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TNO report

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Palynology of well F15-6: a cored caprock section from the Schill Grund High

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1 Introduction

In this report to TNO BU GeoEnergy and GeoInformation for NCP 2 mapping project, the palynological results are presented of a caprock section from well F15-6 on the Schill Grund High. The caprock section of well F15-6 is situated on salt structures. Caprock typically consists of a basal, poorly stratified, anhydritic and dolomitic part and a thin-bedded clastic upper part. These clastics may vary in grainsize from very coarse (breccias) to very fine (shales) and sometimes organic rich intervals or even coal streaks are present. The usually highly porous caprock sections are potential gas reservoirs. The aim of the palynological analysis is therefore to provide detailed age interpretations which are of help in the understanding of caprock genesis of the Schill Grund High salt structures. Furthermore, because of the rare preservation of sediments that have elsewhere been eroded, such datings provide important input for paleogeographic reconstructions.

Gaz de France, Nederland gave permission (February 2008) to use the palynological results from TNO's Geobiology previous study of well F15-6.

Composite logs, digital logs (GR) and core photographs were put at TNO's disposal by GdF and NAM.

Dirk Munsterman and Roel Verreussel are responsible for the palynological interpretation and the report.

2 Material and Methods

2.1 Abbreviations

Standard abbreviations in use by the Geobiology Team of TNO B & O are listed in Table 1.

Table 1 Abbreviations used in this report

CO	Core sample
SC	Sidewall core sample
CU	Cuttings sample
M	Meter
Ft	Feet
LOD	Last Occurrence Datum
FOD	First Occurrence Datum

2.2 Samples

Twenty-five core samples from well F15-6 were processed and analysed for palynology. The samples were selected by Dirk Munsterman and Roel Verreussel during a core display at the core shed facility of NAM (11-3-2005). Huibert van den Brink and Wouter Hazebelt from GdF were present at the core display. The samples are listed in table 2.

Table 2 Sample list

F15-6			
Depth	**Type**	**Depth**	**Type**
2482.1	CO	2510.9	CO
2483.6	CO	2513.25	CO
2485.4	CO	2514.8	CO
2486.4	CO	2515.3	CO
2487.6	CO	2516.5	CO
2489.8	CO	2519.5	CO
2492	CO	2526.2	CO
2492.85	CO	2527.3	CO
2493	CO	2528.9	CO
2495	CO	2530.7	CO
2497.6	CO	2532.2	CO
2499	CO	2532.4	CO
2509.2	CO		

2.3 Sample processing

All rock samples were processed at TNO-B & O, using the standard sample processing procedures of the Laboratory of Palaeobotany and Palynology (Van Steenbergen, 1997). This involves HCl and HF treatment, heavy liquid ($ZnCl_2$) separation and sieving over a 18µm mesh sieve.

2.4 Palynological analysis

The microscopy analysis is according to standard procedures. The semi-quantitative analysis includes an estimate of the main palynomorph categories, and of the determinable sporomorphs and/or dinocysts. The remainder of the slides is then scanned qualitatively for additional sporomorph and dinocyst taxa.

2.5 Age interpretation

The age interpretation is based on the LODs and FODs of palynomorphs. Key-references concerning the palynostratigraphy of the Permian to Early Cretaceous from the North Sea region are: Abbink (1998), Brugman (1983), Costa and Davey (1992), Davey (1982), Duxbury et al. (1999), Herngreen et al. (1989; 2000), Partington et al. (1993), Powell (1992), Riding and Thomas (1992) and Visscher (1980).
Note that in the discussion of the results and on the distribution charts, reference was made to tectono-stratigraphic sequences. These sequences make part of an upper Jurassic-lower Cretaceous stratigraphic framework, which was recently developed by TNO B & O (Abbink et al., 2006).

3 Results

The summary table, displaying the ages against the samples, was incorporated in these sections. The palynological distribution chart was added in StrataBugs format as Enclosure.

3.1 Palynological results of well F15-6

In general, the samples are very rich. A threefold subdivision is recognized: a sporomorph dominated upper part (2482.1m – 2499m), a poor middle part characterized by Permian reworking (2509.2m – 2513.25m), and a lower part with rich dinocyst and sporomorph assemblages (2514.8m – 2532.4m). A summary of the results is listed in Table 3. The palynological distribution chart is added as Enclosure 1.

Table 3 Summary results of well F15-6

Depth (m)	Type	Age	Sequence
2482.1	CO	Not Diagnostic	?
2483.6	CO	Not Diagnostic	?
2485.4	CO	latest Oxfordian to earliest Kimmeridgian	1
2486.4	CO	latest Oxfordian to earliest Kimmeridgian	1
2487.6	CO	latest Oxfordian to earliest Kimmeridgian	1
2489.8	CO	latest Oxfordian to earliest Kimmeridgian	1
2492	CO	Middle Oxfordian to early Late Oxfordian	1
2492.85	CO	Middle Oxfordian to early Late Oxfordian	1
2493	CO	Middle Oxfordian to early Late Oxfordian	1
2495	CO	Middle Oxfordian to early Late Oxfordian	1
2497.6	CO	Middle Oxfordian to early Late Oxfordian	1
2499	CO	Middle Oxfordian to early Late Oxfordian	1
2509.2	CO	Not Diagnostic	1
2510.9	CO	Not Diagnostic	1
2513.25	CO	Not Diagnostic	1
2514.8	CO	Latest Callovian to earliest Oxfordian	1
2515.3	CO	Latest Callovian to earliest Oxfordian	1
2516.5	CO	Latest Callovian to earliest Oxfordian	1
2519.5	CO	Latest Callovian to earliest Oxfordian	1
2526.2	CO	Latest Callovian to earliest Oxfordian	1
2527.3	CO	Latest Callovian to earliest Oxfordian	1
2528.9	CO	Latest Callovian to earliest Oxfordian	1
2530.7	CO	Latest Callovian to earliest Oxfordian	1
2532.2	CO	Latest Callovian to earliest Oxfordian	1
2532.4	CO	Latest Callovian to earliest Oxfordian	1

3.1.1 Age interpretation

Sample/Interval	Age/Ammonite zone
2482.1m – 2483.6m	Not Diagnostic

Only long-ranging sporomorphs and possible (but indeterminable) dinocysts are present.

