeed present, as the Delfland does not occur and the Vlieland transgressed over strata of Jurassic age.

The significant change in Delfland thickness towards the P/6-2 well and the presence of Early Cretaceous dinoflagellates within this extremely thick sequence, which is broadly correlatable with the much thinner Delfland in the other wells, suggests growth faulting and thus tectonic control of earliest Cretaceous sedimentation towards the northeast of the P/6 block.