Sample/Interval	Age/Ammonite zone
2585.4m – 2589.8m	latest Oxfordian to earliest Kimmeridgian *serratum* to *baylei* Ammonite Zone

The age interpretation is based on:

- LOD *Tuberositriletes* sp. A Abbink 1998, 2585.4mCO
- FOD *Cicatricosisporites* spp., 2489.8mCO

The age interpretation is supported by the LOD *Retitriletes undulatus*, which is very common is this interval, and by the common to abundant occurrence of *Densoisporites minor* and *Densoisporites* spp.

Sample/Interval	Age/Ammonite zone
2492.0m – 2499m	Middle Oxfordian to early Late Oxfordian *tenuiserratum* to *glosense* Ammonite Zone

The age interpretation is base on:

- LOD *Tuberositriletes* sp. B Abbink 1998, 2492mCO

The quantitative composition of the sporomorph assemblages (notably *Peromonolites* spp. not being abundant) suggests a stratigraphic position above the early Middle Oxfordian *densiplicatum* climate shift (see Abbink, 1998).

Sample/Interval	Age/Ammonite zone
2509.2m - 2513.25m	Not Diagnostic

Note the presence of abundant Permian sporomorphs. Based on the stratigraphic position of this interval, the sporomorphs are interpreted as reworking.

Sample/Interval	Age/Ammonite zone
2514.8m – 2532.4m	Latest Callovian to earliest Oxfordian *athleta* to *mariae* Ammonite Zone

The age interpretation is based on:

- LOD *Rigaudella aemula*, 2514.8mCO
- LOD *Durotrigia filapicata*, 2515.3mCO
- LOD *Wanaea* spp., 2516.5mCO
- LOD abundant *Rigaudella aemula*, 2519.5mCO
- LOD *Ctenidodinium continuum*, 2519.5mCO
- FOD *Gonyaulacysta jurassica jurassica*, 2519.5mCO
- FOD *Systematophora areolata*, 2519.5mCO

The acme of *Rigaudella aemula*, in the interval 2519.5m – 2526.2m, suggests correlation to the latest Callovian J46 flooding (Abbink, 1998; Partington et al., 1993). The Callovian-Oxfordian boundary must be somewhere in the interval 2515.3m – 2519.5m. Reworked Permian sporomorphs are consistently present and even prominent in the interval 2526.2m – 2528.9m.

3.1.2 Palaeoenvironmental interpretation

Sample/Interval	Palaeoenvironment
2482.1m – 2483.6m	Indeterminate

Very poor assemblages with possible but indeterminable dinocysts. In sample 2482.1m palynomorphs occur which are possibly freshwater algae. This may indicate freshwater influence from lakes or ponds.

Sample/Interval	Palaeoenvironment
2485.4m – 2499m	Non-marine

The rich sporomorph assemblages, in combination with the absence of marine markers such as dinocysts, foraminifera remains or marine algae, indicate a non-marine environment. In the upper two samples palynomorphs occur which are possibly freshwater algae. These may indicate freshwater influence from lakes or ponds.

Sample/Interval	Palaeoenvironment
2509.2m – 2513.25m	Indeterminate

Only reworked Permian sporomorphs are present. It is therefore impossible to assign a palaeoenvironment to this interval, although it is obvious that erosion of nearby Permian rocks took place during deposition of this interval.

Sample/Interval	Palaeoenvironment
2514.8m – 2532.4m	Marine

The rich and diverse dinocyst assemblages indicate a marine environment.

4 Discussion

Thanks to the excellent palynological recovery and the relatively high sample resolution, the results are straightforward: a Sequence 1 dating for the caprock section of well F15-6.

Although Sequence 2 was recorded in caprock sections on the Schill Grund High, this younger classification is not recorded at the current location.

The results of well F15-6 compare very well with those of the G16A field. The overall picture is that of a latest Callovian flooding event (J46), during which formation of the anhydritic, dolomitic part of the caprock section takes place. In the Central Graben this phase coincides, after a period of rift initiation (Aalenian-Callovian), with the rift pulse related transgression in the Central Graben.

The overlying clastics are separated from the anhydritic part by a hiatus, and deposited during the upper part of Sequence 1. These clastics are deposited in a non-marine environment. At the top of the core, there are even some indications of a freshwater environment like a lake or pond.

The F15-6 and G16A structures must have ‘collapsed’ and become buried in the course of the Late Callovian to Oxfordian (Sequence 1).

5 Conclusions

Based on the palynological results, the following conclusions are reached:

- The caprock section of well F15-6 is placed in Sequence 1 (Late Callovian – Oxfordian)
- The anhydritic/dolomitic base of the caprock section of well F15-6 correlates with the latest Callovian J46 flooding (rift pulse related transgression)
- The clastic top of the caprock section of well F15-6 correlates with the (non-marine) Late Oxfordian to earliest Kimmeridgian

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Well Name : F15-6

Interval : 2450m - 2550m
Scale : 1:500
Chart date 23 January 2014

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Palynological distribution chart F15-6

F15-6

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Enclosure 1

Default Abundance Scheme
Present (1) | Rare (2) | Common (5) | Abundant (10) | Super Abundant (50 +)